Soos Creek Total Maximum Daily Load for Fine Sediments

Water Quality Improvement Report and Implementation Plan

By

Cleo Neculae and Teizeen Mohamedali

For the

Water Quality and Environmental Assessment Programs

Washington State Department of Ecology
Olympia, Washington

September 2025

Publication 25-10-072

Publication Information

This document is available on the Department of Ecology's website at:
https://apps.ecology.wa.gov/publications/SummaryPages/2510072.html

Cover photo credit

- Big Soos Creek, Ecology 2023

Contact Information

Water Quality Program

P.O. Box 47600

Olympia, WA 98504-7600

Phone: 360-407-6600

Website[3]:

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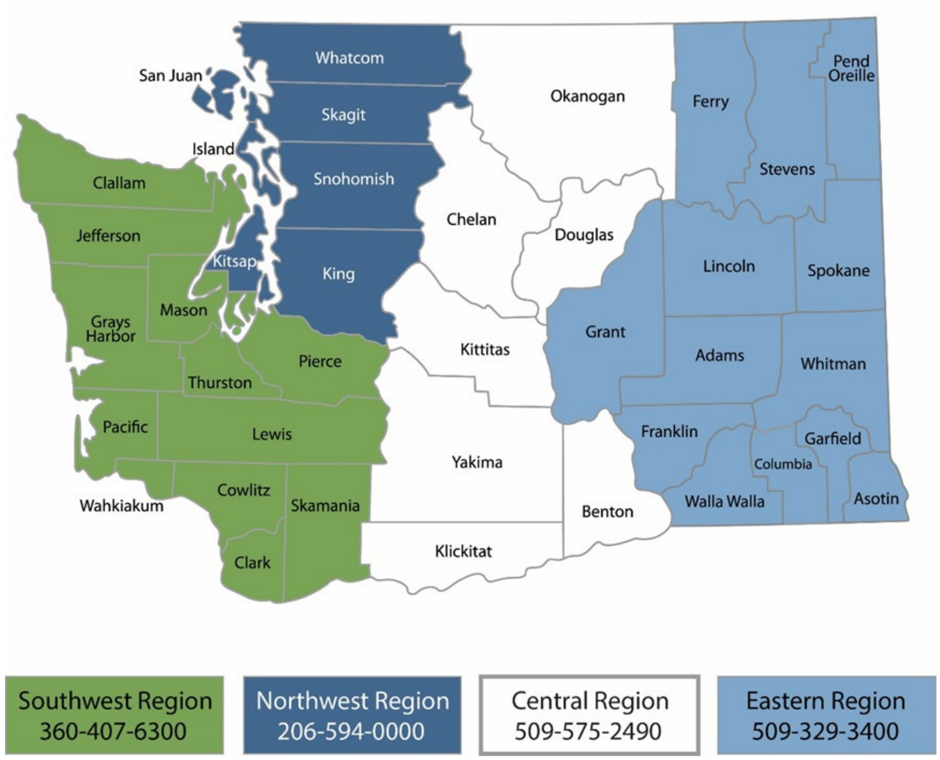

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Olympia, WA

September 2025

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Acknowledgements

The authors of this report thank the following people for their contribution to this study:

- Melanie May and Chris Thorn – City of Auburn
- Scott Hanis, Chris Madeo, Ryan Sweet – City of Black Diamond
- Ben Parrish – City of Covington
- Mike Mactutis, Laura Haren, Nathaniel Wood – City of Kent
- Gordon Cook – Kent School District
- Halley Kimball – City of Maple Valley
- Joe Farah, Kristina Lowthian, Sarah Pyle – City of Renton
- Kate Macneale, Elizabeth Sosik, Jeff Burkey, Curtis Degasperi (retired), Zack Holt, Cameron Chapman, David Batts, Brett Randall, Kollin Higgins – King County
- Brodie Antipa and Mike Wilson – Soos Creek Hatchery
- Talise Rey and Carla Carlson (retired) – Muckleshoot Indian Tribe
- Joel Massmann – Keta Waters (consultant for Muckleshoot Indian Tribe)
- Iris Kemp and Matt Goehring – WRIA 9 Salmon Recovery Group
- Sydney Clark, Ben Cope, Gunnar Johnson, Dino Marshalonis, Jason Pappani – Environmental Protection Agency
- Elsa Pond – Washington State Department of Transportation
- Scott Bohling, Roger Chang, Hannah Coe, Eric Daiber, Jay Fennell, Cristiana Figueroa-Kaminsky, Danielle Gallatin, Lara Henderson, Doug Howie, Becci Larreau, Chad Larson, Nuri Mathieu, Rachel McCrea, Shannon McClellan, Mark Melton, Evan Newell, Laurie Niewolny, Robbie O’Donnell, Niamh O'Rourke, Ben Rau, Abbey Stockwell, Lawrence Sullivan, Amy Waterman, Jennifer Wolfe, Adrianne Yang, Sarah Yepez – Washington State Department of Ecology

Introduction

This Total Maximum Daily Load study (TMDL) addresses impairments in the Soos Creek watershed, where state water quality standards for aquatic life are not met. Section 303(d) of the Clean Water Act (CWA, 33 U.S.C. §1251) directs states to identify water bodies not meeting water quality standards. The objective of the CWA is "*to restore and maintain the chemical, physical, and biological integrity of the Nation's waters*." To reach this objective for waters not meeting water quality standards, states are required to develop plans outlining strategies to reduce the discharge of pollutants from point and nonpoint sources "*to achieve the applicable water quality standard as soon as possible…*" In general, point sources are those that discharge polluting water at a discrete point (e.g., via a pipe), while nonpoint sources are more diffuse, enter streams at multiple locations, and are more difficult to pinpoint (e.g., agricultural fields, livestock, forestry, or rural development). For the purposes of implementing the CWA, permitted stormwater discharges are considered a point source, even though they enter streams at multiple locations.

States develop water quality improvement plans to address the sources of pollution and develop TMDLs, which are an estimation of the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. The pollution limit is divided between point sources, which receive wasteload allocations (WLAs), and nonpoint sources, which receive load allocations (LAs). States also develop implementation plans that accompany TMDLs and provide a framework for actions that need to be taken to restore water quality.

Overview

The 2018 Washington State Water Quality Assessment (WQA) identified ten segments (i.e., assessment units or AUs) in the Soos Creek watershed that are not able to support adequate habitat for benthic macroinvertebrates (Table 1 in the Scope section). Benthic macroinvertebrates are small aquatic animals (e.g., insects, clams, snails) that spend most of their lives in streams. Some species of macroinvertebrates are highly sensitive to specific pollutants, which can influence their abundance and presence in streams. This sensitivity makes them well suited as indicators of water quality conditions, which can be especially useful when pollution occurs episodically or is difficult to monitor.

The conceptual model in Figure 1 shows the relationship between changes in land use and land cover and impacts of these changes to benthic macroinvertebrate communities. Urban development (1) is associated with an increase in hard surfaces (2), which can produce stormwater runoff (3) volumes that are higher than those that would be expected for surfaces pre-development. The resulting stormwater runoff can increase fine sediment loading in streams via two pathways. First, greater volumes of stormwater runoff result in higher instream flows that are flashier (4a) and have more erosive energy, which leads to erosion of sediment within the stream (4b). Second, stormwater runoff washes off fine sediment that accumulates on upland surfaces (5) in between storm events and transports this fine sediment to surface waters. The increased loads of fine sediment (6) to streams from these two pathways negatively impacts benthic macroinvertebrate communities and the quality of stream aquatic habitat (7) signaling degraded watershed health.

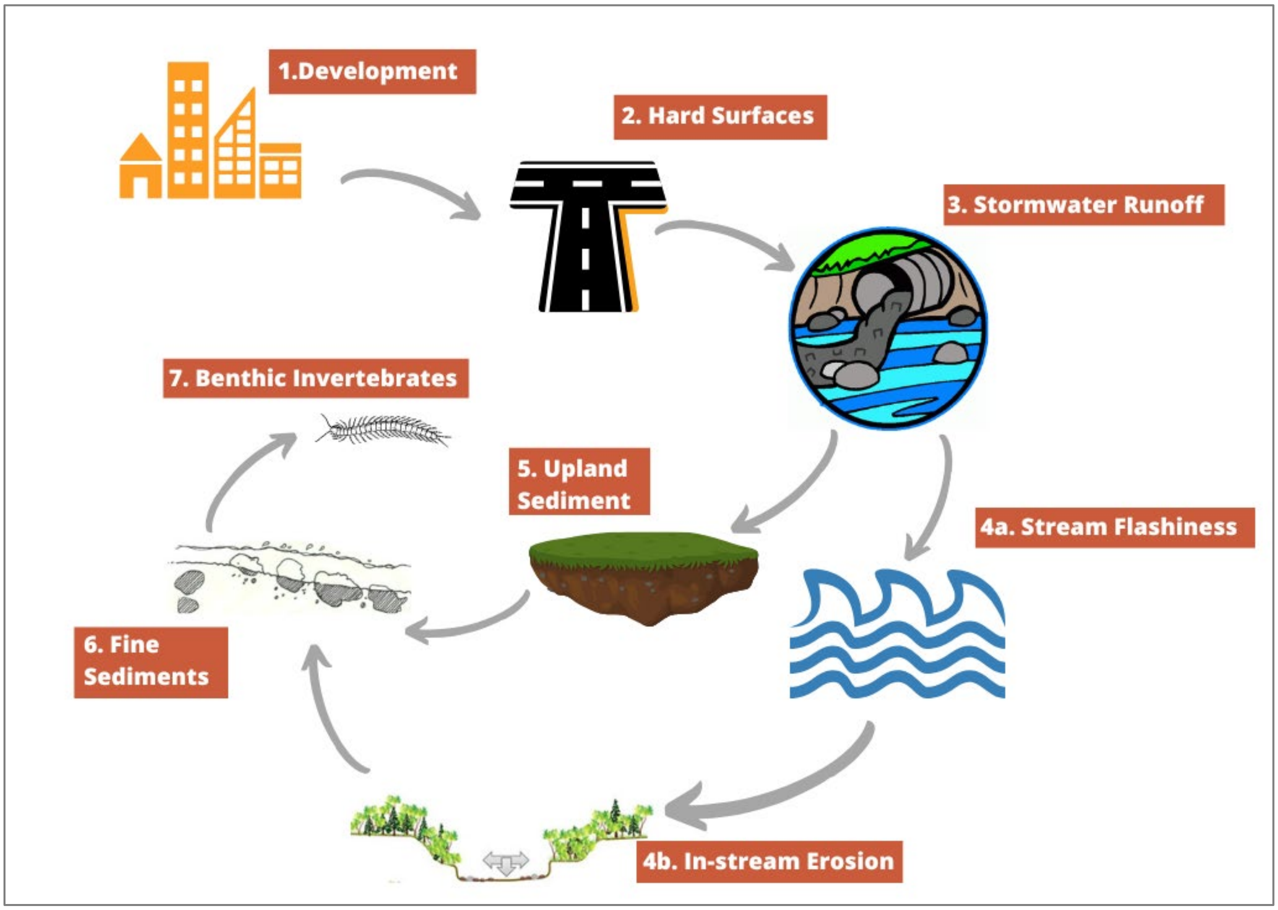

Figure 1. Conceptual model showing the pathways along which development without stormwater controls impacts benthic invertebrates

Stormwater management practices can change the pathways in this conceptual model by minimizing hard surfaces (2), decreasing and slowing down the flow of stormwater so that it is not effectively delivered to the receiving water (3) (also known as reducing effective impervious area or EIA), installing stormwater flow control facilities to control the discharge of flow thereby preventing flashiness (4a), and installing water quality treatment facilities to remove solids before discharge (5).

Alterations to the benthic macroinvertebrate populations in multiple streams in the Soos Creek watershed indicate that the aquatic life beneficial use is not protected (see section on Water Quality Standards, Designated Uses for a discussion on the aquatic life beneficial use). The Soos Creek watershed is home to several communities that were initially developed without stormwater or with less effective controls. Many of these communities are experiencing ongoing development and redevelopment (see Appendix A for a more in-depth description of the Soos Creek watershed.). Current and future development throughout the watershed is now largely subject to stormwater management requirements under Washington State's Phase I Municipal Stormwater Permit or the Western Washington Phase II Municipal Stormwater Permit. These requirements include both the management of flow (i.e., flow control) and the removal of solids (i.e., basic treatment), depending upon the characteristics of the development or redevelopment project. Portions of the watershed, however, have substantial areas of older development where there are few to no stormwater management controls. Monitoring data and a stressor identification (ID) analysis (Marshalonis and Larson 2018) point to fine sediment as one of the stressors linked to the impairment of benthic macroinvertebrates in Soos Creek, along with flashy flows[1] and degraded habitat. These three stressors are consistent with the "urban stream syndrome" discussed in depth in scientific literature (Walsh et al. 2005; Askarizadeh et al. 2015; Booth et al. 2016; Hawley et al. 2016).

Of the three identified stressors, only fine sediment is considered a pollutant that can be regulated under the CWA. As a result, this TMDL develops allocations for upland point and nonpoint sources that contribute fine sediment loadings above those that the watershed can support naturally. The allocations in this TMDL are developed using total suspended solids (TSS) as a surrogate for fine sediment, as discussed later in Targets. The main pathway to achieve the allocations developed in this TMDL is by managing stormwater runoff from developed areas where runoff is not sufficiently controlled. The Implementation Plan describes actions that are expected to result in fine sediment reductions through flow control and/or treatment best management practices, which inherently addresses the impact of flashy flows on benthic macroinvertebrates. This TMDL also addresses impacts of nonpoint sources, which, in this watershed, are considered to be a small contributor of the total fine sediment loadings. The Implementation Plan also highlights the importance of habitat restoration efforts, since all three stressors will likely need to be alleviated to fully address aquatic health impairments.

This report focuses first on describing the regulatory framework and process involved in developing a TMDL and includes a discussion of allocations for point and nonpoint sources. The second part of the report describes the current conditions in the Soos Creek watershed leading

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[1] In this report, "flashy flows" and "stream flashiness" are used interchangeably to refer to stream flows during or immediately after a storm event, when flows peak and decrease fast and reach levels above those seen before the development of the drainage area. Flashy flows are expressed quantitatively as high pulse counts (HPC). For more information on these terms, see Mohamedali (2024).

to impairments, describes point and nonpoint sources of pollution, and outlines a plan for implementation that is expected to lead to the attainment of water quality standards. More details on the Soos Creek watershed, the process to develop this TMDL, including public participation and technical analysis, can be found in the appendices accompanying this report.

Scope

Soos Creek is the main tributary to the Green River and drains approximately 66 square miles. Big Soos Creek makes up the mainstem of the watershed and has four key tributaries: Covington, Jenkins, Little Soos, and Soosette. Other smaller tributaries include Ravensdale Creek, Meridian Valley Creek, and Rock Creeks. For the purpose of this TMDL, we divided the watershed into six subbasins. These include the four major tributaries of the Soos (Soosette, Little Soos, Jenkins, and Covington) as well as Big Soos, which is further split into two subbasins: Upper Big Soos above the confluence with Little Soos, and Lower Big Soos. Lower Big Soos includes areas draining *directly* (not including major tributaries) to Big Soos Creek between the confluence with Little Soos and the confluence with the Green River. Each subbasin has 303(d) listings for fine sediment (Table 1, Figure 1). The Lower Big Soos has an additional Category 2 listing (#97926) for fine sediment for Assessment Unit 17110013000099_001_001 (Figure 1).

Table 1. Waterbodies with fine sediment impairments on the 2018 303(d) list addressed by the TMDL

Listing ID	Waterbody Name	Subbasin	Assessment Unit ID
97925	Big Soos Creek	Lower Big Soos	17110013000097_001_001
97927	Jenkins Creek	Jenkins	17110013000168_001_002
97928	Ravensdale Creek	Covington	17110013000171_001_001
97929	Soosette Creek	Soosette	17110013000172_001_001
97930	Big Soos Creek	Upper Big Soos	17110013000483_001_001
97931	Unnamed Creek (Tributary to Big Soos Creek)	Upper Big Soos	17110013000484_001_001
97932	Jenkins Creek	Jenkins	17110013000493_001_001
97933	Unnamed Creek (Tributary to Rock Creek)	Covington	17110013000552_001_001
97934	Little Soos Creek	Little Soos	17110013002281_001_001
97935	Unnamed Creek (Tributary to Rock Creek)	Covington	17110013007365_001_002

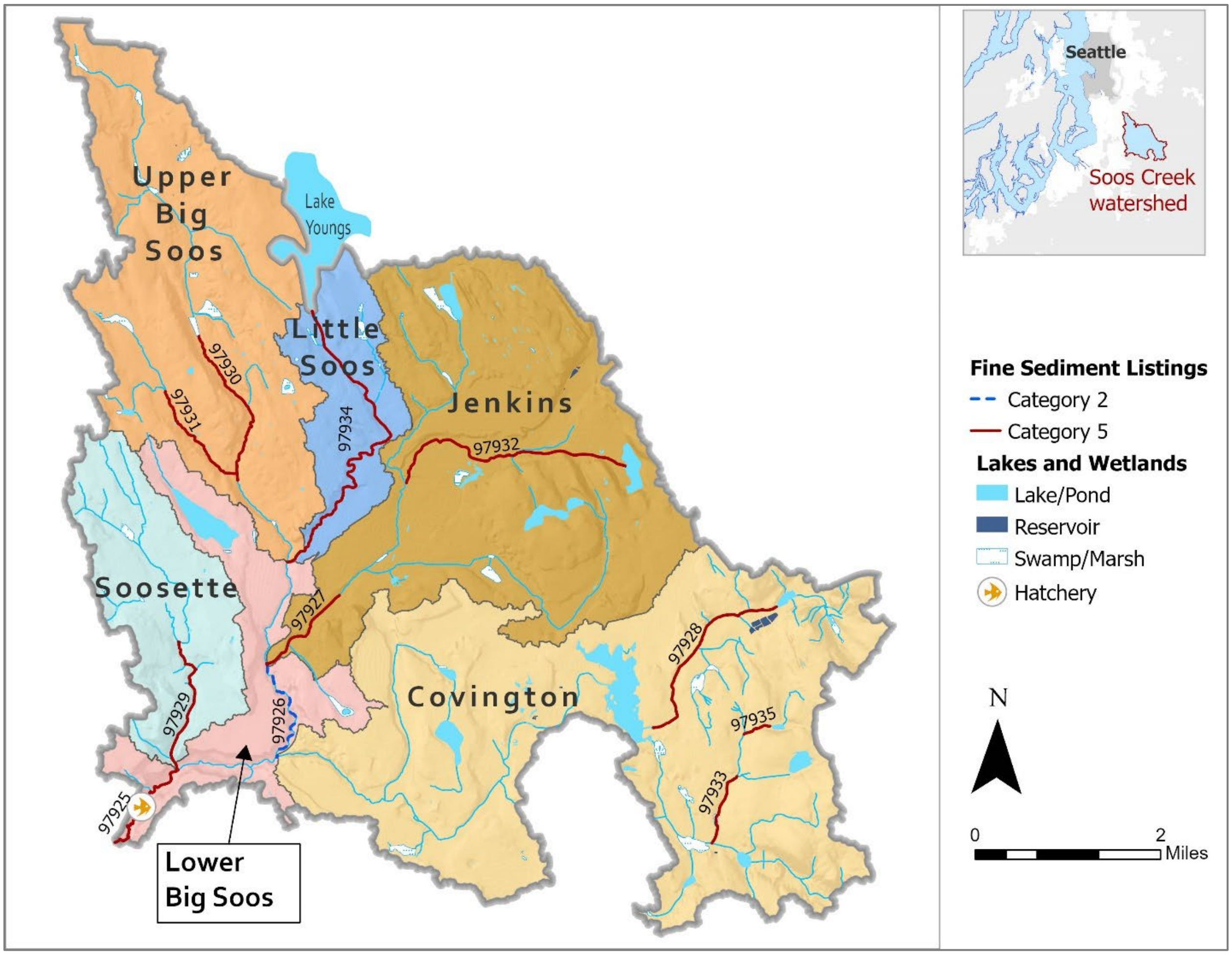

Figure 2. 2018 WQA fine sediment listings, by category, addressed in this TMDL

These fine sediment listings replaced the initial listings for bioassessment. Ecology's Water Quality Policy 1-11 specifies that once the stressor ID analysis determines the most likely causes of impairment, the Category 5 listing for bioassessment will be modified to reflect the identified stressors (Ecology 2023). For each assessment unit that has a listing associated with bioassessment impairments in the Soos watershed, Ecology made the following modifications during the 2018 Water Quality Assessment, along with the addition of the fine sediment listings:

- The bioassessment Category 5 listings were moved to Category 2, reserved for waters of concern.
- Two new Category 4c listings were added: one for instream flow (corresponding to the flashy flows in the stressor ID analysis) and another for fish and shellfish habitat (corresponding to habitat degradation in the stressor ID analysis). Category 4c is reserved for waters that are impaired by non-pollutants.

All listings shown in Table 2 were approved by the EPA in 2022.[2]

Table 2. All Soos Creek listings associated with previously categorized impairments to benthic macroinvertebrates, by assessment unit

Waterbody Name	Assessment Unit ID	Fine Sed. Listing - Category 5	Bioassessment Listing - Category 2	Instream Flow Listing - Category 4c	Fish and Shellfish Hab. Listing - Category 4c
Big Soos Creek	17110013000097_001_001	97925	70181	97947	97936
Jenkins Creek	17110013000168_001_002	97927	70161	97949	97938
Ravensdale Creek	17110013000171_001_001	97928	70150	97950	97939
Soosette Creek	17110013000172_001_001	97929	70182	97951	97940
Big Soos Creek	17110013000483_001_001	97930	70186	97952	97941
Unnamed Creek (Trib. to Big Soos Creek)	17110013000484_001_001	97931	70183	97953	97942
Jenkins Creek	17110013000493_001_001	97932	70162	97954	97943
Unnamed Creek (Trib. to Rock Creek)	17110013000552_001_001	97933	70151	97955	97944
Little Soos Creek	17110013002281_001_001	97934	70187	97956	97945
Unnamed Creek (Trib. to Rock Creek)	17110013007365_001_002	97935	70152	97957	97946

[2] https://ecology.wa.gov/water-shorelines/water-quality/water-improvement/assessment-of-state-waters-303d

King County monitors macroinvertebrate communities annually at different streams throughout the county, including in the Soos Creek watershed. King County's monitoring results are reported in the Puget Sound Stream Benthos[3] database, but they are not submitted to Ecology's Environmental Information Management System (EIM), so they are not included in the Water Quality Assessment. These data show that many other locations in the watershed have signs of degraded macroinvertebrate conditions. While some sites do not have long periods of record (since the locations change periodically or have been dropped altogether from the monitoring circuit), many sites show degraded biological conditions for benthic macroinvertebrates.

There are additional 303(d) listings in the watershed associated with different pollutant impairments, but this TMDL does not address them (Table 2). These listings for temperature, dissolved oxygen, and bacteria will be addressed in a separate TMDL that is currently under development (Mathieu, Gleason, and Neculae 2023).

Table 3. 2018 WQA 303(d) listings in Soos Creek not addressed in this TMDL

Listing ID	Waterbody Name	Pollutant	Assessment Unit ID
6316	Meridian Lake	Bacteria - Fecal coliform	17110013000390_001_001
7045	Jenkins Creek	Temperature	17110013000168_001_002
7046	Little Soos Creek	Temperature	17110013002281_001_001
7048	Covington Creek	Temperature	17110013000103_001_001
7493	Big Soos Creek	Temperature	17110013000097_001_001
10835	Big Soos Creek	Dissolved Oxygen	17110013000097_001_001
12694	Jenkins Creek	Dissolved Oxygen	17110013000168_001_002
12701	Little Soos Creek	Dissolved Oxygen	17110013002281_001_001
13160	Big Soos Creek	Bacteria - Fecal coliform	17110013000097_001_001
13162	Covington Creek	Bacteria - Fecal coliform	17110013000103_001_001
13164	Jenkins Creek	Bacteria - Fecal coliform	17110013000168_001_002
13167	Little Soos Creek	Bacteria - Fecal coliform	17110013002281_001_001
13964	Soosette Creek	Temperature	17110013000172_001_001
15831	Little Soosette Creek	Dissolved Oxygen	17110013000153_001_001

[3] https://pugetsoundstreambenthos.org/

Listing ID	Waterbody Name	Pollutant	Assessment Unit ID
15832	Little Soosette Creek	Bacteria - Fecal coliform	17110013000153_001_001
15836	Little Soosette Creek	Dissolved Oxygen	17110013000166_001_001
15837	Little Soosette Creek	Bacteria - Fecal coliform	17110013000166_001_001
15840	Soosette Creek	Bacteria - Fecal coliform	17110013000172_001_001
15849	Little Soosette Creek	Bacteria - Fecal coliform	17110013007565_001_001
15866	Big Soos Creek	Dissolved Oxygen	17110013000102_001_001
15870	Big Soos Creek	Bacteria - Fecal coliform	17110013000102_001_001
15871	Big Soos Creek	Bacteria - Fecal coliform	17110013000483_001_001
15883	Ravensdale Creek	Temperature	17110013000504_001_001
47477	Covington Creek	Dissolved Oxygen	17110013000104_001_002
72598	Unnamed Creek (Tributary to Little Soosette Creek)	Temperature	17110013000160_001_001
73256	Covington Creeks	Temperature	17110013000104_001_002
82244	Big Soos Creek	Dissolved Oxygen	17110013000494_001_001
82953	Big Soos Creek	Bacteria - Escherichia coli	17110013000097_001_001
83208	Little Soos Creek	Bacteria - Escherichia coli	17110013002281_001_001
83211	Covington Creeks	Bacteria - Escherichia coli	17110013000104_001_002
83272	Jenkins Creek	Bacteria - Escherichia coli	17110013000168_001_002

Future Impairment Listings

This TMDL takes a watershed approach as described in Ecology's Watershed TMDLs and Future Impairment Guidance – Water Quality Program (Ecology 2025). The TMDL and the technical analysis it is based on are developed in a manner that is protective of all assessment units in the Soos Creek watershed from the point of confluence of Big Soos Creek with the Green River to the watershed's headwaters, including all tributaries, as shown in Figure 2. If new impairments for fine sediment are identified in the future, Ecology will follow a process that allows for the newly identified impaired AUs to be listed in Category 4A, instead of Category 5. If new impairments are identified in the watershed footprint, the following steps will be used to move listings into category 4A:

1. Ecology identifies new impairments within the Soos Creek watershed footprint based on new Benthic Index of Biotic Integrity (B-IBI) and Fine Sediment Biotic Index (FSBI) data entered in Ecology's EIM.

2. Ecology submits request to EPA to list these impairments in Category 4A during the WQA's EPA/Tribal preview period. Ecology's request is accompanied by documentation that includes a justification for the request and confirmation that existing allocations account for the newly identified impairments and no new point sources are identified in the basins contributing to the impaired assessment units.

   Ecology will notify the public of the request and offer opportunity for comment as part of the draft water quality assessment review period.

3. EPA approves the TMDL coverage and notifies Ecology of approval either as part of the WQA approval letter or through a separate process. The approval will include the specific AU/pollutant combinations that Ecology can move to Category 4A.

4. Ecology moves the listed AUs to Category 4A. The change is reflected in the final WQA.

Appendix F includes a list of all the AUs in the Soos Creek watershed that currently do not have a fine sediment listing. In the event one or more AUs on this list becomes impaired for fine sediment, the process outlined above applies to including them directly in Category 4A.

Water Quality Standards

The Washington State water quality standards, set forth in Chapter 173-201A of the Washington Administrative Code (WAC), are the basis for protecting and regulating the quality of surface waters in Washington State. The state's water quality standards have three components:

- Designated uses, such as fishing, swimming, aquatic life habitat, which are also referred to as beneficial uses[4]
- Numeric and narrative water quality criteria to indicate if the uses are met
- The antidegradation policy to protect higher quality waters from being further degraded

Uses of the Waterbodies

Segments of Soos Creek streams are identified on the Washington State 2018 303(d) list as being impaired by excess fine sediment and not supporting the designated use of aquatic life (Table 1).

WAC 173-201A-600 describes the designated uses associated with fresh waters throughout the State of Washington. The categories of beneficial uses listed in the WAC are meant to protect different aspects of life that are integral to the state's citizens and include:

- Aquatic life, which is meant to protect salmonids and other aquatic species
- Recreational uses, which are intended to protect citizens' ability to recreate in and near water without health risks
- Water supply, which is related to the consumptive uses of water
- Miscellaneous uses, which include protection of wildlife habitat, fish harvesting, boating and navigation, as well as aesthetic values

Ecology uses a benthic community bioassessment to gauge the health of the state's waters and to determine whether the aquatic life beneficial use is supported (Ecology 2023). For the watershed to support the designated use of aquatic life, fine sediment must be reduced to levels identified in this TMDL. Ecology considers this a necessary condition that has to be met. In its absence, the aquatic life designated use cannot be met. However, additional work may be needed, aside from actions that reduce fine sediment, to address the other two stressors, flashy flows and habitat degradation [see Poff (2018), for a similar discussion in another watershed]. Work that is expected to be done in the future to implement a second TMDL in Soos Creek (currently being developed to address temperature, dissolved oxygen, and bacteria) will also contribute to the improvement of instream habitat for benthic macroinvertebrates by addressing some of the habitat degradation.

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[4] Both terms are used in this report interchangeably.

Improvements of stream health conditions in Soos Creek watershed would also support the downstream beneficial uses of aquatic life in the Green River and can contribute to the restoration of habitat for salmonids (i.e., Chinook, coho, chum, pink, steelhead, and cutthroat trout) and other species that are native to the Green River. The Green River, which has historically supported the core summer salmonid habitat, has documented temperature impairments. In 2011, Ecology published a TMDL to address these impairments (Coffin and Lee 2011). The section “Protection of Downstream Waters and Designated Uses” in Appendix A addresses downstream uses further.

Water Quality Criteria

Indicators of attainment of a beneficial use in a water body can be numeric or narrative. Numeric criteria are quantitative thresholds (e.g., a temperature threshold to gauge if the aquatic life use for salmonids is supported). Narrative criteria are statements that describe the desired water quality goal, such as waters being “free from” pollutants, like oil, scum, fine sediments, and other substances that can harm people and fish. Narrative criteria protect water bodies from pollutants when numeric criteria are difficult to specify. The use of narrative criteria is sanctioned under WAC 173-201A-260(2):

> *“deleterious material concentration must be below those which have the potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters […]”*

Neither the State nor the EPA has numeric criteria for fine sediment in the water column or substrate, so Ecology relies on a narrative criterion approach defined in the WAC to guide the finding of attainment for the water quality standards.[5]

In Soos Creek, the stressor ID analysis concluded that elevated fine sediment loads adversely affect uses. This results in an exceedance of the narrative criterion in WAC 173-201A-260(2). Furthermore, of the three identified stressors[6] impairing the resident benthic invertebrates (Marshalonis and Larson 2018), only fine sediment is considered a pollutant that can be regulated under the CWA, thus this TMDL establishes loading limits only for fine sediment to protect the aquatic life beneficial use in the Soos Creek watershed. This loading limit is based on the estimated loads expected under pre-development conditions that were simulated using a watershed model. More details about the watershed model can be found in Appendix D and Mohamedali (2024). It is important to remember that some level of fine sediment is natural and

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[5] In 2022, Ecology adopted a water quality standard for fine sediment to support aquatic life (WAC 173-201A-200(1)(h)), however, EPA has not taken action to approve it at this point.

[6] The stressor ID study narrowed down the likely stressors to fine sediment, high pulse counts, and habitat degradation.

desirable, and sediment conditions, even in undeveloped watersheds, can vary in response to major storm events. The objective of the TMDL is to estimate the excess fine sediment in the Soos Creek watershed caused by human activities that need to be reduced in order to support healthy benthic taxa.

The targets in this TMDL are estimated in terms of total suspended solids (TSS) because Ecology determined that TSS is an appropriate surrogate for fine sediment (as discussed below in the Targets section). These estimates represent a translation of the narrative criterion in WAC 173-201A-260(2), and thus any TSS loads above these targets would result in an exceedance of fine sediment and of the narrative criterion. The Implementation Plan includes stormwater management actions to reduce fine sediment delivery and manage flows to mimic natural pre-development forested conditions, along with nonpoint source control actions.

Antidegradation

Washington's water quality standards also include an antidegradation policy to ensure that existing and designated uses are maintained, and that no degradation is allowed to alter those uses (WAC 173-201A-300). This TMDL and its associated implementation plan ensure that the antidegradation policy is supported in the Soos Creek watershed. The application of this policy will also protect the reaches in the Soos Creek basin where monitoring indicates that the aquatic life use is supported, so these areas should be maintained and protected from degradation.

Aquatic Health and Bioassessment in Soos Creek

Section 101(a)(2) of the CWA states that water quality standards must protect "fishable" waters, which are attained when parameters characterizing biological conditions that support healthy aquatic habitats are met. Ecology uses a narrative criterion based on bioassessment to determine if the designated use of aquatic life is attained (Ecology 2023).

For the purpose of describing water quality conditions, a bioassessment evaluates the abundance and diversity of benthic macroinvertebrates. These species spend a large portion of their life cycle (up to 1-3 years, depending on taxa) in the streambed gravel. Macroinvertebrates that are sensitive to fine sediments prefer larger sediment for the following reasons:

- Benthic macroinvertebrates spend most of their lives in the interstitial spaces formed by larger sediment, like gravel. These spaces provide protection during high flow events and are an excellent rearing environment.
- The larger spaces between gravel are associated with higher levels of dissolved oxygen, necessary for the macroinvertebrates' developmental growth.
- Larger sediments provide spaces where food for macroinvertebrates is trapped (e.g., leaves, detritus, etc.) or grows (e.g., biofilm).
- Fine sediments fill in these interstitial spaces, and can also clog the gills of some macroinvertebrates, reducing their ability to breathe.

Macroinvertebrates have been selected as indicators of watershed health because of their ability to signal when water quality is impaired. Since they are the main link in the aquatic food chain between primary producers (algae) and higher order predators (fish), they can provide valuable information of a watershed's ability to support an entire aquatic food web (Relyea, Minshall, and Danehy 2012), and thus support the aquatic life use. The goal of any bioassessment is to quantify both the abundance and diversity of all present macroinvertebrate species. When species that are sensitive to specific pollutants are absent or low in abundance, this indicates the presence of those pollutants. For the same location, the presence or prevalence of species with known low sensitivity to those same pollutants, is another indicator of water quality degradation due to these pollutants. Figure 3 shows an overview of macroinvertebrates that are more sensitive to pollutants versus those that are less sensitive, while Figure 4 is a conceptual representation of how benthic macroinvertebrates that are sensitive to fine sediment become replaced by more tolerant species.

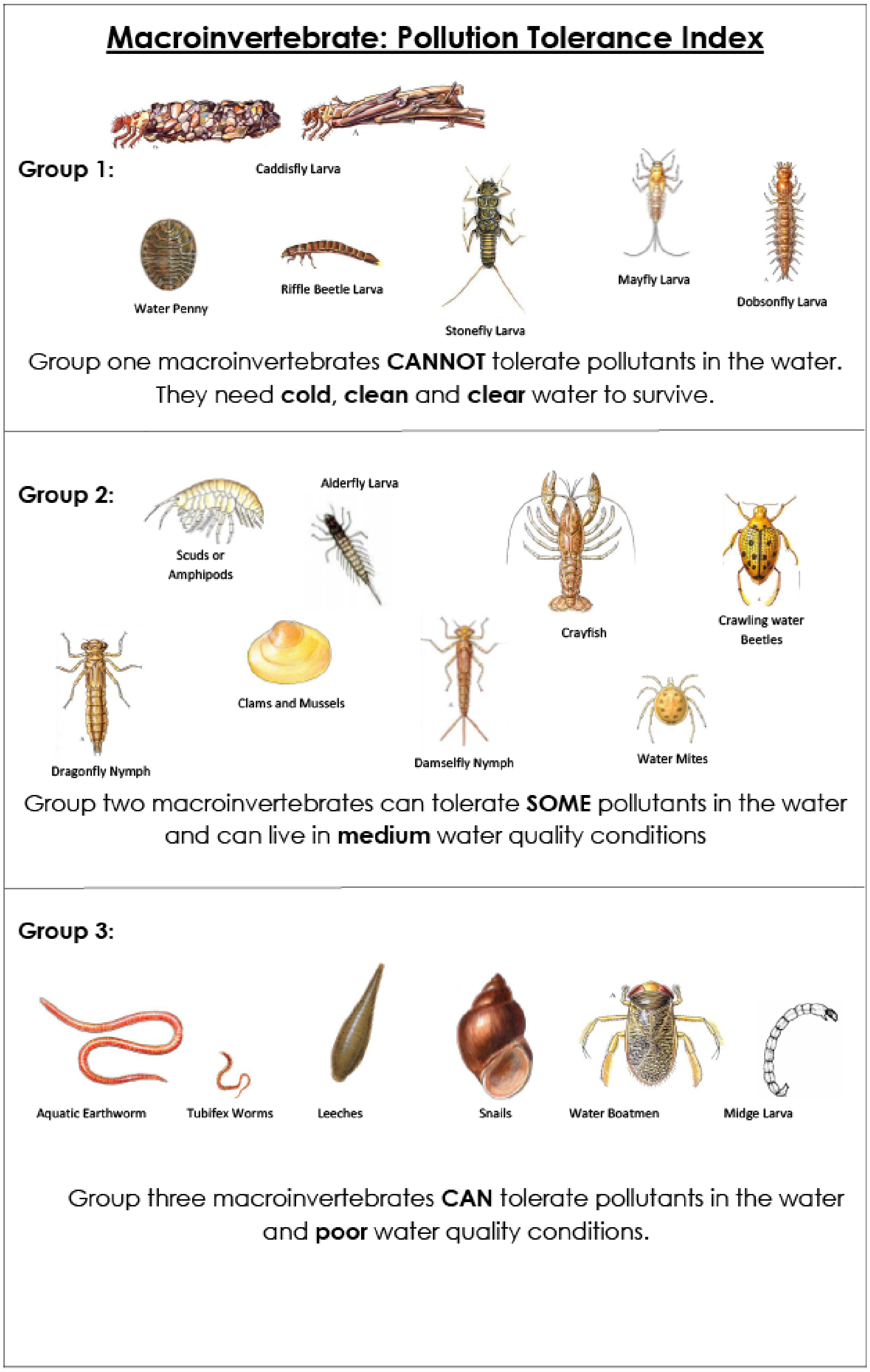

Figure 3. General pollution tolerance for common benthic macroinvertebrates (Source: www.n-sea.org)

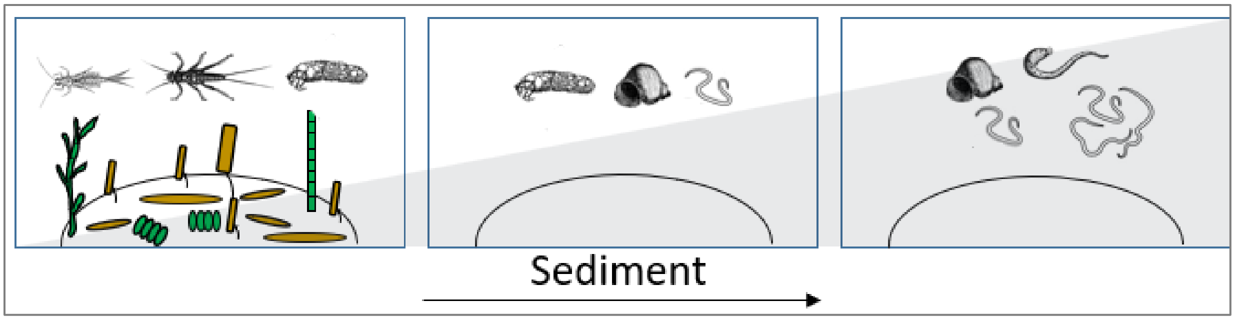

Figure 4. Conceptual representation of benthic macroinvertebrate population shifts in response to changing sediment conditions

Note that as fine sediment increases in the benthic area of a stream bed, sensitive benthic macroinvertebrates become less prevalent and are replaced by species that are tolerant to these degraded conditions

The bioassessment method has been found to be highly effective at identifying water quality impairments, sometimes more accurately than using pollutant-specific criteria and sampling (Karr et al. 1985; Rankin and Yoder 1990). This is not surprising since one of the benefits of bioassessment is that it integrates the impacts of episodic pollution events over time in a way that pollutant-specific water monitoring cannot. As a result, biological assessments have been used to detect the response of resident biotic communities to alterations of the physical habitat and/or water chemistry that occur over long periods of time, due to stormwater runoff, dredging, filling, or channelization.

Policy 1-11 specifically incorporates the use of bioassessment data to determine if waters support the aquatic life use (Ecology 2023). Ecology's assessment relies on the Benthic Index of Biotic Integrity (B-IBI), which is an index that ranges from 0 to 100, where higher scores indicate better stream health (Karr 1991; Karr and Chu 1997). The determination of stream condition is made relative to B-IBI scores from a set of ecoregion[7]-specific reference watersheds (with similar environmental characteristics) that have been subject to minimal anthropogenic influences. The scores from these reference watersheds were used to identify B-IBI thresholds for each of the state's nine ecoregions. The B-IBI was initially developed for the Puget Lowland ecoregion, which includes Soos Creek, in the 1990s (Karr 1991; Karr and Chu 1997), but currently the measure is widely used to assess stream health throughout Washington State. A recent study by King County indicates that between 2009 and 2018, 1,267 sites were monitored in the Puget Lowland region using B-IBI surveys (King County 2019).

[7] https://www.epa.gov/eco-research/ecoregion-download-files-state-region-10#pane-45

B-IBI metric scoring rules have been refined to reflect knowledge of the sensitivity of taxa in the Puget Lowlands[8]. The threshold used in water quality assessments is based on a distribution of B-IBI scores of undisturbed or minimally disturbed reference sites within each ecoregion. B-IBI scores below the 10th percentile of this distribution of scores from reference sites may indicate an impairment. In the Puget Lowlands ecoregion, the 10th percentile for reference sites corresponds to a B-IBI score of 65, meaning that any time monitoring data from two or more years yield an average of B-IBI score of 65 or below, the assessment unit will become a candidate for an impairment listing (Figure *5*).

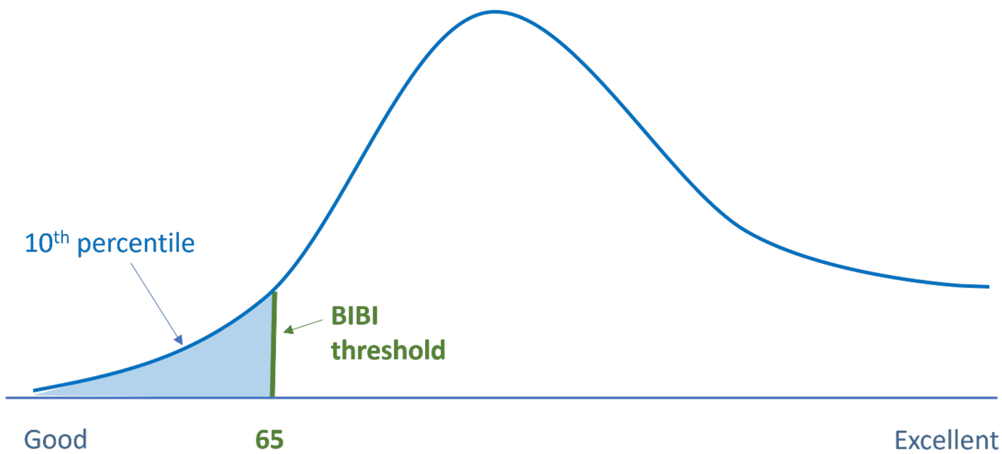

Figure 5. Conceptual representation of the distribution of conditions for reference streams in the Puget Lowlands

A B-IBI score is calculated from samples of stream macroinvertebrate communities. The samples are evaluated for biological attributes or 'metrics' indicating sensitivity to classes of stressors associated with various human activities. In total, there are ten metrics that characterize macroinvertebrate communities such as taxa richness and relative abundance (Stormwater Strategic Initiative 2020). Data collected for these ten metrics are also used to diagnose the possible causes of impairment using three different indices:

- Fine Sediment Biotic Index (FSBI), to gauge the likelihood of impairments from excess of fine sediments in the stream substrate (scores *lower* than 89 indicate a loss of taxa sensitive to excessive fine sediment deposition)
- Hilsenhoff Biotic Index, to test the presence of impairments from nutrient pollution (scores *greater* than 5.5 indicate nutrient pollution)
- Metals Tolerance Index, to assess impairments from metals pollution (scores *greater* than 4 indicate metal pollution)

[8] See https://benthos.kingcounty.gov/Taxa-Attributes.aspx

The thresholds for the Hilsenhoff Biotic and Metal Tolerance indices apply across all Washington's ecoregions; the Fine Sediment Biotic Index is specific to ecoregions in western Washington.

In Puget Lowlands, Policy 1-11 states that Ecology will list an assessment unit in Category 5 whenever the B-IBI score is below 65 and at least one of the three diagnostic indices indicates the likely presence of an impairment from one of the pollutant groups described above. Table 4 shows the scores for the B-IBI assessments completed at sites where there are impairments addressed in this TMDL. Results for the three diagnostic indices described above are also included in this table. FSBI scores below 89 indicate that excessive fine sediments are likely contributing to these impairments. The scores for the other two diagnostic metrics are below the limits pointing at other classes of impairing pollutants. The table does not include Category 2 listing #70185 in the lower Big Soos, where all three metrics and the overall B-IBI score indicate that biological health at the particular location was not impaired when samples were taken.

Table 4. Scores for B-IBI assessments and associated diagnostic metrics in the Soos watershed

B-IBI Listing ID	Corresponding Fine Sediment Listing	Average B-IBI Score	Fine Sediment Biotic Index Score	Hilsenhoff Biotic Index Score	Metal Tolerance Index Score
70150	97928	***62.1***	***77.2***	3.74	2.3
70151	97933	***63.6***	***33.8***	3.40	1.8
70152	97935	***54.5***	***24.6***	3.33	2.9
70161	97927	***60.6***	***31.9***	4.0	2.0
70162	97932	***61.7***	***51.8***	4.59	2.8
70181	97925	***48.3***	***54.5***	3.61	2.0
70182	97929	***54.6***	***74.4***	3.52	2.8
70183	97931	***14.7***	***0***	5.41	0.3
70186	97930	***42.4***	***10.0***	3.55	1.2
70187	97934	**66.2**	***61.9***	3.97	1.6

Note: Bolded and italicized scores indicate an impairment.

Once data are collected, the indices are used to assess the biological health of each monitored site by comparing them with reference or 'least impacted' conditions. It is important to mention that both reference and impaired watersheds can exhibit variability in their scores due to environmental events and potentially other factors. What distinguishes reference from impaired sites is the magnitude of this variability and the ability of the waters to return to reference conditions after such an event. In general, B-IBI scores for reference watersheds are expected to vary from year to year by about 10 percent and be able to return to pre-disturbance conditions even when they have experienced significant damage. In impaired waters, the B-IBI scores vary more widely and the constant exposure to disturbance limits the ability of the system to return to reference-like conditions (Larson, n.d.).

In the case of Soos Creek, once bioassessment impairments were identified, Ecology moved to complete a stressor identification analysis, which is the next step required by Policy 1-11. This analysis is needed to connect bioassessment impairments to their causes and is described in the following section.

Stressor Identification Analysis

Unlike the assessment of water bodies for chemical parameters, an impairment listing based on bioassessment doesn't indicate which pollutants are driving the impairment, so an additional step is necessary to narrow down the causes of impairment. Policy 1-11 recommends that, once an impairment is established using B-IBI scores, a stressor ID be conducted to identify the pollutants or other stressors that are limiting the macroinvertebrate communities. After the stressors are identified, the Category 5 listing is modified to reflect the findings of the stressor ID analysis.

The stressor ID is an analytical method that 1) assesses if sufficient data exists to identify potential causes of aquatic health impacts and 2) provides a determination about the potential causes of biological impairment. The analysis starts by identifying a list of possible causes of pollution. Evidence of the relationships between these pollutants and benthic macroinvertebrates is analyzed statistically to rule out unrelated causes and determine relationships that are most likely impacting stream biology. EPA's guidance on stressor IDs (EPA 2000) allows for different levels of certainty in the results of these analyses, depending on the types of decisions they will influence. In the case of TMDLs, EPA states that a "high degree of accuracy and reliability in the stressor identification processes is necessary".

In the Soos Creek watershed, EPA and Ecology collaborated on a stressor ID which concluded that the resident macroinvertebrate communities in the Soos Creek watershed are most likely impaired by three stressors associated with urban development: flow alteration, increased fine sediments, and loss of habitat complexity (Marshalonis and Larson 2018). The stressor ID ruled out other possible stressors, including temperature, dissolved oxygen, nutrients, metals, and toxics, like PCBs and PAHs. The analysis found that a flow alteration metric, defined as high pulse counts (HPCs), could account for up to 60 percent of the variation in the B-IBI scores. High pulses occur when the average daily flows exceed a threshold set at twice the long-term mean daily flow rate and are a surrogate measure for stream flashiness (Booth et al. 2004; Mohamedali 2018). When impervious cover and watershed area were included in the analysis, the explanatory power of the analysis increased to 65 percent. The stressor ID points out that this relationship holds only for data that are averaged over several years and that if the frequency of HPCs decreases in one year, immediate changes in B-IBI should not be expected. For a sustained improvement in macroinvertebrate communities, the decrease in both the frequency and the amplitude of the HPCs need to be maintained over time.

The stressor ID supports the findings of previous studies that identified stream flashiness as a product of urbanization and impervious cover in watersheds (Walsh et al. 2005; Askarizadeh et al. 2015; Booth et al. 2016; Hawley et al. 2016). HPCs can be indicators of flows that adversely affect waterbodies in at least two ways. First, these flows can transport various pollutants (including fine sediment) from roads, lawns, fields, impervious surfaces, and other land surfaces within the watershed and deliver these pollutants to surface waters. Second, the physical force and 'flashiness' of HPC flows can scour and erode stream banks, result in channel incision, dislodge benthic organisms, and degrade and alter stream channels (Russell, Vietz, and Fletcher 2017).

Another stressor that was found to be negatively impacting macroinvertebrate communities in Soos Creek is habitat degradation. Physical habitat is degraded when there is a reduction in instream habitat complexity, which is another consequence of flow alteration, increased fine sediment, and urban development, in general. Flashy flows cause erosion, incise and straighten stream channels, wash large woody debris downstream, and reduce overall channel complexity. These changes further increase the velocity at which the flow travels downstream and flushes down invertebrates. Loss of riparian cover and of connection to floodplains associated with urban development further degrade the ability of a stream system to dissipate the energy of high flows and moderate associated erosive forces.

Lastly, the stressor ID identified excessive fine sediment deposition in the substrate as another driver of benthic impairment. The study found that all impaired sites in Soos Creek exhibited higher levels of inferred percent fine sediment relative to the Soos non-impaired sites and to regional reference sites. Fine sediment deposition changes macroinvertebrate community structure and functioning and affects sensitive macroinvertebrates in multiple ways (Mathers, Rice, and Wood 2017). The clogging of the substrate due to excess fine sediment creates habitat conditions that hinder taxa with higher oxygen demand and gills or filter-feeding organs. Fine sediment deposition also reduces access to food for sensitive macroinvertebrates (Rabení, Doisy, and Zweig 2005). These instream conditions select for taxa that are resilient to fine sediment (Buendia et al. 2013; Mathers, Rice, and Wood 2017). Overall, higher loadings of fine sediment increase the drift of these sensitive taxa within a short period of time from the stressor event, to the benefit of taxa that can recolonize quickly and thrive in low stability habitats (Suren and Jowett 2001; Buendia et al. 2013). This is why at sites with fine sediment impairments, bioassessment monitoring usually finds low numbers of or the absence of sensitive macroinvertebrates and a high number of macroinvertebrates that are resistant to fine sediment (Figure 4).

To comply with the process laid out in Policy 1-11, Ecology reviewed the findings of the stressor ID and considered how to best integrate them into the 2018 Water Quality Assessment. As discussed previously, flow alteration (or HPCs) and habitat degradation are not considered pollutants subject to TMDLs under the Clean Water Act, but fine sediment is. Therefore, Ecology made the decision to list the impaired assessment units under Category 5 for fine sediment, under Category 4c for flow alteration and habitat degradation, and under Category 2 for B-IBI. The Category 2 listings for B-IBI allow Ecology and interested parties to connect the fine sediment listings back to the conditions of the resident benthic communities.

Continued Bioassessment Data Collection within the Soos Creek Watershed

Yearly monitoring in the watershed has extended the availability of bioassessment data beyond those used in the stressor ID (which included data through 2013). Bioassessment data has been collected in the watershed since 1994. Since 2001, which marks the beginning of the modeling period for this TMDL, King County and Ecology have collected bioassessment data at over 50 locations in the watershed. King County Department of Natural Resources and Parks has been monitoring B-IBI scores yearly, though the number of sites and their locations have changed over time. King County's level of effort peaked in 2007 and 2008, when 23 sites were sampled, and dropped to around 13 sites starting in 2013 and down to five sites in 2023. Table 5 provides a summary of the Soos Creek bioassessment data collected by King County and others, as reported in the Puget Sound Stream Benthos[9] database for several periods, including 1994 (year with earliest data) – 2023, 2001 – 2015 (TMDL modeling period), and 2001 – 2023. As it can be seen in the table, there is little change in the average and percentile threshold values among the data from the three periods of time reviewed.

[9] https://pugetsoundstreambenthos.org/Default.aspx

Table 5. Summary of Soos Creek B-IBI scores based on Puget Sound Stream Benthos data collected by King County and Ecology.

Descriptor	All data	Data from 2001-2015*	Data from 2001-2023	Data from 2015-2023
Number of stations (sample locations)	65	48	51	19
Sample size (n)	384	257	348	106
Average	59.5	59.1	60.3	62.9
Median	61.75	61.0	62.0	63.6
25th percentile	49.8	48.8	51.3	54.9
75th percentile	72.0	71.4	72.0	72.0
90th percentile	79.2	78.9	79.2	79.0

*2001-2015 coincides with the model simulation period.

Across all time periods, the summary statistics in Table 5 indicate that 25 percent of all B-IBI scores in the Soos Creek watershed range from 48.8 to 54.9. Additionally, scores in the top 25 percent (75th percentile) are all above 70, which exceeds the Puget Lowlands B-IBI threshold of 65. 90th percentile scores across all time periods are above 78.

Figure 6 presents the scores for all sites monitored between 2001 – 2023. Colors in Figure 6 represent established B-IBI categories ranging from “very poor” to “excellent.” Figure 6 also illustrates how B-IBI scores have a large amount of variability at the same location between years, and that scores at multiple locations are below 65. However, the fact that scores at many sites exceed a value of 65 indicates that there are parts of the watershed that can support healthy macroinvertebrate communities, and TMDL implementation actions could result in considerable improvements in the conditions for benthic invertebrates in Soos Creek and attainment of beneficial uses.

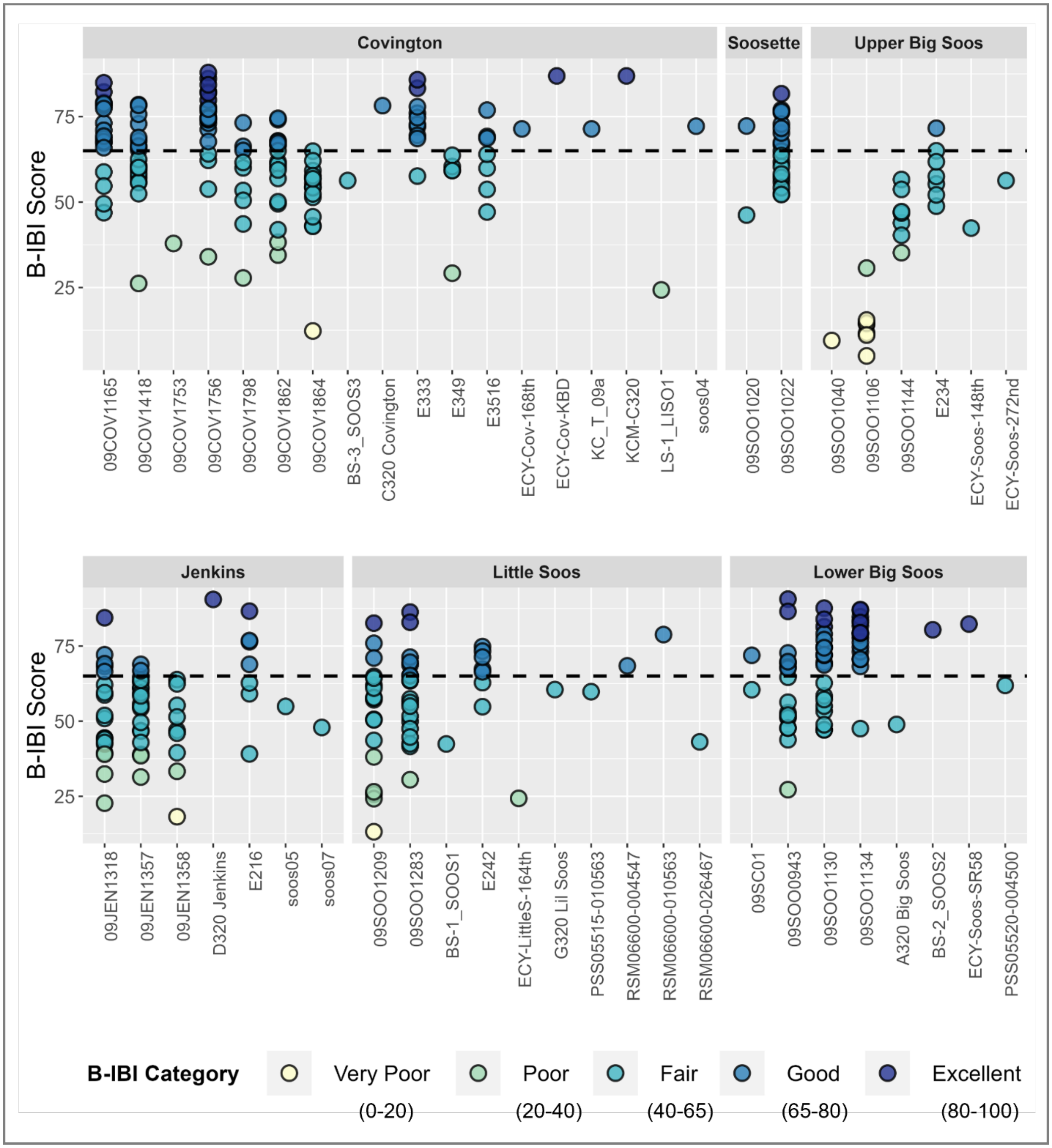

Figure 6. B-IBI scores from data collected by King County and Ecology at locations in the Soos Creek watershed between 2001-2023, by subbasin
(A few station names are shortened from their official names to allow them to fit on the plot.)

It should be noted here that these data were not directly included in the calculations of allocations, but rather that the data are presented to describe the overall condition of the watershed health over the last two decades.

Targets

Measurements of sediment in the water column are commonly made in terms of the concentrations of total suspended solids (TSS). TSS includes suspended fine sediment, some of which also gets deposited to the stream bed. EPA regulations [40 CFR 130.2(i)] allow for the use of alternative appropriate measures, or surrogate measures, in a TMDL. The Report of the Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program (EPA 1998) includes the following guidance on the use of surrogate indicators for TMDL development:

> *When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional "pollutant," the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not.*

For the purpose of this TMDL, TSS is used as a surrogate for fine sediment. The statistical relationship between fine sediment and TSS has been explored by others to understand if there are differences in the ability of each one of these constituents to predict changes in benthic communities. Fine sediment, suspended sediment, and TSS concentrations were found to correlate well with changes in macroinvertebrate behavior and survival rates (Runde and Hellenthal 2000; Shaw and Richardson 2001; Ntloko et al. 2021). TSS is also a commonly used parameter, especially for the implementation of some NPDES permits that regulate discharges (including stormwater runoff) to surface waters. Stormwater discharge monitoring and the effectiveness of BMPs that remove solids from stormwater runoff are often reported in terms of TSS. Since TSS correlates well with macroinvertebrate abundance and diversity, and its concentrations can be reasonably measured and estimated, TSS is an acceptable surrogate of total fine sediment that impairs B-IBI scores in the Soos watershed.

In-stream TSS production within the Soos Creek watershed is difficult to estimate based on field measurements alone because TSS concentrations vary widely during a storm, between and within seasons, and from year to year. Hence, TSS grab samples (which only characterize TSS at the time the sample was taken) fall short of accurately characterizing concentration changes from rain events, even though the effects continue to impact the health of macroinvertebrate populations long after the stressor events have passed.

To capture the variability in TSS loadings under changing flow conditions, Ecology used a watershed model. For more details on the watershed model, see Mohamedali (2024). The model was first calibrated to existing 2001-2015 conditions and then applied to guide the development of TSS targets using a reference condition that assumed all land uses within Soos Creek mimic TSS loadings and the hydrology of pre-developed, natural forested areas. The TMDL target is the natural, annual, flow-normalized TSS load associated with a fully forested condition throughout the watershed. This target corresponds to a fine sediment load that will support a healthy benthic macroinvertebrate community, and, along with reduced high pulse count and habitat restoration, will result in decreased FSBI and increased B-IBI scores and restore the benthic macroinvertebrate community. Ecology believes that this target level is appropriate and creates suitable conditions for the recovery of benthic communities in the Soos Creek watershed because:

- Literature shows that hydrologic alterations from natural hydrology and impacts that are associated with development, including increased fine sediment and TSS loadings, negatively impact aquatic biota that are highly sensitive to excess fine sediment deposition (Walsh et al. 2005; Askarizadeh et al. 2015; Booth et al. 2016; Hawley et al. 2016; Russell, Vietz, and Fletcher 2017; Mathers, Rice, and Wood 2017).
- In the absence of a numeric criterion for fine sediment or TSS, or data that specifically connect B-IBI to TSS concentrations, the model-estimated forested reference condition is the best scientifically defensible target.
- A framework that reduces the excess TSS loadings to levels that are closely aligned with reference conditions by reducing upland TSS and stormwater runoff will also address, at least in part, the other two stressors (flashy flows, or high pulse counts, and habitat degradation) that contribute to the impairment of the aquatic life use in Soos Creek.

TMDL Allocations

TMDL Formula

A waterbody's **loading capacity** is the maximum amount of a given pollutant that can be allowed to enter the waterbody without exceeding water quality standards. The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring the waterbody into compliance with the standards.

The portion of the receiving water's loading capacity assigned to a source is called an allocation. Depending on the nature of the source, these allocations are categorized as either wasteload or load allocations. If the pollutant comes from a discrete (point) source subject to a National Pollutant Discharge Elimination System (NPDES) permit, such as a municipal stormwater or industrial facility's discharge pipe, that facility's share of the loading capacity is called a **wasteload allocation (WLA)**. If the pollutant comes from diffuse (nonpoint) sources not subject to an NPDES permit, such as residential sources not draining to a municipal separate storm sewer system (MS4) or a combined sewer system, or farm runoff, the share is called a **load allocation (LA)**.

The TMDL study must also consider seasonal variations and include a margin of safety (MOS) that accounts for uncertainties in the estimated relationship between pollutant loads and instream water quality. A reserve capacity for future pollutant sources is sometimes included as well.

Therefore, the loading capacity is the sum of the wasteload and load allocations, a margin of safety, and a reserve capacity. Typically, the TMDL is the loading capacity expressed as a maximum daily pollutant loading that cannot be exceeded. In this TMDL, the daily loading limits are specified for several flow intervals to reflect that sediment loads vary naturally under different flow conditions. The approach Ecology used to develop WLAs and LAs is described in Appendix E. The short-hand formula that describes the TMDL is:

$$TMDL=LC=\sum WLA+\sum LA+MOS+RC$$

This equation reads TMDL equals the loading capacity (LC), which equals the sum of wasteload allocations (WLA) plus the sum of load allocations (LA) plus a margin of safety (MOS) plus a reserve capacity (RC).

Loading Capacity

Traditionally, modeling is used to estimate a pollution target equal to the loading capacity for a waterbody, beyond which it no longer meets water quality standards. Most frequently, the loading capacity is defined using a numeric criterion identified in the water quality standards. Washington State does not have a numeric criterion for fine sediment or TSS to support aquatic biological health as indicated by B-IBI values.

Ecology used a Hydrological Simulation Program - FORTRAN (HSPF) model of the Soos Creek watershed to understand the hydrology and sediment loading dynamics. The model was calibrated to 2001 – 2015 conditions; these are referred to as “existing conditions” in this report. The model allowed us to analyze the relative contribution of sediment loads from different sources and land uses and determine the impact storm events and flashy flows have on sediment loading and instream erosion (Mohamedali 2024). Ecology then modeled a reference forested condition to evaluate differences in the hydrologic regime and TSS loads as a result of human development.

In the absence of an equivalent reference watershed or data collected pre-development, the forested condition scenario allows us to estimate what the watershed TSS load would be if human impacts were removed (i.e., under reference conditions). The forested scenario allows us to compare existing flows and sediment loads to a reference condition. Washington State already uses a forested land cover as the hydrologic goal in guiding the design of stormwater facilities to prevent increases in stream channel erosion rates caused by development in Western Washington, as documented in the Stormwater Management Manual for Western Washington or SWMMWW (Ecology 2024). For example, Washington State’s Western Washington municipal stormwater permits require that most new and redevelopment projects install a flow control BMP designed to discharge at rates that match a forested land cover unless there is reasonable, historical information that indicates the site was prairie prior to settlement (Ecology 2024, Volume 1-3.4.7).

The forested model scenario was represented by converting all land uses, except for open water bodies and wetlands, to the ‘forest’ category within the watershed model schematic. The geology/soils and topographic soils, flow routing, channel geometry, and water withdrawals remained unchanged. This ‘forested condition’ scenario formed the basis for determining the loading capacity (Mohamedali 2024).

Appendix E and Mohamedali (2024) provide further details on the approach used to calculate the loading capacity which varies temporally and spatially. These types of variability and implications for the analysis in the Soos Creek watershed are discussed below.

Temporal variation

Rather than specify the loading capacity as a single average daily TSS load, Ecology adopted a 'load duration curve' approach to specify different TSS loading capacities and allocations for different flow intervals. The load duration curve approach is recommended by EPA in TMDLs where streamflow is one of the most important factors driving pollutant loads (in this case, TSS) since it accounts for how streamflow patterns affect pollutant loads and concentrations over the course of the year (EPA 2007). For example, TSS loads will naturally be lower during summer baseflow/low flow conditions relative to winter high flows, as well as from one year to the next depending on whether it is a 'high flow' or 'low flow' year, or somewhere in between. Appendix E and Mohamedali (2024) outline in more detail how the load duration was used to estimate loading capacities for each subbasin. Table 6 presents the loading capacity (and existing loads) for each flow interval by subbasin. The flows intervals in Table 6 represent the following flow conditions:

a. Low flows: > 50th percentile
(flows that are exceeded most often, more than 50% of the time)

b. Midrange flows: 30th – 50th percentile
(flows exceeded between 30% – 50% of the time)

c. Moist conditions: 20th – 30th percentile
(flows exceeded between 20% – 30% of the time)

d. High flows: 10th – 20th percentile exceedance flows
(flows exceeded between 10% – 20% of the time)

e. Very high flows: 5th – 10th percentile exceedance flows
(flows exceeded between 5% – 10% of the time)

f. Extremely high flows: 2.5th – 5th percentile exceedance flows
(flows exceeded between 2.5% – 5% of the time)

g. Rare high flows: < 2.5th percentile exceedance flows
(exceeded infrequently, less than 2.5% of the time)

The TSS loading capacity was specified as the median model-predicted TSS load (median flows multiplied by median concentrations) under the reference condition model run for each of these seven flow intervals.

Spatial variation

The TSS loading capacity is established for each Soos Creek subbasin based on forested TSS loads for that subbasin, by flow interval. These six subbasins include the four major tributaries of the Soos (Soosette, Little Soos, Jenkins, and Covington) as well as Big Soos, which is split into two subbasins: Upper Big Soos above the confluence with Little Soos, and Lower Big Soos. Lower Big Soos includes areas draining *directly* (not including major tributaries) to Big Soos

Creek between the confluence with Little Soos and the confluence with the Green River. Figure 7 illustrates the locations where the loading capacities are estimated for each subbasin. Table 6 presents the range of existing flows for the respective subbasin's confluence with Lower Big Soos, as well as the reference modeled flows, for each flow interval. The table also shows the loading capacities calculated for each of the six subbasins and the estimated existing TSS loadings associated with one of these subbasins, by flow interval. The last column in the table shows total TSS reductions that will need to be made to reach the TMDL targets. These values are presented at the watershed level and for each subbasin, by flow interval. At the basin scale, Covington and Jenkins need reductions that range between 46% - 52% and between 53% - 60%, respectively, for the top three flow intervals. The more developed subbasins, such as Upper Big Soos, Soosette, and Little Soos, will need higher reductions for these top flow intervals, ranging between 89% - 93%, 80% - 81%, and 84% - 86%, respectively.

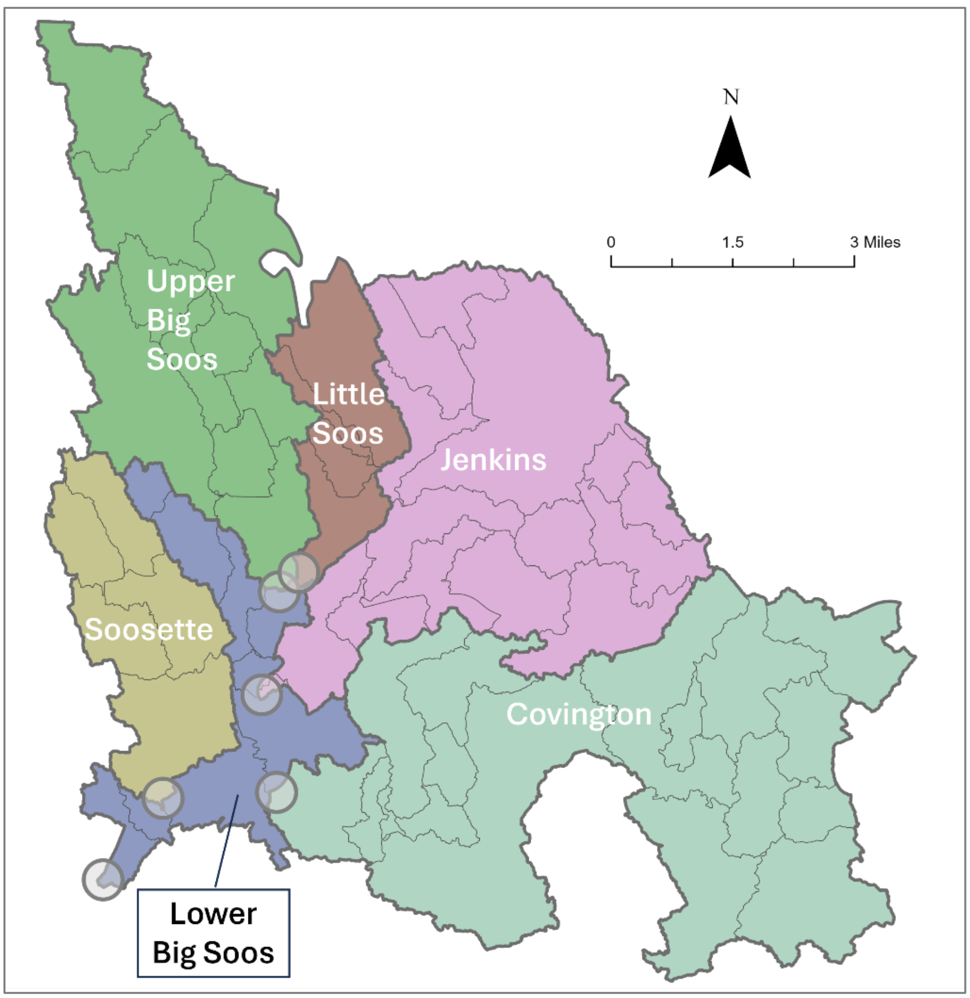

Figure 7. Locations where loading capacity was estimated for each subbasin

Table 6. TSS loading capacity by flow interval comparison

TSS loading capacity by flow interval, at the mouth of the whole watershed as well as at the mouths of the six subbasins, compared to their existing median loads, along with the reference and existing flows associated with each flow interval at the mouth of each subbasin.

Subbasin	Flow interval	Range of reference flows (cfs)	Range of existing flows (cfs)	Loading capacity (TSS lbs/day)	Existing median load (TSS lbs/day)	TSS reductions
Total Watershed	**< 2.5%**	**314 - 544**	**401 - 962**	**17,385**	**49,900**	**65%**
Total Watershed	**2.5-5%**	**260 - 314**	**325 - 401**	**7,430**	**22,200**	**67%**
Total Watershed	**5-10%**	**205 - 260**	**253 - 325**	**3,522**	**11,700**	**70%**
Total Watershed	**10-20%**	**156 - 204**	**185 - 253**	**1,802**	**4,850**	**63%**
Total Watershed	**20-30%**	**120 - 156**	**143 - 185**	**1,115**	**2,260**	**51%**
Total Watershed	**30-50%**	**71 - 120**	**86 - 143**	**581**	**971**	**40%**
Total Watershed	**> 50%**	**15 - 71**	**15 - 86**	**153**	**105**	**(46%)**
Soosette	< 2.5%	18 - 36	35 - 137	1,770	9,240	81%
Soosette	2.5-5%	14 - 18	27 - 35	773	3,820	80%
Soosette	5-10%	10 - 14	18 - 27	368	1,930	81%
Soosette	10-20%	7.2 - 10	11 - 18	196	788	75%
Soosette	20-30%	5.3 - 7.2	7.2 - 11	116	233	50%
Soosette	30-50%	3.0 - 5.3	3.4 - 7.2	52.2	93.1	44%
Soosette	> 50%	0.42 - 3	0.32 - 3.4	18.6	15.6	(19%)
Upper Big Soos	< 2.5%	63 - 104	92 - 294	877	12,300	93%
Upper Big Soos	2.5-5%	53 - 63	73 - 91	311	2,720	89%
Upper Big Soos	5-10%	42 - 53	55 - 73	90.3	1,330	93%
Upper Big Soos	10-20%	33 - 42	39 - 55	16.7	347	95%
Upper Big Soos	20-30%	26 - 33	30 - 39	10.3	27.3	62%
Upper Big Soos	30-50%	16 - 26	18 - 30	5.98	9.06	34%
Upper Big Soos	> 50%	2.8 - 16	2.7 - 18	1.23	1.25	2%
Little Soos	< 2.5%	10 - 20	18 - 60	618	3,790	84%
Little Soos	2.5-5%	8.0 - 10	14 - 18	180	1,260	86%
Little Soos	5-10%	6.1 – 8.0	10 - 14	83.1	601	86%
Little Soos	10-20%	4.7 - 6.1	6.9 - 10	55.5	246	77%
Little Soos	20-30%	3.8 - 4.7	5.2 - 6.9	34.4	74.9	54%
Little Soos	30-50%	2.8 - 3.8	3.4 - 5.2	25.4	39.2	35%
Little Soos	> 50%	2.1 - 2.8	2.1 - 3.4	17.0	17.0	0%

Subbasin	Flow interval	Range of reference flows (cfs)	Range of existing flows (cfs)	Loading capacity (TSS lbs/day)	Existing median load (TSS lbs/day)	TSS reductions
Jenkins	< 2.5%	103 - 159	124 - 260	3,580	7,670	53%
Jenkins	2.5-5%	86 - 102	103 - 124	1,640	3,680	55%
Jenkins	5-10%	71 - 86	83 - 103	782	1,950	60%
Jenkins	10-20%	56 - 71	63 - 83	503	837	40%
Jenkins	20-30%	45 - 56	51 - 63	370	483	23%
Jenkins	30-50%	27 - 45	32 - 51	235	306	23%
Jenkins	> 50%	5.8 - 27	6.4 - 32	64.1	74.8	14%
Covington	< 2.5%	96 - 199	113 - 257	9,410	18,900	50%
Covington	2.5-5%	78 - 96	90 - 113	4,030	7,480	46%
Covington	5-10%	60 - 78	69 - 90	1,970	4,140	52%
Covington	10-20%	42 - 60	49 - 69	915	1,880	51%
Covington	20-30%	30 - 42	36 - 49	519	1,060	51%
Covington	30-50%	16 - 30	20 - 36	229	456	50%
Covington	> 50%	2.5 - 16	2.8 - 20	47.1	65.7	28%
Lower Big Soos	< 2.5%	n/a*	n/a*	1,130	n/a*	n/a*
Lower Big Soos	2.5-5%	n/a*	n/a*	496	n/a*	n/a*
Lower Big Soos	5-10%	n/a*	n/a*	229	n/a*	n/a*
Lower Big Soos	10-20%	n/a*	n/a*	116	n/a*	n/a*
Lower Big Soos	20-30%	n/a*	n/a*	65	n/a*	n/a*
Lower Big Soos	30-50%	n/a*	n/a*	33	n/a*	n/a*
Lower Big Soos	> 50%	n/a*	n/a*	5.5	n/a*	n/a*

*For the Lower Big Soos, existing loads, reference flows, and existing flows are equivalent to those at the mouth of the Soos watershed and cannot be separately isolated since the Lower Big Soos consists of downstream reaches that drain directly to the mainstem Big Soos, rather than reaches that represent a separate tributary.

Seasonal Variation and Critical Conditions

The load duration approach implicitly accounts for seasonal variation, since it considers the full duration of flows and TSS loads that occur year-round, based on daily flow and TSS model predictions over a 15-year simulation period. Several HSPF parameters also vary by month to account for seasonal variation in hydrology and sediment loading. This accounts for a wide range of meteorological and hydrological conditions that include seasonal effects. See discussion in Mohamedali (2024) for more information on how the model captures seasonal variation.

Since TSS loads are generated during every rainfall or storm event regardless of season or timeframe, there is not a single 'critical condition' that can be applied. Benthic macroinvertebrate communities are influenced by fine sediment loadings, which can vary throughout the year. B-IBI scores therefore reflect the impacts of fine sediment that stress resident macroinvertebrates throughout the year, not just during a certain critical period. These impacts accumulate at sub-annual, annual, and multi-year timescales, integrating acute and chronic effects. A single large acute storm event could stress the benthic community, but chronic habitat conditions, such as embeddedness[10] from several years of sediment loading, also contribute to poor health of macroinvertebrates.

While large storm events that occur every five or ten years can mobilize a significant amount of sediment, they do not occur as frequently as smaller storm events that happen multiple times a year. Smaller storm events also result in increased TSS loading from the watershed and instream erosion. Thus, the critical condition for this TMDL is captured by making sure that the loading capacity is based on a range of rainfall conditions.

We also ensured that the 15-year simulation period captured a range of meteorological and hydrological conditions and did not just represent wet or dry years. To do this, we compared precipitation data during the modeled time period (2001 – 2015) against long-term precipitation data (1989-2022) at King County's gauge 03u located just west of the Soos Creek watershed (Mohamedali, 2024). The analysis shows that our model simulation period, on which the loading capacity is based, is not biased towards particularly wet or dry years, and adequately captures the full range of flow conditions when compared to longer-term precipitation data.

Wasteload Allocations

WLAs are allocated to existing NPDES-permitted sources of TSS. There are seven local jurisdictions and one state agency that are regulated by municipal stormwater (MS4) general permits in the Soos Creek watershed. WLAs allocated to these entities represent the majority of allocations in this TMDL. The remaining WLAs are distributed among three industrial NPDES permittees, two sand and gravel permittees and one fish hatchery, in addition to transitory discharges regulated under the Construction Stormwater General Permit. The WLAs are detailed in the following sections. Appendix E describes the approach used to develop the WLAs.

Figure 8 shows the geographic footprints for the NPDES permittees in the study area. Blank areas on the map in Figure 8 show where load allocations for nonpoint sources are assigned.

[10] Embeddedness refers to the degree to which cobbles and large gravels are buried because of fine sediment deposition. Higher embeddedness indicates more deposited fine sediment.

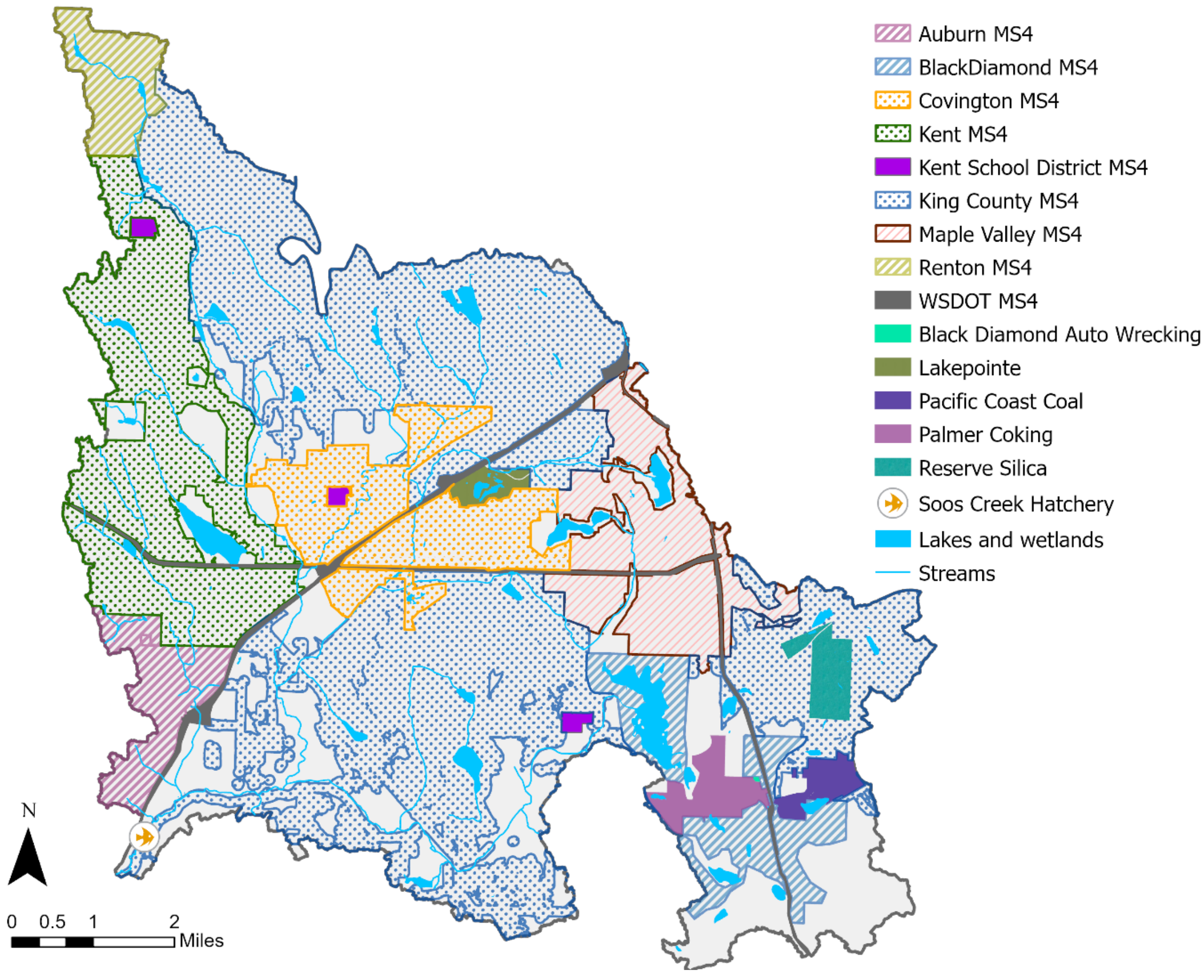

Figure 8. Geographic extent of NPDES permittees receiving WLAs

Note: Blank areas indicate where LAs are assigned.

Municipal Stormwater Permittees

The cities of Auburn, Black Diamond, Covington, Kent, Maple Valley, and Renton have permits for their stormwater discharges under the Western Washington Phase II Municipal Stormwater General Permit. Kent School District is a secondary permittee under the same MS4 permit. Stormwater discharges from the unincorporated area in the Soos Creek watershed are the responsibility of King County, a Phase I Municipal Stormwater Permit holder. The current Phase I and Western Washington Phase II Municipal Stormwater Permits became effective on August 1, 2024, and expire on July 31, 2029. These permits are renewed every five years. Runoff from state highways that cross the watershed is regulated by the WSDOT Municipal Stormwater Permit (the currently active version went into effect on April 5, 2019, and Ecology is in the process of renewing this permit). For the purpose of assigning WLAs, we distinguished between drainage areas within jurisdictional boundaries that drain to municipal separate storm sewer systems (MS4s) – these areas were assigned WLAs – and areas disconnected from the MS4 systems in the watershed, which drain directly to a surface water. The latter are treated as nonpoint sources and are assigned load allocations. The assignment of wasteload or load allocations to areas within the watershed was done by Ecology based on information received from these permittees.

As noted earlier, this TMDL assigns different municipal stormwater TSS allocations for different hydrologic conditions, or 'flow intervals', expressed as daily loads for each flow interval. The available loading capacity in each subbasin was distributed to each MS4 permittee based on the proportion of each jurisdiction's surface area within that subbasin (and excluding any other NPDES permittees that may overlap). For example, if a city's MS4 covered 20% of the area within a specific subbasin in the Soos, that entity received 20% of the remaining loading capacity for that subbasin. Appendix E includes details of this calculation, including the jurisdictional areas for each MS4 permittee.

Table 7 presents the final WLAs for each MS4 permittee. Tables 8 through 16 present the WLA for each individual MS4 permittee by subbasin and flow interval. If an MS4 is not present in a subbasin, its WLA in that subbasin is zero. Some MS4s have a very small portion of area within a subbasin, and subsequently, their calculated WLAs were small in magnitude – all calculated WLAs below 0.1 lb./day are therefore expressed as "< 0.1 lb./day" to account for the negligible amount of loading from very small surface areas associated with those permittees in those subbasins. Appendix E outlines the steps of the analysis performed to derive the allocations in this section.

Table 7. Cumulative WLAs for each MS4 permittee for each flow interval at the watershed scale

MS4 permittee	WLA in < 2.5% Flow Interval (lbs/day)	WLA in 2.5-5% Flow Interval (lbs/day)	WLA in 5-10% Flow Interval (lbs/day)	WLA in 10-20% Flow Interval (lbs/day)	WLA in 20-30% Flow Interval (lbs/day)	WLA in 30-50% Flow Interval (lbs/day)	WLA in > 50% Flow Interval (lbs/day)
Auburn	556.9	243.4	115.4	61.0	35.9	16.2	5.1
Black Diamond	1,171.0	501.6	245.1	113.7	64.5	28.2	5.4
Covington	842.4	349.5	162.2	102.4	73.3	47.2	14.9
Kent	1472.7	619.5	274.0	134.0	78.6	36.3	10.6
Kent School District	54.1	21.3	9.9	4.7	2.7	1.4	0.4
King County	7,767.6	3,316.2	1,581.0	805.0	499.0	260.1	62.8
Maple Valley	1,254.3	562.4	270.3	158.1	109.4	64.4	15.9
Renton	97.6	34.6	10.0	1.8	1.1	0.7	0.1
WSDOT	366.1	159.7	76.2	42.1	27.1	14.8	3.9

Municipal stormwater WLAs are gross allocations and will not be apportioned to specific outfalls. The TMDL develops a WLA for the entire pollution-generating impervious and pervious surfaces within the boundaries of each permittee's jurisdiction, by subbasin.

Wasteload Allocations for Municipal Stormwater Permittees

Permittee Name: City of Auburn
Permit Number: WAR045502
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Soosette Creek and Big Soos Creek
Listing ID of Receiving Water: 97929 and 97925

Table 8. TSS wasteload allocations for the City of Auburn by subbasin and for each flow interval

Subbasin	Flow Interval	Auburn WLA (lbs/day)
Total Watershed	**< 2.5%**	**556.9**
Total Watershed	**2.5-5%**	**243.4**
Total Watershed	**5-10%**	**115.4**
Total Watershed	**10-20%**	**61.0**
Total Watershed	**20-30%**	**35.9**
Total Watershed	**30-50%**	**16.2**
Total Watershed	**> 50%**	**5.1**
Soosette	< 2.5%	491.2
Soosette	2.5-5%	214.5
Soosette	5-10%	102.1
Soosette	10-20%	54.3
Soosette	20-30%	32.1
Soosette	30-50%	14.3
Soosette	> 50%	4.8
Lower Big Soos	< 2.5%	65.8
Lower Big Soos	2.5-5%	28.9
Lower Big Soos	5-10%	13.3
Lower Big Soos	10-20%	6.7
Lower Big Soos	20-30%	3.8
Lower Big Soos	30-50%	1.9
Lower Big Soos	> 50%	0.3

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: City of Black Diamond
Permit Number: WAR045505
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Jenkins Creek, Ravensdale Creek, two unnamed tributaries to Rock Creek[11], and Big Soos Creek
Listing IDs of Receiving Water: 97927, 97928, 97933, 97935, and 97925

Table 9. TSS wasteload allocations for the City of Black Diamond by subbasin and for each flow interval

Subbasin	Flow Interval	Black Diamond WLA (lbs/day)
Total Watershed	**< 2.5%**	**1,171.0**
Total Watershed	**2.5-5%**	**501.6**
Total Watershed	**5-10%**	**245.1**
Total Watershed	**10-20%**	**113.7**
Total Watershed	**20-30%**	**64.5**
Total Watershed	**30-50%**	**28.2**
Total Watershed	**> 50%**	**5.4**
Jenkins	< 2.5%	1.7
Jenkins	2.5-5%	0.8
Jenkins	5-10%	0.4
Jenkins	10-20%	0.2
Jenkins	20-30%	0.2
Jenkins	30-50%	0.1
Jenkins	> 50%	< 0.1
Covington	< 2.5%	1,169.3
Covington	2.5-5%	500.8
Covington	5-10%	244.8
Covington	10-20%	113.5
Covington	20-30%	64.3
Covington	30-50%	28.1
Covington	> 50%	5.4

Other load limits and requirements: See Additional Requirements subsection below.

[11] For the purpose of WLA calculations, Ravensdale Creek and Rock Creek are included in the Covington Creek subwatershed.

Permittee Name: City of Covington
Permit Number: WAR045510
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Jenkins Creek, Little Soos Creek, and Big Soos Creek
Listing ID of Receiving Water: 97927, 97934, and 97925

Table 10. TSS WLAs for the City of Covington by subbasin and for each flow interval

Subbasin	Flow Interval	Covington WLA (lbs/day)
Total Watershed	**< 2.5%**	**842.4**
Total Watershed	**2.5-5%**	**349.5**
Total Watershed	**5-10%**	**162.2**
Total Watershed	**10-20%**	**102.4**
Total Watershed	**20-30%**	**73.3**
Total Watershed	**30-50%**	**47.2**
Total Watershed	**> 50%**	**14.9**
Upper Big Soos	< 2.5%	53.9
Upper Big Soos	2.5-5%	19.1
Upper Big Soos	5-10%	5.5
Upper Big Soos	10-20%	1.0
Upper Big Soos	20-30%	0.6
Upper Big Soos	30-50%	0.4
Upper Big Soos	> 50%	< 0.1
Little Soos	< 2.5%	186.4
Little Soos	2.5-5%	54.2
Little Soos	5-10%	25.0
Little Soos	10-20%	16.7
Little Soos	20-30%	10.3
Little Soos	30-50%	7.6
Little Soos	> 50%	4.8
Jenkins	< 2.5%	602.1
Jenkins	2.5-5%	276.1
Jenkins	5-10%	131.6
Jenkins	10-20%	84.7
Jenkins	20-30%	62.3
Jenkins	30-50%	39.2
Jenkins	> 50%	10.0

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: City of Kent
Permit Number: WAR045520
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Soosette Creek, unnamed tributary to Big Soos Creek, and Big Soos Creek
Listing ID of Receiving Water: 97929, 97930, 97931, and 97925

Table 11. TSS wasteload allocations for the City of Kent by subbasin and for each flow interval

Subbasin	Flow Interval	Kent WLA (lbs/day)
Total Watershed	**< 2.5%**	**1,472.7**
Total Watershed	**2.5-5%**	**619.5**
Total Watershed	**5-10%**	**274.0**
Total Watershed	**10-20%**	**134.0**
Total Watershed	**20-30%**	**78.6**
Total Watershed	**30-50%**	**36.3**
Total Watershed	**> 50%**	**10.6**
Soosette	< 2.5%	948.7
Soosette	2.5-5%	414.4
Soosette	5-10%	197.2
Soosette	10-20%	104.9
Soosette	20-30%	62.0
Soosette	30-50%	27.6
Soosette	> 50%	9.2
Upper Big Soos	< 2.5%	294.4
Upper Big Soos	2.5-5%	104.4
Upper Big Soos	5-10%	30.2
Upper Big Soos	10-20%	5.5
Upper Big Soos	20-30%	3.4
Upper Big Soos	30-50%	2.0
Upper Big Soos	> 50%	0.4
Lower Big Soos	< 2.5%	229.6
Lower Big Soos	2.5-5%	100.8
Lower Big Soos	5-10%	46.5
Lower Big Soos	10-20%	23.5
Lower Big Soos	20-30%	13.2
Lower Big Soos	30-50%	6.7
Lower Big Soos	> 50%	1.0

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: Kent School District
Permit Number: WAR045713
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Covington Creek, Little Soos Creek, and Big Soos Creek
Listing ID of Receiving Water: 97934, 97931, 97930, and 97925

Table 12. TSS wasteload allocations for Kent School District by subbasin and for each flow interval

Subbasin	Flow Interval	Kent School District WLA (lbs/day)
Total Watershed	**< 2.5%**	**54.1**
Total Watershed	**2.5-5%**	**21.3**
Total Watershed	**5-10%**	**9.9**
Total Watershed	**10-20%**	**4.7**
Total Watershed	**20-30%**	**2.7**
Total Watershed	**30-50%**	**1.4**
Total Watershed	**> 50%**	**0.4**
Upper Big Soos	< 2.5%	5.9
Upper Big Soos	2.5-5%	2.1
Upper Big Soos	5-10%	0.6
Upper Big Soos	10-20%	0.1
Upper Big Soos	20-30%	< 0.1
Upper Big Soos	30-50%	< 0.1
Upper Big Soos	> 50%	< 0.1
Little Soos	< 2.5%	10.2
Little Soos	2.5-5%	3.0
Little Soos	5-10%	1.4
Little Soos	10-20%	0.9
Little Soos	20-30%	0.6
Little Soos	30-50%	0.4
Little Soos	> 50%	0.3
Covington	< 2.5%	37.9
Covington	2.5-5%	16.2
Covington	5-10%	7.9
Covington	10-20%	3.7
Covington	20-30%	2.1
Covington	30-50%	0.9
Covington	> 50%	0.2

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: King County
Permit Number: WAR044501
Permit Type: Phase I Municipal Stormwater General Permit
Waterbody Names: Covington Creek, Jenkins Creek, Little Soos Creek, Ravensdale Creek, unnamed tributary to Rock Creek, Soosette Creek, and Big Soos Creek
Listing ID of Receiving Water: 97927, 97932, 97934, 97928, 97935, 97929, 97930, 97925

Table 13. TSS wasteload allocations for King County by subbasin and for each flow interval

Subbasin	Flow Interval	King County WLA (lbs/day)
Total Watershed	**< 2.5%**	**7,767.6**
Total Watershed	**2.5-5%**	**3,316.2**
Total Watershed	**5-10%**	**1,581.0**
Total Watershed	**10-20%**	**805.0**
Total Watershed	**20-30%**	**499.0**
Total Watershed	**30-50%**	**260.1**
Total Watershed	**> 50%**	**62.8**
Soosette	< 2.5%	64.8
Soosette	2.5-5%	28.3
Soosette	5-10%	13.5
Soosette	10-20%	7.2
Soosette	20-30%	4.2
Soosette	30-50%	1.9
Soosette	> 50%	0.6
Upper Big Soos	< 2.5%	320.7
Upper Big Soos	2.5-5%	113.7
Upper Big Soos	5-10%	32.9
Upper Big Soos	10-20%	6.0
Upper Big Soos	20-30%	3.7
Upper Big Soos	30-50%	2.1
Upper Big Soos	> 50%	0.4
Little Soos	< 2.5%	321.8
Little Soos	2.5-5%	93.6
Little Soos	5-10%	43.2
Little Soos	10-20%	28.8
Little Soos	20-30%	17.9
Little Soos	30-50%	13.1
Little Soos	> 50%	8.2

Subbasin	Flow Interval	King County WLA (lbs/day)
Jenkins	< 2.5%	1,733.9
Jenkins	2.5-5%	795.1
Jenkins	5-10%	379.0
Jenkins	10-20%	243.9
Jenkins	20-30%	179.4
Jenkins	30-50%	113.0
Jenkins	> 50%	28.9
Covington	< 2.5%	4,940.7
Covington	2.5-5%	2,116.2
Covington	5-10%	1,034.2
Covington	10-20%	479.6
Covington	20-30%	271.7
Covington	30-50%	118.7
Covington	> 50%	22.9
Lower Big Soos	< 2.5%	385.7
Lower Big Soos	2.5-5%	169.3
Lower Big Soos	5-10%	78.1
Lower Big Soos	10-20%	39.5
Lower Big Soos	20-30%	22.1
Lower Big Soos	30-50%	11.2
Lower Big Soos	> 50%	1.7

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: City of Maple Valley
Permit Number : WAR045525
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Covington Creek, Jenkins Creek, and Big Soos Creek
Listing ID of Receiving Water: 97927, 97932, and 97925

Table 14. TSS wasteload allocations for the City of Maple Valley by subbasin and for each flow interval

Subbasin	Flow Interval	Maple Valley WLA (lbs/day)
Total Watershed	**< 2.5%**	**1,254.3**
Total Watershed	**2.5-5%**	**562.4**
Total Watershed	**5-10%**	**270.3**
Total Watershed	**10-20%**	**158.1**
Total Watershed	**20-30%**	**109.4**
Total Watershed	**30-50%**	**64.4**
Total Watershed	**> 50%**	**15.9**
Jenkins	< 2.5%	833.3
Jenkins	2.5-5%	382.1
Jenkins	5-10%	182.1
Jenkins	10-20%	117.2
Jenkins	20-30%	86.2
Jenkins	30-50%	54.3
Jenkins	> 50%	13.9
Covington	< 2.5%	421.0
Covington	2.5-5%	180.3
Covington	5-10%	88.1
Covington	10-20%	40.9
Covington	20-30%	23.2
Covington	30-50%	10.1
Covington	> 50%	2.0

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: City of Renton
Permit Number: WAR045539
Permit Type: Western Washington Phase II Municipal Stormwater General Permit
Waterbody Names: Big Soos Creek
Listing ID of Receiving Water: 97925 and 97930

Table 15. TSS wasteload allocations for the City of Renton by subbasin and for each flow interval

Subbasin	Flow Interval	Renton WLA (lbs/day)
Total Watershed	**< 2.5%**	**97.6**
Total Watershed	**2.5-5%**	**34.6**
Total Watershed	**5-10%**	**10.0**
Total Watershed	**10-20%**	**1.8**
Total Watershed	**20-30%**	**1.1**
Total Watershed	**30-50%**	**0.7**
Total Watershed	**> 50%**	**0.1**
Upper Big Soos	< 2.5%	97.6
Upper Big Soos	2.5-5%	34.6
Upper Big Soos	5-10%	10.0
Upper Big Soos	10-20%	1.8
Upper Big Soos	20-30%	1.1
Upper Big Soos	30-50%	0.7
Upper Big Soos	> 50%	0.1

Other load limits and requirements: See Additional Requirements subsection below.

Permittee Name: Washington State Department of Transportation
Permit Number: WAR043000
Permit Type: WSDOT Municipal Stormwater Permit
Waterbody Names: Jenkins Creek, Little Soos Creek, Ravensdale Creek, two unnamed tributaries to Rock Creek, Soosette Creek, and Big Soos Creek
Listing ID of Receiving Water: 97927, 97932, 97934, 97928, 97933, 97935, 97929, and 97925

Table 16. TSS wasteload allocations for WSDOT by subbasin and for each flow interval

Subbasin	Flow Interval	WSDOT WLA (lbs/day)
Total Watershed	**< 2.5%**	**366.1**
Total Watershed	**2.5-5%**	**159.7**
Total Watershed	**5-10%**	**76.2**
Total Watershed	**10-20%**	**42.1**
Total Watershed	**20-30%**	**27.1**
Total Watershed	**30-50%**	**14.8**
Total Watershed	**> 50%**	**3.9**
Soosette	< 2.5%	89.0
Soosette	2.5-5%	38.9
Soosette	5-10%	18.5
Soosette	10-20%	9.8
Soosette	20-30%	5.8
Soosette	30-50%	2.6
Soosette	> 50%	0.9
Little Soos	< 2.5%	2.0
Little Soos	2.5-5%	0.7
Little Soos	5-10%	0.2
Little Soos	10-20%	< 0.1
Little Soos	20-30%	< 0.1
Little Soos	30-50%	< 0.1
Little Soos	> 50%	< 0.1
Jenkins	< 2.5%	13.6
Jenkins	2.5-5%	4.0
Jenkins	5-10%	1.8
Jenkins	10-20%	1.2
Jenkins	20-30%	0.8
Jenkins	30-50%	0.6
Jenkins	> 50%	0.3

Subbasin	Flow Interval	WSDOT WLA (lbs/day)
Covington	< 2.5%	125.5
Covington	2.5-5%	57.5
Covington	5-10%	27.4
Covington	10-20%	17.7
Covington	20-30%	13.0
Covington	30-50%	8.2
Covington	> 50%	2.1
Lower Big Soos	< 2.5%	101.6
Lower Big Soos	2.5-5%	43.5
Lower Big Soos	5-10%	21.3
Lower Big Soos	10-20%	9.9
Lower Big Soos	20-30%	5.6
Lower Big Soos	30-50%	2.4
Lower Big Soos	> 50%	0.5

Other load limits and requirements: See Additional Requirements subsection below.

Other Load Limits and Requirements

MS4 permits are updated approximately every five years. Ecology incorporates new requirements based on EPA-approved TMDLs at each permit renewal. Actions related to this TMDL that will be incorporated in future MS4 permits include the following:

- Municipalities are expected to achieve WLAs through permit requirements, prioritizing stormwater planning, and retrofit projects (1) to reduce the delivery of fine sediment, measured by TSS, and (2) to control flows to levels that are equal to pre-development runoff. Refer to the Point Sources & Implementation Actions section for additional information.
- All MS4 permittees in the Soos Creek watershed are required by their respective permits to develop Stormwater Management Programs (SWMP) that include a set of actions and activities that meet permit requirements, including any additional actions necessary to meet the requirements of applicable TMDLs. In addition to the WLAs specified in tables 8 – 16, the TMDL requires each MS4 permittee to also develop a Stormwater Implementation Plan. The plan may be a standalone document or incorporated in the permittees' SWMP plans. The Stormwater Implementation Plan will identify and prioritize specific actions the jurisdiction will take to meet the WLAs in this TMDL. The plan will include a prioritization of stormwater BMPs (structural and programmatic) to achieve the identified WLAs and a methodology to track projects that contribute to TSS

reduction and flow control. The plan should take into account findings from this TMDL, Mohamedali (2024), and any other local knowledge that permittees have of individual watershed reaches. It is recommended that the Stormwater Implementation Plan go through an internal and external outreach process to ensure that the plan goals and objectives are supported by relevant municipal departments and local communities. The Stormwater Implementation Plan should be updated periodically, following an adaptive management approach.

- The Stormwater Implementation Plan should include at a minimum a detailed implementation schedule, an estimated date for meeting applicable WLAs, cost estimates for all elements of the plan, a system that evaluates and tracks implementation to document progress towards meeting established benchmarks, and a public participation program. The plan should also include a description of existing conditions and list areas that have already been retrofitted, if applicable, when the retrofit occurred, and any current actions implemented that reduce TSS. Actions resulting in TSS reductions from the implementation of MS4 permit requirements (e.g., the Stormwater Management Program or SWMP) in the Soos Creek watershed may also be included in the Stormwater Implementation Plan.

MS4 Permittees are encouraged to collaborate to develop programs and to implement BMPs, to the extent possible and consistent with existing MS4 permit requirements.

- Achievement of the MS4 WLAs will require municipalities to take targeted actions in the MS4 drainage areas where TSS and stormwater flows are not currently managed, are only partially managed, or are managed with structural stormwater BMPs designed under older criteria. Retrofitting these areas is necessary.
- Documentation of implementation actions is necessary to evaluate the effectiveness of the TMDL and document attainment of relevant water quality criteria. Annual reporting is required by the MS4 permits, and Ecology expects that MS4 permittees included in this TMDL will prepare and submit detailed information about activities conducted each calendar year that are targeted to implement the WLAs. Reported information should include, but not be limited to, equivalent TSS reductions and/or equivalent acres with controlled flows associated with each BMP.
- In addition to the BMPs described in this TMDL’s Implementation Plan, if other structural or operational practices are used, the resulting TSS reductions can be counted towards meeting the wasteload allocations, provided Ecology concurs with the calculation of the BMP effectiveness.

Industrial and Construction Stormwater Permittees

There are six industrial permittees with relevant footprints in the Soos Creek watershed, in addition to more temporary construction stormwater permittees, that are assigned wasteload allocations in this TMDL. These WLAs were calculated using the Simple Method, which estimates annual pollutant loads based on expected pollutant concentrations, the permitted area over which stormwater runoff occurs, the extent of impervious cover, and the amount of annual runoff due to rainfall from the site (Schueler, 1987). A description of the Simple Method parameters used to calculate the WLA for each permittee can be found in Appendix E.

For the purpose of their permits, the WLAs are expressed as an annual daily average limit. However, in order to facilitate the calculation of WLAs for MS4s and LAs for nonpoint sources (both of which are expressed by flow interval), we needed to distribute these loads by flow intervals. This allowed us to subtract these WLAs from the loading capacity and determine the remaining capacity (more details in how these loads were distributed into flow intervals can be found in Appendix E). Table 17 lists the industrial and construction stormwater permittees in the watershed that receive a WLA, including their average annual daily WLA, as well as how this load is distributed by flow interval. This information is followed by individual WLA tables for each of these permittees. Entities authorized to discharge solely to groundwater under state authority were not assigned allocations as they are not NPDES permittees, and their groundwater discharges are not expected to have an impact on TSS loads.

Table 17. TSS WLAs for industrial and construction stormwater permittees in the Soos Creek watershed

Permittee	Annual TSS WLA (lbs/day)	TSS load in 2.5% flow interval (lbs/day)	TSS load in 2.5-5% flow interval (lbs/day)	TSS load in 5-10% flow interval (lbs/day)	TSS load in 10-20% flow interval (lbs/day)	TSS load in 20-30% flow interval (lbs/day)	TSS load in 30-50% flow interval (lbs/day)	TSS load in > 50% flow interval (lbs/day)
Pacific Coast Coal	**18.9**	10.64	4.29	2.03	1.01	0.58	0.27	0.06
Palmer Coking (PCCC Industrial)	**11.1**	6.25	2.52	1.19	0.59	0.34	0.16	0.03
Reserve Silica	**9.6**	5.41	2.18	1.03	0.51	0.30	0.14	0.03
Black Diamond Auto Wrecking	**1.0**	0.57	0.23	0.11	0.05	0.03	0.01	0.003
Lakepointe (Lakeside Industrial)	**46.9**	26.44	10.67	5.05	2.50	1.45	0.68	0.14

Permittee	Annual TSS WLA (lbs/day)	TSS load in 2.5% flow interval (lbs/day)	TSS load in 2.5-5% flow interval (lbs/day)	TSS load in 5-10% flow interval (lbs/day)	TSS load in 10-20% flow interval (lbs/day)	TSS load in 20-30% flow interval (lbs/day)	TSS load in 30-50% flow interval (lbs/day)	TSS load in > 50% flow interval (lbs/day)
Construction SW Permittees	**34.1**	19.21	7.75	3.67	1.82	1.05	0.49	0.10
WDFW Soos Hatchery	**28.1**	0.61	0.75	1.57	3.37	3.35	7.12	11.31
Total	**150**	**69.1**	**28.4**	**14.7**	**9.9**	**7.1**	**8.9**	**11.7**

Note: Only the WLAs expressed as annual daily average loads are intended to be used to develop permit requirements. The average daily loads by flow interval are shared because they were used in the calculation of other allocations (i.e., WLAs for MS4s and LAs).

Wasteload Allocations for Non-Municipal Stormwater Permittees

Permittee Name: Pacific Coast Coal
Permit Number: WA0030830
Permit Type: Industrial NPDES Individual Permit
Waterbody Names: Unnamed tributary to Rock Creek and Big Soos Creek
Listing ID of Receiving Water: 97935 and 97925

Table 18. TSS WLAs for Pacific Coast Coal

WLA	Unit	Pollutant	Critical Period	Additional Information
18.9	Pounds / day	TSS	Year round	See Other Load Limits and Requirements section below.

Permittee Name: Palmer Coking Coal Company (PCCC Industrial)
Permit Number: WAR001189
Permit Type: Industrial Stormwater General Permit
Waterbody Names: Unnamed tributary to Rock Creek and Big Soos Creek
Listing ID of Receiving Water: 97933 and 97925

Table 19. TSS WLAs for Palmer Coking Coal Company (PCCC Industrial)

WLA	Unit	Pollutant	Critical Period	Additional Information
11.1	Pounds / day	TSS	Year round	See Other Load Limits and Requirements section below.

Permittee Name: Reserve Silica
Permit Number: WAG503029
Permit Type: Sand and Gravel General Permit
Waterbody Names: Unnamed wetland eventually draining to Lake Sawyer, Covington Creek and Big Soos Creek
Listing ID of Receiving Water: 97928 and 97925

Table 20. TSS WLAs for Reserve Silica

WLA	Unit	Pollutant	Critical Period	Additional Information
9.6	Pounds / day	TSS	Year round	See Other Load Limits and Requirements section below.

Permittee Name: Black Diamond Auto Wrecking
Permit Number: WAR004125
Permit Type: Industrial Stormwater General Permit
Waterbody Names: Unnamed tributary to Rock Creek and Big Soos Creek
Listing ID of Receiving Water: 97933 and 97925

Table 21. TSS WLAs for Black Diamond Auto Wrecking

WLA	Unit	Pollutant	Critical Period	Additional Information
1.0	Pounds / day	TSS	Year round	See Other Load Limits and Requirements section below.

Permittee Name: Lakepointe (Lakeside Industrial)
Permit Number: WAG503267
Permit Type: Sand and Gravel General Permit
Waterbody Name: Jenkins
Listing ID of Receiving Water: 97927, 97932, and 97925

Table 22. TSS WLAs for Lakepointe (Lakeside Industrial)

WLA	Unit	Pollutant	Critical Period	Additional Information
46.9	Pounds / day	TSS	Year round	See Other Load Limits and Requirements section below.

Permittee Name: Multiple permittees
Permit Number: Multiple permits
Permit Type: Construction Stormwater General Permit
Waterbody Name: All subbasins
Listing ID of Receiving Water:
Location of NPDES-permitted construction discharges varies over time and across the watershed, and construction stormwater permittees are therefore associated with multiple listing ID's: 97925, 97927, 97928, 97929, 97930, 97931, 97932, 97933, 97934, and 97935.

Table 23. TSS WLAs for Construction Stormwater permittees

WLA	Unit	Pollutant	Critical Period	Additional Information
34.1	Pounds / day	TSS	Year round	See Other Load Limits and Requirements section below.

Permittee Name: Washington Department of Fish and Wildlife (WDFW) Soos Creek Hatchery
Permit Number: WAG133014
Permit Type: Upland Fish Hatchery General Permit
Waterbody Name: Big Soos Creek
Listing ID of Receiving Water: 97925

Table 24. TSS WLAs for the WDFW Soos Creek Hatchery

Month	WLA (lbs/month)	Load during feeding (lbs/month)	Load during drawdown (lbs/month)
January	627	627	0
February	755	755	0
March	1,463	1,463	0
April	1,485	1,416	69
May	1,532	1,463	69
June	849	809	40
July	283	283	0
August	283	283	0
September	850	850	0
October	850	850	0
November	850	850	0
December	425	425	0
Annual WLA (lbs/day)	**28.1**		
Annual WLA (tons/year)	**5.1**		

Note: See Appendix E for a discussion of the basis for expressing hatchery WLAs monthly and annually.

Other Load Limits and Requirements

Industrial and construction point source permits are updated approximately every five years. Ecology incorporates new requirements based on EPA-approved TMDLs at each permit renewal. The WLAs for these permittees are based on the following:

- No more than a 25 mg/L TSS effluent limit for all industrial permittees identified in Table 18 - Table 21. See Appendix E for concentrations not to be exceeded for Lakepoint and the Soos Creek hatchery.
- Compliance with the Construction Stormwater General Permit, including but not limited to the turbidity benchmark.

In addition, regular TSS monitoring is necessary to track the effectiveness of implementing the permits' requirements. The monitoring frequency will be expected to occur at least monthly. Construction permittees will continue to monitor their discharges in terms of turbidity.

Load Allocations

Load allocations (LAs) represent the portion of the loading capacity reserved for nonpoint sources and natural background. Load allocations for this TMDL are applied to all areas in the watershed not covered by a permit, e.g. areas of the watershed that are outside of the NPDES permittee footprints and that drain directly to surface waters (Figure 9). This loading capacity is based on the TSS load that would be generated from these areas in the absence of human development, using the TSS output(s) generated by HSPF watershed model under forested conditions.

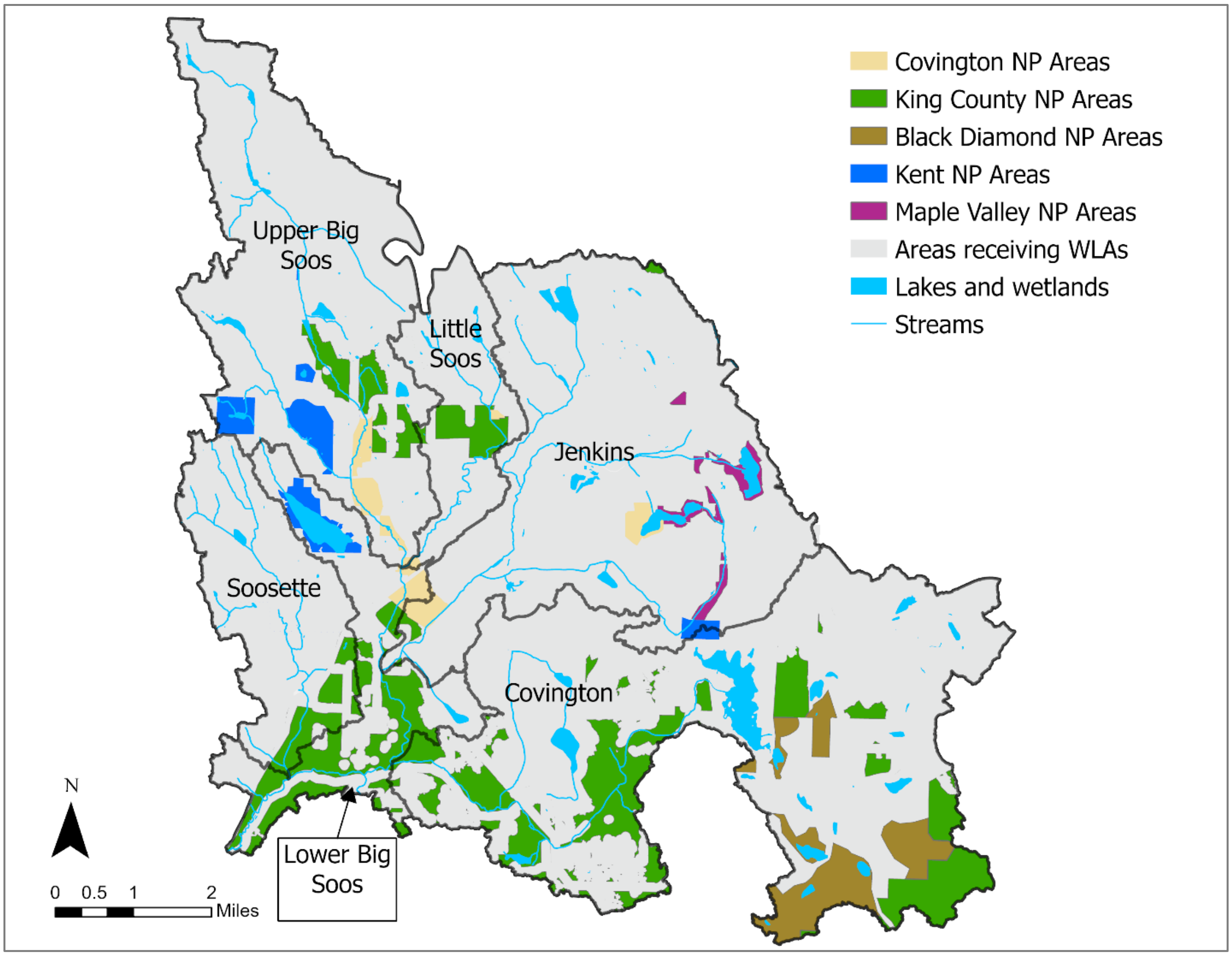

Figure 9. Portions of the Soos Creek watershed where load allocations are assigned to nonpoint (NP) areas, by subbasin

Natural background sources are inputs that would be expected under natural, undisturbed conditions. These sources can include natural geologic processes, such as upland erosion of areas not disturbed by human activity or loadings from forests and other natural land covers. In this TMDL, since the loading capacity is based on forested conditions, the natural background is accounted for implicitly in the load allocation. As a result, the entire load allocation, presented in Table 25, represents the natural background TSS loads. Similar to the WLA calculations, the LAs are estimated based on median TSS loadings within each flow interval modeled for each subbasin, which are distributed proportionally using the nonpoint surface areas in each subbasin (Figure 9).

Table 25. TSS load allocations

Flow Interval	Subbasin	Load Allocations (lbs/day)
< 2.5%	**Total Watershed**	**3,733.1**
2.5-5%	**Total Watershed**	**1,593.4**
5-10%	**Total Watershed**	**763.6**
10-20%	**Total Watershed**	**369.4**
20-30%	**Total Watershed**	**215.9**
30-50%	**Total Watershed**	**102.7**
> 50%	**Total Watershed**	**22.6**
< 2.5%	Soosette	172.6
2.5-5%	Soosette	75.4
5-10%	Soosette	35.9
10-20%	Soosette	19.1
20-30%	Soosette	11.3
30-50%	Soosette	5.0
> 50%	Soosette	1.7
< 2.5%	Upper Big Soos	100.6
2.5-5%	Upper Big Soos	35.7
5-10%	Upper Big Soos	10.3
10-20%	Upper Big Soos	1.9
20-30%	Upper Big Soos	1.2
30-50%	Upper Big Soos	0.7
> 50%	Upper Big Soos	0.1
< 2.5%	Little Soos	84.8
2.5-5%	Little Soos	24.7
5-10%	Little Soos	11.4
10-20%	Little Soos	7.6
20-30%	Little Soos	4.7
30-50%	Little Soos	3.4
> 50%	Little Soos	2.2
< 2.5%	Jenkins	252.3
2.5-5%	Jenkins	115.7
5-10%	Jenkins	55.2
10-20%	Jenkins	35.5
20-30%	Jenkins	26.1
30-50%	Jenkins	16.4
> 50%	Jenkins	4.2

Flow Interval	Subbasin	Load Allocations (lbs/day)
< 2.5%	Covington	2709.9
2.5-5%	Covington	1160.7
5-10%	Covington	567.3
10-20%	Covington	263.0
20-30%	Covington	149.0
30-50%	Covington	65.1
> 50%	Covington	12.6
< 2.5%	Lower Big Soos	412.8
2.5-5%	Lower Big Soos	181.2
5-10%	Lower Big Soos	83.6
10-20%	Lower Big Soos	42.3
20-30%	Lower Big Soos	23.6
30-50%	Lower Big Soos	12.0
> 50%	Lower Big Soos	1.8

Note: The number of acres in each subbasin that are assigned LAs are as follows (these can be used to calculate the normalized LA for smaller areas within each subbasin): Soosette (336 acres), Upper Big Soos (876 acres), Little Soos (304 acres), Jenkins (702 acres), Covington (3,639 acres), Lower Big Soos (1,159 acres).

Margin of Safety

The margin of safety (MOS) is included in the TMDL calculation to offset uncertainties related to the methodology used to establish a relationship between pollutant loading rates and water quality (Section 303(d)(1)(C) of the Clean Water Act and Title 40, Section 130.7(c)(1) of the Code of Federal Regulations). In general, there are two accepted approaches for estimating the MOS of a TMDL: an implicit and an explicit approach. An implicit approach is used when the calculation of the TMDL uses conservative assumptions which means the calculation has a built-in MOS, while an explicit approach is used when a specific portion of the TMDL is set aside for the MOS. In this TMDL, the MOS is implicit because the loading capacity is based on model-predicted TSS concentrations under fully forested conditions within each modeled flow interval. The model-estimated TSS load under fully forested conditions provides an implicit MOS since it represents TSS loads in the absence of any human development. Fully forested conditions with no development represent the most optimal watershed conditions and is therefore a conservative assumption.

Reserve Capacity

Some TMDLs set aside a portion of the WLA to account for future growth and development in the watershed. No allocations are reserved for future growth in this TMDL for the following reasons:

- The wasteload and load allocations are based on reference (forested) conditions. This means that when the TMDL is fully implemented, all developed areas are expected to mimic these conditions. Any new or redevelopment that will occur in the Soos Creek watershed will need to be designed to meet the forested-condition flow control and/or TSS assumption.
- If some current land uses change to development, load allocations associated with the reference conditions will be shifted to wasteload allocations for the respective permittee, and that jurisdiction is responsible for ensuring that BMPs are implemented such that there are no net increases in TSS loadings from the land cover changes.

TMDL Calculation

Table 26 presents the distribution of the loading capacity, at the watershed scale, between wasteload allocations and load allocations. After establishing the WLAs for industrial and construction permittees (as described in previous sections), we then subtracted these out of the loading capacity to calculate the remaining loading capacity available to distribute between MS4 permittees. Since the industrial and construction WLAs are expressed as annual WLAs (or monthly and annual WLAs in the case of the Soos hatchery) but the loading capacity is expressed by flow interval, we first had to distribute the magnitude of these WLAs between each flow interval – or translate these annual WLAs into magnitudes associated with each flow interval. More details on the steps followed to translate these are included in Appendix E.

Table 26. Distribution of the TSS loading capacity between wasteload allocations for various permittees and load allocations, for each flow interval at the mouth of the Soos watershed

	TSS Load in < 2.5% flow interval (lbs/day)	TSS Load in 2.5-5% flow interval (lbs/day)	TSS Load in 5-10% flow interval (lbs/day)	TSS Load in 10-20% flow interval (lbs/day)	TSS Load in 20-30% flow interval (lbs/day)	TSS Load in 30-50% flow interval (lbs/day)	TSS Load in > 50% flow interval (lbs/day)
Loading capacity	**17,385**	**7,430**	**3,522**	**1,802**	**1,115**	**581**	**153**
Soos Hatchery	0.6	0.7	1.6	3.4	3.4	7.1	11.3
Industrial and construction permittees*	68.5	27.6	13.1	6.5	3.7	1.8	0.4
Auburn WLA	556.9	243.4	115.4	61.0	35.9	16.2	5.1

	TSS Load in < 2.5% flow interval (lbs/day)	TSS Load in 2.5-5% flow interval (lbs/day)	TSS Load in 5-10% flow interval (lbs/day)	TSS Load in 10-20% flow interval (lbs/day)	TSS Load in 20-30% flow interval (lbs/day)	TSS Load in 30-50% flow interval (lbs/day)	TSS Load in > 50% flow interval (lbs/day)
Black Diamond WLA	1,171.0	501.6	245.1	113.7	64.5	28.2	5.4
Covington WLA	842.4	349.5	162.2	102.4	73.3	47.2	14.9
Kent WLA	1,472.7	619.5	274.0	134.0	78.6	36.3	10.6
Maple Valley WLA	54.1	21.3	9.9	4.7	2.7	1.4	0.4
Renton WLA	7,767.6	3,316.2	1,581.0	805.0	499.0	260.1	62.8
WSDOT WLA	1,254.3	562.4	270.3	158.1	109.4	64.4	15.9
King County WLA	97.6	34.6	10.0	1.8	1.1	0.7	0.1
Kent School District WLA	366.1	159.7	76.2	42.1	27.1	14.8	3.9
Load allocations	3,733.1	1,593.4	763.6	369.4	215.9	102.7	22.6

* This line represents all industrial and construction stormwater permittees' WLAs by flow interval (from Table 17). Appendix E explains how these WLAs were translated from annual averages to flow intervals. Permitted effluent limits for specific facilities will be calculated using WLAs from tables 18-24.

Implementation Plan

Introduction

This implementation plan was developed jointly by Ecology and interested and responsible parties. The plan describes actions that need to be taken to improve water quality and restore stream health in Soos Creek as indicated by the recovery of benthic invertebrate communities. The plan explains the roles and authorities of partners responsible for management actions, along with the programs or other means through which they will address these water quality issues. It prioritizes specific actions expected to improve water quality and achieve water quality standards. TMDL reductions are expected to be achieved by 2066, and the water quality standards are expected to be met by 2070.

This implementation plan presents the following information:

- Geographic setting – Describes any Tribal lands and the existing land cover in the Soos Creek watershed as important context for implementation actions.
- Point sources of pollution and implementation actions – describes the NPDES permits in the Soos Creek watershed and their existing permit requirements relevant to this TMDL. Provides details about implementation actions for point sources including structural stormwater best management practices, low impact development principles, and NPDES permitting procedures and relevant additional requirements.

Some wasteload allocations will be self-implementing through the administration of the NPDES program. These are discussed further in the Implementation Plan. The TMDL lead for this project is tasked to work with Ecology's permit managers to ensure that the new WLAs become permit conditions when the respective NPDES permits are renewed. This includes the Phase I and Phase II MS4 permits, which are expected to be renewed in 2029.

- Nonpoint sources of pollution and implementation actions – describes the nonpoint pollution sources in the Soos Creek watershed. Provides details about implementation actions for nonpoint sources.

Nonpoint load reductions will be achieved primarily by reducing TSS and stormwater runoff from upland areas that are developed but not assigned WLAs because they drain directly to surface waters. These actions will be implemented by municipalities in the watershed, as well as by organizations like the King Conservation District or Midsound Fisheries Enhancement Group. Where protection or restoration of upland areas is necessary to reduce TSS loadings, nonprofit organizations, like Midsound Fisheries Enhancement Group, Green River Coalition, Orca Conservancy, and jurisdictional entities, like King County and cities in the watershed, will implement BMPs that are consistent with Ecology' Voluntary Clean Water Guidance for Agriculture (Ecology 2020). Other actions that result in the restoration of the channel morphology and complexity for the streams in the Soos Creek basin will also help improve benthic habitat. These actions should be considered in addition to, not in lieu of, actions that meet WLAs and LAs.

While this TMDL establishes a TSS loading target for the entire Soos Creek, watershed managers and other interested parties should keep in mind that the endpoint of this TMDL and its successful implementation are based on improvements to benthic macroinvertebrate health. TSS load reductions are critical to accomplishing this goal because they are based on modeled simulation of reference conditions when benthic invertebrates were not impaired by land uses (i.e., the TMDL target is defined as the point where TSS loads match those expected under pre-development conditions). However, the waters cannot be classified as meeting water quality standards until it is demonstrated that the biological health of the stream system, measured in terms of B-IBI scores, is no longer impaired. In planning any implementation efforts related to this TMDL, careful consideration should be given both to the fine sediment load reductions and to their direct potential impacts on aquatic macroinvertebrate communities.

Tribal Lands

The Soos Creek watershed is located on the traditional homelands of the Muckleshoot Indian Tribe. However, no part of the watershed is located within the boundary of the federally recognized Tribal land. The TMDL doesn’t allocate a pollutant load to any federally recognized Tribal Nations in this watershed.

Land Cover Distribution

Soos Creek drains approximately 66 square miles in south King County. Seven municipal jurisdictions are located with the watershed area and include unincorporated King County (55% of Soos Creek watershed) and the cities of Kent (15%), Covington and Black Diamond (each covering 9% of the watershed), Maple Valley (8%), Auburn (3%), and Renton (2%). State Route 18 bisects the watershed starting at the mouth with the Green River to Maple Valley, in the northern part of the watershed.

The watershed is located within commuting distance to Seattle and has experienced tremendous rates of growth and development, similar to those of other areas within King County. Based on 2021 National Land Cover Database (NLCD), almost 40% of the watershed was considered developed, with an additional 20% of the drainage classified as open space within developed areas. Evergreen, deciduous, and mixed forests represent 27% of the watershed (Figure 10). Table 27 shows a breakdown of the major land cover categories within each subbasin. Data indicate that Soosette, Upper Big Soos, and Jenkins have the highest levels of development, 60%, 50%, and 46% of the respective subbasins, and have the lowest forest cover at 12%, 16%, and 23%, respectively. The drainage area of Covington Creek is the least developed, with only 24% development, and has the largest proportion of forest cover (43%), most of it in the eastern portion of the subbasin, upstream of Lake Sawyer.

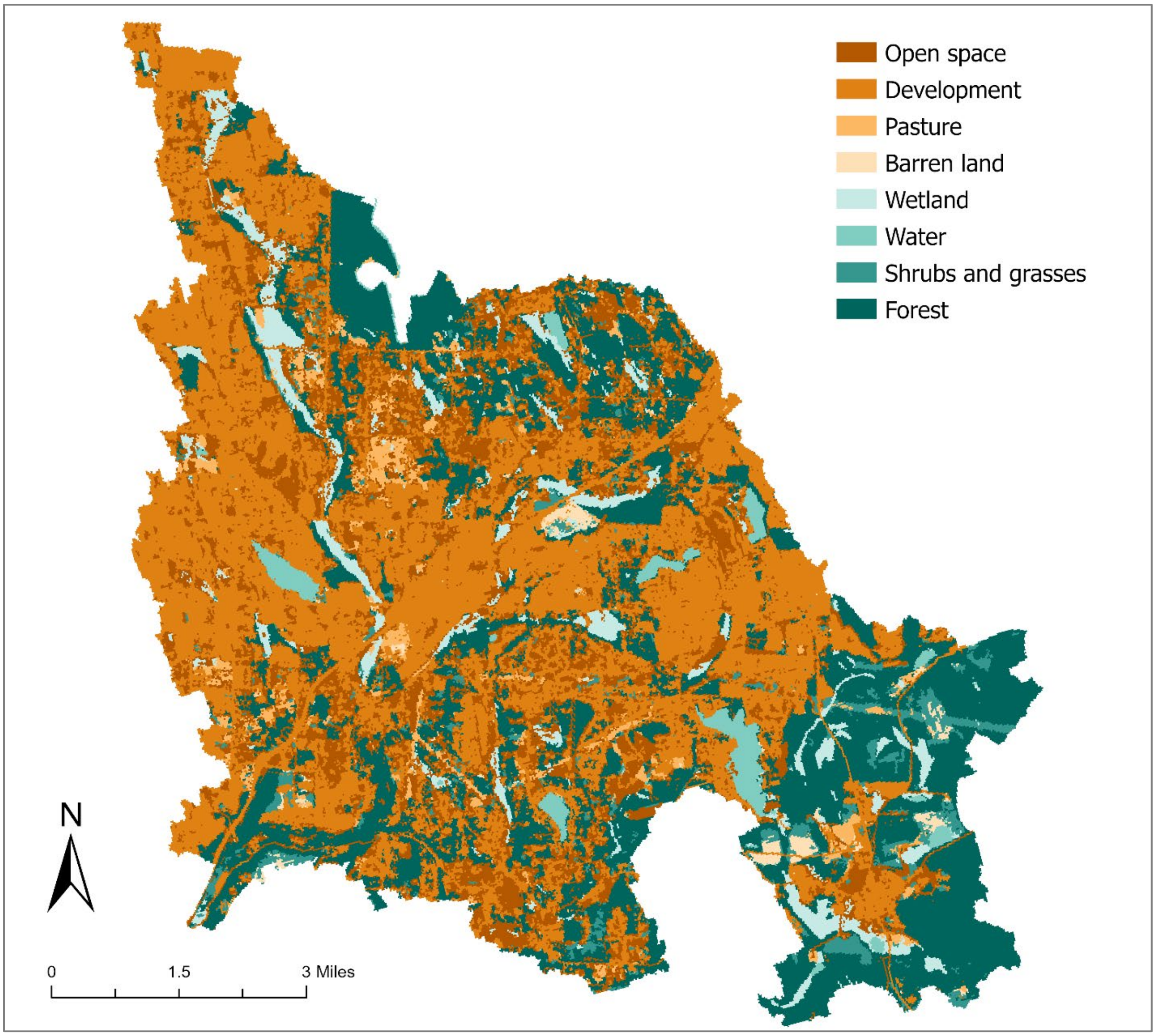

Figure 10. Land cover distribution in Soos Creek in 2021

Table 27. Land cover distribution in the Soos Creek watershed, by subbasin, based on 2021 NLCD data

Land cover type	Covington	Jenkins	Little Soos	Soosette	Upper Big Soos	Lower Big Soos	Total
Barren land	1.2%	0.7%	0.1%	0.3%	0.1%	0.9%	0.7%
Development	24.0%	46.0%	37.7%	60.0%	49.8%	43.0%	39.8%
Forest	43.0%	22.8%	28.2%	11.6%	15.9%	23.2%	27.7%
Open space	16.9%	21.8%	25.4%	20.9%	21.5%	19.5%	20.0%
Agriculture/ Pasture	2.2%	1.1%	4.1%	3.5%	4.1%	3.1%	2.6%
Shrub/Scrub	5.7%	1.6%	1.2%	2.0%	1.2%	4.1%	3.1%
Water	2.9%	1.7%	0.1%	0.0%	0.4%	3.9%	1.8%
Wetland	4.3%	4.3%	3.1%	1.6%	7.1%	2.3%	4.4%

Not all developed areas are covered by impervious surfaces, as lawns and landscaped areas are considered pervious. However, it is well understood that developed pervious surfaces are less effective at reducing stormwater runoff than forests are (Ecology 2024). While development represents 40% of the Soos Creek watershed, impervious surfaces cover 20% of the total drainage area. The spatial distribution pattern among different subbasins observed above for development holds for impervious cover, as well. Soosette, Upper Big Soos, and Jenkins have the highest proportion of impervious surfaces that cover 31%, 25%, and 24% of each subbasin, respectively, while the Covington Creek drainage has the least impervious cover, at 11% (Figure 11). Effective impervious areas (EIA) are a subset of impervious areas and represent the impervious surfaces that are hydraulically connected to surface waters via a collection drainage system usually made up of pipes or ditches. Empirical data on how much of the impervious surfaces are effective impervious surfaces are not available for Soos Creek, though Mohamedali (2024) discusses how assumptions of EIA spatial distribution were incorporated in the watershed model.

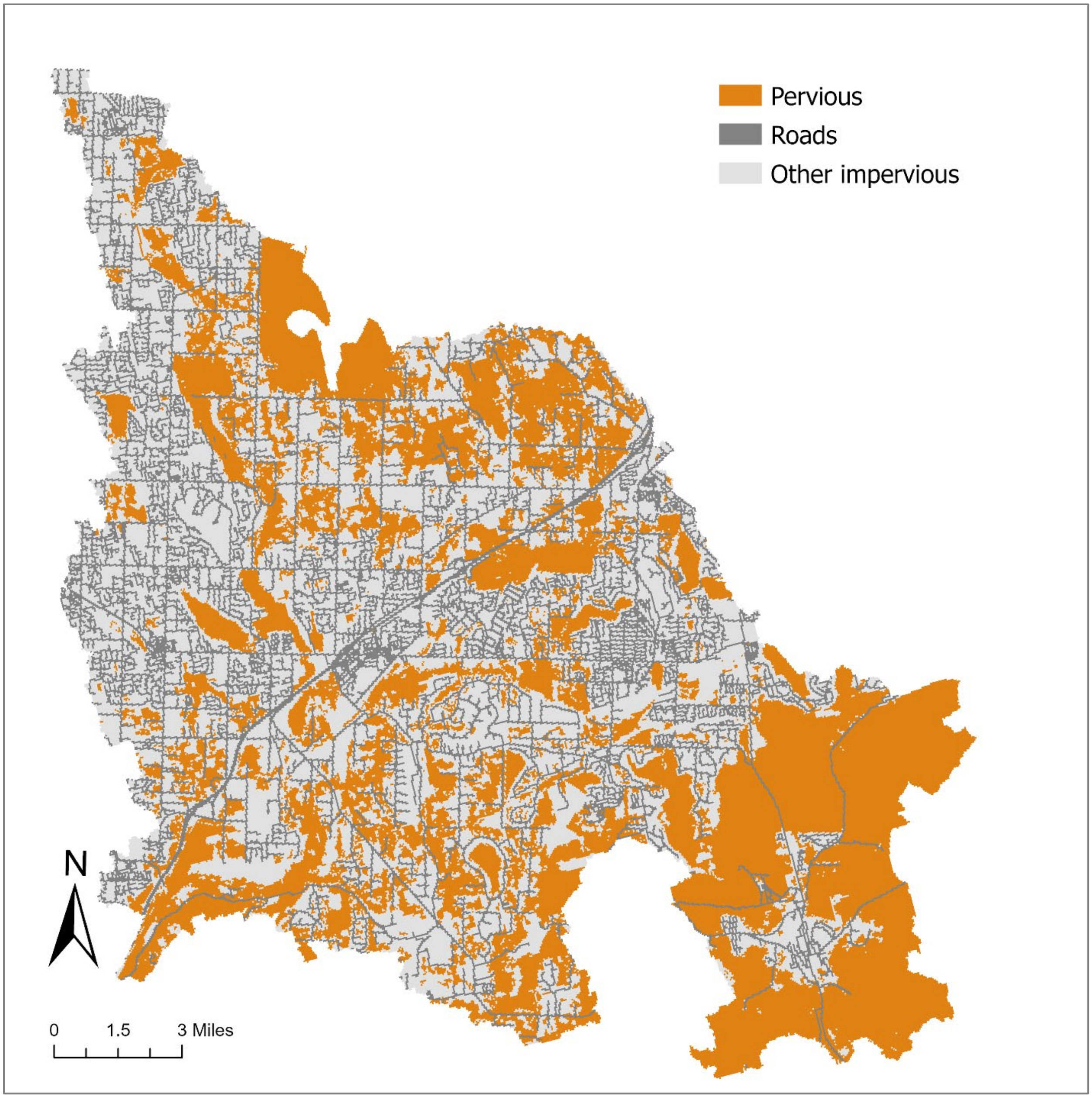

Figure 11. Impervious cover in Soos Creek (2021 data)
Note: Rates of imperviousness in the grey areas of the map range from 1% to 100%.

Most of the urban development in the watershed occurred before 1995 in unincorporated King County and before 2010 for the rest of the watershed. King County first began conditioning new development projects to control stormwater flows when they adopted the 1992 King County Surface Water Design Manual. By 2007, all the cities and King County were under municipal stormwater permit requirements, and new and redevelopment projects occurring in those municipal stormwater service areas have been conditioned to meet applicable post-construction stormwater requirements since roughly 2010. Due to the amount of developed land that occurred prior to modern stormwater management requirements, this implementation plan describes actions for areas of older existing development without stormwater controls separately from other actions. Sources of stormwater from developed areas covered by various types of NPDES permits are discussed in the next section Point Sources of Pollution.

The rapid urbanization of the watershed is a recent occurrence. Before urban development started to increase in Soos Creek, the land, which historically was inhabited by the Muckleshoot Tribes, was altered first by Tribal uses and then, to a much larger extent, by logging and agriculture. Settlers who colonized the Soos Creek Plateau logged the forests and built infrastructure to process and transport the timber to lumber mills. The development of the infrastructure took advantage of the complex network of interconnected lakes, wetlands, and streams that facilitated the transportation of timber from forests to mills. Once the watershed was mostly deforested, "Soos Creek stump ranchers"[12] settled on the plateau, removed the tree stumps and brush left from the clear cuts, and converted the land to dairy pastures. Agriculture remained the dominant land use until the late 1980s. Diffuse nonpoint sources continue to contribute loadings of fine sediment in the Soos Creek watershed, though to a lesser extent than in the past since the amount of land in agricultural use has declined over time. Information on relevant nonpoint sources is described in the Nonpoint Sources of Pollution section.

[12] https://www.covingtonwa.gov/celebrate20/covingtonhistory.php

Point Sources of Pollution & Implementation Actions

Federal regulations require that all new or revised NPDES permits be consistent with the assumptions and requirements of any applicable TMDL WLAs (40 CFR §122.44(d)(1)(vii)(B)). Once a TMDL is approved by EPA, Ecology includes any additional relevant requirements in NPDES permits it issues to point source dischargers that will lead to the attainment of the WLAs. In some cases, the special conditions in the permit are sufficient; in other cases, additional requirements are necessary. In this way, the implementation of the required reductions is not duplicative but complementary to permit conditions. An overview of existing NPDES permit requirements that help to achieve the WLAs of this TMDL is provided below for each of the relevant permitted discharge types (industrial stormwater, sand and gravel, fish hatchery, construction stormwater, and municipal stormwater). Detailed discussions of relevant stormwater best management practices and other implementation actions for point sources are also provided below.

Industrial Point Sources

NPDES-permitted industrial stormwater dischargers include:

- Pacific Coast Coal Company (Individual NPDES Permit #WA0030830) – the facility is no longer mining for coal but is conducting reclamation activities and discharges stormwater and dewatering water to the wetlands surrounding Mud Lake located upstream of Lake Sawyer. This permit contains a stringent effluent limit for turbidity of 25 NTU. Ecology's PARIS[13] database shows a permitted area of 480 acres.
- Black Diamond Auto Wrecking (Industrial Stormwater General Permit #WAR004125) – this facility consists of a single 104,283 square foot tax parcel with one 13,200 square foot building, approximately 12,000 square feet of paved surfaces, and a mixture of gravel and lightly vegetated surfaces. Vehicles are processed inside of the building which includes fluid draining and battery removal. The facility implements best management practices to minimize pollutants to stormwater runoff and is subject to a turbidity benchmark of 25 NTU. If the facility were to exceed the benchmark value, escalating actions will, if necessary, lead to treatment.
- Palmer Coking Coal Company Industrial Yard (Industrial Stormwater General Permit #WAR001189) – this facility consists of an industrial yard providing sand and gravel supplies. The facility implements best management practices to minimize pollutants to stormwater runoff and is subject to a turbidity benchmark of 25 NTU and a TSS benchmark of 100 mg/L. If the facility were to exceed either benchmark value, escalating actions will, if necessary, lead to treatment. The PARIS database shows a permitted area of 160 acres.

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[13] Permitting and Reporting Information System (PARIS): https://ecology.wa.gov/regulations-permits/guidance-technical-assistance/water-quality-permits-database

There are six active facilities that are conditionally authorized to discharge stormwater and/or mine dewatering water under the Sand and Gravel General Permit to surface waters and/or groundwaters. As of the date of this publication, four facilities discharge to groundwater and two discharge to surface water (Table 20). The two facilities discharging to surface water are:

- Lakepointe (Permit #WAG503267) – this facility discharges dewatering water to Jenkins Creek via pumping from the onsite settling pond system. The permit requires best management practices to minimize pollutants and requires compliance with a turbidity effluent limit of 50 NTU and an average quarterly TSS limit of 25-40 mg/L, depending upon the type of site activities. All stormwater from this facility is discharged to the ground.
- Reserve Silica (Permit # WAG503029) – this facility discharges stormwater to an unnamed wetland tributary which eventually flows into Lake Sawyer (through Sonia Lake and Grinder Lake upstream). The facility discharges Type 3 stormwater. The permit requires best management practices to minimize pollutants and requires compliance with a turbidity effluent limit of 50 NTU.

Table 28. Sand and Gravel permits active in the Soos Creek watershed and associated receiving waters

Sand and Gravel General Permit	Permit #	Receiving Waters Associated with Permit
Palmer Coking Coal Co Morgan Kame	WAG503004	Groundwater
Palmer Coking Coal Co Morgan Kame	WAG503007	Groundwater
Reserve Silica Corporation*	WAG503029	Groundwater and unnamed wetland in the Covington subbasin which eventually flows into Lake Sawyer
Lakepointe*	WAG503267	Jenkins Creek (only mine dewatering water) Groundwater for stormwater
Girard Resources & Recycling, LLC	WAG507220	Groundwater
Rainier Wood Recyclers a Division of Girard Resources & Recycling	WAG994520	Groundwater

* Only discharges from these two sand and gravel facilities are relevant for the purposes of this TMDL, since their activities include discharges to surface waters.

The Soos Creek Hatchery (Upland Finfish Rearing and Hatchery General Permit #WAG133014), owned by the Washington Department of Fish and Wildlife, is located close to the mouth of Soos Creek and discharges to Big Soos Creek. The Muckleshoot Indian Tribe is a co-manager of this hatchery where juvenile Chinook, coho, and steelhead are raised. The hatchery diverts surface water from the creek and a neighboring spring. The creek water is pretreated to settle the fine sediment, so that fish are successfully reared. All the water flows through the facility and is released into Big Soos Creek. The permit regulates discharges from the rearing ponds and limits net TSS discharges (defined as the difference between the TSS concentrations of the effluent minus the TSS concentrations of the influent). During the rearing period, the discharges from the hatchery must meet TSS effluent limits of 5 mg/L monthly average, and 15 mg/L instantaneous maximum. When juveniles are released, maximum instantaneous TSS effluent concentrations cannot exceed 100 mg/L. Current hatchery operations generally do not add TSS (in fact, their operations remove TSS in settling basins) to the water before discharging it back to Big Soos Creek. However, TSS is managed in hatchery effluent due to fish feed and fecal matter residues, as well as drawdown and cleaning events. The hatchery monitors effluent flow and TSS concentrations and reports them monthly to Ecology to comply with the requirements of the Upland Finfish Hatching and Rearing General Permit. The WLA assigned to the Soos Creek Hatchery in this TMDL is based on full-capacity production because the hatchery is implementing plans to increase its production.

Washington State's Construction Stormwater General Permit (CSGP) conditionally authorizes discharges to surface waters during construction activities. Because the CSGP is only applicable during construction activities, these discharges are inherently temporary. The permit is designed to prevent water pollution from chemicals and solids, including fine sediment. In 2023, there were 69 active construction permits in the Soos Creek watershed. Jenkins, Big Soos, and Covington subbasins had the majority of the construction permits (16, 12, and 12 permits, respectively), while Soosette and Little Soos had the least number of permits (6 and 1, respectively). The permit applies to stormwater discharges from construction sites that disturb more than one acre, or smaller projects that are part of a common plan of development or sale. Permitted construction projects are required to implement best management practices to minimize pollutants in stormwater and dewatering water. Permittees are subject to a turbidity benchmark of 25 NTU. If they exceed the benchmark value, escalating actions are required, including treatment where necessary. Where the discharge is to a 303(d) listed water body for fine sediments, the benchmark value (or equivalent) becomes a numeric effluent limit. The CSGP also contains special conditions that apply to discharges to waters subject to an EPA-approved TMDL that require permittees to sufficiently demonstrate, with data and other technical information, that their discharge is not expected to cause or contribute to an exceedance of the relevant water quality standard. Compliance with the CSGP, including the implementation of BMPs that prevent fine sediment from being discharged to surface waters, is considered sufficient to meet the fine sediment WLAs reserved for discharges from construction sites.

Municipal Stormwater Point Sources

Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) permits conditionally authorize discharges of stormwater to surface waters and groundwater from all municipal stormwater systems located in the Soos Creek watershed. MS4 service areas are defined by the jurisdictional boundaries of incorporated cities and unincorporated counties (or regulated properties for permittees like the Kent School District and Washington Department of Transportation), including all land uses within those boundaries that are served by the public drainage system. The municipal stormwater discharges reflect the largest suite of point sources in this TMDL. The Phase I Municipal Stormwater Permit, the Western Washington Phase II Municipal Stormwater Permit, and the Washington Department of Transportation Municipal Stormwater Permit all contain programmatic and site-specific requirements to implement best management practices to minimize pollutants in stormwater runoff. While all the stormwater management program requirements in these permits play a role in protecting water quality, the requirements most relevant to this fine sediment TMDL, and discussed further below, are:

1. Controlling Runoff from New Development, Redevelopment and Construction Sites
2. Stormwater Planning
3. Illicit Discharges Detection and Elimination
4. Source Control for Existing Development
5. Operations and Maintenance
6. Stormwater Management for Existing Development

Controlling Runoff from New Development, Redevelopment and Construction Sites – The permits require that cities and counties have specific local permitting thresholds for development projects in their jurisdictions, and that they ensure such projects design and implement stormwater management practices and infrastructure consistent with Ecology's Stormwater Management Manual for Western Washington (SWMMWW), the authoritative technical guidance for operational and structural stormwater controls in Washington State west of the Cascade Mountains. They do this through local codes and adoption of the SWMMWW or an Ecology-approved equivalent manual, such as the King County Surface Water Design Manual. It is through this programmatic requirement that development projects design and construct permanent stormwater management infrastructure that addresses long-term fine sediment loading and high pulse counts (or flashy stream flows) summarized below.

- Projects with land-disturbing activities must implement construction stormwater pollution prevention best management practices equivalent to those found in the SWMMWW (referred to as Minimum Technical Requirement #2).

- Projects must design and implement on-site stormwater management best management practices (referred to as Minimum Technical Requirement #3) that are designed to "infiltrate, disperse and retain stormwater runoff on the project site" consistent with the SWMMWW. In the Soos Creek watershed, the targeted performance standard for these BMPs is to match developed discharge durations to forested durations for the range of forested discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. Ecology uses the term Low Impact Development (LID) BMPs to describe the suite of practices readily available to meet this requirement.
- Projects of a certain size and pollution-generating characteristic (including projects that add 5,000 square feet or more of new hard surfaces and have a total of 5,000 square feet of pollution generating hard surface that drains to a single point or multiple points in close proximity to each other) are required to install, at a minimum, a permanent basic treatment BMP designed to achieve 80% removal of TSS for influent concentrations that are greater than 100 mg/L, but less than 200 mg/L. For influent concentrations less than 100 mg/L, the BMP is intended to achieve an effluent goal of 20 mg/L TSS. This is referred to as Minimum Technical Requirement #6.
- Projects of a certain size that will discharge directly or indirectly to a surface water of the sizes that are present in the Soos Creek watershed are required to install a permanent flow control BMP designed to meet a predeveloped forested land cover condition (i.e., match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow). Projects built according to these specifications meet Minimum Requirement 7.

The on-site stormwater management (or LID) and the flow control requirements work together to mimic the site runoff rate and duration of a forest, consistent with this TMDL's technical analysis. This means that development that complies with these standards is less likely to contribute to elevated fine sediment loads in Soos Creek. Development projects below the minimum requirement thresholds are too small to have effective treatment or flow control BMPs and instead rely solely on the on-site stormwater management practices to minimize stormwater pollution and control smaller storm event flows.

Stormwater Planning – The MS4 permits require that municipalities integrate stormwater management with local land use planning processes and identify and address barriers to implementing LID Principles including, but not limited to, tree canopy goals and policies. LID Principles are defined in the SWMMWW as "land use management strategies that emphasize conservation, use of onsite natural features, and site planning to minimize impervious surfaces, native vegetation loss, and stormwater runoff."

Illicit Discharges Detection and Elimination (IDDE) – The IDDE program requirements in the MS4 permits result in continuous efforts to identify and resolve sources of pollution to the stormwater system. This work is both reactive (in response to complaints) and proactive (routine field screening for illicit or illegal discharges to the stormwater system).

Source Control for Existing Development – City and county MS4 permittees are required to have local codes in place that require operational BMPs be implemented at businesses and for pollution-generating activities across the MS4 service area. The permittees have inspection programs and escalating enforcement authority to ensure stormwater pollution prevention practices are being followed.

Operations and Maintenance (O&M) – The O&M program requirements in the MS4 permit, in part, ensure that stormwater infrastructure is regularly inspected and maintained when needed to ensure the facility is functioning as designed. Permittees are also required to implement a street sweeping program. Street sweeping is known to remove material that can be washed off into surface waters and will help to implement this TMDL.

Stormwater Management for Existing Development – These are the MS4 permits' programmatic requirements to prevent or reduce watershed hydrology disturbances and stormwater pollutant discharges from areas of existing development (and new development where cumulative impacts are anticipated). While the details vary between the different MS4 permits, this permit requirement results in the design and installation of stormwater management infrastructure (such as LID, treatment and/or flow control BMPs) in areas that were developed before approximately 2010, also known as retrofits. Permittees may also perform certain enhanced operational stormwater management activities under this program, including but not limited to permanent removal of impervious surfaces and additional street sweeping.

Implementation of this TMDL will necessarily include stormwater management for existing development, also known as retrofit projects, because development built before the MS4 permit requirements were put in place is more likely to be a source of fine sediment and erosive stream flows. Retrofitting these developed areas with BMPs that effectively control flows and treat, or filter, runoff is expected to be the main pathway for meeting the MS4 WLAs outlined in this TMDL, however, municipalities have multiple types of structural and operational BMPs available to address sources of fine sediment that will also be helpful in the meeting the goals and requirements of the TMDL.

As discussed in the Land Cover Distribution section, 40% of the Soos Creek watershed has development ranging from low to high intensity. Forty-one percent of this development is within the jurisdictional boundaries of unincorporated King County (Phase I Municipal Stormwater Permit #WAR044501). This development, however, is less concentrated than in other parts of the watershed. The impervious cover associated with development in unincorporated King County accounts for 32% of all impervious cover in the watershed. Ecology doesn't have data on the age of all development in the watershed, but based on data we received from King County, the majority (80%) of the development in unincorporated King County occurred before 1995, when the first Phase I MS4 permit started regulating stormwater runoff from development. This estimation may overpredict the development without appropriate stormwater management controls, since King County implemented flow control practices in 1977 (King County 1977). Most of the development built in King County prior to the MS4 permits is in the Covington (34%), Big Soos (30%), and Jenkins (28%) subbasins.

The cities of Kent (Western WA Phase II Municipal Stormwater Permit #WAR045520), Covington (Western WA Phase II Municipal Stormwater Permit #WAR045510), and Maple Valley (Western WA Phase II Municipal Stormwater Permit #WAR045525) account for the next largest proportion of impervious cover in the watershed, at 25%, 16%, and 15% respectively. The impervious cover within the cities of Black Diamond, Auburn, and Renton represents smaller portions of the entire watershed's impervious cover at 5%, 4%, and 4%, respectively.

The Kent School District has three campuses within the Soos Creek watershed with municipal stormwater infrastructure that serves a population of 1,000 or more that are subject to Western Washington Phase II Municipal Stormwater Permit #WAR045713 secondary permittee requirements. The Kentridge High School is located in the Upper Big Soos subbasin covers 49 acres; the Kentwood High School is located in the Little Soos subbasin is 40 acres; and the Kentlake High School is located in the Covington subbasin and covers 51 acres. Kent School District implements a range of stormwater management actions, similar to those of the cities, under this permit.

The Washington Department of Transportation is subject to stormwater management requirements in the WA DOT Municipal Stormwater Permit #WAR043000. These requirements apply to 830 acres of the Soos Creek watershed.

Table 29 shows a distribution of development, by jurisdiction, within each subbasin estimated to have occurred prior to the MS4 permit requirements described above. These data provide insight into how each municipality will likely allocate its retrofit efforts relative to each other within each subbasin. This is not a representation of actual future resource distribution to meet WLAs since these decisions will be made based on prioritization criteria determined by each permittee. Each jurisdiction should also account for known areas of development that did not include LID or that used older stormwater BMP design criteria.

Table 29. Distribution of development within each subbasin, by jurisdiction, prior to 2010 for cities, and prior to 1995 for the unincorporated county area

Jurisdiction	Big Soos	Jenkins	Covington	Little Soos	Soosette
Auburn	2%	-	-	-	23%
Black Diamond	-	-	25%	-	-
Covington	9%	30%	-	50%	-
Kent	48%	-	-	-	73%
King County Unincorporated	32%	44%	67%	50%	4%
Maple Valley	-	26%	7%	-	-
Renton	9%	-	-	-	-

Structural Best Management Practices for Stormwater

The SWMMWW contains requirements, limitations, and criteria for structural stormwater BMPs that represent the current state of all known, available and reasonable methods of prevention control and treatment (AKART) for stormwater management relevant to this TMDL. These BMPs, designed and constructed on a site-specific basis, are expected to be the primary methods that WLAs and LAs will be met. Detailed design criteria and feasibility information are available in the SWMMWW.

Similar to the MS4 permit requirements for new and redevelopment, the structural BMPs fall into three categories:

- LID (or onsite stormwater management) BMPs
- Flow control BMPs
- Runoff treatment BMPs

Examples of how these BMPs will support implementation of this TMDL for fine sediments are provided below. To reduce TSS loads in Soos Creek, MS4 jurisdictions will have to address sediment that is sourced from upland areas and delivered directly to surface waters, as well as sediment that is created through instream erosion by runoff entering the waters at levels that are higher than predevelopment runoff. The discussion below describes BMPs that can reduce flow and/or reduce upland fine sediment entering the streams. For more detailed information on all stormwater BMPs and design criteria, the SWMMWW should be consulted. The manual is updated regularly, so entities implementing these BMPs should consult the most up-to-date version of this guiding document.

LID BMPs

LID, or onsite stormwater management, BMPs are available for the range of post-development surfaces – lawns/landscaping, roofs and other hard surfaces. Many LID BMPs rely on some infiltration into the native soil. By design, these BMPs are intended to address runoff from the more frequent, smaller storm events that are too small to be managed with a larger flow control BMP. Commonly used LID BMPs include:

- Assuring a post-construction soil quality and depth for lawn and landscaped areas
- Downspout-related BMPs relying on dispersion and/or infiltration for roof runoff
- Engineered bioretention facilities and rain gardens
- Sheet flow or concentrated dispersion BMPs for runoff from other hard surfaces
- Permeable pavement
- Tree retention and tree planting
- Rainwater harvesting

Note that the infiltration benefit of rain gardens is more difficult to quantify and Ecology (2024) states that they cannot meet the LID or Flow Control Performance Standards, largely because they are not engineered facilities. This is supported by the findings of a study in which bioretention cells outperformed the cumulative effects of rain gardens and rain barrels (Avellaneda et al. 2017).

Other miscellaneous LID BMPs have more limited application and/or effects. These include vegetated roofs, tree retention and tree planting, and rainwater harvesting. The ability of some of these BMPs to reduce runoff from smaller storms is controlled by key features that those implementing the BMPs should be aware of. For example, the amount of rainwater that is intercepted by trees is dependent on the tree species, as well as rainfall intensity and duration. A study in Vancouver, British Columbia, found that interception for a light rain event (1.11 mm/hour) can range between 46% for deciduous trees in the winter, when they have no foliage, and 82% for coniferous trees in the summer (Asadian 2010). The same study found that conifers, in general, can intercept 71% of rainfall overall. When the rainfall intensity or the duration of the storm increases, these interception rates decrease to 61% for Western red cedar and to 49% for Douglas fir (Asadian and Weiler 2009).

Another example is rainwater harvest or collection, which can take the form of cisterns and rain barrels that capture rainwater from rooftops and even vegetated or green roofs. Since the storage capacity of these BMPs is usually small, they function best as components of a distributed network of BMPs, usually alongside LID BMPs. Ecology allows the practice of rainwater collection on individual properties without requiring a water right under certain conditions. Parties interested in harvesting rainwater should consult Ecology's guidelines[14] for this practice.

[14] https://ecology.wa.gov/water-shorelines/water-supply/water-recovery-solutions/rainwater-collection

In general, LID BMPs have a much smaller capacity than flow control BMPs and manage runoff from smaller areas. Since individual BMPs support smaller surfaces, they become effective at controlling runoff when they are part of a distributed network. Implementation of some LID BMPs has added benefits, including air quality improvements and neighborhood beautification, and has been viewed as a method of greening urban spaces and controlling stormwater runoff. Especially when the BMPs are implemented in socially vulnerable communities (as retrofits), planning and decision-making should involve local residents where these structures will be built to avoid the social costs of displacement and green gentrification (Gould and Lewis 2017; Taguchi et al. 2020).

Flow Control BMPs

The objective of flow control BMPs is “to prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e. prior to disturbance by European settlement)” (Ecology 2024).

There are many ways of controlling stormwater flows to prevent in-stream erosion. Where feasible, infiltration BMPs capture runoff from impervious surfaces and infiltrate it into the ground, effectively disrupting the direct pathway that runoff usually takes from developed land to streams when no stormwater management exists. BMPs that provide flow control via infiltration include infiltration basins and trenches, and Underground Injection Control (UIC) wells. UIC wells and other subsurface infiltration systems include such as drywells, drain fields, infiltration trenches with perforated pipe, storm chamber systems with the intent to infiltrate, French drains, and bioretention systems intending to infiltrate water from a perforated pipe below the treatment soil. Discharges to groundwater through UICs are regulated under the UIC program (WAC 173-218), not the Municipal Stormwater permits, and must be authorized by Ecology.

The volume of runoff that can be infiltrated by a facility is dependent on the type of soil to which stormwater discharges, with sandy soils having higher design infiltration rates than clay soils, though soil compaction can also play an important factor (Minnesota Pollution Control Agency 2022). In general, outwash soils are more conducive to infiltration, while till soils infiltrate water more slowly. Saturated soils have very little to no capacity to infiltrate additional water. Figure 12 shows a distribution of these two major soil types in Soos Creek, as represented in the watershed model (Mohamedali 2024). Outwash soils are more prevalent in the eastern part of the Soos watershed, in the Jenkins, Covington, Lower Big Soos subbasins. Till soils are more dominant in the Upper Big Soos, Little Soos, Soosette, and the most eastern portion of Covington subbasin.

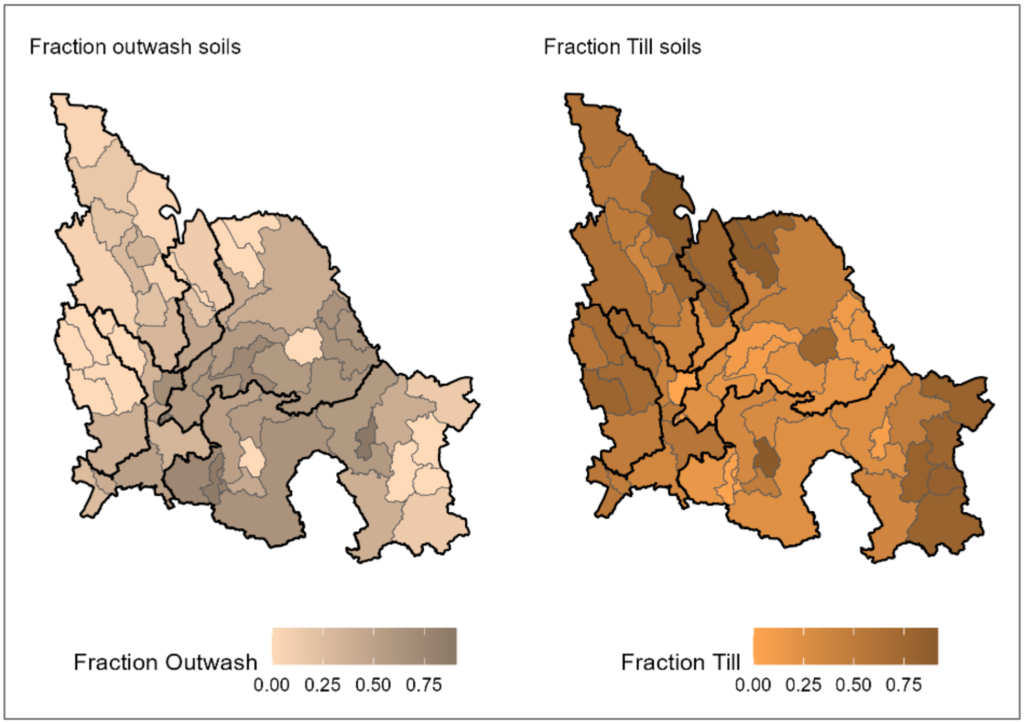

Figure 12. Fraction of outwash and till soils, by watershed model catchment

Some infiltration BMPs can also meet the requirements for basic treatment because they may be designed to reduce TSS (Ecology 2024). This is addressed in the next section "Runoff Treatment BMPs".

Design configurations and pairing these BMPs with others, including detention ponds, as part of a BMP train, can maximize the flow control benefits of the infiltration BMPs (Hunt, Davis, and Traver 2012). Model simulations have shown that implementation of infiltration BMPs on at least 5% of effective impervious surfaces is necessary to start reducing peak flows and that flow control on at least 11% of effective impervious areas would result in a 10% reduction in peak flows and 5% reduction in flow volumes (Palla and Gnecco 2015).

Detention BMPs provide flow control by temporarily storing the increased stormwater runoff that results from development. These structures collect and hold stormwater runoff and subsequently release it slowly over a few hours or days to protect surface waters from erosive forces. Detention BMPs include detention ponds, detention tanks, wet pools, and detention vaults. All detention BMPs have an engineered control structure. Control structures are catch basins or manholes with a restrictor device for controlling outflow from a detention BMP to meet the desired performance standard. The restrictor device usually consists of two or more orifices and/or a weir section sized to meet performance requirements. The benefit of using these BMPs in Soos Creek comes from the reduction in peak flows, which results in reduced instream erosion. While there may be some particulates that settle out in these BMPs, they are not designed to achieve a specific treatment target and are thus not considered treatment BMPs.

Older detention BMPs may have been designed to achieve a lesser standard of flow control, when the BMPs were built to reduce only peak flows, without addressing the duration of the outflow above the predevelopment flows. In these cases, even if the peak flows reductions were to result in lower erosive forces instream, the channels' prolonged exposure to flows that are still higher than before development can increase fine sediment mobilization and excess TSS loads (Booth and Bledsoe 2009; Hawley et al. 2017). Retrofits of older detention ponds have proven to be successful at reducing erosion downstream of the pond outlets by extending the amount of time detention ponds drain and by lowering the discharge rate at the outfall (Hawley et al. 2017). The City of Redmond, a jurisdiction located in another watershed in King County, is in the middle of an effectiveness-monitoring project that will help stormwater managers understand to what extent a continuous monitoring and adaptive control (CMAC) system can help reduce peak flows compared to other ponds that have not been retrofitted.[15]

Controlling the timing of discharges from detention ponds may help alleviate the problem of cumulative impacts from several ponds discharging at the same time in different parts of the catchment by staggering their releases. Previous studies found that even when detention ponds can control peak flows at the reach level, these benefits are lost downstream, as discharges from other ponds contribute to flows, and may even have unintended consequences by increasing peak flows downstream or increasing the risk for localized flooding (McCuen 1979; Emerson, Welty, and Traver 2005; Askarizadeh et al. 2015).

From a watershed perspective, the location of the detention BMP can play an important role for its ability to influence peak flows in the stream. A recent study found that a detention pond that is located in the upper part of the study basin can significantly reduce peak flows but if the same pond is located in the lower reaches of the same basin, these benefits may be less likely to materialize (Ronalds and Zhang 2019).

A note of caution related to detention ponds in Soos Creek is that prolonged exposure of the stored water to warm air temperatures and direct sunlight risks adding thermal loadings to streams that are already impaired for temperature. The impacts on stream temperatures are not always clear (Herb, Mohseni, and Stefan 2009; Sabouri et al. 2016; Somers et al. 2016) and can depend on the timing of the storm events and eventual release. Pond discharges occurring during the spring and fall, when the numeric criterion for temperature[16] in parts of the watershed is 13℃ (55.4°F) have the potential to contribute warm water to the system during this sensitive time.

[15] Technical Memorandum: Redmond Paired Watershed Study Pond Retrofit Effectiveness Monitoring Proposal can be found at https://www.ezview.wa.gov/Portals/_1962/Documents/SAM/14-05806-000_TM_RPWS_PondRetrofitEffctvnssMonPrpsl_20211011_rev1.pdf

[16] The numeric criterion for the supplemental spawning and incubation protection applies in some Soos Creek streams September 15 – July 1 (Payne 2011).

These findings underscore the importance of taking a watershed-wide view for the implementation of this TMDL, which will most likely require active collaboration between different jurisdictions in each of the Soos Creek subbasins. Effectiveness-monitoring and adaptive management will be crucial to understanding how implemented detention facilities contribute to overall reductions in TSS and fine sediments.

Runoff Treatment BMPs

While flow control BMPs are designed to protect streams from erosive forces, runoff treatment BMPs are designed to remove solids and other pollutants from the stormwater prior to discharge to the receiving water. Treatment for fine sediment (or solids) from upland sources is another effective way to reduce TSS loads in Soos Creek. According to the SWMMWW, some LID and flow control BMPs can be designed to achieve a targeted TSS reduction (e.g., detention ponds with longer holding times, bioretention cells, and permeable pavement with at least a 6-inch sand layer underneath). The SWMMWW also describes runoff treatment BMPs that specialize in removal of TSS and meet the basic treatment performance goals of 80% removal for influent TSS concentrations ranging from 100 mg/L to 200 mg/L and of 20 mg/L for inflow concentrations below 100 mg/L. In addition to the BMPs already mentioned above, the SWMMWW lists basic treatment BMPs that include, but are not limited to, sand filter basins and vaults, biofiltration swales, vegetated filter strips, and others. Ecology has also approved manufactured treatment devices for basic treatment. A list of them can be found in Ecology's TAPE database[17].

Operational BMPs for Stormwater

In addition to the types of structural stormwater BMPs discussed above, there are numerous operational BMPs available at the site-specific and subbasin scales that prevent the mobilization of soils or solids in stormwater runoff. As mentioned in the descriptions of permit requirements for point sources, such operational BMPs are foundational permit requirements. The SWMMWW devotes a chapter to operational BMP guidance.

One important operational BMP that is applied at small and large scales is street sweeping. Street sweeping can control TSS at the source before it enters the stormwater conveyance system or the stream. Many variables affect the effectiveness of street sweeping, including sweeper type, sweeping frequency, and speed. Sweeping can have some limitations in controlling fine sediments. For example, a study from Seattle has shown that street sweeping is more effective at capturing the coarser sediment than the finest particles (Seattle Public Utilities 2018). The study found that sediment larger than 500 microns can be reduced by 64%, those between 250 and 500 microns can be reduced by 48%, but the clay/colloidal range

[17] https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

particles (less than 3.9 microns) increased by 133%, meaning that street sweeping is likely increasing loadings of these small particles from runoff. Overall, though, the study found that street sweeping reduces TSS by 24%. Additional street sweeping effectiveness studies are underway and suggest this is a reasonable practice to reduce TSS and related pollutant loading.

This brief overview of the range of BMPs that will likely make up the basis for implementation of this TMDL in the Soos Creek watershed is meant to emphasize that while there are many tools available to jurisdictions to meet TSS reductions and meet WLAs, there is not one tool that is a silver bullet. Rather, a combination of BMPs will have to be employed, sized and located appropriately, both within and outside of municipal stormwater service areas, with an eye towards not only their individual effectiveness but also towards their cumulative impacts at the subbasin level (Roesner, Bledsoe, and Brashear 2001).

Nonpoint Sources of Pollution & Implementation Actions

Nonpoint pollution comes from diffuse sources that are not required to be regulated by the Clean Water Act's National Pollutant Discharge Elimination System. Nonpoint sources of TSS are generally more difficult to identify and quantify than point sources. In this TMDL, load allocations are assigned for areas that are developed but were identified by jurisdictions as draining directly to surface waters and for all other areas whose discharges are not covered by an NPDES permit.

Table 30 shows the distribution of land cover for nonpoint sources. This summary shows that forest, open space, and development represent the most prevalent land cover classes outside of the municipal stormwater permit coverage areas of the watershed. The forest land cover class includes evergreen, deciduous, and mixed forested areas. The majority of the forested cover (57%) is made up of mixed forests and can be found throughout the watershed, while evergreen treed lots represent 36% of the total forest area and are mostly concentrated in the eastern portion of the Covington subbasin. The main landowners of forested areas are King County Parks and the City of Black Diamond, but the majority of forested areas can be found on small lots owned by private parties. Open space is similarly distributed throughout the land representing nonpoint sources, usually among small parcels that are owned mostly by private landowners, with a few exceptions of small lots owned by local jurisdictions. Table 30 shows that pasture and shrubs represent less than 10% of the areas receiving load allocations.

Table 30. Distribution of land cover classes for areas receiving load allocations, by subbasin

Land Cover Class	Covington	Jenkins	Little Soos	Lower Big Soos	Soosette	Upper Big Soos	Soos Creek Watershed
Barren Land	0%	0%	0%	2%	1%	0%	1%
Forest	73%	30%	40%	38%	51%	16%	53%
Development	8%	36%	18%	26%	19%	25%	16%
Open Space	14%	32%	35%	20%	19%	43%	21%
Agriculture/Pasture	1%	2%	6%	5%	1%	14%	4%
Shrub/Scrub	4%	1%	1%	9%	9%	3%	5%
All Classes	100%	100%	100%	100%	100%	100%	100%

While agriculture is no longer a driver of revenue in the Soos Creek watershed, parts of the basin have preserved a rural characteristic. Residential areas with homes on lots larger than one acre make up 16% of the entire watershed. Most of this low-density residential land use type (89%) is in unincorporated King County and is fairly evenly split between Big Soos, Covington, and, to a lesser extent, Jenkins subwatersheds.

This section focuses on implementation actions that can address nonpoint sources of fine sediment from development and from land that is used for livestock keeping, which is the main type of agriculture in the watershed.

Implementation Actions for Nonpoint Residential Development

Depending on subbasin, development represents between 8% (in Covington) and 36% (in Jenkins) of the land cover receiving load allocations. The nonpoint implementation actions that can be used to control stormwater runoff from the developed areas are generally the same as those discussed in the section "Structural Best Management Practices for Stormwater". Of these BMPs, the practices most suitable to manage stormwater from nonpoint sources are likely the on-site stormwater management BMPs, as they are best applied at small scales.

Open Space

Open space makes up 20% of the entire watershed. In Soos Creek, this category of land use includes public lands, parks, wetlands, open water, and others. Of all the open space in the watershed, only 13% is located within areas that drain directly to surface waters. Eighty-seven percent of open spaces are found within areas which drain to MS4s. The largest areas classified as open spaces in non-MS4 portions of the watershed are found in Covington (470 acres) and Upper Big Soos (375 acres) subbasins. Jurisdictions and other local organizations working on reducing TSS and controlling runoff from these lands should consider site characteristics to make decisions about the most appropriate BMPs. Depending on site, stormwater BMPs, such as those discussed in the "Point Sources of Pollution & Implementation Actions", actions that restore the stream channel or the riparian and upland habitats, such as those mentioned in "Addressing Other Stressors: High Pulse Counts (HPCs) and Habitat Degradation", or a combination of these two categories of approaches may be appropriate for the implementation of this TMDL.

Implementation Actions for Land Used for Livestock Keeping and Other Agriculture

Ecology acts as the lead agency to restore, maintain, and enhance water quality collaboratively with communities, interested parties, Tribes, local governments, and state and federal agencies. Ecology's nonpoint source program uses a combination of technical assistance, financial assistance, and regulatory tools to help citizens understand and comply with state and federal water quality laws and regulations. Ecology's Voluntary Clean Water Guidance for Agriculture (CWG; Ecology 2020) has a management plan to address water quality impacts from nonpoint sources of pollution. This statewide management plan meets the EPA Clean Water Act requirements and ensures Washington State's eligibility for Section 319 federal nonpoint source program funding. Enacting relevant local codes along with implementing site-specific pollution prevention guidance, programs, and activities is the identified system of practice that can most effectively achieve and maintain the TMDL LAs associated with rural land management.

Currently land in the Soos Creek watershed that is reserved for agriculture makes up only a small portion of the overall land use and is primarily used to keep livestock. Pasture, the only type of agricultural land identified in the 2021 NLCD, represents only 2.6% of the total watershed area (Table 27) and among nonpoint sources, it represents 4% across the watershed (Table 30). If BMPs are not implemented or not implemented properly, large animals can increase soil erosion on pastureland and stream buffers. Ecology (2020) recommends a series of practices that prevent soil erosion, including the establishment of riparian buffers, the use of permanent exclusion fencing to prevent livestock from entering streams and to protect riparian buffers, and the use of off-stream watering systems. Keeping livestock off pastures that are saturated during the wet season can also reduce soil erosion. These BMPs and recommendations are summarized below. Some of the practices have multiple benefits for water quality. This summary focuses on the connections of these BMPs to fine sediment reductions. For more information, parties interested in applying these BMPs in Soos Creek should consult Ecology's CWG, which is updated periodically.

The CWG is a technical resource that describes Ecology's recommended BMPs to protect water quality. It is intended to help landowners meet water quality standards. The recommendations within the CWG are based on a robust gathering of peer-reviewed scientific research. These recommended practices provide water quality protections to a level that is presumed to be in compliance with state water quality law. This provides assurances for landowners and removes uncertainty around which BMPs will be adequate to address nonpoint pollution. The guidance empowers landowners to take action to protect water quality, be incompliance with state law, and avoid potential regulatory action from Ecology.

Riparian Buffers

Riparian buffers should be protected or planted and maintained along all perennial, intermittent and ephemeral streams to reduce upland fine sediment and TSS loadings and to support meeting water quality standards (Ecology 2020).

Site Potential Tree Height Riparian Buffers

The preferred recommendation is for fully forested riparian zones along all natural streams. The width of the forested riparian zones is equal to one site potential tree height, which has a default value of 215 feet. The site potential tree height is the average maximum height of the tallest dominant trees for a given site class; the index tree age is 200 years, except where shorter-lived trees (such as cottonwoods) are the tallest dominant trees. This buffer is also called a Riparian Management Zone (RMZ). For more information on site potential tree heights applicable in the Soos Creek watershed, see the map that the Washington State Department of Fish and Wildlife developed.[18]

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[18] https://wdfw.maps.arcgis.com/apps/MapSeries/index.html?appid=919ea98204eb4f5fa70eca99cd5b0de1

Three-Zone Riparian Buffer

Where it is not feasible to restore full riparian habitat functions (i.e., not practicable to have a fully forested RMZ due to natural or anthropogenic factors), Ecology recommends that landowners select an alternative three-zone buffer configuration (Table 31).

Table 31. Western Washington RMZ options for perennial and intermittent stream reaches with riparian forest potential (Ecology 2020)

Channel Width	Riparian Management Zone (RMZ) Configurations
< 5 ft	Core zone: ≥ 65 ft minimally managed site potential forest Inner zone: 0-25 ft filter strip, depending on topography, soils, land use Outer zone: 125-150 ft of agriculture implementing all applicable BMPs Total RMZ width: ≥ 215 ft
5-30 ft	Core zone: ≥ 80 ft minimally managed site potential forest Inner zone: 0-25 ft filter strip, depending on topography, soils, land use Outer zone: 110-135 ft of agriculture implementing all applicable BMPs Total RMZ width: ≥ 215 ft
30-150 ft	Core zone: ≥ 100 ft minimally managed site potential forest Inner zone: 0-25 ft filter strip, depending on topography, soils, land use Outer zone: 90-115 ft of agriculture implementing all applicable BMPs Total RMZ width: ≥ 215 ft
> 150 ft	Core zone: ≥ 125 ft minimally managed site potential forest Inner zone: 0-25 ft filter strip, depending on topography, soils, land use Outer zone: 65-90 ft of agriculture implementing all applicable BMPs Total RMZ width: ≥ 215 ft

Three-Zone Riparian Buffer with Agroforestry

Properties that are implementing agroforestry and silvopasture principles and have native trees integrated that provide supplementary stream shading and organic material inputs to streams may be eligible to use the following buffer options (Table 32).

Table 32. Western Washington RMZ options for agroforestry (Ecology 2020)

Channel Width	Riparian Management Zone (RMZ) Configurations
All Channels	Core zone: ≥ 80 ft minimally managed site potential forest Inner zone: 110- 135 ft agroforestry/silvopasture within native forest Outer zone: 0-25 ft filter strip, depending on topography, soils and upland land use Total RMZ width: ≥ 215 ft

Additional Considerations for Riparian Buffers

- TMDL implementers should consider the species composition and structure of riparian buffers. The CWG recommends planting only native species in the form of a mix of grasses, forbs, shrubs and trees.
- Buffers should be actively maintained (e.g., weeded, replanted) until the riparian forest becomes self-sufficient, typically 5-10 years after planting. Buffers are expected to remain in place in perpetuity.

A combination of factors influences the effectiveness of riparian buffers at controlling TSS loadings to receiving water bodies. In general, the following factors should be evaluated and considered when implementing RMZ buffer BMPs:

- Climate and weather
- Geology
- Geomorphology and topography
- Soil properties including hydrologic groups
- Buffer vegetation type, height, and density
- Land use and land use intensity and practices
- Runoff volumes, rates, and flow types
- Buffer size, and the area of land comprising a buffer relative to the area of land contributing surface and subsurface flow to the buffer (i.e., buffer area ratio).

Limit Livestock Access to Streams and Streamside Areas

The CWG recommends that landowners limit the access of livestock to streams and riparian areas and provides the following guidance to reduce fine sediment or TSS loadings to surface waters:

- Exclude livestock from streamside areas (riparian buffers) and streams to prevent livestock from grazing and trampling native riparian vegetation.
- Exclude livestock from drainage ditches and other surface water conduits.
- Use well-constructed, permanent fencing because it is the most effective livestock exclusion tool.
- Use dedicated watering facilities, such as tanks and troughs, to provide water for livestock and stabilize areas around watering stations to prevent soil erosion.
- Locate watering facilities away from streamside areas and avoid locations likely to be saturated or with preferential flow paths to surface waters.

Pasture and Rangeland Grazing

The following practices are recommended to protect streamside areas, prevent the generation and discharge of pollutant to surface waters and support healthy upland pastures and rangeland:

- Protect and restore the RMZ.
- Install and maintain permanent streamside exclusion fences.
- Install and maintain off-stream water facilities.
- Stabilize heavy use area to provide a sturdy, non-eroding surface commonly used at off-stream watering facilities and sacrifice areas especially when these sites are likely to become muddy or erode. Heavy use area protection may also be used in other locations such as areas where mineral supplements are provided, supplemental feeding areas and loading corrals.
- Manage stream crossings to provide livestock or equipment access to pastures on the other side of a stream without damaging streambanks or the streambed. This practice applies to ephemeral, intermittent and perennial water courses and includes fords, bridges or culvert-type crossings. Occasional ford crossing may be suitable for shallow, low velocity watercourses with gently sloped streambanks and a firm or stabilized streambed. Ford crossings are not suitable for high traffic areas with frequent use. Bridges or culverts should be used for high traffic situations.
- Provide emergency water access point (where applicable). An emergency access point is a location along a stream where livestock can temporarily access the stream for drinking water purposes. These locations may be needed or desired as a contingency should off-stream water equipment fail or need to be maintained or replaced. However, they must only be used under emergency situations and may not be used as alternatives to permanent off-stream water sources.
- Manage grazing to balance forage removal and plant health by adjusting the timing of grazing, stocking rates, duration of grazing and periods of rest to maximize forage utilization while promoting recovery. When properly applied, grazing management systems that incorporate timing, proper stocking rates and forage management can be a valuable tool to help livestock managers better control animal behavior and tendencies, maximize forage potential and utilization, promote pasture and rangeland health and protect water quality.
- Use seasonal confinement areas to protect pastures and avoid forage damage.

Animal Confinement Areas and Other Heavy Use Areas

The following practices are recommended to ensure that heavy use areas for livestock minimize TSS discharge to surface waters:

- Confinement areas and other heavy use area sites should be located as far away as possible from any surface water or conduit to surface water.
- Install or maintain gutters, and downspouts and divert runoff away from heavy use areas and manure storage facilities.
- Create a stabilized area that prevents erosion and runoff and supports manure collection and maintenance.
- Animal confinement areas should be situated on high level ground, not in depressional areas where water collects.
- Avoid locations near conduits to surface waters such as swales, tile lines or other natural or artificial drainage ways that outlet to surface waters.
- Locate and design the confinement area such that it is outside the 100-year floodplain unless site restrictions require locating it within the floodplain. If located in the floodplain, protect the facility from inundation or damage from a 25-year flood event.
- Use vegetated filter strips downgradient capture sediment and infiltrate runoff when needed.
- Conduct routine inspections especially after significant runoff events.
- Site away from seasonally saturated or flooded areas and setback from surface waters and conduits to surface waters.
- Divert clean water from the roofs of heavy uses areas and use additional BMPs to capture and treat polluted runoff.

Forest Practices

The state's forest practice regulations are intended to protect water quality, including preventing soil/solids/sediment discharges, from sediment discharges associated with these types of sources. Land in Soos Creek is no longer managed for timber harvest and Ecology is not aware of any historical legacy sources related to past forest practices that could discharge TSS at elevated rates.

State Environmental Policy Act and Land Use Planning

TMDLs should be considered during State Environmental Policy Act (SEPA) and other local land use planning reviews. If the land use action under review is known to potentially impact fine sediment as addressed by this TMDL, then the project may have a significant adverse environmental impact. SEPA lead agencies and reviewers are required to look at potentially significant environmental impacts and alternatives and to document that the necessary environmental analyses have been made. Land-use planners and project managers should consider findings and actions in this TMDL to help prevent new land uses from violating water quality standards. Additionally, the TMDL should be considered in the issuance of land use permits by local authorities.

Information and findings identified in this TMDL should be considered best available science when local governments make planning decisions that have the potential to result in increased fine sediment loadings in the watershed. The general master program provisions in WAC 173-26-221 requires planners to use scientific and technical information described in WAC 173-26-201(2)(a) when proposed actions may result in adverse effects to Critical Areas and vegetation along shorelines. Information described in this TMDL, implementation plan, appendices, and modeling results presented in Mohamedali (2024) can be used to characterize functions and ecosystem-wide processes that should be protected or restored, as required in WAC 173-26-201(3)(d)(i).

Addressing Other Stressors: High Pulse Counts (HPCs) and Habitat Degradation

Many of the BMPs that reduce fine sediment also address the two non-pollutant stressors of benthic invertebrates, specifically flashy flows (or HPCs) and habitat degradation. BMPs that reduce fine sediment loadings and also address these non-pollutant stressors should be prioritized for the implementation of this TMDL. For instance, BMPs that infiltrate stormwater to reduce fine sediment loadings may also decrease flashy flows.

In general, HPCs can be reduced by any of the flow control BMPs discussed in the “Point Sources of Pollution & Implementation Actions” section. The technical analysis in Mohamedali (2024) provides an overview of where in the Soos Creek watershed HPCs are highest to inform those implementing the TMDL, while also targeting the reduction of HPCs. Figure 13 shows that the highest HPCs are in Soosette and Upper Big Soos, followed by Little Soos, Jenkins, and Lower Big Soos. Covington subbasin appears to have the lowest instances of HPCs, with the exception of a few reaches.

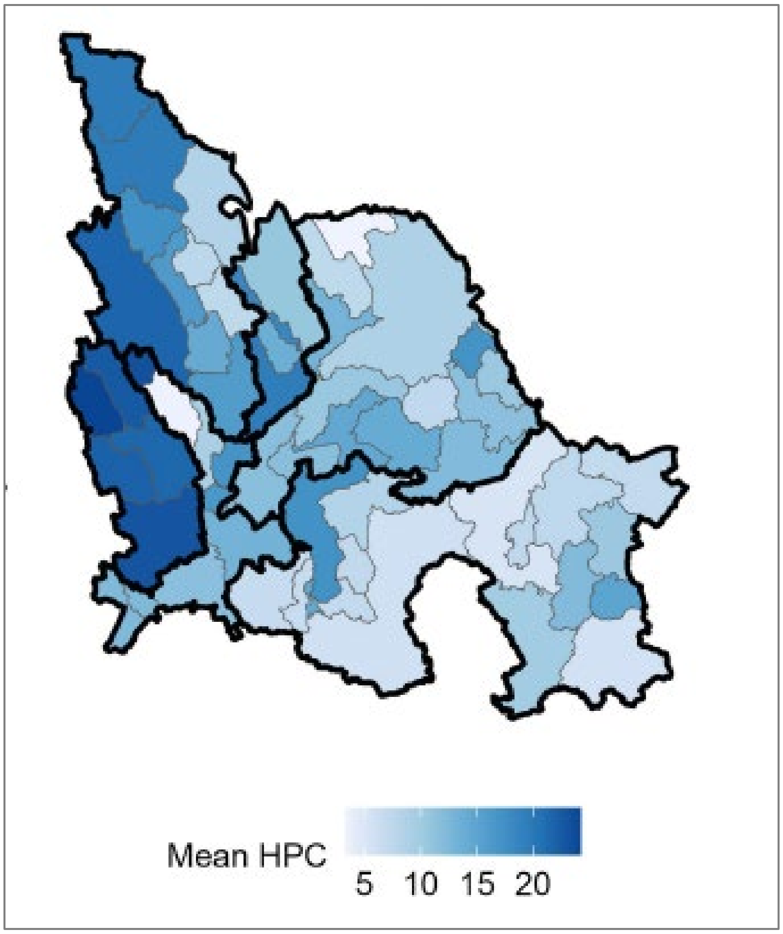

Figure 13. HPCs in the Soos Creek watershed, by reach

The impact of high peak flows on instream erosion is also exacerbated by the lack of healthy riparian vegetation. The root systems of native vegetation, in particular, can help prevent stream bank erosion. In Soos Creek, many stretches of streams have poor riparian cover. Its restoration can result in increased resilience of the channel to the erosive forces associated with peak flows. It is important to note here that a healthy riparian habitat alone is not likely sufficient to prevent bank erosion because stormwater runoff must also be addressed. Hawley (2022) argues that following up hydrologic restoration with instream habitat restoration actions, such as placing logs instream or planting live stakes, can improve the habitat quality from average to excellent, in a watershed where hydrologic restoration alone had already improved habitat quality from poor to average. For restoration to be effective, coordinating the implementation of stormwater management BMPs with habitat restoration should be done at the subbasin scale, accounting for effects that are expected to occur downstream of the implemented BMPs, in addition to the localized effects. This is a preferable approach to those that are more opportunistic and is believed to have the highest likelihood for restoration success and the highest sediment reduction in comparison to existing conditions (Lammers, Dell, and Bledsoe 2020).

Reconfiguration of channel morphology to increase complexity and variability of instream features is another tool set that can be effective at restoring processes controlling sediment erosion and the habitat quality for benthic invertebrates. Hydraulic conditions are key to the link between flow and stream ecology and as such, parameters, like flow depth, velocity, and duration, have been found to characterize the impact of flow on sediment mobilization very well. Actions that restore pools and riffles, shallow water habitat, and instream bars and benches can build resilience into the system and protect valuable substrate from getting clogged with fine sediments to support a healthy benthic population (Anim and Banahene 2021).

Floodplain reconnection that is focused on restoring healthy stream processes is another strategy that may be suitable for the restoration of benthic habitat in Soos Creek. Engineered hyporheic zones, an approach that was part of a floodplain reconnection effort in the region, are being monitored to evaluate their effectiveness at restoring water quality and instream habitat in another urban creek. In Thornton Creek, the largest creek in the City of Seattle, three sections of the hyporheic zone were engineered to maximize onsite water, sediment and wood storage capacity, lower stream temperatures, filter contaminants from stormwater runoff, increase hydraulic diversity, and improve instream biological conditions (Morley, Rhodes, Baxter, et al. 2021). Ongoing monitoring found that the project achieved a lot of its water quality goals, with the engineered hyporheic zones being able to maintain their loose alluvial gravel aspect without becoming embedded with fine sediments. While the restoration areas also experienced a significant increase in crustaceans and worms, the project did not reach its goals of reestablishing benthic insects even when the restored gravel was reseeded with invertebrates from reference forested areas (Morley et al., 2021). The watershed is highly urbanized, without significant stormwater management due to older development. The authors offer the presence of anthropogenic stressors, including a highly modified hydrologic regime, as one of the possible causes for the slow progress in the condition of benthic invertebrate taxa, which supports the argument that the benefits of restoration and stormwater management are enhanced when both are implemented at a meaningful scale.

It is vital for entities implementing this TMDL to keep in mind that these actions are not to be put into practice in place of stormwater management but in addition to it, as the Thornton Creek example suggests. Without addressing flow control and elevated TSS loads, investments made to restore instream habitat and processes could be jeopardized and rendered ineffective (Roesner, Bledsoe, and Brashear 2001; Walsh, Fletcher, and Ladson 2005; Whipple and Viers 2019; Russell, Vietz, and Fletcher 2020; Anim and Banahene 2021). Increasing roughness and channel complexity are valuable tools, but they are insufficient at reducing sediment transport capacity, which controls the ability of stream flows to mobilize sediment and move it downstream. When a study weighed the ecological benefits of these options against a flow reduction approach for an urbanized stream, it found that the benefits of instream work without flow control can be expected to be low, with the exception of large wood addition, which can result in medium benefits, and can be undone if flows are not controlled (Table 33; Russell et al., 2020).

Conversely, addressing only the impact of stormwater on hydrology is also likely to fail in restoring the decades-long degradation of channel morphology in Soos Creek. Sequencing the implementation actions in a way that is protective of previous restoration investments is essential for ensuring that the reductions in TSS occur in a timely manner and that the restoration of benthic habitat endures.

Overall, successfully creating an environment that supports temporal and spatial variability and complexity is key to the restoration of a resilient habitat that can sustain benthic macroinvertebrates in the long term. The focus should be on the restoration of processes and mechanisms that allow for the ecological system to be resilient under different social and environmental conditions (Poff 2018), which can be achieved when both stormwater and habitat quality are addressed. This may mean a new multi-pronged approach to implementation – one in which stormwater and habitat managers collaborate closely within and across jurisdictions in the watershed to coordinate the implementation of stormwater BMPs, along with instream habitat restoration. For more discussion on how to foster collaboration among different stakeholders implementing this TMDL, see the section on Adaptive Management.

Table 33. Ecological benefits of different approaches to reduce sediment transport capacity (based on Russell et al. (2020))

Approach	Expected result*	Discussion	Ecological benefit
Decrease flow by using infiltration and harvest BMPs	Reduces sediment transport capacity by 97%	For the modeled stream, 76% of the runoff volume would have to be retained in the catchment, infiltrated, or evaporated for restoration to near-natural conditions. Flow mitigation structures are often barriers for larger sediment and may therefore need to be paired with sediment replenishment, bypass, or source protection to maintain adequate sediment supply.	High
Increase resistance by introducing large wood, complex planform, bedforms, vegetation (effectively increase Manning's *n* to 0.10)	Reduces sediment transport capacity by 92%	Increasing flow resistance could have a beneficial impact on overall transport capacity. Roughness elements also increase diversity in transport capacity, which can help a supply-limited stream accumulate sediment and create low-shear zones.	Moderate
Increase channel width using excavation, bank grading and revegetation or remove bank protection and allow managed enlargement	Reduces unit-width sediment transport capacity by 71% and total transport capacity by 46%	Options for doubling the width of the modeled stream can be limited due to high costs and space constraints. It may also have more negative than positive impacts on stream health from vegetation removal. Managed enlargement may be possible if there is adequate space, but processes can cause additional sedimentation and high turbidity.	Low
Coarsen sediment by adding material coarser than native bed material	Reduces sediment transport capacity by 59%	Adding coarse sediment to the stream bed could reduce transport capacity but it will not reduce severe hydraulic conditions over the bed which could still affect biota.	Low
Decrease energy slope by controlling grade	Reduces sediment transport capacity by 85%	Slope would need to decrease dramatically to keep natural bed material in place, but this can create barriers to fish migration and can shift erosion problems downstream.	Low
Increase sediment supply by protecting pre-urban sources and supply pathways and/or adding sediment to streams	Not modelled	Coarse sediment would have to increase 70-fold to account for excess transport capacity in the modeled stream, which would not be feasible and would increase sedimentation downstream. The addition of sediment would not mitigate the severe bed disturbance regime and may change channel character.	Low

***Note**: The values in this table are specific to the case study in Russell et al. (2020). They are not indicative of the level of implementation necessary in Soos Creek.

Organizations to Implement TMDL

The following government agencies, citizen groups, and tribes have regulatory authority, influence, information, resources, or other involvement in activities to protect and restore the health of Soos Creek watershed. This section lists some of these relevant authorities, activities, and proposed actions.

Federal, State, and Tribal Agencies

U.S. Environmental Protection Agency

The United States Environmental Protection Agency (EPA) is responsible for the implementation of the federal CWA. EPA and Ecology jointly evaluate the implementation of TMDLs in Washington State. These evaluations will address whether interim targets are being met, whether implementation measures such as BMPs have been put into effect, and whether NPDES permits are consistent with TMDL WLAs. EPA also provides technical assistance and funding to states and tribes to implement the CWA. For example, EPA's CWA Section 319 grants are combined with Ecology's grant and loan funds and are made available to stakeholders through Ecology's annual Water Quality Combined Financial Assistance process. On occasion, the EPA also has other grant monies available (CWA 104(b) (3)) to address stormwater pollution problems.

Muckleshoot Indian Tribe

The Usual and Accustomed Area (U&A) of the Muckleshoot Indian Tribe (MIT) was affirmed in the "Boldt Decision", U.S. v. Washington (1974). The U&A covers all or portions of several basins, including the Green-Duwamish watershed, of which Soos Creek is a part. The MIT's Fisheries Division has an active resource protection program and may assist with stream restoration and water quality improvement efforts. The MIT staff review permits for all the jurisdictions in the TMDL area and will continue to monitor these permits and restoration projects to evaluate whether the TMDL is implemented and not adversely affected by future land actions.

MIT has been a partner in the development of the Soos Creek Fine Sediment TMDL, along with EPA and King County Science Group, which form the Technical Advisory Group for this TMDL. The work that MIT did to assess groundwater withdrawals in the watershed was an important piece for the watershed model used in this TMDL. The modifications that MIT did to the HSPF model are included in Appendix B of Mohamedali (2024).

MIT also works with local governments and homeowners to protect and restore the Soos Creek watersheds. They conduct water-quality monitoring and spawning surveys.

Washington State Department of Ecology

Ecology is responsible, under the federal Clean Water Act, for establishing water quality standards, issuing NPDES discharge permits, developing water cleanup projects (e.g., TMDLs), and enforcing water quality regulations under the Water Pollution Control Act (Chapter 90.48 RCW). In addition to this regulatory role, Ecology gives grants and loans to local governments, Tribes, conservation districts, and citizen groups for water quality projects. Projects that implement TMDLs are given a high priority for funding.

Ecology helps local governments, Tribes, conservation districts, and nonprofit organizations with funding for water quality facilities and activities through the Combined Financial Assistance, Terry Husseman Account, and Streamflow Restoration Implementation grant programs.

Ecology acts as the lead agency in restoring, maintaining, and enhancing water quality collaboratively with citizens, interested parties, Tribes, local governments, local governmental entities, state agencies, and federal agencies. Ecology's nonpoint source program uses a combination of public education, technical assistance, financial assistance and regulatory tools to help citizens understand and comply with state and federal water quality laws and regulations that protect water quality (Figure 14).

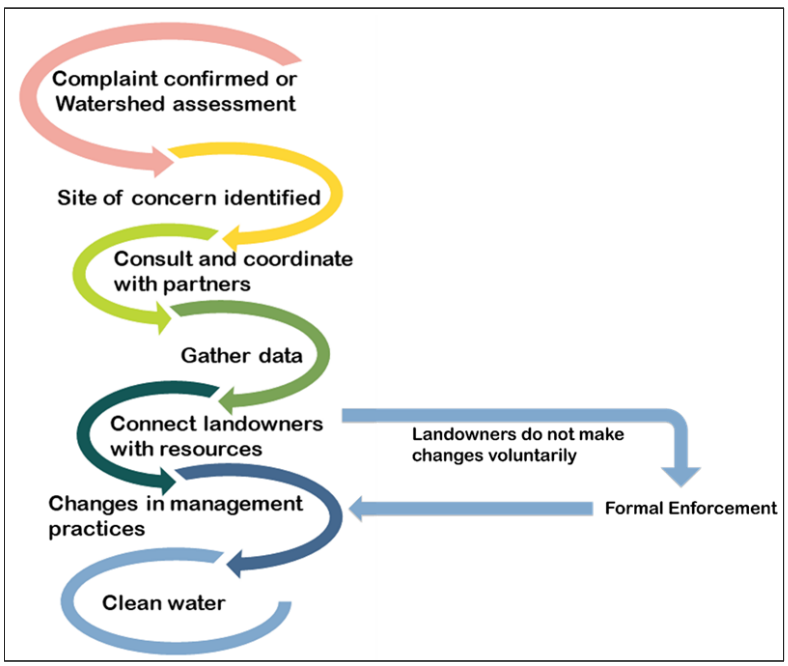

Figure 14. Ecology's nonpoint source program flow chart

The nonpoint source pollution plan (Ecology 2020) aims to protect public health and restore our state's waters by setting clear goals and objectives. Ecology's strategy to address nonpoint source pollution focuses on cleaning up impaired watersheds, completing watershed evaluations to identify pollution issues, and implementing suites of BMPs to address identified pollution sources and ensure compliance with the WQS.

Ecology will apply the following key principles in the implementation of this nonpoint strategy:

- Communicate clear standards and compliance expectations
- Implement BMPs that ensure compliance with state WQS and state law
- Implement watershed-based plans/strategies designed to meet WQS
- Identify and correct nonpoint pollution sources in impaired watersheds
- Be proactive in addressing pollution problems (i.e., provide incentives or education and outreach)
- Escalate to enforcement when education, outreach, and technical assistance fail
- Be accountable by collecting data on watershed evaluations and tracking BMP implementation
- Target effectiveness monitoring where implementation of BMPs has occurred
- Promote adaptive management
- Develop or strengthen partnerships to achieve water quality improvement goals

Ecology's priorities for TMDL implementation include the following objectives:

- Maintain the current level of staff dedicated to nonpoint pollution complaint response and follow nonpoint guidance where water quality data point to a source of fine sediment pollution
- Coordinate or meet regularly with the organizations implementing the TMDL for information sharing and planning
- Provide information about funding opportunities to local organizations
- Administer grants and loans programs
- Assist and facilitate implementation activities leading to clean water
- Prepare and carry out effectiveness monitoring, as resources allow, to track the outcomes of implementation efforts

Once permit requirements are developed based on the wasteload allocations in this TMDL, Ecology staff will manage and enforce these requirements in the same manner as other permit conditions.

Washington State Department of Fish and Wildlife (WDFW)

The mission of the Washington State Department of Fish and Wildlife (WDFW) is to provide sound stewardship of fish and wildlife. The WDFW is an important partner in managing the water resources in the Soos Creek watershed. The agency provides technical assistance for the design of restoration projects and reviews hydraulic permit approvals. The WDFW also operates the Soos Creek hatchery under the Upland Fish Hatchery General Permit issued by Ecology, which regulates that hatchery's discharges.

Washington State Department of Transportation

The Washington State Department of Transportation (WSDOT) Water Quality Program provides guidance and technical support to road planning, design, construction, and maintenance of state transportation projects. Discharges from state roads, highways, and related facilities are regulated under Ecology's WSDOT Municipal Stormwater Permit.[19] The permit went into effect on April 5, 2019 and is in the process of being reissued.

To achieve compliance with the federal Clean Water Act and State water quality laws, WSDOT prepares stormwater pollution prevention plans for major road projects, prepares annual NPDES compliance reports and plans, conducts mitigation stream restoration projects, and monitors water quality. WSDOT is an active participant in the Soos Creek Fine Sediment TMDL process since WSDOT facilities or operations contribute stormwater runoff to the streams in the watershed.

The Soos Creek TMDL study did not directly monitor state highway discharges. The TMDL assigns WLAs to WSDOT within each subbasin to account for the contribution of the state highway stormwater discharges to the impairment of receiving waters. As required under the WSDOT NPDES municipal stormwater permit, WSDOT will implement its Stormwater Management Program Plan (SMPP) in jurisdictions covered by Phase I and II municipal stormwater permits.

Puget Sound Partnership

The Puget Sound Partnership (PSP) is a state agency whose primary focus is the recovery of Puget Sound health. PSP coordinates the efforts of citizens, governments, Tribes, scientists, businesses, and nonprofits to set priorities, implement a regional recovery plan, and ensure accountability for results. PSP's 2022—26 Action Agenda establishes science-based goals to achieve recovery and protection. The agenda addresses habitat protection, toxic contamination, pathogen and nutrient pollution, stormwater runoff, water supply, ecosystem biodiversity, species recovery, and capacity for action. PSP prioritizes cleanup and improvement projects and coordinates with federal, state, tribal, and private resources to ensure all entities work cooperatively. In 2020, the PSP published a Stormwater Strategic Initiative[20] that outlined possible actions and approaches to address stressors and pressures affecting the health of streams in the Puget Sound.

[19] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Municipal-stormwater-general-permits/WSDOT-Municipal-Stormwater-Permit

[20] https://pspwa.app.box.com/v/BIBI-IS-Public/file/752505138418

Local Governmental Agencies

King County

About 35 percent of the development in the Soos Creek watershed is in unincorporated King County, making the county the jurisdiction with the largest developed area in the basin. Several departments and programs within the County's government oversee actions and regulations that influence how development shapes the landscape in the watershed. The Water and Land Resources Division (WLRD) in King County's Department of Natural Resources and Parks oversees local restoration efforts, nonpoint pollution prevention, and compliance with stormwater regulations under several general NPDES permits, including meeting requirements related to WLAs established in this TMDL. The County has WLA requirements to meet loading capacities established for all of the watershed's subbasins. Discharges from the County's MS4 in the Soos Creek basin are regulated under the Municipal Stormwater Permit Phase I. Some of the programs within WLRD and outside, that may support the implementation of this TMDL include:

- Stormwater Services Section, which provides source control inspections and technical assistance to businesses in the basin. The section is responsible for Phase I NPDES compliance, including TMDL implementation and Surface Water Design Manual updates. The section also responds to drainage and water quality complaints. Additionally, the section identifies and facilitates the removal of any illicit discharges or connections to the storm drainage system.
- Basin Steward Program, whose staff work with residents and technical staff to develop and implement priority habitat protection and restoration projects in critical habitat areas.
- River and Floodplain Section, which designs and implements projects to improve and reconnect floodplains to reduce flood risks and restore stream functions.
- Science and Technical Support Section, which collects, analyzes, and interprets information related to land use, habitat management, water quality, and water resources.
- Benthic Macroinvertebrate Ambient Monitoring Program, which collects benthic macroinvertebrate samples in streams across the county to calculate B-IBI scores. Continuation of this monitoring is key to tracking improvements in aquatic health in the watershed.
- Livestock Program, which implements the County's Livestock Ordinance. The ordinance supports livestock raising and keeping while minimizing possible adverse impacts on water quality and fish habitat. The program provides technical and financial assistance to agricultural landowners for BMP implementation, including stream and wetland buffer fencing, stream buffer revegetation, pasture restoration, roof runoff management, heavy use area protection, etc.

- Department of Local Services, which reviews development proposals to ensure that they are designed to be consistent with the King County's Surface Water Design Manual. Local Service also inspects developments during construction to ensure that stormwater runoff is controlled and required stormwater facilities are installed according to standards. Department staff also inspect the clearing and grading operations, including those of mines and sand and gravel facilities. Code enforcement officers within the section investigate complaints of irresponsible or hazardous development in unincorporated King County that are also violations of the King County Code, including zoning, housing and building, shorelines, and critical areas.
- King County Land Conservation Initiative, which is a regional collaboration between King County, cities, business owners, farmers, and environmental groups to preserve natural areas and urban green spaces over the next 30 years.
- King County Strategic Climate Action Plan, which guides policy and actions consistent with the County's priorities related to climate change.
- King County Forest Plan, which identifies priorities and goals to recover forest health, increase urban tree canopy, and improve water quality for humans and salmon.

City of Auburn

The Public Works Department oversees the planning, design, construction, operations, and maintenance of the City's stormwater system. The department also implements the City's Stormwater Management Program developed under the Western Washington Phase II Municipal Stormwater Permit. The Planning Services division of the Department of Community Development is responsible for zoning, including critical area regulations, and long-term land use planning. City of Auburn has WLA requirements to meet loading capacities established for the Soosette and Lower Big Soos subbasins.

City of Black Diamond

Black Diamond's Stormwater Utility, which is part of the Public Works Department, aims to protect the natural environment from the impacts of stormwater runoff. To accomplish this goal, the utility maintains the City's stormwater system by complying with the requirements of the Phase II Municipal Stormwater Permit, based on actions described in the Stormwater Management Plan. The City's Planning Division in the Community Development Department is responsible for the development and applying zoning regulations, including the Critical Areas Ordinance and the Shoreline Master Program. City of Black Diamond has WLA requirements to meet loading capacities established for the Covington and Jenkins subbasins.

City of Covington

The Engineering Division within the City's Public Works Department is in charge of the stormwater infrastructure systems. Similar to the other cities in the Soos Creek basin, discharges from Covington's MS4 are subject to regulations included in the Phase II Municipal Stormwater Permit. The City's Comprehensive Stormwater Plan from 2010 includes documentation of a review for a regional flow control facility along Little Soos Creek, in the vicinity of SE 256th Street, near the Wingfield development. Current and long-term zoning-related planning is performed by the Community Development Department. City of Covington has WLA requirements to meet loading capacities established for the Upper Big Soos, Jenkins, Little Soos, Covington, and Lower Big Soos subbasins.

City of Kent

The Storm Drainage Section within Kent's Public Works Department operates and maintains the City's stormwater infrastructure. The section also implements a Stormwater Management Program (SWMP) to comply with the requirements of the Phase II Municipal Stormwater Permit. To accomplish the actions and activities outlined in the SWMP, the Public Works collaborates and coordinates with other city departments, including the Economic and Community Development Department, which is in charge of the City's current and long-term planning, as well as local zoning regulations. City of Kent has WLA requirements to meet loading capacities established for the Upper Big Soos, Soosette, and Lower Big Soos subbasins.

City of Maple Valley

Stormwater runoff within the limits of Maple Valley is handled by the Storm and Surface Water Management Program within the Public Works Department. The City is a Phase II Municipal Stormwater Permittee and complies with the permit by implementing actions described in the annual Surface Water Management Program Plan. Zoning and critical area regulations are the responsibility of the City's Community Development Department. City of Maple Valley has WLA requirements to meet loading capacities established for the Jenkins and Covington subbasins.

City of Renton

Stormwater management and implementation of the Phase II Municipal Stormwater Permit for the City of Renton are the obligation of the Public Works Department, Surface Water Utility Division. The division is involved in the planning, permitting, design and construction of capital improvement projects, but also policy development and design standards for new development. The City implements its Stormwater Management Program Plan that outlines planned actions and activities and is updated annually. The Community and Economic Development Department is responsible for land use planning and regulations, including those related to the Growth Management Act and critical areas. City of Renton has WLA requirements to meet loading capacities established for the Upper Big Soos subbasin.

City of Seattle

Seattle Public Utilities (SPU) is the public utility agency for the City of Seattle and among its missions provides water for the City of Seattle. One of its water reservoirs is Lake Youngs. SPU controls the outlet from Lake Youngs to Little Soos Creek. The City does not have a MS4 footprint in the Soos watershed and is not subject to WLAs in this TMDL.

Note that the local jurisdictions listed in this section that received WLAs in this TMDL should also consider implementing LAs to manage stormwater from development that drains outside of their MS4s, directly to surface waters.

Special Districts and Interlocal Agreements

WRIA 9 Salmon Recovery Group

Water Resources Inventory Area 9 (WRIA 9) is a lead entity for salmon recovery under Washington's watershed-based framework for salmon recovery established under RCW 77.85. The partnership was formalized the under an interlocal agreement (ILA) in 2000 and includes 17 local governments. The ILA was most recently renewed in 2017 and extends through 2025. WRIA staff are working on renewing the ILA. In 2021, WRIA 9 updated its Salmon Habitat Plan[21], which identified a couple of major restoration projects in Soos Creek as important for habitat restoration and salmon recovery: (1) Lower Soos Green channel restoration, a $1.5 million project to restore habitat and water quality at the confluence with the Green River, classified as a Tier 1 (highest priority) project; and, (2) Little Soos restoration in the Wingfield neighborhood in the City of Covington, which would reconnect the stream with its floodplain, add instream large wood, and revegetate the riparian buffers.

Our Green Duwamish

Our Green Duwamish is a coalition of local governments, state agencies, nonprofit organizations, community groups, and businesses working in the Green-Duwamish to coordinate efforts to improve water quality in the watershed, with a focus on stormwater. The initiative is intended to increase coordination of work in the watershed at the local, state, and federal levels to manage habitat restoration, salmon recovery, flood control, stormwater management, public health, social equity, environmental cleanups, economic development, open space preservation, water quality, and more.

King Conservation District

The King Conservation District (KCD) is a non-regulatory public agency created under Chapter 89 RCW that administers programs to conserve the natural resources of King County. KCD efforts focus on individual contact with farm owners and residents within the unincorporated King County and 34 cities, excluding the Cities of Enumclaw, Federal Way, Milton, Pacific, and Skykomish. The goal of the district is to promote practices that maximize productive land use while conserving natural resources and protecting water quality through education, technical consultation, funding assistance, and cooperation. KCD advises landowners on the implementation of BMPs to protect water quality and fish and wildlife habitat; designs and installs stream buffer enhancement projects; provides education; conducts farm and riparian tours; and provides project financial assistance.

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[21] https://www.govlink.org/watersheds/9/pdf/2021_PlanUpdate.pdf

One of the main tools that KCD uses to accomplish its goals is the development of farm plans. BMPs that are part of farm plans include proper animal waste management, streamside planting, and livestock fencing. KCD also financially assists landowners through grants and cost-share funding for water quality-related farm improvement projects. KCD has developed numerous farm plans within the Soos Creek watershed.

Kent School District

Kent School District (District) is a secondary permittee under the Phase II municipal permit. The District's Stormwater Division of the Public Works Department maintains the District's stormwater collection and conveyance system on the school properties it owns in Soos Creek. The District is responsible for the stormwater management of three high-school campuses in the watershed under the MS4 permit. When retrofits of the school properties are undertaken to comply with the TMDL WLAs, the District may consider approaches that can transform schoolyards and yield multiple benefits, including improved student learning and well-being. For examples of such opportunities, see Green Schoolyards America[22]. KSD has WLA requirements to meet loading capacities established for all of the watershed's subbasins.

Nonprofits and Volunteer Organizations

Green River Coalition

Green River Coalition (GRC) focuses on restoration work in the Middle Green River, which includes the Soos Creek watershed. The Coalition works with partners and volunteers to improve water quality, revitalize salmon populations, and improve access to recreation. GRC organizes volunteer planting events and forges partnerships with local school districts, colleges, and service groups. GRC is actively participating in projects to restore the riparian buffer in Soos Creek and is leading an effort to monitor water temperature in the watershed by partnering with students from the Green River Community College and private property owners.

Mid Sound Fisheries Enhancement Group

Mid Sound Fisheries Enhancement Group (Mid Sound) is one of several statutorily authorized Regional Fisheries Enhancement Groups within Washington. Mid Sound works with Tribes, municipalities, conservation districts, state agencies as well as private landowners and other non-profits. The group works to restore habitats by removing fish barriers, restoring riparian habitat, and improving salmonid habitat. Mid Sound has had successful partnerships with volunteer organizations, businesses, and other nonprofits that empower youth by teaching them skills translatable to green jobs. Mid Sound has participated in restoration projects across the Soos Creek watershed.

[22] https://www.greenschoolyards.org/

Friends of the Soos Creek Park

Friends of Soos Creek Park is a non-profit organization comprised of volunteer members who take a pro-active role in preserving and extending the Soos Creek Park and Trail. The group sponsors and leads park clean-ups and interpretive walks for public education about the importance of wetlands specifically and undisturbed nature generally.

SHADOW Lake Nature Preserve

SHADOW (Save Habitat and Diversity of Wetlands) Lake Nature Preserve is involved in the acquisition and restoration of open land to preserve and restore habitat near Shadow Lake in Jenkins Creek subbasin. The organization manages over 100 acres of land, organizes volunteer events to restore habitat, and provides youth and adults with environmental educational opportunities.

Horses for Clean Water

Horses for Clean Water has offered horse owners ways to care for horses that benefit the animals, the farm, the owner, the community, and the environment. They actively educate horse owners through classroom series, workshops, farm tours, and educational material development. Educational outreach is also achieved through partnerships between Horses for Clean Water and conservation districts, natural resource agencies, extension offices, environmental groups, horse organizations, and other equine professionals.

Other Organizations and Private Citizens

The support of all landowners is needed for the TMDL to be successful. The participation of organizations and special interest groups to help guide this TMDL and meet its ultimate goals is critical. Groups, such as Greater Maple Valley Unincorporated Area Council or Soos Creek Area Response, will be vital to help local jurisdictions and property owners engage in the TMDL process. Ecology does not have authority to require these groups to take specific actions but encourages all to consider:

- Continued engagement with federal, state, and local discussion regarding local and regional planning efforts, conservation goals, ongoing research, and stakeholder activities.
- Advocate for financial incentives, including grants, subsidized loans, shares, leases and indirect financial assistance such as property or sales tax relief, to help landowners participate in TMDL implementation.

Priorities and Timeline

Priority Actions and Areas

Implementation resources are limited, which places a constraint on the ability of interested parties to address all the sources of pollution at once. This means that the prioritization of areas and actions that have the largest impact is critical to making meaningful progress from the beginning.

This prioritization process must take into account the impact of upstream sources that could compromise the effectiveness of actions taken to reduce fine sediments. For instance, failing to address stormwater runoff that causes flashy flows downstream of an instream restoration site will jeopardize the end goal of the instream work. Lammers et al. (2020) showed that the best outcomes for fine sediment control are realized when instream restoration is coordinated with stormwater management and problems are addressed in an upstream-downstream direction.

Planning among the jurisdictions within the Soos Creek watershed and interdepartmental coordination within each jurisdiction are vital to ensuring that priority areas in the watershed and priority approaches are well known and understood by staff and other stakeholders. Jurisdictions should ensure that their codes, regulations, and policies support the implementation of this TMDL, potential barriers are removed, and internal collaboration between different departments is encouraged, so that opportunities to leverage synergies with other actions can be pursued to enhance effective stormwater management. EPA built a Land Use and Green Infrastructure Scorecard[23] as a tool to assist jurisdictions in determining if development review, municipal practices, planning, public engagement, and enforcement are protective of water resources and facilitate the use of green infrastructure in their respective communities. Jurisdictions are highly encouraged to audit their regulatory and codified systems to see if they find opportunities or barriers to green stormwater infrastructure, for example. In 2023, Puget Sound Regional Council and Washington State Department of Commerce released guidance[24] on how comprehensive plans can be used to set up a collaborative framework between different jurisdictional departments to promote more effective and far-reaching stormwater management. Jurisdictions responsible for implementing this TMDL should consider adopting recommendations from this guidance to facilitate a more expeditious implementation pace.

One of the early actions expected from this TMDL is the development of a Stormwater Implementation Plan that each jurisdiction will use to assess a baseline condition for existing stormwater management controls and to identify where BMPs are necessary. To help prioritize the substantial work that will have to be accomplished to achieve targets and to make decisions about the type and location of BMPs to be implemented, municipalities are encouraged to use

[23] https://www.epa.gov/green-infrastructure/land-use-and-green-infrastructure-scorecard
[24] https://www.psrc.org/media/7640

EPA's Augmented Alternatives Analysis[25], or an equivalent tool. The Augmented Alternatives Analysis is a decision-making framework that is based on sustainability principles and accounts for costs and benefits of alternatives. The relative benefits associated with the alternatives are based on community-defined criteria, ensuring that the preferred alternative meets not only the goals of the TMDL but also those of the communities the municipalities are serving.

While these strategies provide recommendations on how to prioritize the type of implementation work that needs to happen in Soos Creek, the discussion below provides insights into where this work should happen to address the major sources of TSS first. The modeling analysis in Mohamedali (2024) found that, while there are opportunities to reduce TSS loads throughout the watershed, particular catchments in Upper Soos Creek, the upper portions of Little Soos, Jenkins, and Covington subbasins, and the majority of Soosette contribute substantial loads, so controlling their TSS outputs will result in big loading reductions. The darker colors in each of the three maps in Figure 15 indicate the portions of the watershed where the upland TSS loads, TSS yields (TSS lbs./acre/year), and in-water loads that accumulate downstream are higher.

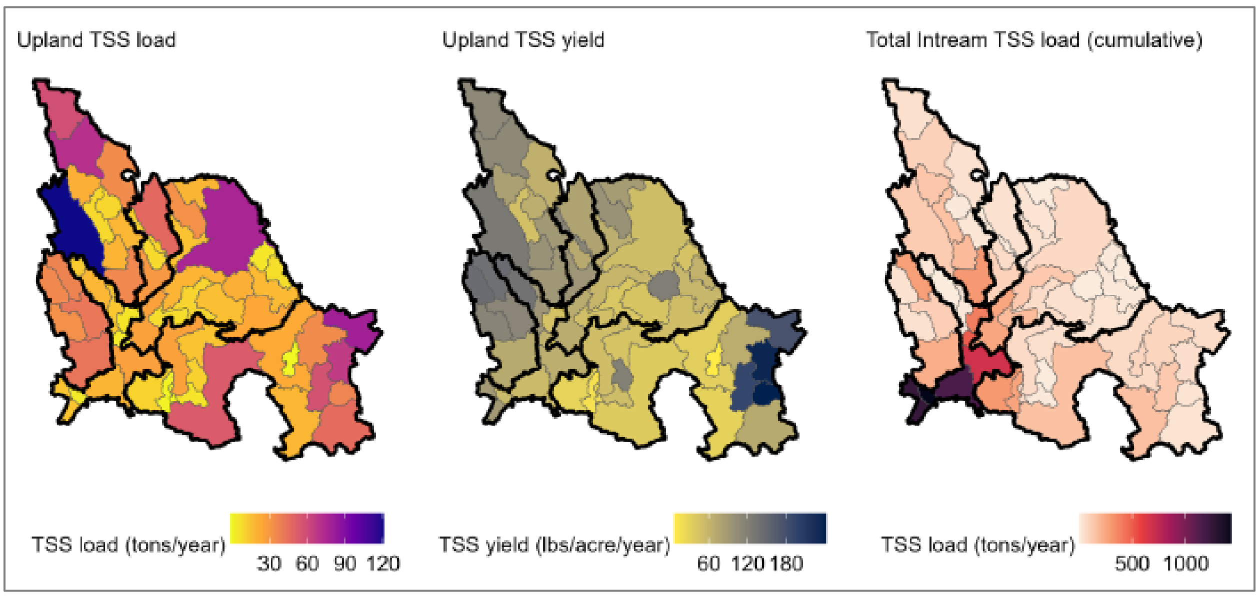

Figure 15. Annual average upland TSS loads, upland TSS yields, and cumulative instream TSS loads for 2001-2015

As discussed elsewhere in this report, TSS loads vary throughout the year based on precipitation levels, as well as soil and land cover types. Figure 16 shows a distribution of existing (monthly averages for 2001-2015) TSS loadings for each subbasin, compared to those expected under reference (forested) conditions. The figure shows that the differences between these two states is the largest during the wet months (September through June).

[25] https://www.epa.gov/compliance/making-right-choices-your-utility-using-augmented-alternatives-analysis-planning-water

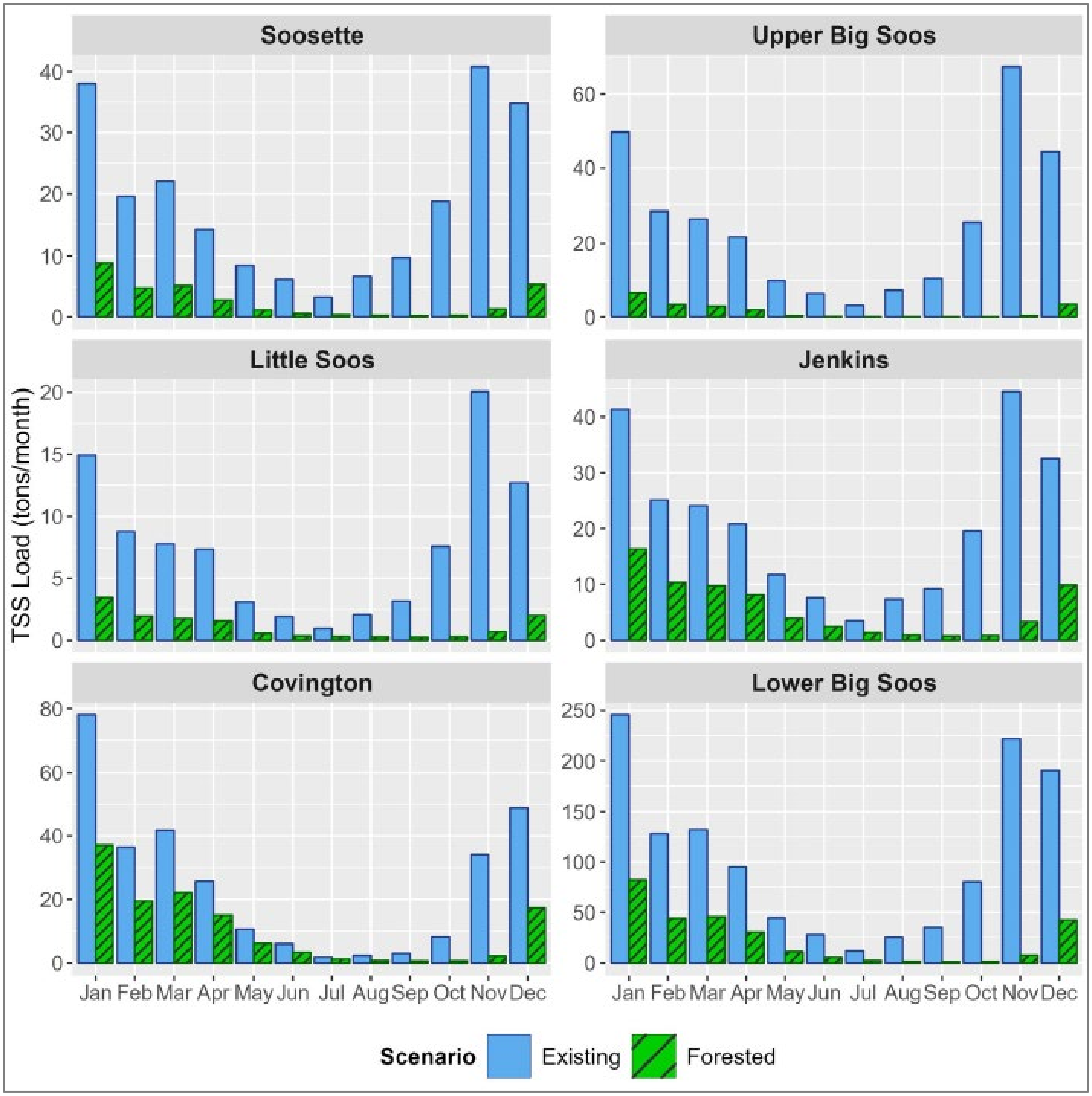

Figure 16. Average monthly TSS loads under existing and reference conditions, by subbasin

Similarly, Mohamedali (2024) shows how the fraction of upland versus instream TSS varies by subbasin (Figure 17). The results may provide an indication of the types of BMPs (LID, flow control, or runoff treatment) should be prioritized within each subbasin. While the results at the subbasin level are informative, implementing entities should keep in mind that they need to consider both localized and downstream effects of BMPs. For instance, while the TSS fraction in most subbasins shows that a large portion of the TSS is produced upland, the fraction of TSS produced instream in the Lower Big Soos indicates that flow control BMPs will be necessary both in the Lower Big Soos but also in the upstream subbasins.

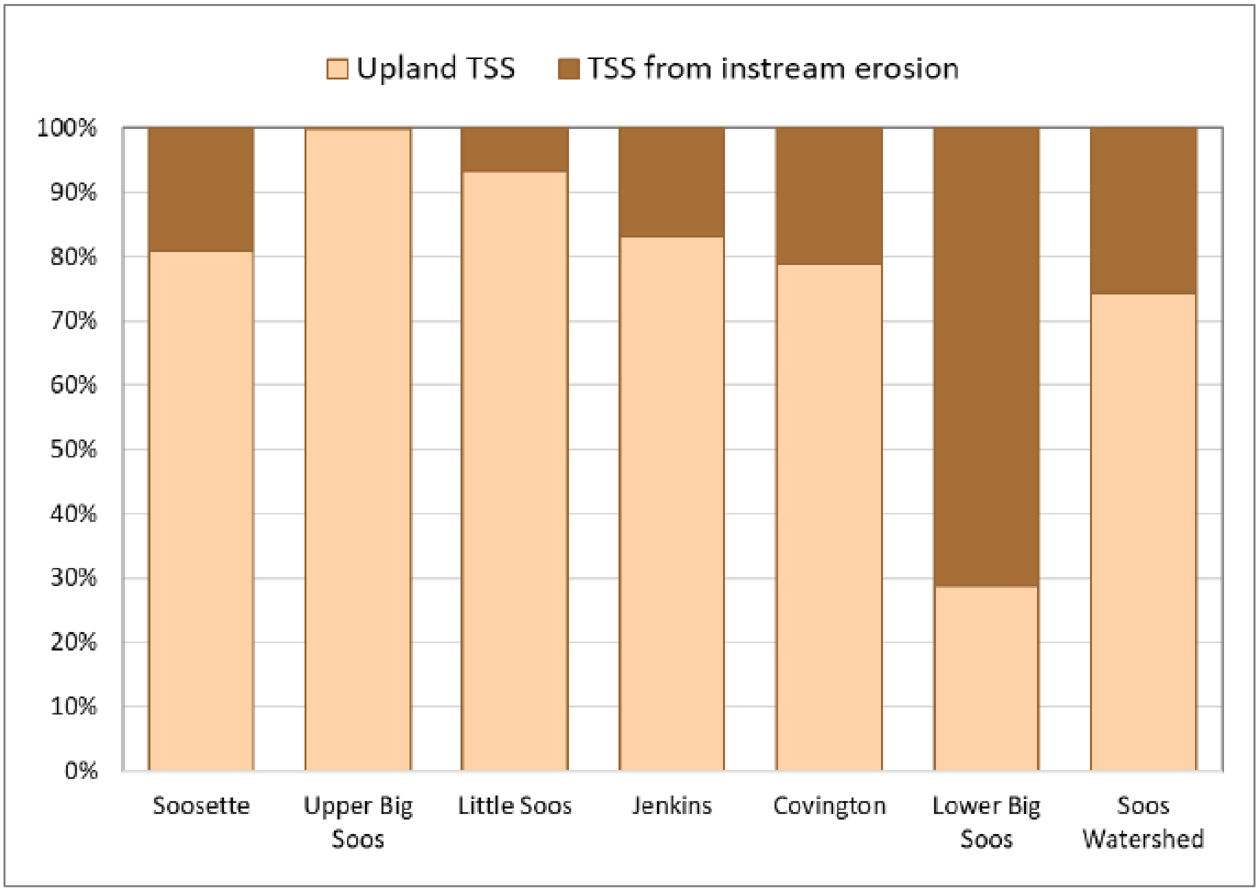

Figure 17. Fraction of upland versus instream TSS, as a portion of the total annual average TSS load, by subbasin

The upland TSS produced within each subbasin is influenced by the land cover type over which runoff travels before discharging to surface water. Mohamedali (2024) includes information on both the amount of TSS loadings entering waters in Soos Creek and the proportion of TSS loads each land cover type is associated with in each subbasin. Figure 18 shows that even though forest cover represents a considerable portion of some subbasins (top panel), this land cover produces a very small fraction of upland TSS across subbasins (bottom panel). Similarly, pastureland cover represents a minor portion of the total upland TSS. In contrast, effective impervious areas and high-density developed pervious areas contribute a disproportionate load of upland TSS in all subbasins, relative to their portion of individual subbasins. These profiles of upland TSS loads should inform implementing entities where to prioritize their investments.

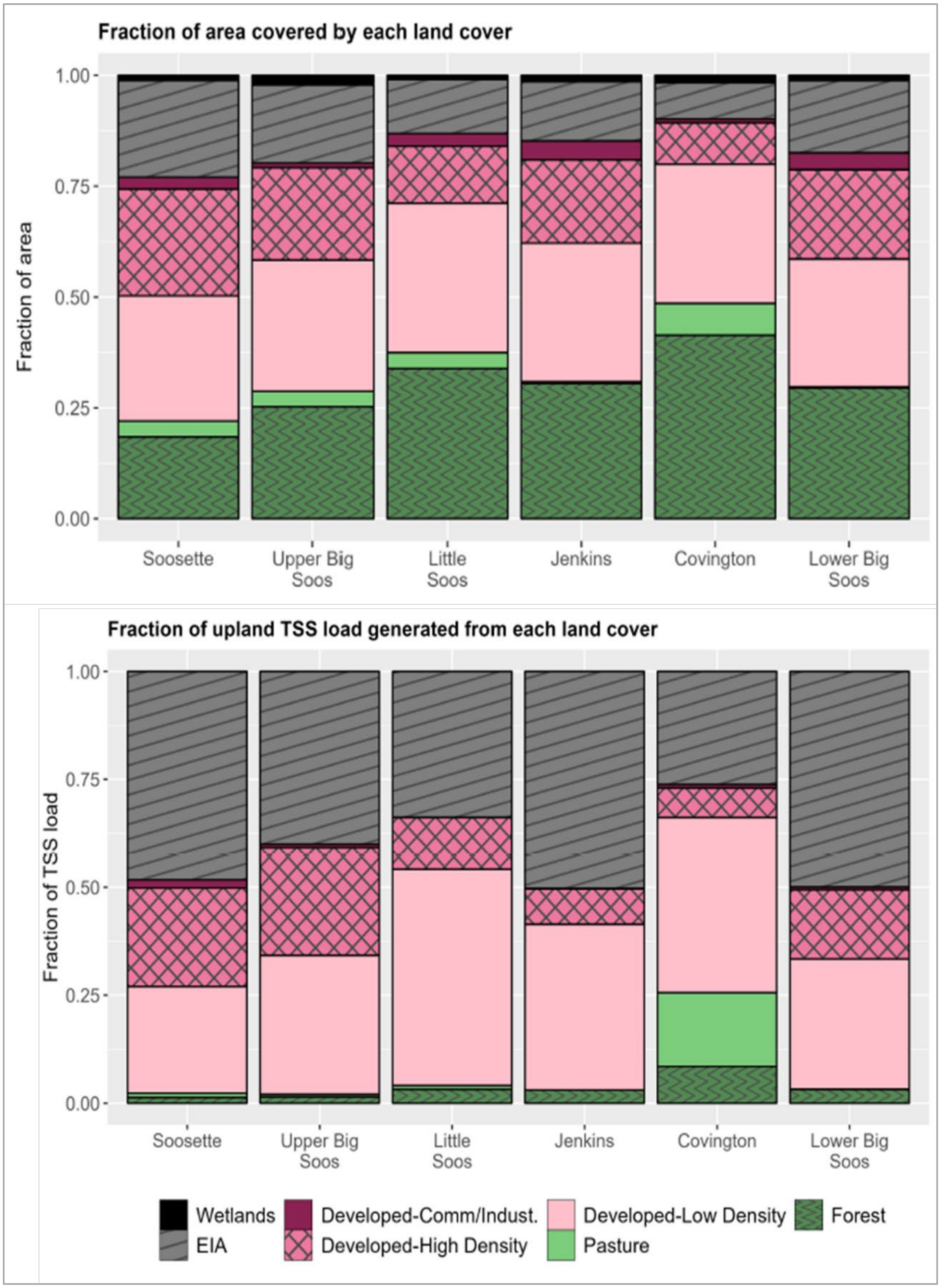

Figure 18. Land cover distribution (top) and fraction of TSS load generated by each land cover type (bottom), by subbasin

The top panel of Figure 18 shows that most opportunities for TSS reductions will be in MS4 areas, where the majority of impervious and developed land is concentrated. Nonpoint BMPs will be most effective at controlling TSS from pastureland and some low-density development. As a result, the Covington subbasin appears to be the main portion of the Soos Creek watershed where nonpoint BMPs are expected to be employed most frequently, though Ecology nonpoint staff will evaluate other locations on a site-by-site basis, depending on available information from ERTS or other sources. Within the watershed, properties that are within the RMZ (215-foot buffer) are considered a priority for implementation purposes. Parcels farther from waterbodies are less likely to be significant contributors of fine sediment. Ecology does not assume that all parcels close to surface water cause pollution. This may be determined on a parcel-by-parcel basis.

Timeline

Ecology expects that sustained implementation that achieves the TSS reductions documented in the TMDL will result in meeting WQS within forty years from the approval of this TMDL. Figure 19 presents a tentative outline of the major implementation milestones and the entities in charge of implementing them.

Requirements based on WLAs will be included in each one of the permits regulating the entities with authorized discharges to surface waters in Soos Creek. Some of the requirements, including monitoring requirements, will be first documented in administrative orders before being included in the respective permits and others will be included directly in the permits. Administrative orders are expected to be issued for permittees covered under the ISGP and the Sand and Gravel permits and for Pacific Coast Coal, which is covered by an Individual Industrial Permit. Requirements for MS4 jurisdictions, WSDOT, the Soos Creek hatchery, and construction sites will be included in the next cycle of permit renewals, which are represented in Figure 19.

Note that permittees will continue to have requirements in their respective permits to maintain the WQS once they are attained even beyond the 2066 timeline estimated for this TMDL's implementation.

Nonpoint BMPs, as well as education and outreach, technical assistance, and enforcement actions are expected to be implemented throughout the duration of the implementation phase and beyond.

Every five years, Ecology's Watershed Health Monitoring group is expected to conduct a thorough monitoring assessment of the several sites throughout the watershed to evaluate the changes in stream conditions as a result of implementation. More details about this monitoring effort are described in the Tracking Progress section of this Implementation Plan. Data collected during this monitoring will be used to evaluate progress towards the attainment of water quality standards. At the end of the implementation phase, when Ecology expects that water quality standards are met, Ecology will need data from at least two years to determine standard attainment. Data will be collected from the AUs that are currently listed as impaired but may extend to other AUs in the watershed to ensure water quality standards are met throughout Soos Creek. Based on current methodology outlined in Policy 1-11, the years when data are collected do not have to be consecutive. The assessment of water quality standard attainment will be based on B-IBI scores and scores from the three related subindices, including FSBI, the Hilsenhoff biotic index, and the metals tolerance index.

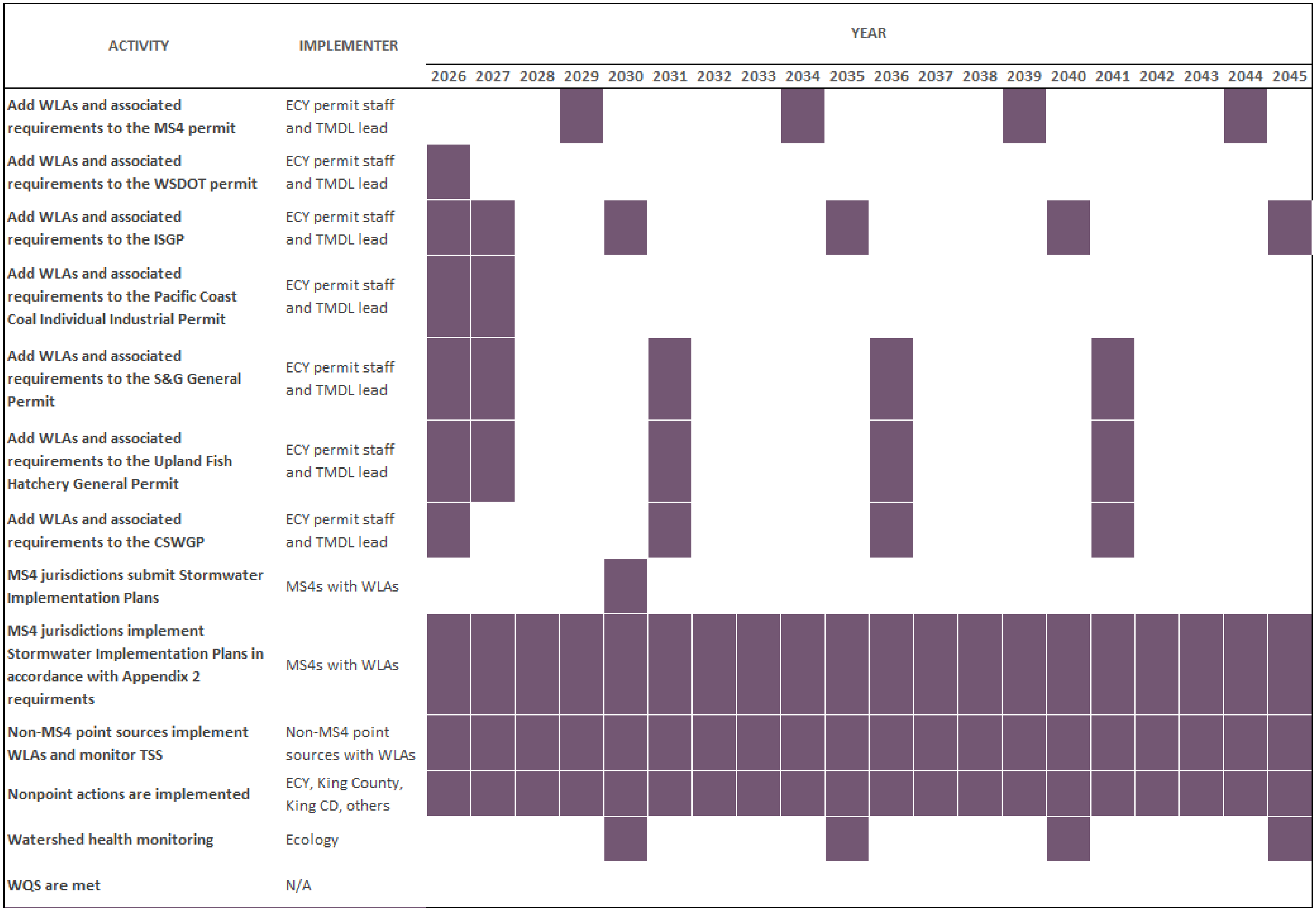

Figure 19. Tentative Soos Creek Fine Sediment TMDL implementation timeline

Note: All dates in this figure, including permit reissuance years, are tentative.

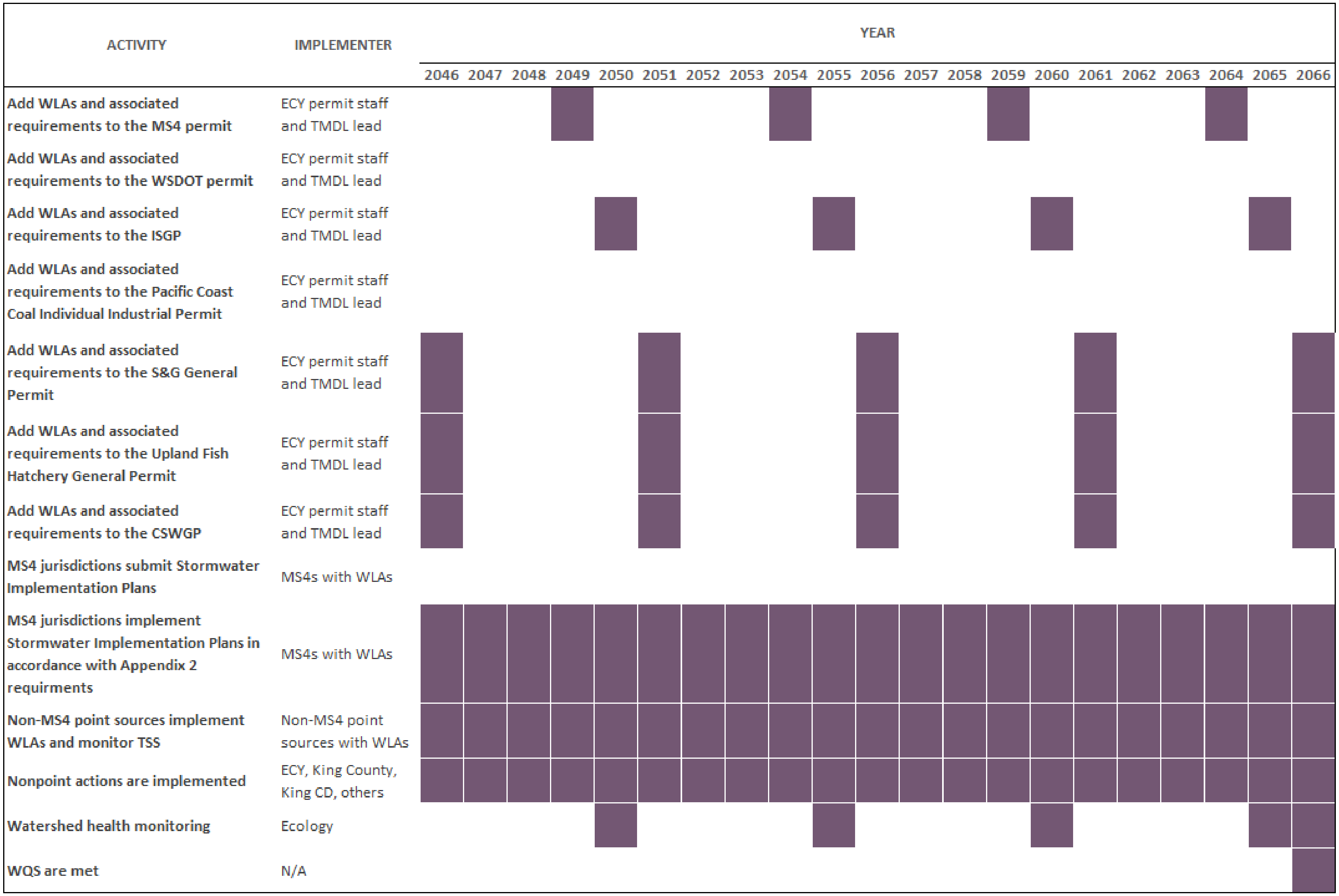

Figure 19. Tentative Soos Creek Fine Sediment TMDL implementation timeline (cont.)

Note: All dates in this figure, including permit reissuance years, are tentative.

Technical Feasibility

The TSS reductions estimated in this TMDL are feasible, as discussed below. The stressor ID (Marshalonis and Larson 2018) and Ecology's technical analysis (Mohamedali 2024) show that reducing upland TSS and stormwater runoff is necessary in order to restore the benthic habitat in Soos Creek. While the investments necessary to implement the TMDL are significant, the implementation timeline is estimated to be several decades, which makes it more feasible to plan, budget, secure funding, and use the most effective BMPs.

Ecology believes that attaining water quality standards in Soos Creek is technically feasible for the following reasons:

- The problem affecting water quality is well understood and we know what needs to be done to address it. The first step in assessing if a technically feasible solution exists for the water quality impairments in this TMDL is to determine the root of the problem. The stressor ID performed this function, and its results confirmed that the Soos Creek watershed is afflicted by the same set of stressors that many urban waters are. The TMDL used the information from the stressor ID and used modeling to set a limit for the polluting constituent.
- Implementation actions described in this Implementation Plan are based on scientific understanding and technologies that are currently available and accessible to parties that are responsible for taking management actions. According to EPA (1990),

"if the control technology has been installed and operated successfully on the type of source under review, then it is demonstrated, and it is technically feasible." (p. B-17)

The MS4 jurisdictions in Soos Creek have been implementing and maintaining stormwater management BMPs for over a decade to comply with their respective MS4 permits. Jurisdictions are familiar with most, if not all, BMPs listed in the Implementation Plan. What will be different from the current practices is the scale at which these BMPs will have to be implemented, the need for inter-jurisdictional collaboration, and the need for planning to prioritize cumulative, basin-wide effects, not just localized improvements.

- Implementation doesn't depend on unique technologies, rather it relies on BMPs that are substitutable and interchangeable with other BMPs yielding similar TSS reductions. The Implementation Plan discusses a wide range of BMPs and actions that can be used to reduce TSS loadings in Soos Creek. Future advances in technology and understanding how to most effectively control stormwater to protect watershed health will most likely broaden the options for implementation. Permittees should also consider how to make best use of the range of BMP options by developing BMP trains that link small-scale BMPs with facilities that manage stormwater runoff at larger scales.

- Nonpoint BMPs are well established practices with a long track record of successful implementation in the state. These practices are known to be practical and technically feasible to install, as described in the Voluntary Clean Water Guidance for Agriculture.

Though outside of the scope of this TMDL, it should be mentioned that actions that address other stressors of benthic communities in Soos Creek are also technically feasible. Stream restoration that could include floodplain reconnection, hyporheic areas restoration, and instream placement of woody debris are actions that have been successfully implemented regionally.

Costs

Reducing fine sediment loads in the Soos Creek watershed to the level identified by loading capacities identified in this TMDL will require large investments for the jurisdictions that are assigned WLAs and everyone else who will participate in the TMDL implementation. Some of the actions (e.g., street sweeping, catch basin cleaning, some retrofits included in the MS4 permits' SMAP process) that contribute towards meeting WLAs are already occurring to meet stormwater permit requirements, so the costs of those actions will be incurred regardless of commitments related to this TMDL. Similarly, the costs of some retrofits that have been implemented since 2015, when the TMDL modeling period ends, have already been incurred. These, however, represent a small fraction of the implementation that will be necessary to reduce fine sediment loads to a level that allows for the recovery of benthic invertebrates and overall watershed health. Below we discuss funding opportunities that may be pursued to cover the costs of implementing both the WLAs and LAs. First, we provide an overview of the costs and funding sources for stormwater BMPs and then those for nonpoint actions.

Stormwater Implementation Costs

To get a sense of the investments associated with the stormwater implementation of this TMDL, we queried cost information for Ecology's Stormwater Financial Assistance Program (SFAP) grants, where construction was completed between 2017 and 2023, and projects were located in King County. The query focused on retrofits and excluded planning and operational projects because they are more difficult to compare and generally represent a smaller portion of the overall stormwater implementation costs. This yielded 26 projects whose cost information we were able to review after they were adjusted to 2024 dollars using Mortenson's Construction Cost Index[26] for nonresidential construction in Seattle. We limited the costs to those directly related to water quality benefits. For example, if a project installed several water quality treatment facilities but they were part of a much larger street improvement and beautification project, only the costs associated with stormwater control and the infrastructure necessary for these facilities to function properly were included in the analysis. The average construction cost of a retrofit project was $1.5 million, while the median cost was $1.1 million.

[26] https://www.mortenson.com/cost-index/seattle

The lowest cost was $189,000 and the highest went up to $5.6 million. Design costs during the same period of time ranged between $278,000 and $3.4 million, depending on the size and complexity of the project. All 26 projects had a water quality treatment element, while 16 of them also had a flow control component. On average, the projects fully treated the equivalent of 16.8 acres (median of 3.1 acres) and fully controlled 1.2 acres (median of 0.4 acres).

It is difficult to translate these costs into unit costs that can be applied to the case of Soos Creek for several reasons, including the following:

- Costs are controlled by the types of BMPs that are built. In most cases, the projects funded with the SFAP grants involved the implementation of more than one type of BMP, so using the project costs to estimate a cost per BMP would lead to confounding results. This is because the cost of installing a single BMP decreases when the facility is part of a project that installs multiple BMPs.
- The size of the area being retrofitted is another factor in the cost estimation, where efficiencies of scale may reduce the per acre cost.
- It is not uncommon for the costs of a project to be influenced by limiting factors, such as space availability or the presence of underground infrastructure. Assessing to what extent the costs of the reviewed projects were increased by these factors was beyond the scope of this report.
- When a facility needs to be sited on parcels that are not publicly owned, the cost of purchasing the land will add to the cost of implementing the facility.
- Operation and maintenance are not included in the grant costs but should be factored in when decisions are made about future BMPs to be built.

To cover the costs of stormwater retrofits, jurisdictions will most likely have to secure funding from multiple sources. Table 23 shows only a few of the possible funding sources that could provide full or partial capital to implement actions that help jurisdictions meet their WLAs and that can reduce fine sediment loadings throughout the Soos Creek watershed. Some funding opportunities are temporary, but new funding sources arise over time. Keeping track of these opportunities may be a daunting undertaking. Several organizations, however, have built databases that aggregate grants that fund projects like those that are recommended in this implementation plan. Here are a few examples:

- Washington State Recreation and Conservation Office – Find a Grant - Recreation and Conservation Office (wa.gov)[27]
- Puget Sound Partnership – PS RAFT - Recovery Acceleration Funding Tool (arcgis.com)[28]

[27] https://rco.wa.gov/recreation-and-conservation-office-grants/find-a-grant/

[28] https://experience.arcgis.com/experience/6f12941d99644b0e93deaed86f1674f0/page/Home/?views=Active-Announcements

- Puget Sound Partnership – Bipartisan Infrastructure Law (BIL) Funding Opportunities for Puget Sound Recovery[29]
- EPA –Green Infrastructure Federal Collaborative[30]

Researching funding opportunities, developing and submitting grant applications, and managing grants when funding is secured can add up to a large amount of work that smaller municipalities in the watershed may not be able to support financially. It is recommended that the jurisdictions in the Soos Creek watershed explore different options to ensure that they can access sources of funding to cover the costs of TMDL implementation. Some of these options may include cooperatively supporting a staff position that can complete tasks related to securing and managing grant funding for actions described in this Implementation Plan.

Additional efficiencies may also be realized when jurisdictions leverage related project types with which to combine stormwater retrofits to reduce planning, design, and implementation costs.

Nonpoint Implementation Costs

Where implementation consists of managing stormwater runoff from land surfaces that are assigned LAs, the implementation tools, costs, and funding resources are similar to those discussed in the previous section.

This section addresses costs associated with implementation that will be done in Soos Creek to reduce TSS loads from agricultural land and properties that are used for nonagricultural purposes but have large animals on their premises. The Implementation Plan identified several BMPs that can be used to prevent soil erosion, including riparian buffers, using fencing for livestock exclusion, grazing management, as well as appropriate watering facilities and animal confinement. Funding opportunities to cover some of these costs are referenced in Table 34. Costs associated with these BMPs are described below.

Riparian Vegetative Buffers or Filter Strips

Ecology's Water Quality Combined Funding Program estimated that the average cost to complete riparian restoration is approximately $15,500 per acre, based on 33 previously funded grant agreements across the state from State Fiscal Years 2016 to 2019. Cost per acre varies based on specific site conditions and project scale. Costs range from approximately $3,500 to $35,000, depending on the extent of invasive species control, ease of access, plant stock quality, and if maintenance is included in the budget. Typically, larger scale projects have a lower cost per acre. Costs for site preparation, plant materials, plant protectors, and planting labor vary between $500-$2,000 per acre.

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[29] https://app.powerbigov.us/view?r=eyJrIjoiNjE3ZGJlYTktMGFkYy00OWNlLTgyYWUtYjMyMDBkNWM0ZDE5Ii widCI6IjExZDBlMjE3LTI2NGUtNDAwYS04YmEwLTU3ZGNjMTI3ZDcyZCJ9&pageName=ReportSection4135b7dbe512 3b276369

[30] https://www.epa.gov/green-infrastructure/green-infrastructure-federal-collaborative

Livestock Exclusion Fencing

Fencing should be designed using the NRCS Field Office Technical Guidelines (FOTG)[31]. Specific fencing types and styles are recommended based on the observed or anticipated type of livestock and site conditions. The cost of the fencing will depend on the style and materials used. Based on information collected by the USDA Extension service guidance[32], costs (including labor and materials) range between $5-7 per foot for woven wire, barbed wire, and electric fencing. To account for the increased cost of materials and labor since 2012, as well as Ecology implementation specialist input, $7-10 per foot may be used as the typical cost for fencing projects across the state. Specific projects may require additional elements (high tensile materials, additional height fencing) which may exceed the $10 per foot budget estimate.

Heavy Use Protection

Heavy use protection is used to stabilize a ground surface that is frequently and intensively used by people, animals, or vehicles to reduce onsite erosion. In order to reduce the negative water quality impact of heavy use areas, landowners should locate them as far away as possible from water bodies or water courses.

In some cases, this may require relocating the heavily used area rather than armoring an area that is already in use. Preferred practices would limit impervious surfaces, such as concrete pads, used for protection. Gravels and stabilizing materials (such as geotextile fabric) are the preferred option when feasible, based on NRCS heavy use protection guidance[33].

Based on NRCS FOTG guides and scenarios for heavy use protection practices (NRCS practice code 561), average practices range between 2,500-4,000 square feet, but actual size should be developed based on the number of animal units and other site-specific information. Heavy use protection scenarios used to estimate typical costs place each practice cost between $10,000 and $16,000.

Stock Watering Facilities

Watering facilities are designed to provide alternative locations for livestock to get water while protecting streams from livestock damage and soil erosion. This BMP is recommended on sites where it appears that animals have direct access to the watercourse as a primary drinking source. It can also be used near other vulnerable surface waters where water quality is an issue.

Due to animals congregating near the watering facilities, this practice often includes heavy use protection BMPs near the watering location. The resulting heavy use protection costs are described in the heavy use protection section above and not duplicated here. Based on NRCS site scenarios and cost share program guidelines, the estimated cost is approximately $2,500-$4,000 per facility.

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[31] https://www.nrcs.usda.gov/resources/guides-and-instructions/field-office-technical-guides

[32] https://www.extension.iastate.edu/agdm/livestock/pdf/b1-75.pdf

[33] https://efotg.sc.egov.usda.gov/references/public/MO/561HeavyUseAreaProtection.pdf

Stormwater Control

Gutters, downspouts ($7-9 per linear foot) and outlet piping ($20 per linear foot) may be necessary to upgrade existing livestock facilities. The additional plumbing would direct water away from potential sources of pollution during rain events. Cost sharing for gutters, downspouts, and outlet piping, may be available through federal, state, or local cost share programs. The NRCS offers guidance under practice 651 in the FOTG.

Table 34. Possible funding sources that could fund Soos Creek TMDL implementation projects

Funding organization	Funding source	Eligible activities*	Eligible recipients	Eligible project phases	Website
Ecology	Stormwater Funding Assistance Program (SFAP)	Stormwater retrofits and planning	Counties and cities	Planning, design, construction	https://ecology.wa.gov/water-shorelines/water-quality/water-quality-grants-and-loans/wqc-funding-cycle
Ecology	Centennial Fund	Stormwater activities and restoration of streams and buffers	Counties, cities, conservation districts, Tribes, etc.	Planning, design, construction	https://ecology.wa.gov/water-shorelines/water-quality/water-quality-grants-and-loans/wqc-funding-cycle
Ecology	Section 319	Restoration of streams and buffers and watershed planning	Counties, cities, conservation districts, Tribes, nonprofits, etc.	Planning, design, construction	https://ecology.wa.gov/water-shorelines/water-quality/water-quality-grants-and-loans/nonpoint-source-project-resources
Ecology	State Revolving Fund	Stormwater facilities	Counties, cities, conservation districts, Tribes, etc.	Planning, design, construction	https://ecology.wa.gov/water-shorelines/water-quality/water-quality-grants-and-loans/wqc-funding-cycle
Ecology	Stormwater Grants of Regional or Statewide Significance (GROSS)	Stormwater-related projects that benefit multiple permittees (e.g, education and outreach, training, etc.). *Excludes capital projects*	Phase I and II permittees	Planning and land acquisition	https://ecology.wa.gov/about-us/payments-contracts-grants/grants-loans/find-a-grant-or-loan/grants-of-regional-or-statewide-significance

Funding organization	Funding source	Eligible activities*	Eligible recipients	Eligible project phases	Website
Ecology	Community-Based Public-Private Partnership Program	Technical assistance, other	Local governments, other entities	Planning only currently	https://ecology.wa.gov/water-shorelines/water-quality/water-quality-grants-and-loans/community-based-public-private-partnership-program
Ecology	Floodplains by Design	Projects that reduce flood risk, restore ecological function, support climate change resilience	Counties, cities, conservation districts, Tribes, nonprofits, etc.	Planning, design, construction, land acquisition	https://ecology.wa.gov/about-us/payments-contracts-grants/grants-loans/find-a-grant-or-loan/floodplains-by-design-grants
Ecology	Streamflow Restoration	Water storage, watershed function, riparian and fish habitat improvements	Tribes, local governments, quasi-governments, nonprofits	Planning, design, construction	https://ecology.wa.gov/about-us/payments-contracts-grants/grants-loans/find-a-grant-or-loan/streamflow-restoration-implementation-grants
Ecology	National Estuary Program Stormwater Strategic Initiative	Stormwater retrofits	Counties, cities, tribes, nonprofits, etc.	Planning	https://pugetsoundestuary.wa.gov/stormwater-sil-rfp/
EPA	Water Infrastructure Finance and Innovation Act (WIFIA)	Stormwater management	Public and private organizations and public-private partnerships	Planning, design, construction, land acquisition	https://www.epa.gov/wifia

Funding organization	Funding source	Eligible activities*	Eligible recipients	Eligible project phases	Website
Restore America's Estuaries	National Estuary Program Watersheds Grant	Stormwater management that implements Puget Sound Agenda	Counties, cities, tribes, nonprofits, etc.	Planning, design, construction	https://estuaries.org/nep-watersheds-grant/
US Department of Transportation	Rebuilding American Infrastructure with Sustainability and Equity (RAISE)	Road infrastructure improvements, including stormwater management	Counties, cities, tribes, etc.	Planning, design, construction	https://www.transportation.gov/rural/grant-toolkit/rebuilding-american-infrastructure-sustainability-and-equity-raise
Washington State Recreation and Conservation Office and Puget Sound Partnership	Puget Sound Acquisition and Restoration (PSAR)	Salmon habitat restoration	Counties, cities, tribes, nonprofits, etc.	Planning, design, construction	https://rco.wa.gov/grant/salmon-recovery/
Washington State Department of Natural Resources	Community Forest Assistance Grant Program	Urban tree planting	Counties, cities, tribes, nonprofits, etc.	Implementation	https://www.dnr.wa.gov/urbanforestry/#grants
King County	WaterWorks	Water quality improvement projects in the service area for King County's regional wastewater system.	Cities, tribes, nonprofits, etc.	Planning, design, construction	https://kingcounty.gov/en/dept/dnrp/about-king-county/about-dnrp/grants-partnerships/waterworks-grant

Funding organization	Funding source	Eligible activities*	Eligible recipients	Eligible project phases	Website
King County Flood Control District	Original Flood Reduction	Stormwater retrofits that reduce flooding	County, cities, tribes, nonprofits, etc.	Planning, design, construction	https://kingcountyfloodcontrol.org/grant-programs-funding/flood-reduction-grants-open/
King County Flood Control District	Urban Streams	Green infrastructure, sediment ponds, flow control, stream restoration, habitat restoration	County, cities, tribes, nonprofits, etc.	Planning, design, construction	https://kingcountyfloodcontrol.org/grant-programs-funding/flood-reduction-grants-open/
King County Flood Control District	Culvert Replacement/ Fish Passage	Revegetation and habitat restoration where fish blockage removed	County, cities, tribes, nonprofits, etc.	Planning, design, construction	https://kingcountyfloodcontrol.org/grant-programs-funding/flood-reduction-grants-open/
King County Flood Control District via WRIA 9	Cooperative Watershed Management	Revegetation and habitat restoration	County, cities, tribes, nonprofits, etc.	Planning, design, construction	https://www.govlink.org/watersheds/9/funding/
King Conservation District	Member Jurisdiction Grant Program	Projects that lead to direct improvement of natural resource conditions	County and most cities in King County	Planning, design, construction	https://kingcd.org/tools-resources/grants/member-jurisdiction-grant-program/

*Some of the funding opportunities may fund more activities than those named here. The table shows eligible activities that are relevant to implementation for the Soos Creek TMDL.

Outreach

For the TMDL implementation to be successful, outreach to interested and affected parties is necessary. The Implementation Plan will not attempt to provide a detailed outreach and communications plan. That should be developed post TMDL approval/adoption in concert with key implementing entities. This TMDL recommends the following as a general outreach approach to the public:

- Ecology staff should coordinate with key implementing entities to develop a collaborative, detailed education/outreach strategy
- Key interested parties include jurisdictions that receive WLAs in this TMDL, as well as other entities, including but not limited to, King Conservation District, Muckleshoot Indian Tribe, Mid-Sound Fisheries Enhancement Group, King County basin stewards, WRIA 9 Salmon Recovery Group
- Be sure to include staff with communication/outreach training/expertise
- Identify target audience
- Reach out to property owners in areas that need stormwater runoff management to levels identified in this TMDL
- Landowners with property adjacent to surface water
- Identify geographic areas to focus outreach efforts
- Focus on implementation priorities, working through ranked reach priorities sequentially
- Anticipate problems and develop solutions
- Identify barriers to implementation
- Brainstorm potential solutions to overcome barriers and facilitate personal and institutional behavior change
- Develop messaging
- Concentrate on BMPs that provide multi benefits for water quality and other improvements (e.g., air quality, neighborhood beatification, improved property values)
- Emphasize funding assistance opportunities
- Incorporate solutions to barriers (above)
- Ensure messaging consistency
- To the extent possible, ensure messaging is consistent amongst partners and across various media and events
- Produce educational materials to support messaging (examples: flyers, brochures, pamphlets, post cards, door hangers)

- Install restoration project and creek signage, especially where it appears residents are less familiar with water quality issues
- Use social media/mass media (examples: Facebook, Twitter, Instagram, Nextdoor Neighbor)
- Use short messages that are customized for different audiences
- Use messaging to disseminate information on local programs and advertising upcoming workshops or other education events
- Make use of local TV and newspapers to spread messages
- Use education events and tools
- Develop new public events or make use of existing education events to present messaging and answer questions to the public
- Use Ecology's 'Enviroscape'2 model to teach basic riparian ecology and BMP functions
- Partner with local schools to further spread messaging

Tracking Progress

The targets in this TMDL are described in terms of wasteload or load allocations. Partners will work together to monitor progress toward these goals, evaluate successes, obstacles, and changing needs, and readjust the cleanup strategy as needed using adaptive management. As actions and BMPs are implemented, Ecology will perform effectiveness-monitoring to determine if progress towards the attainment of water quality standards is being made.

In this TMDL, allocations are specified in terms of TSS loads that need to be reduced. Industrial and construction permittees will track their progress by monitoring the TSS concentrations in their discharges and reporting the monitoring results in Ecology's PARIS database. For MS4 permittees, WLAs can be achieved through retrofits and actions that reduce TSS and control runoff from developed areas in the watershed. This progress will be documented in annual reports jurisdictions submit to fulfil their MS4 permit requirements.

One way to track progress is to track the extent of development in the watershed where retrofits are implemented such that stormwater runoff is treated and controlled to mimic reference conditions. To assist entities involved in implementation, including MS4 permittees, to track progress, we used the calibrated HSPF model for the Soos watershed to create a series of model runs where we converted developed areas in the watershed to forested conditions in increments of 5% up to 100%. These conversions to forested land cover were applied proportionally across the whole watershed. To show the relationship between developed acres and TSS loads, results from these model runs were analyzed in terms of the percent reduction of TSS load in each flow interval, relative to the difference between existing and forested condition model runs. These results can be used as a benchmark to track progress toward reducing runoff and TSS load from these areas to levels that are equal to those in the modeled forested conditions. Ultimately, these tools can be used to estimate the expected overall percent progress towards achieving TSS loads under forested conditions. Table 35 shows the results of these model runs, presenting the expected percent progress in achieving the forested TSS load in each flow interval as developed acres are increasingly converted to forested acres in the model. Interested parties can use this relationship to track their implementation progress. The lowest flow interval (>50%) is not presented since the overall TSS loads are relatively low in magnitude in this interval. Figure 20 illustrates these data visually for two flow intervals.

To illustrate how Table 35 can be used to inform interested parties of the progress being made during the implementation phase, we will assume that stormwater runoff is managed from 8,214 acres of development, representing 30% of all developed areas in Soos Creek, at levels recommended in this TMDL. This level of implementation amounts to 46 percent of the reductions needed to reach the loading capacity for very high (<2.5th percentile) flows, 48 percent of the loading capacity for the 2.5th – 5th percentile flow interval, and so on down the line, until we reach the 30-40th percentile flow interval, where that level of effort represents 30 percent of the loading capacity. These differences in progress towards meeting the loading capacity within the <2.5th percentile and the 30-40th percentile flow intervals when stormwater runoff from 30% of development is fully managed can be visually explored in Figure 20.

Table 35. Percent progress towards meeting the TSS load in each flow interval as baseline development conversion to forested conditions is simulated in the HSPF watershed model

Developed acres converted to simulated forest	% development converted to simulated forest	% progress towards meeting TSS load in <2.5th %tile flow interval	% progress towards meeting TSS load in 2.5-5th %tile flow interval	% progress towards meeting TSS load in 5-10th %tile flow interval	% progress towards meeting TSS load in 10-20th %tile flow interval	% progress towards meeting TSS load in 20-30th %tile flow interval	% progress towards meeting TSS load in 30-40th %tile flow interval
0	0%	0%	0%	0%	0%	0%	0%
1,369	5%	8%	7%	6%	7%	9%	3%
2,738	10%	21%	15%	15%	17%	14%	9%
4,107	15%	30%	24%	21%	25%	15%	15%
5,476	20%	34%	31%	26%	31%	21%	21%
6,845	25%	42%	37%	34%	37%	29%	27%
8,214	30%	46%	48%	39%	44%	34%	30%
9,584	35%	51%	55%	45%	50%	38%	37%
10,953	40%	54%	59%	52%	55%	42%	42%
12,322	45%	59%	65%	57%	61%	49%	47%
13,691	50%	66%	68%	62%	65%	52%	51%
15,060	55%	70%	73%	67%	69%	58%	57%
16,429	60%	73%	77%	72%	73%	63%	61%
17,798	65%	77%	81%	77%	76%	67%	65%
19,167	70%	82%	85%	82%	81%	73%	70%
20,536	75%	86%	87%	85%	83%	77%	75%
21,905	80%	90%	90%	89%	88%	82%	80%
23,274	85%	91%	92%	93%	90%	86%	84%
24,643	90%	95%	95%	96%	93%	90%	88%
26,012	95%	98%	97%	98%	97%	95%	93%
26,719	100%	100%	100%	100%	100%	100%	100%

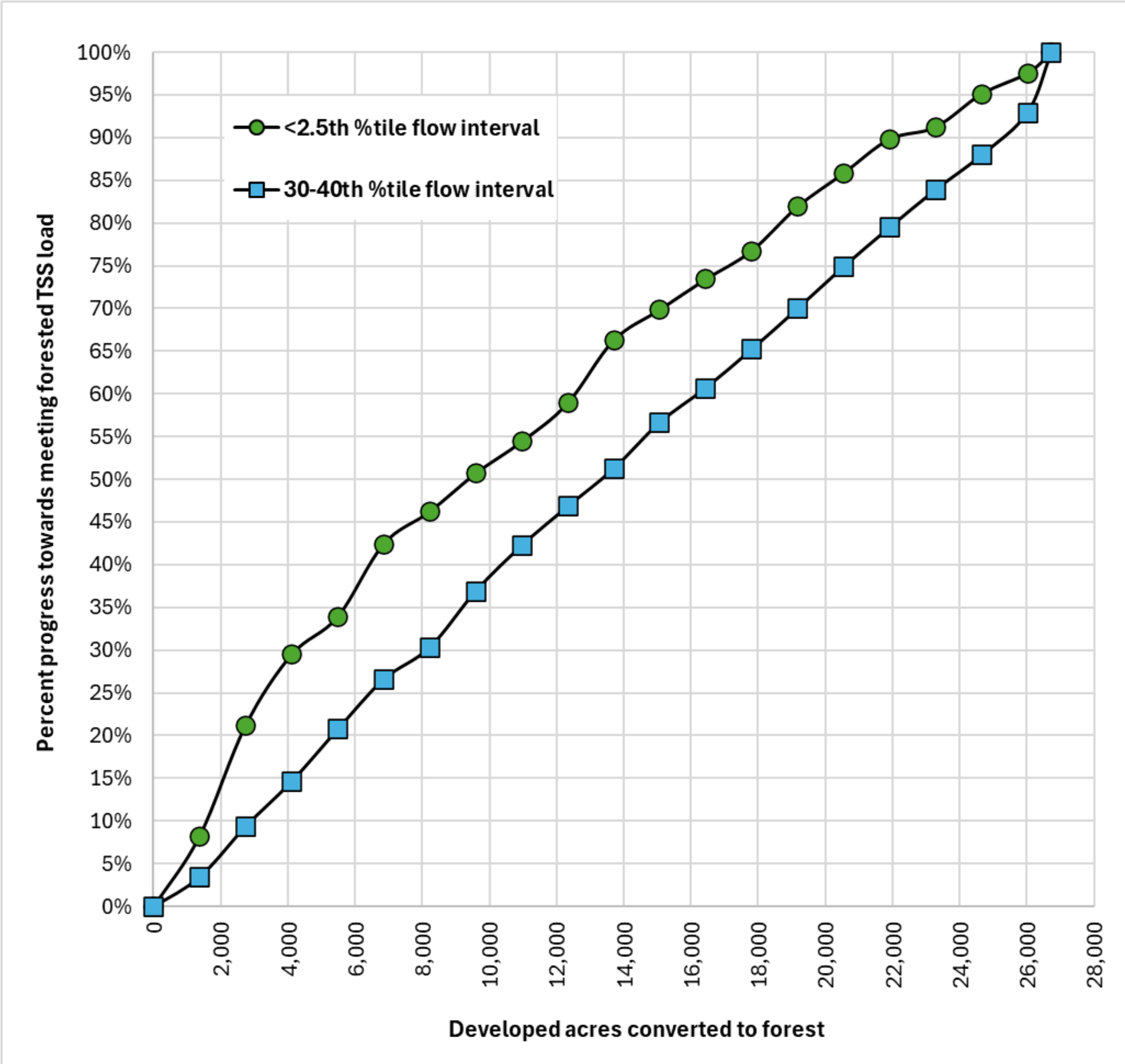

Figure 20. Relationship between development converted to simulated forested conditions in the HSPF model, and the expected progress towards meeting the TSS load in the highest (<2.5%) and second lowest (30-40%) flow intervals

Effectiveness Monitoring

Monitoring during the implementation phase gauges progress towards water quality improvements targeted in the TMDL. There are at least two types of monitoring that will be beneficial to understanding the pace at which advancement towards these goals and targets is being made. First, implementation monitoring tracks the efficiency of installed BMPs to remove TSS from stormwater runoff or control flow effectively. This type of monitoring is expected to be done by entities that are responsible for meeting WLAs. The permittees can use the presumptive approach (Ecology 2024) for BMPs that are approved by Ecology or use an Ecology-approved process to establish the TSS load reductions from BMPs that are not Ecology-approved.

Second, effectiveness monitoring will determine if the interim targets and water quality standards have been met after measures described in this Implementation Plan are built or put into action. This determination is made based on instream monitoring. In the case of this TMDL, the monitoring will follow Ecology's Watershed Health Monitoring protocols. In 2023, EAP conducted a baseline monitoring effort that documented the current state of stream health at 10 locations in the Soos Creek watershed. The protocol includes measurements and observations at 21 cross-sections (one center transect plus 10 upstream and 10 downstream of the center transect) for each location. Metrics include parameters used to evaluate conditions related to water quality, sediment (both suspended and embedded), channel and floodplain structure, large woody debris, and riparian conditions (Ecology et al. 2006). EAP will follow the same protocol monitoring every five years at least at the high priority sites shown in Figure 21 and, if resources are available, at lower priority locations. Data from King County's Ambient B-IBI Monitoring Program, which covers additional sites and typically occurs every year, may be used to supplement and track B-IBI scores at their monitoring sites in the watershed.

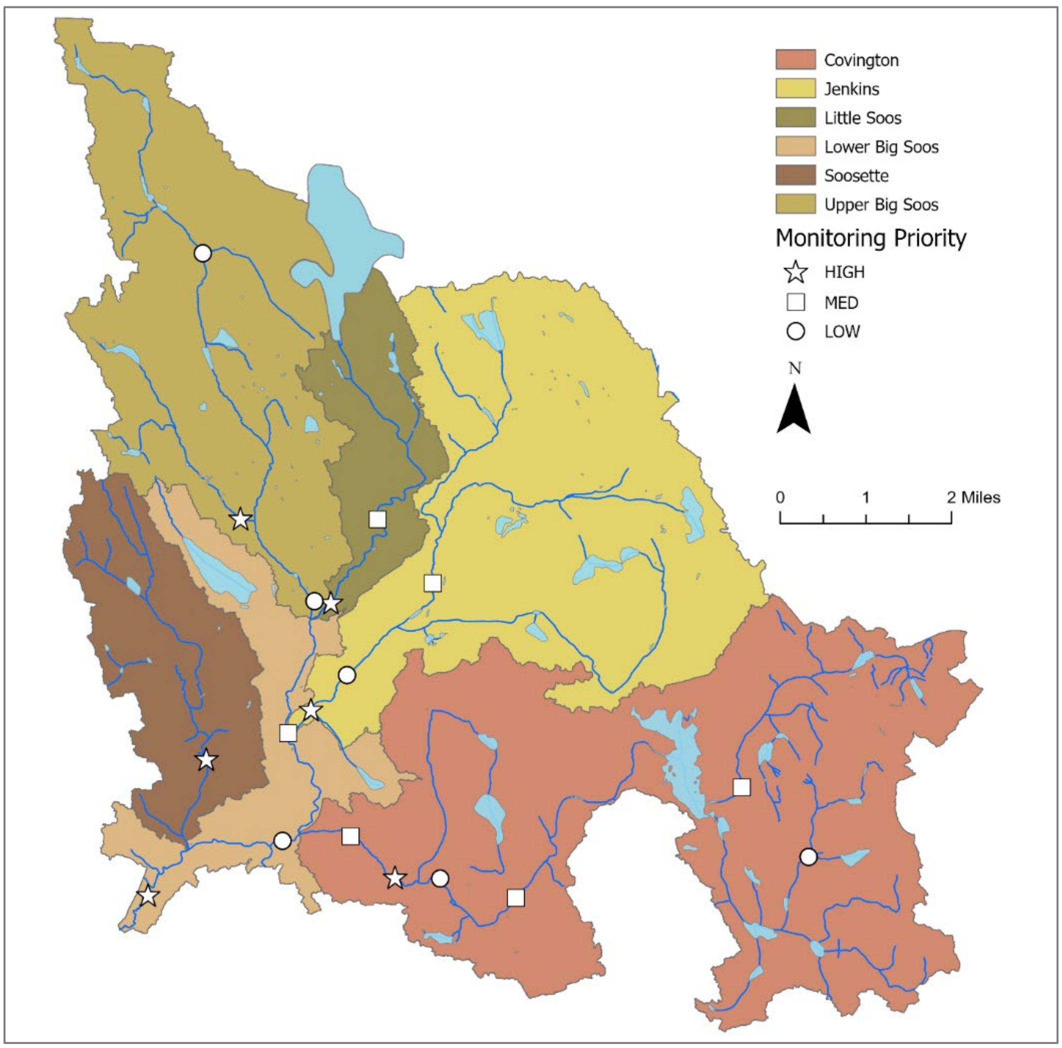

Figure 21. Proposed effectiveness-monitoring locations within each subwatershed, by priority

Adaptive Management

Natural systems are complex and dynamic. The way a system will respond to management actions is often unknown and can only be described in terms of probabilities. Ecology recognizes that models are inherent simplifications of these complex processes and, as such, are unlikely to reproduce exactly how waterbodies will respond to the application of various management strategies. Therefore, TMDLs have a varying level of uncertainty depending on factors, such as data availability, model resolution, and how well the natural processes are understood.

Adaptive management is an approach that allows water managers and the public to deal with these uncertainties, especially when efforts to restore water quality occur over a long period of time. By periodically reassessing if the existing implementation track is expected to lead to meeting water quality goals or if adjustments need to be made to this implementation approach, decision makers have the opportunity to incorporate new knowledge and perspectives to the course of actions and modify it to improve the chances of success. Adaptive management usually takes the form of a feedback loop (Figure 22) consisting of the following steps:

Step 1. The activities in the water quality implementation plan are put into practice.

Step 2. Programs and BMPs are evaluated for technical adequacy of design and installation.

Step 3. The effectiveness of the activities is evaluated by assessing new monitoring data and comparing them to the data used to set the TMDL targets.

Step 3a. If the goals and objectives are on pace to be achieved within the agreed-upon timeline, the implementation efforts are adequate as designed, installed, and maintained. Project success and accomplishments will be reported to continue project implementation and secure public support.

Step 3b. If not, the implementation plan and BMPs will be modified and alternative actions identified. The new or modified activities are then applied as in Step 1. Additional monitoring may be necessary to better identify pollution sources so that new BMPs can be designed and implemented to address all sources of fine sediment to Soos Creek.

Each iteration of this cycle should take place at the conclusion of each round of effectiveness-monitoring that Ecology's Watershed Health Monitoring is expected to perform every five years.

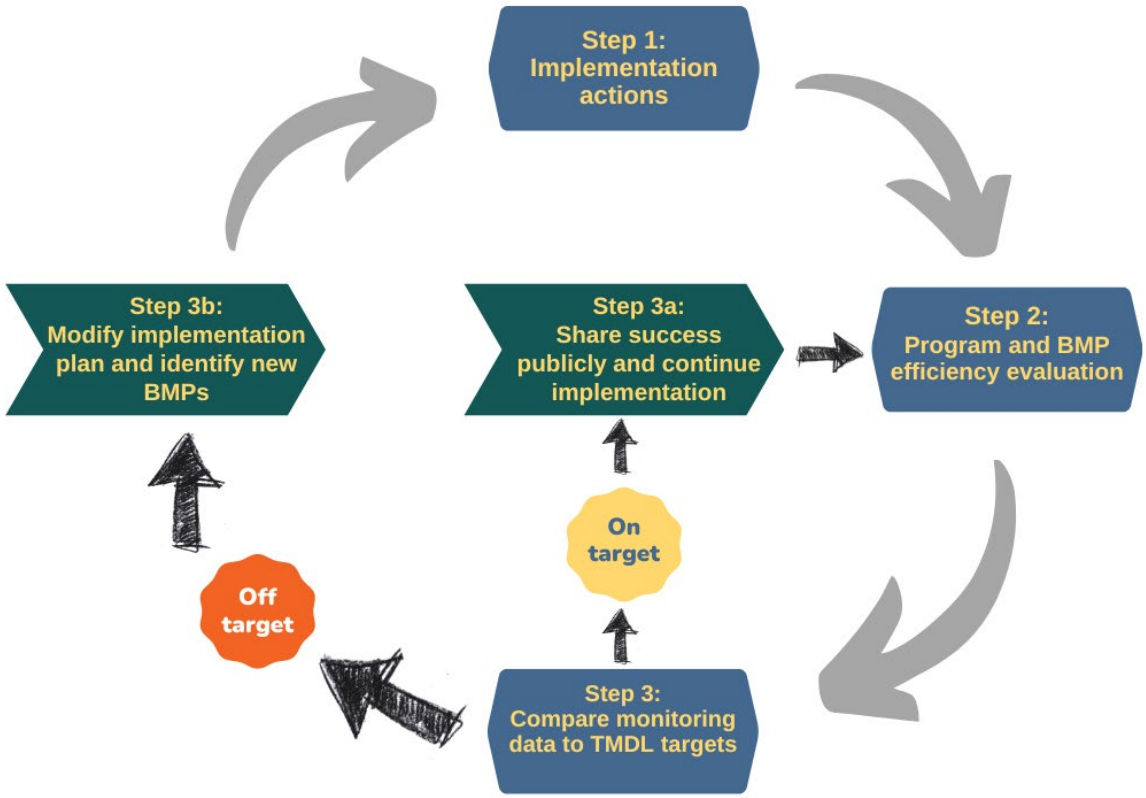

Figure 22. Traditional adaptive management phases

Under this approach, adaptive management is thought of as an iterative construct that involves testing, monitoring, evaluating applied strategies, incorporating new knowledge into management approaches, and repeating the cycle at certain points during the project. In this traditional framework, all steps are evaluated solely through a scientific lens. More recently, however, adaptive management itself has undergone a reevaluation prompted by a history of unsuccessful applications due to lack of follow-through, tokenism, and failure to incorporate different kinds of knowledge besides the scientific perspective (Mussehl et al. 2022). But environmental variability and incomplete knowledge due to lack of data or full understanding of processes that govern water quality and flows are not the only factors that should be addressed during the adaptive management cycles to ensure successful implementation (Horne et al. 2022). Newer concepts of streams as complex systems that exist at the intersection of river ecosystems, social communities, and political institutions can create the basis for an adaptive management framework that involves participation from water managers, scientists, Tribal representatives, and the local community (Webb et al. 2018; Mussehl et al. 2022). This new framework updates the traditional adaptive management concept in two ways. First, it assumes consistent and intentional engagement from all these three types of interested parties that keep each other accountable as implementation takes place but also when effectiveness monitoring occurs. This creates a space where multiple sources of knowledge, including Tribal understanding of water systems and community use of local streams, are recognized, leading to increased transparency, legitimacy, trust, and local buy-in that support resource-intensive projects even in the face of uncertainty (Webb et al. 2017; Horne et al. 2022; Mussehl et al. 2022). Second, the adaptive management's iterative cycle made up of planning, doing, monitoring, and learning steps that occur over a long period of time should also include mini-cycles that operate at smaller time scales and that incorporate learning occurring between the major steps (Figure 23). Including these mini-cycles gives an opportunity for stakeholders from different backgrounds to prioritize some of these loops over others at different times within the process and provide timely input, allowing progress in the outer loop and towards the ultimate environmental goal (Webb et al. 2017).

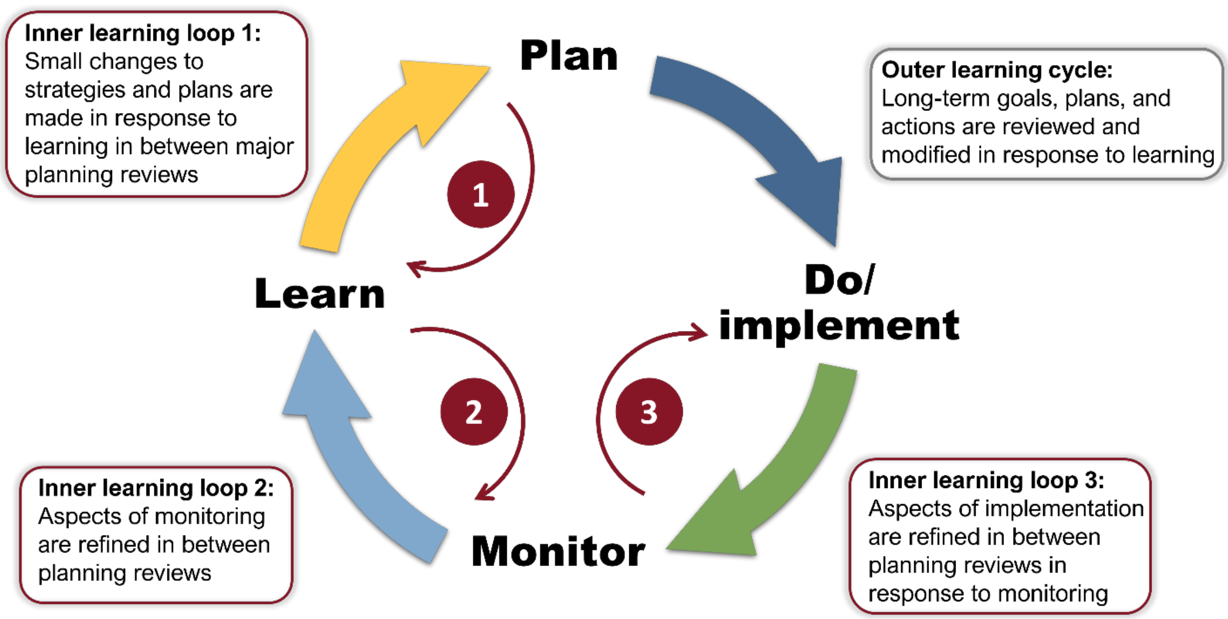

Figure 23. Alternative adaptive management conceptual model

In the context of TMDLs, Ecology uses adaptive management to assess whether the actions identified as necessary to solve the pollution problems are effective. Establishing clear interim objectives while also allowing for flexibility to adapt goals based on new information and stakeholder input are critical tools to understand the effectiveness of implementation actions. Setting clear goals while remaining flexible is important in this setting since the relationship between management strategies, application of BMPs, and pollution load reductions cannot always be precisely predicted. As these actions are implemented, the system will respond but it will also change as a result of implementation and other forces. Adaptive management allows us to fine-tune actions to make them more effective, to track water quality changes, and to try new strategies when evidence shows that a new approach could help attain water quality standards more effectively.

What this new paradigm effectively means for this TMDL is that adaptive management should be regarded as a continuous process that goes beyond a simple act of accounting and checking to see if goals are being met. It is an ongoing process that engages Ecology, permittees, Tribal representatives, and interested community groups and creates space for open communication on how to manage implementation priorities and how to incorporate the restoration of the Soos Creek watershed health in the overall community planning goals.

Based on discussions with permittees and other local interested parties, TMDL reductions are expected to be achieved by 2066. It is ultimately Ecology's responsibility to ensure that implementation is being actively pursued, and water quality standards are achieved. If water quality standards are achieved, but wasteload and load allocations are not, the TMDL will be considered satisfied. Alternatively, if the wasteload and load allocations are met but water quality standards are not attained, data collected to inform the adaptive management will be used to assess if the wasteload and load allocations need to be updated or if the impairments to the benthic invertebrates are due to factors that were not included in the TMDL analysis because they were not well understood at the time of the source ID.

Reasonable Assurance

Ecology believes that the activities identified in this Implementation Plan support this TMDL and add to the assurance that fine sediment in the Soos Creek watershed will meet criteria in the Washington State water quality standards. This assumes the identified activities are continued and maintained.

Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards. However, it is the goal of all participants in the TMDL process to achieve clean water through cooperative efforts.

When establishing the allocations in the Soos Creek fine sediment TMDL, pollution reductions are allocated among point and nonpoint sources in a way that Ecology expects the applicable WQS will be met. Reductions of point source pollution to meet the WLAs are based on the assumption that reducing nonpoint source pollution to meet the LAs will also occur. The Soos Creek fine sediment TMDL and Implementation Plan show reasonable assurance that these sources will be reduced to their allocated amount. If the reasonable assurance changes in the future, EPA guidance indicates that the load reductions can be transferred to point sources.

Adhering to the pollution control strategies described in this TMDL and Implementation Plan provides reasonable assurance that pollution sources are addressed through a suite of specific activities. The point sources expressed as WLAs shall be addressed by fulfilling the established regulatory permit requirements. Ecology ensures that point source reductions are met by incorporating this TMDL's WLAs and associated requirements in the respective NPDES permits every time the permits area renewed or reissued. The TMDL directs TMDL leads to work with the permit writers and managers to ensure that the requirements are adequately addressed in the renewed permits and that the permittees' responsibilities related to this TMDL under their permits are reasonable and practicable to the extent possible.

The nonpoint sources expressed as LAs will be addressed using similar pollution control strategies under cooperative management of these areas, which includes state and local code enforcement along with responsible public conduct. Ecology will implement the framework for providing outreach, technical assistance, and enforcement outlined in the "Organizations to Implement TMDL" section. Adaptive management provides the foundation for evolving water quality improvement strategies based on the development of new information. Documenting sufficient reasonable assurance increases the probability that regulatory and voluntary mechanisms will be applied and the WQS will be attained.

The Environmental Reporting and Tracking System (ERTS)[34] is a statewide database that connects local governments and state agencies when responding to an immediate pollution concern. Each reported issue is assigned a tracking number along with follow up personnel from Ecology as well as personnel from other state and local organizations with jurisdictions over the reported issue. Each organization has plans and procedures to address pollution concerns that can be coordinated using the ERTS.

[34] https://ecology.wa.gov/Footer/Report-an-environmental-issue

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Appendices

Appendix A. Background

Clean Water Act and TMDLs

What is a Total Maximum Daily Load (TMDL)?

A TMDL is a numerical value representing the highest pollutant load a surface water body can receive and still meet water quality standards. Any amount of pollution over the TMDL level renders the water body impaired and needs to be reduced or eliminated to achieve clean water.

Federal Clean Water Act Requirements

The Clean Water Act (CWA) established a process to identify and clean up polluted waters. The CWA requires each state to develop and maintain water quality standards that protect, restore, and preserve water quality. Water quality standards consist of (1) a set of designated uses for all water bodies, such as salmon spawning, swimming, and fish and shellfish harvesting; (2) numeric or narrative criteria to indicate if these uses are achieved; and (3) an antidegradation policy to protect high quality waters.

The Water Quality Assessment and the 303(d) List

Every two years, states are required to prepare a list of water bodies that do not meet water quality standards. This list is called the CWA 303(d) list. In Washington State, this list is part of the Water Quality Assessment (WQA) process.

To develop the WQA, Ecology compiles its own water quality data along with data from local, state, and federal governments, tribes, industries, and citizen monitoring groups. All data in this WQA are reviewed to ensure that they were collected using appropriate scientific methods before they are used to develop the assessment. The WQA divides water bodies into five categories. Those not meeting standards are given a Category 5 designation, which collectively becomes the 303(d) list.

- **Category 1** —Meets standards for parameter(s) for which it has been tested.
- **Category 2** — Waters of concern.
- **Category 3** — Waters with no data or insufficient data available.
- **Category 4** — **Polluted** waters that do not require a TMDL because:
  - **4a** —They have an approved TMDL being implemented.
  - **4b** —They have a pollution control program in place that should solve the problem.
  - **4c** — They are impaired by a non-pollutant, such as low water flow, dams, culverts.
- **Category 5** — **Polluted** waters that require a TMDL – the 303(d) list.

Further information is available at Ecology's Water Quality Assessment website[1].

The CWA requires that a TMDL be developed for each of the water bodies on the 303(d) list.

[1] https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d

TMDL Process Overview

Ecology uses the 303(d) list to prioritize and initiate TMDL studies across the state. The TMDL study identifies pollution problems in the watershed and specifies how much pollution needs to be reduced to achieve clean water. Ecology, with the assistance of local governments, tribes, agencies, and the community, then develops a plan to control and reduce pollution sources, as well as a monitoring plan to assess effectiveness of the water quality improvement activities. The implementation plan identifies specific tasks, responsible parties, and timelines for reducing or eliminating pollution sources and achieving clean water.

After the public comment period, Ecology addresses the comments. Then, Ecology submits the TMDL to EPA for approval.

Study Area

The Soos Creek watershed is located in the Puget Lowlands ecoregion, in western Washington, in Water Resource Inventory Area 9 (WRIA 9). The Soos Creek system drains about 66 square miles. All four main tributaries (i.e., Little Soos, Soosette, Jenkins, and Covington creeks) drain into the mainstem Big Soos Creek, which then drains into the Middle Green River near Auburn at River Mile (RM) 33.7. The watershed includes the city of Covington and parts of the cities of Auburn, Black Diamond, Kent, Maple Valley, and Renton, and a portion of unincorporated King County (Figure A-1).

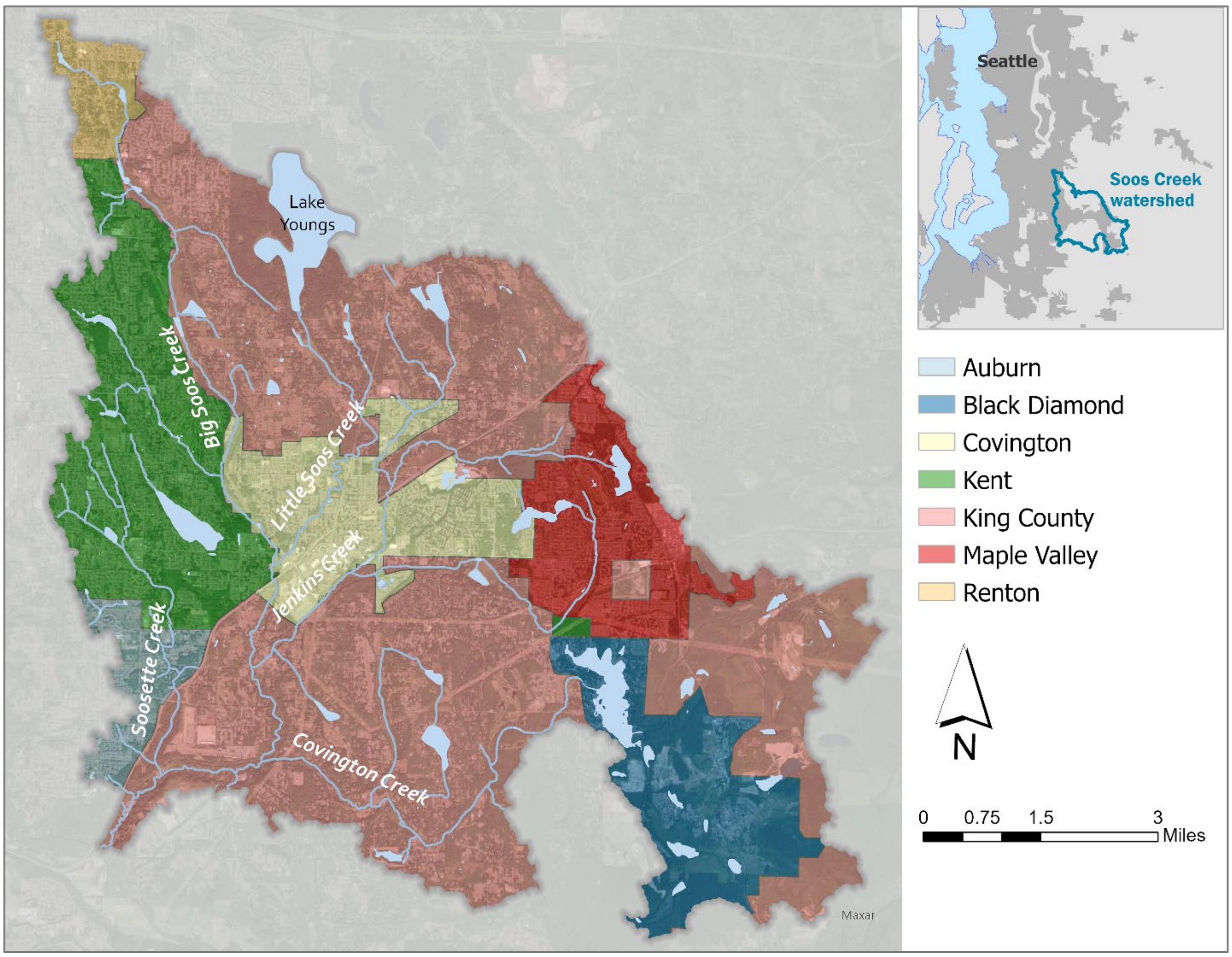

Figure A-1. Jurisdictions within the Soos Creek watershed

The relatively moderate climate of the study area is typical of other Puget lowland watersheds and is characterized by warm, dry summers and cool, wet winters. The flow patterns are typical of rain-dominated western Washington streams, receiving high precipitation in the form of rain during the winter and relatively low precipitation during the summer.

The Soos Creek headwaters originate in a rolling low-gradient glacial outwash plain, and the watershed has an extensive system of interconnected lakes, wetlands, and infiltrating soils (King County 1990). The entire watershed is rain-fed since the elevation of its headwaters remains below snow lines most of the winter. The highest elevations are attained in the Covington and Little Soos watersheds, at approximately 500 feet. Overall, the elevation changes from the headwaters to the confluence with Green River are dominated by gentle slopes, not exceeding 3% (Figure A-2).

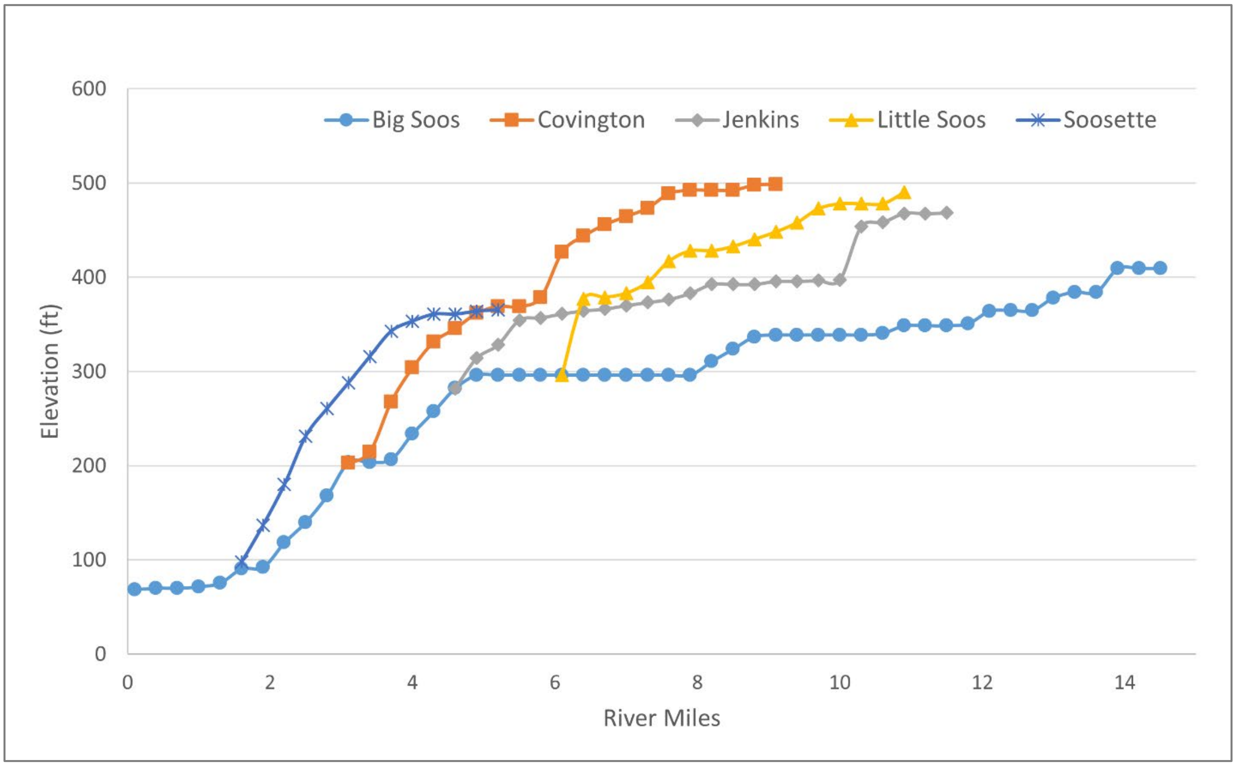

Figure A-2. Elevation profile of Big Soos Creek and its tributaries (RM 0 represents the confluence with the Green River)

Hydrology is also controlled by the types of soils across which water, including stormwater, runs and into which water infiltrates. In general, outwash soils can infiltrate water at a higher rate than till soils, which means that implementation of green infrastructure in areas dominated by outwash can more easily infiltrate stormwater. This doesn't mean, however, that green infrastructure is not an adequate option for till soils, only that the efficiency of these BMPs at infiltrating runoff will likely be lower than in outwash soils. In Soos Creek, outwash soils represent 42 percent of the total watershed, while till soils represent 51 percent, with the remaining 7 percent covered by glacial and alluvial deposits, bed rock, and saturated soils. These soil types are not evenly distributed across the watershed, however. The western and northern portions of the Soos Creek are dominated by till and the eastern and southern areas are dominated by outwash, with pockets of till (Figure A-3). Watershed geology and soils are described in more detail in Mohamedali (2024).

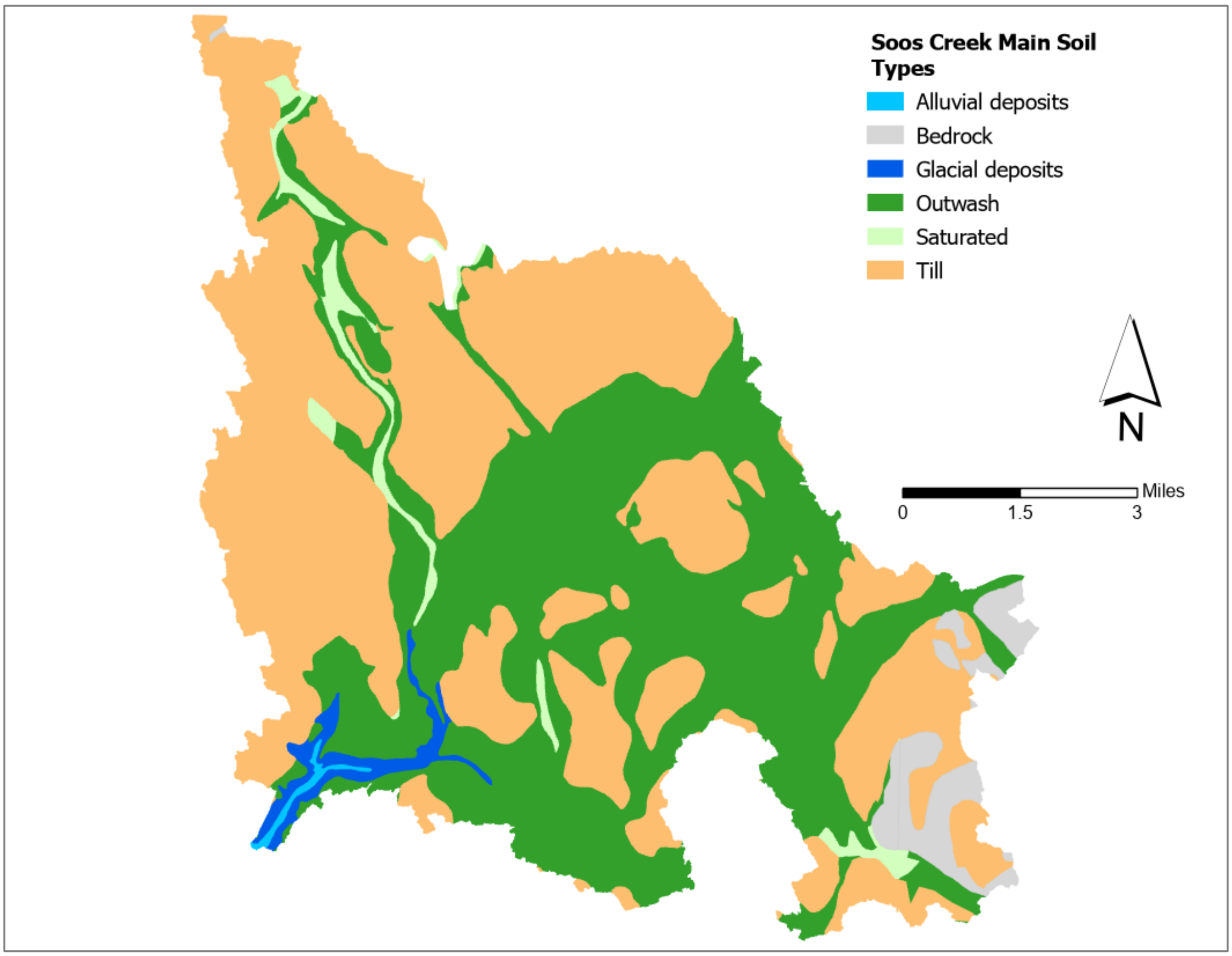

Figure A-3. Soil distribution, by type, in Soos Creek

Land use-land cover in the watershed is a mix of low- to high-density urban residential areas, high-density commercial development, as well as rural residential, agriculture/pasture, and forest. In the last few decades, the proximity of the communities in the watershed to the metropolitan Seattle area has been a major factor driving the rate of development and infrastructure building, resulting in fast rates of conversion from agricultural and forest land to impervious surfaces. Figure A-4 shows the distribution of land cover throughout the watershed, with development covering 40 percent of the total watershed area.

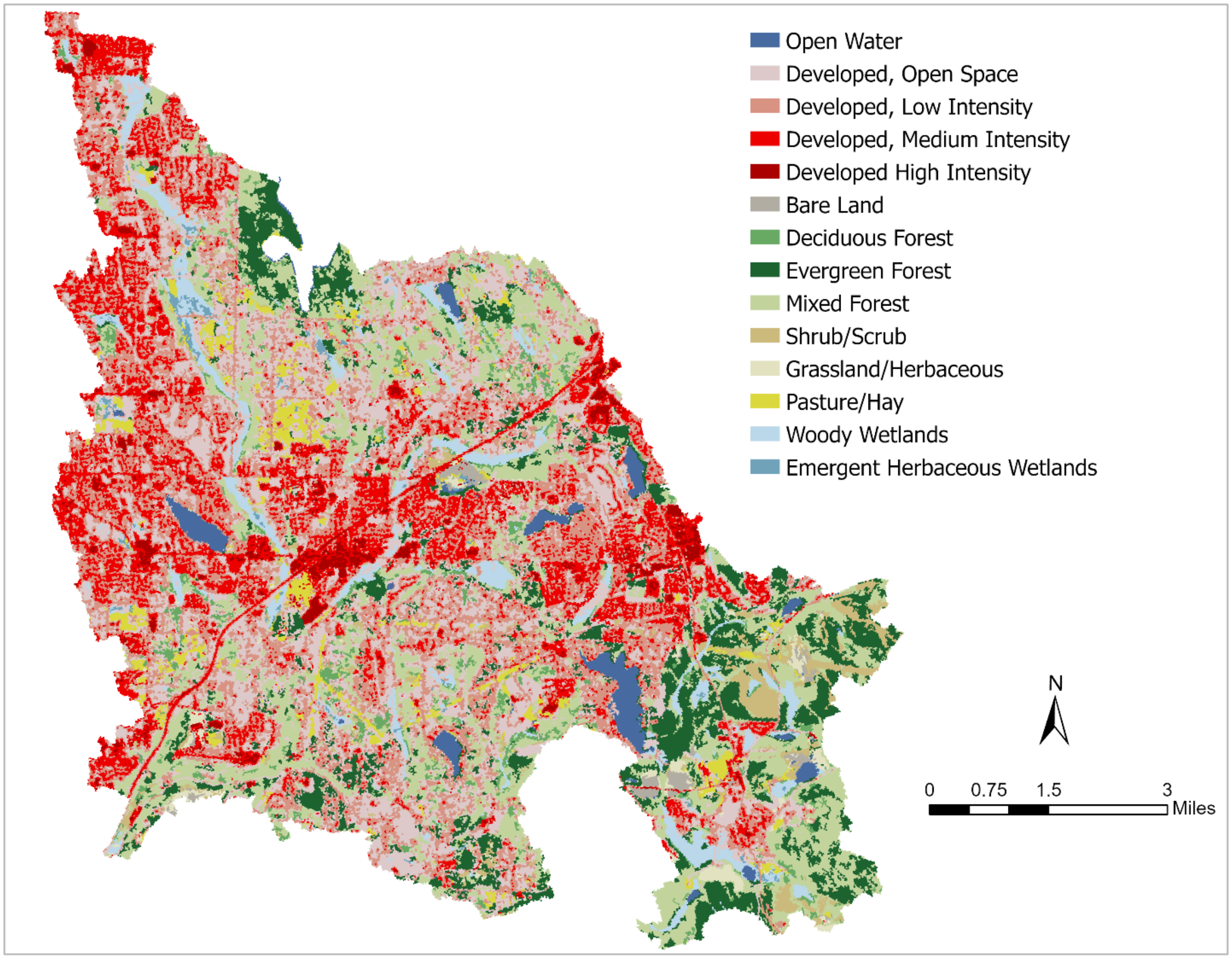

Figure A-4. Land cover distribution in Soos Creek

Development that has occurred in the last century, and especially the accelerated development that has taken place in the last few decades, has resulted in significant land cover conversions. Most recent trends in development have been driven by fast population increases across the watershed. Overall, the population in Soos Creek increased by 69% between 1990 and 2010 (Figure A-5). In the last decade (2011-2020), population increased by another 30% across the watershed.

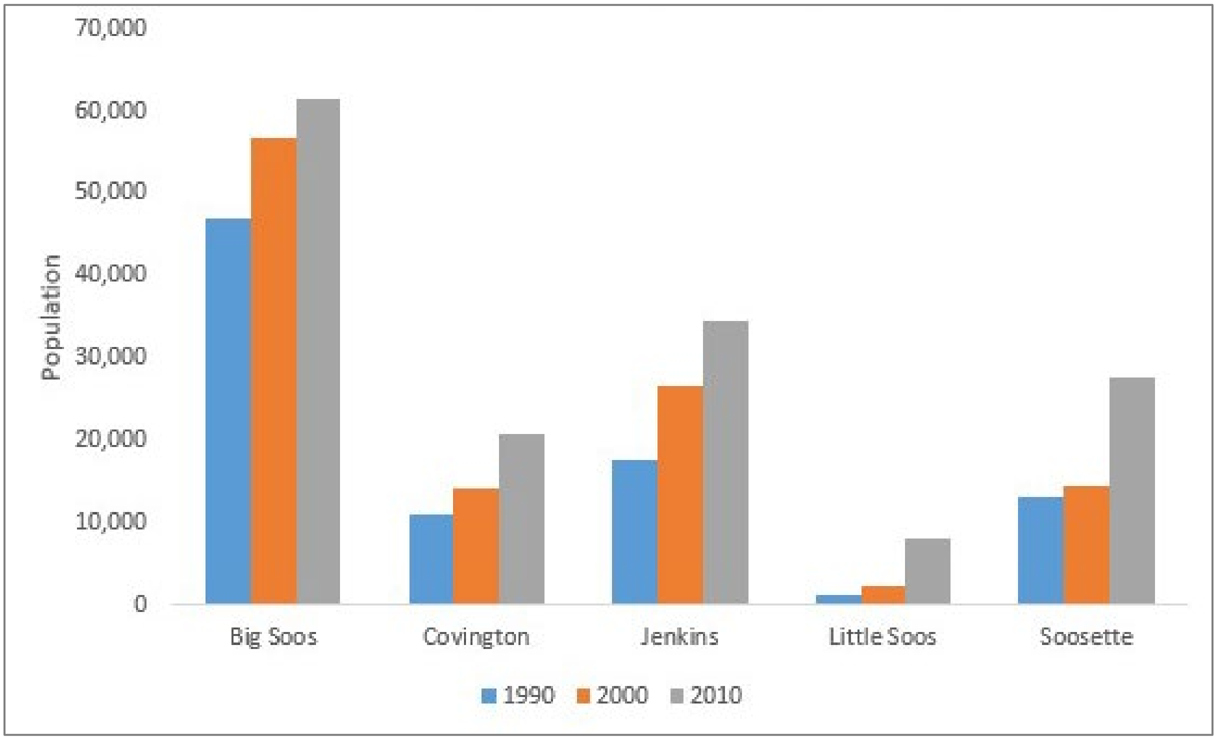

Figure A-5. Census population data between 1990 and 2010 for the Soos Creek watershed, by subbasin

Water Quality Issues

Monitoring at several locations in Soos Creek has shown that the aquatic habitat is impaired and the watershed's designated use to support aquatic life is not met. Urban development without stormwater runoff management has left its imprint on the streams in the watershed, impairing their water quality and physical integrity. The deterioration of stream channels and water quality, including the presence of high levels of fine sediment, are indicators of the "urban stream syndrome" (Walsh et al., 2005). The "urban stream syndrome" sums up a multitude of impacts affecting the health of urban streams, which in large part are reflected in considerably lower B-IBI scores than those for reference streams. The impacts of urban development on flow regimes include increased frequency of high flows, increased daily variation in stream flows, and reductions in base flows (Konrad & Booth, 2005). Before development, precipitation would infiltrate into the ground, part of it would be returned to the atmosphere through evapotranspiration, and the very little remaining runoff would flow overland into streams. Post development, the majority of precipitation runs off impervious surfaces (e.g., buildings, pavement, compacted soils, etc.) or semi-pervious surfaces (e.g., lawns, bare soils) and ends up in pipes or ditches that deliver flows very efficiently to stream channels. Here they can cause flashiness (i.e., high, fast flows) and increased instream bed erosion. The fast delivery of runoff to streams leads to modifications to the flow duration curve that extend beyond the wet season, resulting in restricted aquifer recharge and reduced base flows. The relationship between urbanization and streamflow modifications is not linear, however. Booth et al. (2004) found that the degree of stream flashiness, defined as the fraction of the year during which the daily mean discharge exceeds annual mean discharge, varies widely at low levels of impervious area but that this variability declines considerably at higher levels of imperviousness (Figure A-6). Stream flashiness variability is expected to be high in streams with gradual recession rates and relatively high baseflow and expected to be low in streams with high flows and rapid recessions rates (Konrad & Booth, 2002). This finding means that varying levels of flashiness can be expected from streams draining land that is less developed, but flashiness is certain to occur in urbanized areas.

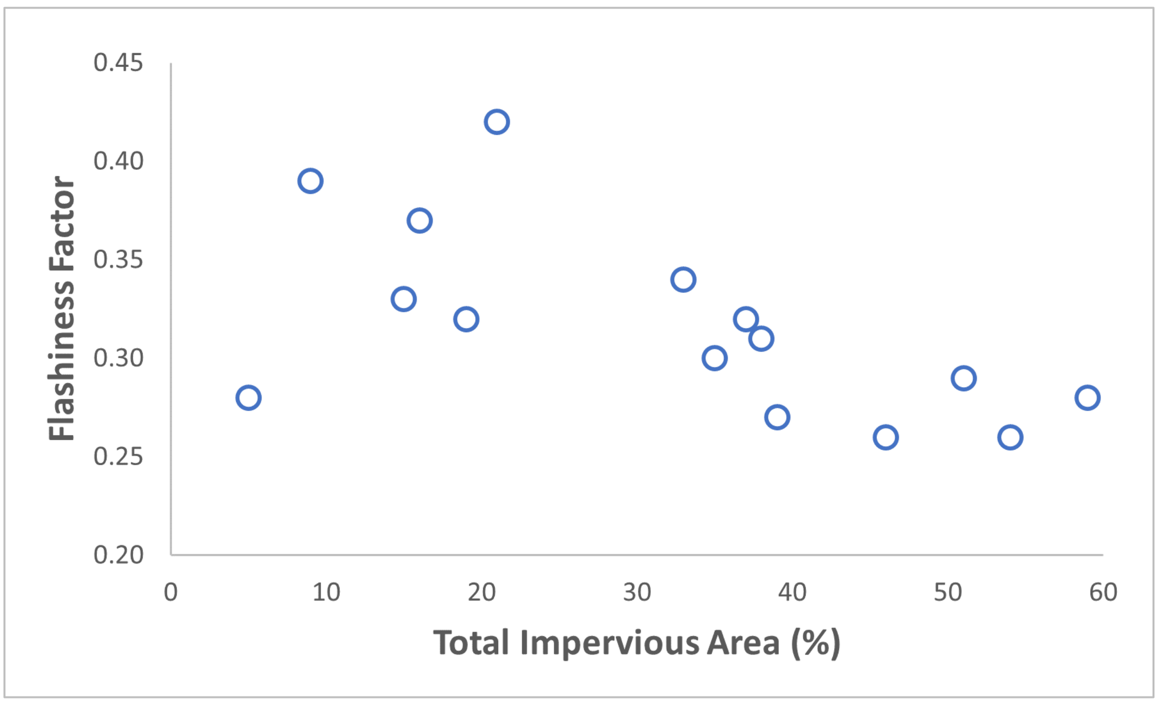

Figure A-6. Discharge flashiness relative to total impervious area (modified from Booth et al., (2004))

Another relationship that follows the pattern described in Figure A-6 between flashiness and total impervious area is related to biological condition and urbanization gradient (Figure A-7). The variability in biological response to changes in urbanization is best described as a wedge-shaped or a factor-ceiling distribution (Paul et al. 2009). As Figure A-7 shows, this type of distribution has two distinctive characteristics:

(1) The data points are distributed as a wedge. The scatter plot of the data points describes how biological conditions vary widely at low levels of urbanization but considerably less for high urbanization. This variability in the biological index is likely the result of variability in factors other than urbanization that may include biological interactions, geomorphology, hydrology, riparian conditions, as well as how these factors play out at different scales (Paul et al. 2009; Lancaster and Belyea 2006; Booth et al. 2004; Wang et al. 2001).

(2) The outer envelope describes the upper limit of this distribution. The outer envelope representing the upper bound of the scatter plot describes the biological potential for certain levels of urbanization and is an indicator of the best observed biological condition that can be attained along the urbanization gradient. It is essential to understand that this upper bound does not represent a line of best attainable condition, defined as the condition under which all BMPs have been implemented (Paul et al. 2009). Instead, it offers a quick reference of the potential condition a site can achieve based on observations at sites with similar levels of urbanization. This means that urban streams are not forever condemned to poor biological conditions but that continuing the status-quo ensures that their ability to improve is limited.

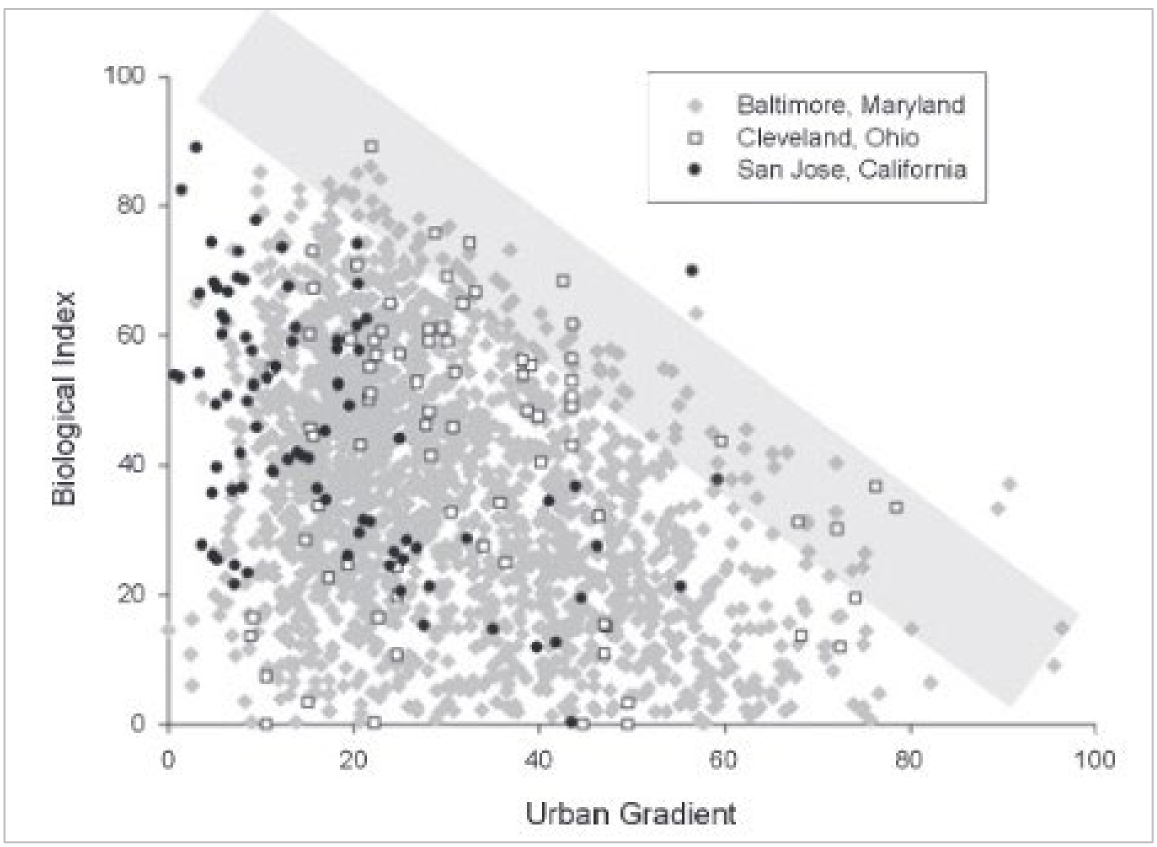

Figure A-7. The relationship between biological condition and urban gradient follows a "wedge"-like distribution (Paul et al. 2009)

Many other relationships between biological indices and other hydrologic or hydraulic parameters follow a similar pattern to that described in Figure 18, including B-IBI scores and total impervious area (Booth et al. 2004), macroinvertebrate species richness and percent urbanization (Carter, Steven, and Fend 2005), macroinvertebrate density and flow velocity (Didham 2006), biological index and urban gradient (Paul et al. 2009), fine sediment and fine sediment biotic index scores (Relyea, Minshall, and Danehy 2012).

Based on this discussion and the findings of the stressor ID analysis, we can conclude that in the case of Soos Creek, addressing fine sediment is a necessary condition for the recovery of macroinvertebrates but it may not be sufficient (Poff 2018). Addressing the other factors named in the stressor ID will improve the conditions that make the recovery more likely. These factors were discussed previously in this report in the Implementation Plan, in section *Addressing high pulse counts (HPC) and habitat degradation*.

Protection of Downstream Waters and Designated Uses

Washington water quality standards require that actions support not only the designated uses in the reach where they are found to be impaired but also in the downstream waters. The standards also require that the most stringent water quality criteria apply where multiple criteria for the same water quality parameter are assigned to a water body to protect different uses and at the boundary between water bodies protected for different uses. These principles are outlined in WAC 173-201A-260 (3)(b)-(d):

> *(b) Upstream actions must be conducted in manners that meet downstream water body criteria. Except where and to the extent described otherwise in this chapter, the criteria associated with the most upstream uses designated for a water body are to be applied to headwaters to protect nonfish aquatic species and the designated downstream uses.*
>
> *(c) Where multiple criteria for the same water quality parameter are assigned to a water body to protect different uses, the most stringent criterion for each parameter is to be applied.*
>
> *(d) At the boundary between water bodies protected for different uses, the more stringent criteria apply.*

This TMDL sets WLAs and LAs to protect the designated aquatic life uses of the waters listed on the 303(d) list and of those downstream of the impaired assessment units. Section Uses of the Waterbodies in the introduction of this TMDL report discusses the aquatic life uses that apply in the Soos Creek watershed. The reductions in fine sediment in Soos Creek would also support aquatic life designated uses downstream of the watershed, in the Green River. The TSS WLAs and LAs in this TMDL, which are based on fully forested conditions, will ensure that uses and benthic invertebrates are supported in downstream receiving waters as well because the reduction in fine sediment loads in Soos Creek will help move the Green River closer to its natural fine sediment loads. To our knowledge, no assessment of benthic macroinvertebrates has been performed in the Green River nor is it expected in the future because such assessments are usually done in wadable streams, which are smaller than the Green.

Appendix B. Public Participation

Public Comment

Ecology held a 30-day public comment period for this TMDL from September 15 through October 19, 2025, and hosted an information public meeting on <enter date here>. Ecology sent a news release to all local media in the watershed, local interested parties, and work groups in the watershed. Ecology announced the release of the draft TMDL report and the workshop using online outreach platforms through its listserve and on the <enter hyperlink and include the following text: Washington State Department of Ecology homepage.>, Information about this TMDL is available on the _______ website.

Ecology welcomes and appreciates public involvement, which is integral to improving and protecting water quality in the Soos Creek watershed. Coordination with governmental and non-governmental organizations is essential for TMDL development and implementation. The comments on the draft TMDL and Implementation Plan are provided below along with Ecology's response. This Comment and Response section is organized starting with those received from the members of the public and followed by those received from governmental organizations.

Comments and Response

[To be completed after public comment period.]

Appendix C. Glossary, Acronyms, and Abbreviations

303(d) List: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited water bodies (ocean waters, estuaries, lakes, and streams) that fall short of state surface water quality standards and are not expected to improve within the next two-year cycle of the Water Quality Assessment.

Beneficial uses: *See* Designated uses.

Best management practices (BMPs): Physical, structural, or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Clean Water Act (CWA): A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained. Also referred to as beneficial uses.

Exceeded criteria: Did not meet criteria.

Existing uses: Uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington and put-and-take fisheries comprised of non-self-replicating introduced native species do not need to receive full support as an existing use.

Hyporheic: The area beneath and adjacent to a stream where surface water and groundwater intermix.

Load allocation: The portion of a receiving water's loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a pollutant that a water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, stormwater, or other wastes; (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and, (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

National Pollutant Discharge Elimination System (NPDES): National program for issuing and revising permits, as well as imposing and enforcing pretreatment requirements, under the Clean Water Act. The NPDES permit program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint source: Source of pollution that enters waters of the state from any dispersed land-based or water-based activities, including but not limited to, atmospheric deposition; surface water runoff from agricultural lands; urban areas; or forest lands; subsurface or underground sources; or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, this class includes any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act is considered a nonpoint source.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

Phase I stormwater permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) and construction sites of five or more acres. The first Phase I permit was issued in 1995.

Phase II stormwater permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre. The first Phase II permit was issued in 2010.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than five acres of land. Discharges from point sources are regulated under the NPDES permit program.

Pollution: Contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Reach: A specific portion or segment of a stream.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and watercourses within the jurisdiction of Washington State.

Surrogate measures: To provide more meaningful and measurable pollutant loading targets, EPA regulations [40 CFR 130.2(i)] allow other appropriate measures, or surrogate measures in a TMDL. The Report of the Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program (EPA, 1998) includes the following guidance on the use of surrogate measures for TMDL development:

> *When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional "pollutant," the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not.*

System potential: The design condition used for TMDL analysis.

Total maximum daily load (TMDL): An acceptable distribution of a pollutant in a water body designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of: (1) all individual wasteload allocations for point sources, (2) all load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the loading capacity determination. A reserve for future growth may also be provided.

Total suspended solids (TSS): The suspended particulate matter in the water column, measured in a water sample as retained by a filter.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMPs: best management practices

cfs: cubic feet per second

Ecology: Washington State Department of Ecology

EPA: U.S. Environmental Protection Agency

GIS: Geographic Information System software

NPDES: National Pollutant Discharge Elimination System

RM: river mile

TMDL: total maximum daily load (water cleanup plan)

USGS: United States Geological Survey

WDFW: Washington Department of Fish and Wildlife

WRIA: Water Resources Inventory Area

Appendix D. Analytical Framework

The analytical framework and modeling details are published in a detailed report by Mohamedali (2024), but a summary of this work is included here.

Summary of Technical Approach

Ecology used a combination of watershed modeling and statistical analysis to address bioassessment impairments and fine sediment listings in the watershed. The main goals of the technical analysis, as stated in the Quality Assurance Project Plan (QAPP) Addendum (Mohamedali 2018), were to:

1. Develop and use a calibrated sediment HSPF (Hydrologic Simulation Program — Fortran) model of the Soos Creek watershed to understand, identify, and quantify the various sources and processes that influence sediment transport and delivery, as well as flow alteration in the watershed.
2. Use a combination of modeling and statistical tools to determine the sediment reduction targets and/or flow alteration targets needed to alleviate the effect of these stressors on the biological community and address bioassessment impairments in the creeks.
3. Use statistical and modeling analysis results to set TMDL load and wasteload allocations, make TMDL recommendations, and determine the implementation actions needed to meet these targets.

HSPF Modeling

HSPF is a process-based and quasi-physically based lumped parameter watershed model that can continuously simulate hydrologic and associated water quality processes on pervious and impervious land surfaces and in streams. It simulates runoff processes, instream interactions, and pollutant loads and concentrations at a sub-daily dynamic time scale. The processes and algorithms within the model have been developed from theory, lab experiments, and empirical watersheds (Duda et al. 2012).

The model simulates fundamental hydrologic processes that make up the water budget, including precipitation, evapotranspiration, interception, surface runoff, interflow, infiltration, and various components of groundwater flow and storage. It is typically run at an hourly time step. Additional modules (e.g., sediment and water quality) can be added once the hydrology has been calibrated. For this study, the sediment module was applied.

We extended and recalibrated an existing HSPF model of the watershed to simulate flow and sediment for 2001 – 2015. The calibration process involved comparing model simulated flow and TSS concentrations to observed flow and TSS concentrations and iteratively adjusting model parameters (while keeping these values within reasonable ranges) to improve agreement between predictions and observations. The final calibrated model performed well in most locations based on established quantitative model criteria as well as qualitative evaluation, based on comparisons between simulated and observed flow and sediment.

The calibrated model also underwent a formal independent peer review by RESPEC Consulting, LLC (RESPEC), which included a review of the model set up, model updates, and model performance of the recalibrated model, as well as recommendations (Lupo and Donigian 2022). We subsequently incorporated the recommendations from their review in the final calibrated model.

The calibrated model was then used to compare flow and sediment loads between existing/baseline and forested conditions. This comparison confirmed the following:

- Development and EIA contribute to a higher frequency of high flow events, an increase in HPCs, and an increase in the potential for instream scour and erosion.
- TSS concentrations are generally higher under existing than under forested conditions, but this difference is largely due to concentrations during higher flow intervals or exceedances.
- TSS loads are significantly higher under existing conditions relative to forested conditions across all subbasins and all months. However, the difference is again more prominent during wetter times of the year.
- The proportion of fine sediment (silt plus clay) in TSS loads is also higher under existing conditions relative to forested conditions.
- Forest cover appears to buffer the effects of development. For example, in the Covington subbasin, which has the highest percentage of forest cover (41%), we found the smallest impact from existing development. Existing TSS loads in Covington are about twice those of the corresponding forested condition, whereas, in other locations, existing loads are about four to almost ten times those of the corresponding forested condition.

Statistical Analysis

Our analysis of B-IBI scores against other habitat metrics, inferred fine sediment, high pulse count, and land cover indicates that sites in the Soos are negatively influenced by development, reduced forest cover, stream flashiness, fine sediment loading and other local factors. All these factors are interrelated and point to mechanisms by which urban landscapes negatively affect aquatic health. This points to the need to attenuate and retain stormwater flows to reduce stream flashiness, reduce the fine sediment load (using TSS reductions as a surrogate), and restore and conserve physical habitat.

Conclusions

The technical analysis supported the following conclusions (Mohamedali 2024):

- In the Soos watershed, development has increased high pulse counts (HPCs), a shift in the flow duration curve (more frequent high flow events), higher TSS concentrations, and higher TSS loads.

- The difference between existing and forested TSS loads increases with higher flows. Higher flow events produce greater TSS loads even when they are less frequent.
- The proportion of TSS composed of fine sediment (i.e., silt and clay) is higher under existing conditions than in forested conditions, where sand represents a higher proportion of the total estimated TSS load.
- The largest TSS loads come from developed areas and impervious cover in the watershed.
- While B-IBI scores in the Soos are highly variable over time and space, multiple lines of evidence indicate that the extent of impervious areas and development, in general, contribute to reduced B-IBI scores due to flashier flows and loading of fine sediment.
- In general, when looking at mean B-IBI scores, sites with a higher percent EIA and lower percent forest cover tend to have lower B-IBI scores. However, not all sites with high HPCs or stream flashiness have poor B-IBI scores, indicating that sites with higher B-IBI scores and high HPCs appear to be buffered from some of the effects of stream flashiness potentially due to other factors.
- Forested parts of the watershed and potentially locations with more intact local riparian areas might buffer the impact of development on the stressors that negatively affect the benthic community. While we did not conduct a specific analysis, there is one well-buffered site where this appears to be the case.

The loading capacity approach for this TMDL was developed to address sediment loading, including that from stream flashiness, but it is important to note that other site-specific factors mentioned above are present at locations that may preclude or enhance the aquatic community. Therefore, while this loading capacity provides a quantitative metric for a target load, a fully successful strategy should include instream restoration and conservation activities, in addition to stormwater runoff management tools.

References

Duda P.B., P.R. Hummel, A.S. Donigian Jr., and J.C. Imjoff. 2012. BASINS/HSPF: Model Use, Calibration and Validation. *Transactions of the American Society of Agricultural and Biological Engineers* 55(4): 1523-1547. http://www.aquaterra.com/resources/pubs/pdf/Duda.et.al.2012.pdf

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Mohamedali, T. 2024. *Soos Creek Watershed Modeling and Analysis to Address Bioassessment Impairments for the Soos Creek Fine Sediment TMDL*. Washington State Department of Ecology. https://apps.ecology.wa.gov/publications/documents/2403003.pdf.

Appendix E. TMDL Analysis

Details of the TMDL analysis are presented in Mohamedali (2024). Information in this appendix describes the approach to establishing the loading capacity, and the methods used to distribute this loading capacity between load and wasteload allocations.

Loading Capacity Approach

Load Duration Approach

Rather than specify the loading capacity as a single average daily TSS load, we adopted a 'load duration curve' approach to specify different TSS loading capacities and allocations for different flow intervals. The load duration curve approach is recommended by the EPA in TMDLs where streamflow is one of the most important factors driving pollutant loads (in this case, TSS) since it accounts for how streamflow patterns affect pollutant loads and concentrations over the course of the year (EPA 2007).

This approach has the following practical implications and advantages:

- It accounts for the fact that TSS concentrations and loads vary with flow. A single daily or annual TSS load that does not vary with flow would ignore known watershed and stormwater dynamics where flows are one of the main drivers of the pollutant loads and concentrations.
- It accounts for the fact that TSS loads could be reduced by a combination BMPs that reduce flows and those that treat TSS in runoff.
- It allows the loading capacity to adjust as we experience changes in precipitation and streamflow patterns due climate change – for example, if the flows shift to a different part of the flow duration curve, then the corresponding loading capacity will also shift.

The load duration curve approach used to establish the TSS loading capacity for Soos is described in the steps below and illustrated in Figure E-1. This approach has a few modifications since it was originally described in Mohamedali (2024). Differences between the original approach and the one described here are pointed out in **bold** within each step where relevant (including the reasoning behind these modifications).

1. Forested flow duration curve was calculated (Figure E-1A):
   - Forested flow duration curves were calculated from the forested condition model run for the most downstream reach in the watershed at the mouth of the Soos.
2. Flow intervals or zones along the flow duration curve were identified (Figure E-1B):
   - The flow duration curve was divided into the following flow intervals, which serve as general indicators of hydrologic condition (from dry conditions to very high flows).
     a. Low flows: > 50^{th} percentile (flows that are exceeded most often, more than 50% of the time)

b. Midrange flows: 30th – 50th percentile (flows exceeded between 30 – 50% of the time)
c. Moist conditions: 20th – 30th percentile (flows exceeded between 20 – 30% of the time)
d. High flows: 10th – 20th percentile exceedance flows (flows exceeded between 10 – 20% of the time)
e. Very high flows: 5th – 10th percentile exceedance flows (flows exceeded between 5 – 10% of the time)
f. Extremely high flows: 2.5th – 5th percentile exceedance flows (flows exceeded between 2.5 – 5% of the time)
g. Rare high flows: < 2.5th percentile exceedance flows (exceeded infrequently, less than 2.5% of the time)

- **Modifications since Mohamedali (2024):**
  a. **The lowest flow interval (> 70th percentile flows) was merged into a single interval with the next lowest flow interval rather than being removed from the analysis, now referred to as low flows (>50%) – flow magnitudes and TSS concentrations and loads under existing and forested conditions do not vary much between these two intervals, so merging made sense. Additionally, including flows in the lowest flow interval captures the full range of low flows.**
  b. **The highest flow interval (with < 10% exceedance probability) was split into three new flow intervals, now referred to as very high (5-10%), extremely high (2.5-5%) and rare high (<2.5%) flows – this enabled us to separate out the large range of flow magnitudes that occur less frequently at these higher flow intervals, and account for how different these flows and TSS concentrations and loads between forested and existing conditions in these flow intervals.**

3. TSS target concentrations for each flow interval were identified:
   - We used modeled forested TSS concentrations as the basis of the TSS target concentrations.
   - We first binned all forested TSS concentrations corresponding to each flow interval to calculate the range in TSS concentrations within each flow interval. We also compared this range to existing TSS concentrations in each flow interval.
   - We calculated the target TSS concentration as median forested TSS concentration within each flow interval (Figure E-1D).
   - **Modifications since Mohamedali (2024): a single TSS concentration target within each flow interval (median concentrations) was selected rather than setting the TSS targets as the interquartile range. While the interquartile range still captures**

the range of possible TSS concentrations under forested conditions, selecting a single TSS concentration value for each flow interval makes it more practical to distribute loading capacity between pollutant sources, establish allocations, and track progress over time.

4. TSS load targets for each flow interval were calculated:
    - The median flow was then multiplied by the median forested TSS concentration for each flow interval to calculate the target TSS load range for the respective flow interval (Figure E-1E).
    - The TSS load target is the loading capacity for each flow interval (Figure E-1E). We compared the loading capacity to the full range of existing loads within each flow interval (Figure E-1F).
    - **Modifications since Mohamedali (2024): Median flows and median TSS concentrations (rather than the interquartile range of each) were used to calculate a single TSS load target for each flow interval instead of a range in TSS load targets for each flow interval.**

Steps 1-4 were carried out at the mouth of each subbasin in the Soos watershed to determine the loading capacity for each subbasin. To isolate the loading capacity associated with just of the reaches in the Lower Big Soos, its loading capacity was calculated separately as a proportion of the forested TSS loads in each flow interval at mouth of the Soos watershed. This proportion was 6.5%, which represents the percentage of the upland forested TSS load generated from the reaches that make up the Lower Big Soos relative to the watershed-wide forested TSS load. The loading capacity at the mouth of the Soos watershed is simply the sum of the individual subbasin loads (for each flow interval). Table E-1 presents the loading capacities at the mouth of each subbasin and compares these loads to the existing median loads for each flow interval.

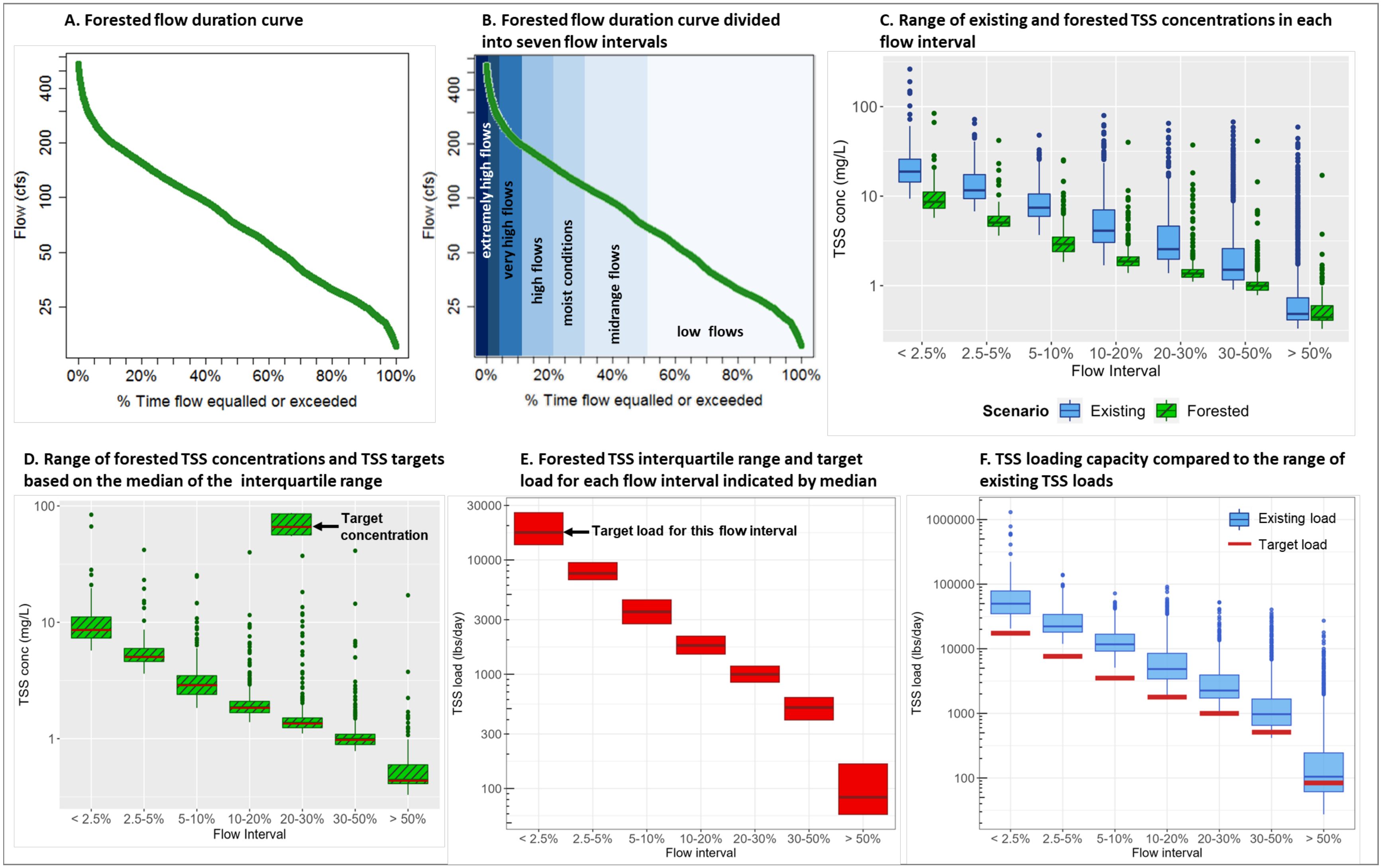

Figure E-1. Approach for setting TSS loading capacity (all flow and TSS values presented here represent model-predicted values). Note that the y-axis is on a log scale for plots C through F.

Table E-1. TSS loading capacity, for each flow interval, for each subbasin, compared to existing median loads

Subbasin	Flow interval	Loading capacity (lbs/day)	Existing median load (lbs/day)	Range of forested flows (cfs)	Range of existing flows (cfs)
Total Watershed	**< 2.5%**	**17,385**	**49,900**	**314 - 544**	**401 - 962**
Total Watershed	**2.5-5%**	**7,430**	**22,200**	**260 - 314**	**325 - 401**
Total Watershed	**5-10%**	**3,522**	**11,700**	**205 - 260**	**253 - 325**
Total Watershed	**10-20%**	**1,802**	**4,850**	**156 - 204**	**185 - 253**
Total Watershed	**20-30%**	**1,115**	**2,260**	**120 - 156**	**143 - 185**
Total Watershed	**30-50%**	**581**	**971**	**71 - 120**	**86 - 143**
Total Watershed	**> 50%**	**153**	**105**	**15 - 71**	**15 - 86**
Soosette	< 2.5%	1,770	9,240	18 - 36	35 - 137
Soosette	2.5-5%	773	3,820	14 - 18	27 - 35
Soosette	5-10%	368	1,930	10 - 14	18 - 27
Soosette	10-20%	196	788	7.2 - 10	11 - 18
Soosette	20-30%	116	233	5.3 - 7.2	7.2 - 11
Soosette	30-50%	52.2	93.1	3.0 - 5.3	3.4 - 7.2
Soosette	> 50%	18.6	15.6	0.42 - 3	0.32 - 3.4
Upper Big Soos	< 2.5%	877	12,300	63 - 104	92 - 294
Upper Big Soos	2.5-5%	311	2,720	53 - 63	73 - 91
Upper Big Soos	5-10%	90.3	1,330	42 - 53	55 - 73
Upper Big Soos	10-20%	16.7	347	33 - 42	39 - 55
Upper Big Soos	20-30%	10.3	27.3	26 - 33	30 - 39
Upper Big Soos	30-50%	5.98	9.06	16 - 26	18 - 30
Upper Big Soos	> 50%	1.23	1.25	2.8 - 16	2.7 - 18
Little Soos	< 2.5%	618	3,790	10 - 20	18 - 60
Little Soos	2.5-5%	180	1,260	8.0 - 10	14 - 18
Little Soos	5-10%	83.1	601	6.1 – 8.0	10 - 14
Little Soos	10-20%	55.5	246	4.7 - 6.1	6.9 - 10
Little Soos	20-30%	34.4	74.9	3.8 - 4.7	5.2 - 6.9
Little Soos	30-50%	25.4	39.2	2.8 - 3.8	3.4 - 5.2
Little Soos	> 50%	17.0	17.0	2.1 - 2.8	2.1 - 3.4

Subbasin	Flow interval	Loading capacity (lbs/day)	Existing median load (lbs/day)	Range of forested flows (cfs)	Range of existing flows (cfs)
Jenkins	< 2.5%	3,580	7,670	103 - 159	124 - 260
Jenkins	2.5-5%	1,640	3,680	86 - 102	103 - 124
Jenkins	5-10%	782	1,950	71 - 86	83 - 103
Jenkins	10-20%	503	837	56 - 71	63 - 83
Jenkins	20-30%	370	483	45 - 56	51 - 63
Jenkins	30-50%	235	306	27 - 45	32 - 51
Jenkins	> 50%	64.1	74.8	5.8 - 27	6.4 - 32
Covington	< 2.5%	9,410	18,900	96 - 199	113 - 257
Covington	2.5-5%	4,030	7,480	78 - 96	90 - 113
Covington	5-10%	1,970	4,140	60 - 78	69 - 90
Covington	10-20%	915	1,880	42 - 60	49 - 69
Covington	20-30%	519	1,060	30 - 42	36 - 49
Covington	30-50%	229	456	16 - 30	20 - 36
Covington	> 50%	47.1	65.7	2.5 - 16	2.8 - 20
Lower Big Soos	< 2.5%	1,130	n/a*	n/a*	n/a*
Lower Big Soos	2.5-5%	496	n/a*	n/a*	n/a*
Lower Big Soos	5-10%	229	n/a*	n/a*	n/a*
Lower Big Soos	10-20%	116	n/a*	n/a*	n/a*
Lower Big Soos	20-30%	65	n/a*	n/a*	n/a*
Lower Big Soos	30-50%	33	n/a*	n/a*	n/a*
Lower Big Soos	> 50%	5.5	n/a*	n/a*	n/a*

*For the Lower Big Soos, existing loads, forested flows, and existing flows are equivalent to those at the mouth of the Soos Watershed and cannot be separately isolated since the Lower Big Soos consists of downstream reaches that drain directly to the mainstem Big Soos, rather than reaches that represent a separate tributary.

Wasteload Allocation Calculations

WLAs were calculated for the following NPDES-permitted sources:

- Industrial, sand and gravel, and construction stormwater - one individual industrial permittee, two Industrial Stormwater General Permit (ISGP) holders, two general sand and gravel permittees, and many construction stormwater general permittees, whose number varies
- The Soos Creek Hatchery operated by Washington State Department of Fish and Wildlife (WDFW)
- Several Phase I and Phase II MS4 permittees

Table E-2 presents the final WLAs, expressed as annual daily averages, for all non-MS4 facilities. The subsequent sections describe the methods used to calculate these WLAs.

Table E-2. WLAs for all non-MS4 permittees discharging to surface waters in the Soos Creek watershed

Permittee	NPDES Permit type	Subbasin	TSS WLA (lbs/day)
Pacific Coast Coal	Individual Industrial	Covington	18.9
Palmer Coking (PCCC Industrial)	Industrial General	Covington	11.1
Reserve Silica	Sand and Gravel	Covington	9.6
Black Diamond Auto Wrecking	Industrial General	Covington	1.0
Lakepointe (Lakeside Industrial)	Sand and Gravel	Jenkins	46.9
Construction Stormwater	Construction SW	Multiple	34.1
Soos Hatchery	Hatchery General Permit	Lower Soos	28.1

WLAs for Industrial, Sand and Gravel, and Construction permittees

The permitted areas associated with industrial, sand and gravel, and construction activities make up a small percentage of the total watershed area (2.6%), and consequently, the TSS in their stormwater runoff is also a small proportion of the total existing TSS load. Since the HSPF model used for the TMDL does not explicitly model these facilities, average annual loads for all these facilities (except Lakeside/Lakepointe) were estimated using the Simple Method (Schueler, 1987). Given their relatively small contributions to the overall watershed TSS load, the WLAs for these permittees are specified as an average annual daily value, rather than a value for each flow interval. There are a few non-municipal permittees in the watershed that were not given WLAs because they discharge directly to groundwater.

Several of these facilities already have a discharge limit of either 25 mg/L or 30 mg/L of TSS specified in their respective permits. The WLAs for these permittees were calculated by applying the lower of these two concentrations (25 mg/L), as the concentration limit for all facilities, and then calculating their annual average TSS load using the Simple Method equation:

$$L = P * P_j * A * C * 0.226 * R_v$$

$Where$:

$L = annual\ load\ (lbs/year)$
$P = yearly\ rainfall\ depth\ (in)$
$P_j = fraction\ of\ rainfall\ events\ producing\ runoff$
$A = site\ area\ (acres)$
$C = average\ annual\ TSS\ concentratoin\ (mg/L)$
$0.226 = unit\ conversion\ factor$
$R_v = runoff\ coefficient;\ R_v = 0.05 + 0.009 * I;$
$where\ I = percent\ impervious\ cover$

The values for P, P_j, and C were the same across all facilities. P, the yearly rainfall depth, was set to 46.3 inches based on the annual average rainfall (for years 2001-2015) used in the HSPF model for this TMDL (originally based on King County rain gauge data). The default value of 0.90 was used for P_j. The values for all other parameters are presented in Table E-3.

Each permittee has a permitted area reported in Ecology's Permit and Reporting Information System (PARIS), which was used to estimate its site area, AD. For construction stormwater permittees, since construction varies throughout the watershed from year to year, we estimated the average disturbed acres of construction area between 2018-2023 (based on data from Ecology's PARIS) to represent construction area. Percent impervious cover for each site, which is used in the calculation of the runoff coefficient, R_v, was estimated using the 2021 National Land Cover Database (NLCD)[1] data which represents percent impervious cover for each 30-m pixel. The exception to this was Reserve Silica, which has compact gravel (not recognized as 'impervious cover' in NLCD) covering a significant portion of their site where stormwater runoff discharges to surface water – here, we used an imperviousness value of 22%. Percent impervious cover for construction activities was set to 20% based on personal communication with D. Howie, Ecology senior stormwater engineer (pers. comm., May 2024). Construction sites have gravel and other loose material that is relatively pervious, but some of the area may be more impervious as it becomes compacted during construction. Many construction sites also have roads on the site, but we do not expect that these construction sites will have impervious surfaces that make up more than 20% at the permitted area.

[1]NLCD 2021 Land Cover: https://www.mrlc.gov/data?f%5B0%5D=project_tax_term_term_parents_tax_term_name%3AAnnual%20NLCD

Table E-3 presents the different parameters of the Simple Method for construction, industrial, and sand and gravel stormwater permittees, as well as their final WLA for TSS.

Table E-3. TSS WLAs for construction, industrial and sand and gravel permittees in the Soos Creek watershed

Permittee	A Site area (acres)	C Avg. annual TSS conc. (mg/L)	I Imperv-iousness (%)	R_v Runoff coefficient*	TSS WLA (tons/year)	TSS WLA (lbs/day)
Pacific Coast Coal	480	25.0	1.22	0.061	3.5	18.9
Palmer Coking (PCCC Industrial)	160	25.0	6.39	0.108	2.0	11.1
Reserve Silica	60	25.0	22	0.248	1.8	9.6
Black Diamond Auto Wrecking	2.5	25.0	64	0.626	0.2	1.0
Construction Stormwater Permittees	230	25.0	50	0.500	13.5	34.1

*Runoff coefficient = 0.05 + (0.009 x I), *where* **I = imperviousness**.

WLA for Lakepointe

Lakepointe (also known as Lakeside Industries) is a sand and gravel facility where all stormwater runoff goes into groundwater. However, the facility does discharge dewatering water to Jenkins Creek. An annual WLA for this discharge was based on a TSS concentration of 2.9 mg/L, which is the average TSS concentration of their discharge as reported in PARIS between 2018 and 2023. The flow to Jenkins Creek from Lakepointe was estimated based on the difference in flow in Jenkins Creek between two locations – one upstream (Location ID JEN-6.0), and one downstream (Location ID JEN-4.0) of the discharge from this site. These flow data were collected as part of the ongoing Soos Creek Temperature, DO, and Bacteria TMDL study (Mathieu, Gleason, and Neculae 2023). Using only data collected between June and October 2023, when an intermittent tributary to Jenkins was observed to be dry, the residual flow between the two sites was between 1.96 to 3.80 cfs. We applied the average residual flow of 3 cfs during this period (rounded to the nearest cfs) to represent the discharge of dewatering water from this site to Jenkins Creek.

The 2.9 mg/L TSS concentration multiplied by 3 cfs of flow results in an annual average TSS load of 46.9 lbs/day.

WLA for the Soos Creek Hatchery

The Soos Creek Hatchery is located at RM 0.9 of lower Big Soos Creek, downstream of all the major tributaries, and is operated by the Washington State Department of Fish and Wildlife (WDFW). The facility has two non-consumptive water rights that allow the hatchery to withdraw up to 35 cfs from Big Soos Creek. This flow is first routed through the hatchery's settling ponds and then through rearing ponds or adult ponds. The hatchery uses a pollution abatement pond to settle solids during rearing vessel cleaning events. Water used in incubation is withdrawn from Wilson Creek, for which the hatchery has an additional water right of 0.71 cfs. All this flow is eventually released back into Big Soos Creek, just downstream of the intake location. While currently the hatchery does not use its full water right, WDFW is in the process of implementing upgrades to the hatchery, which will allow the facility to increase its production. At that point, WDFW estimates that the average monthly water use will vary between 15-35 cfs, with the lower use in the summer months and the higher use during the winter and early spring (personal communication with Brodie Antipa, November 30, 2023).

The WLA for the Soos Creek Hatchery was calculated to best match their TSS loads, based on existing hatchery operations and current TSS concentrations in their effluent, and assuming they are operating at optimal capacity/design flows. Since hatchery effluent TSS concentrations vary based on different hatchery activities, the TSS load for each activity was first estimated, and then its contribution to the monthly TSS load determined based on the proportion of the time each month that these activities generally occur.[2]

After water is removed from Big Soos Creek, significant amounts of suspended sediment are removed by two pre-settling ponds. However, hatchery activities such as rearing vessel cleaning, feeding, and drawdown for fish release can also add suspended solids (not all of which is fine sediment) to the water as it moves through the facility and before it is discharged back into Big Soos Creek. The TSS in hatchery effluent therefore varies based on the three main hatchery activities: 1) vessel cleaning during rearing times, 2) fish feeding during rearing times, and 3) fish release and associated drawdown. Feeding primarily occurs during business hours, cleaning occurs once every week or two, and fish releases only happen a few times a year, with associated drawdown events lasting for a few hours with each fish release. During baseline conditions, when there are no feeding, cleaning, or drawdown events, water flows through the facility without any known addition of TSS.

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[2] The duration of each activity and which months they occur in was determined via several conversations with WDFW staff based on their operations between 2023 and 2024.

The hatchery measures and submits TSS concentrations to Ecology's PARIS database. These data are collected during different hatchery activities in their intake as well as in the distribution box (just upstream of the effluent location inside the hatchery). TSS data from PARIS collected between 2019 to 2023 were used to estimate TSS concentrations during these hatchery activities as follows:

1. **Cleaning/Feeding**: the hatchery is required to sample throughout the day when cleaning and feeding for a composite or a representative TSS measure to ensure both are done in a manner least likely to entrain solids in the effluent. The hatchery reports the net TSS concentrations (which is the difference in concentration between the intake and the distribution box near the point of discharge) during the cleaning/feeding activities. This net, composite concentration represents the TSS added by the hatchery during cleaning and feeding. The 75th percentile of this net concentration (1.0 mg/L) was used to reflect TSS contributions from hatchery operations during cleaning/feeding. We used the 75th percentile, as opposed to the average net concentration (0.5 mg/L) to add a margin of safety. At full production, feeding is expected to occur year-round for 5-7 hours per day, based on conversations with hatchery staff. Rearing vessel cleaning events will not change in occurrence during full production as cleaning is typically performed every week or two for fish health needs.
2. **Fish release/drawdown events**: the hatchery also reports TSS concentrations during drawdown events, when juvenile salmon are released into Soos Creek. Again, we took the 75th percentile of TSS concentration during drawdown events to represent concentrations in the effluent during drawdown; this TSS concentration was 2.2 mg/L. Drawdown events occur when fish are released, approximately two times a month between April and June, and last about 1-2 hours. TSS is measured during the tail end of the drawdown event when most of the turbulence occurs.

When the hatchery is not feeding, cleaning, or releasing fish, it is operating under 'baseline' conditions and not conducting any activities that would add TSS to the water flowing through the facility. We therefore assumed that the TSS load from the hatchery during baseline conditions is zero.

The concentrations defined above were then applied to each month, based on the duration (in hours per month) that each activity typically lasts, and then combined with the facility's design flows to calculate their TSS WLA. The hatchery's final WLAs are presented in Table E-4, and the values used to calculate the WLA are presented in Table E-5.

Table E-4. TSS WLAs for the Soos Creek Hatchery based on full capacity hatchery operations

Month	TSS WLA (lbs/month)	TSS load during feeding (lbs/month)	TSS load during drawdown (lbs/month)
January	627	627	0
February	755	755	0
March	1,463	1,463	0
April	1,485	1,416	69
May	1,532	1,463	69
June	849	809	40
July	283	283	0
August	283	283	0
September	850	850	0
October	850	850	0
November	850	850	0
December	425	425	0
Annual WLA (lbs/day)	**28.1**		
Annual WLA (tons/year)	**5.1**		

Table E-5. Values used in the WLA calculation values for the Soos Creek Hatchery based on hatchery operations at design capacity. Flow values are based on full capacity hatchery operations, and not current hatchery operations.

Month	# Days in month	# hrs per month	# Feeding days per week	# Feeding days per month	# Drawdown events per month	Flows (cfs)	Duration of feeding events (hrs/month)	Duration of drawdown events (hrs/month)	Effluent TSS during feeding (mg/L)	Effluent TSS during drawdown (mg/L)
January	31	744	7	31	0	15	186	0	1.0	2.2
February	28	672	7	28	0	20	168	0	1.0	2.2
March	31	744	7	31	0	35	186	0	1.0	2.2
April	30	720	7	30	2	35	180	4	1.0	2.2
May	31	744	7	31	2	35	186	4	1.0	2.2
June	30	720	7	30	2	20	180	4	1.0	2.2
July	31	744	5	21	0	10	126	0	1.0	2.2
August	31	744	5	21	0	10	126	0	1.0	2.2
September	30	720	5	21	0	30	126	0	1.0	2.2
October	31	744	5	21	0	30	126	0	1.0	2.2
November	30	720	5	21	0	30	126	0	1.0	2.2
December	31	744	5	21	0	15	126	0	1.0	2.2

Distributing Annual/Monthly WLAs into Flow Intervals

After establishing the WLAs for non-MS4 permittees (as described in previous sections), we then subtracted these out of the loading capacity to calculate the remaining loading capacity available to distribute between MS4 permittees. Since the non-MS4 WLAs are expressed as annual WLAs (or monthly and annual WLAs in the case of the Soos hatchery) but the loading capacity is expressed by flow interval, we first had to distribute the magnitude of these non-MS4 WLAs between each flow interval – or, divide these annual WLAs into the TSS load associated with each flow interval. This was done primarily for internal calculations (i.e. to remove them from the flow-based loading capacity), and not to assign flow-based WLAs to non-MS4 permittees. This calculation was done as follows:

1. Calculated the proportion of is the TSS load generated within each flow interval under forested conditions at the mouth of the Soos watershed (Table E-6):

Table E-6. Proportion of model-estimated TSS load generated within each flow interval at the mouth of the Soos watershed under forested conditions between 2001-2015.

Flow Interval	< 2.5%	2.5-5%	5-10%	10-20%	20-30%	30-50%	> 50%
Proportion of flow generated in this flow interval	56.35%	22.74%	10.8%	5.3%	3.1%	1.4%	0.3%

2. Distributed the annual WLAs for all non-MS4 permittees (except that of the Soos hatchery) into flow intervals based on the proportions of flow volumes associated with each flow interval from Table E-6. This calculation is presented in Table E-7.

Table E-7. Distribution of annual WLAs into flow intervals for several non-MS4 permittees

Permittee	Annual TSS WLA (lbs/day)	TSS load in < 2.5% flow interval (lbs/day)	TSS load in 2.5-5% flow interval (lbs/day)	TSS load in 5-10% flow interval (lbs/day)	TSS load in 10-20% flow interval (lbs/day)	TSS load in 20-30% flow interval (lbs/day)	TSS load in 30-50% flow interval (lbs/day)	TSS load in > 50% flow interval (lbs/day)
Pacific Coast Coal	**18.9**	10.6	4.29	2.03	1.01	0.58	0.27	0.06
Palmer Coking (PCCC Industrial)	**11.1**	6.25	2.52	1.19	0.59	0.34	0.16	0.03
Reserve Silica	**9.6**	5.41	2.18	1.03	0.51	0.30	0.14	0.03
Black Diamond Auto Wrecking	**1.0**	0.57	0.23	0.11	0.05	0.03	0.01	0.003
Lakepointe (Lakeside Industrial)	**46.9**	26.4	10.67	5.05	2.50	1.45	0.68	0.14
Construction SW Permittees	**34.1**	19.2	7.7	3.67	1.82	1.05	0.49	0.10
Total WLAs by flow interval (lbs/day)	--	**68.5**	**27.6**	**13.1**	**6.5**	**3.7**	**1.8**	**0.37**

3. For the Soos hatchery, their monthly WLA was distributed into flow interval based on the average percentage of days in a month when flows are in a particular flow interval (using forested modeled flows at the mouth of the Soos watershed). These calculations are shown in Table E-8.

Table E-8. Percentage of days in each month when modeled forested flows are in a particular flow interval and the distribution of monthly Soos hatchery WLAs into flow intervals based on these percentages

Month	WLA (lbs/month)	Percent of days in < 2.5% flow interval	Percent of days in 2.5-5% flow interval	Percent of days in 5-10% flow interval	Percent of days in 10-20% flow interval	Percent of days in 20-30% flow interval	Percent of days in 30-50% flow interval	Percent of days in > 50% flow interval
January	**627**	12.7%	8.4%	13.5%	26.9%	14.0%	17.4%	7.1%
February	**755**	3.5%	7.8%	12.3%	25.5%	23.9%	22.5%	4.5%
March	**1,463**	4.3%	7.1%	10.1%	23.7%	18.3%	24.7%	11.8%
April	**1,485**	1.6%	2.7%	10.7%	20.9%	23.6%	35.1%	5.6%
May	**1,532**	0.0%	0.0%	2.8%	7.5%	9.5%	54.0%	26.2%
June	**849**	0.0%	0.0%	0.0%	3.1%	6.0%	30.2%	60.7%
July	**283**	0.0%	0.0%	0.0%	0.0%	0.0%	5.6%	94.4%
August	**283**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
September	**850**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
October	**850**	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	99.1%
November	**850**	0.0%	0.0%	0.7%	2.4%	7.3%	27.1%	62.4%
December	**425**	7.5%	4.3%	9.9%	11.4%	18.7%	23.2%	24.9%
WLA for flow interval (lbs/month)[1]	--	**224**	**273**	**575**	**1,229**	**1,223**	**2,598**	**4,130**
WLA for flow interval (lbs/day)[2]	**--**	**0.6**	**0.7**	**1.6**	**3.4**	**3.4**	**7.1**	**11.3**

1. These values are the sum product of monthly loads and the percent of days in that month where flow values are within each flow interval.
2. These values are simply converting the values in the row above (which are in lbs/month) to lbs/day based on the number of days in that month.

4. Added up all the non-MS4 WLAs by flow interval and by subbasin (sum of the last rows in Table E-7 and Table E-8, but by subbasin) and then subtracted these loads from the loading capacity for each respective subbasin to calculate the remaining loading capacity in each subbasin, by flow interval.

WLAs for Phase I and Phase II MS4 permittees and WSDOT

Most of the Soos watershed is covered by jurisdictions that have MS4 permits. The bulk of the WLAs of this TMDL are assigned to MS4 permittees. After subtracting the WLAs assigned to non-MS4 permittees (as described in the previous section), the remaining loading capacity was then distributed between the following nine MS4 permittees:

- Phase I permittee: King County, which covers stormwater runoff from unincorporated areas of the watershed
- Phase II permittees: covers stormwater runoff from the cities of Auburn, Black Diamond, Covington, Kent, Maple Valley, and Renton, as well as Kent School District (which is a secondary permittee under the same permit)
- WSDOT: covers stormwater runoff from state highways

The remaining loading capacity was distributed between the above MS4 permittees based on the proportion of each subbasin covered by each MS4's service area (which is sometimes different from jurisdictional boundaries). For example, if a city's MS4 covered 20% of the area within a specific subbasin in the Soos, that entity received 20% of the remaining loading capacity for that subbasin.

The starting point for the calculation of these percentages was Ecology's GIS layer that represents MS4 Phase I and Phase II jurisdictional boundaries[38]. Within these boundaries, wherever appropriate, the following areas were removed:

1. Surface areas of open water within the watershed, e.g. lakes using the 2021 NLCD land cover layer from year
2. Areas within the each subbasin already covered by other permittees (construction stormwater, industrial, and sand and gravel).
3. Areas associated with permittees that discharge to groundwater, since runoff from these areas would not contribute to the MS4 system.
4. Areas within these jurisdictions where runoff drains directly to streams and lakes in the watershed instead of being routed through the MS4 system – this runoff is a 'nonpoint source' and needs to be accounted for as a load allocation (LA) instead of a WLA. We worked within each MS4 to identify these areas using GIS layers that identify areas within their jurisdictional area but not part of their MS4 service area. Once received, these areas were removed from the area associated with each MS4.

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[38] https://waecy.maps.arcgis.com/home/item.html?id=b7c9798d4cdc457f90f3d4411d26a9eb

Table E-9 presents the final percentage associated with each MS4 permittee within each subbasin.

Table E-9. Percentage areas associated with each MS4 permittee as well as the remaining area outside of MS4 boundaries within each subbasin of the Soos watershed

MS4 permittee	Covington	Jenkins	Little Soos	Lower Big Soos	Soosette	Upper Big Soos
Auburn	0.00%	0.00%	0.00%	5.83%	27.8%	0.00%
Black Diamond	12.5%	0.049%	0.00%	0.00%	0.00%	0.00%
Covington	0.00%	17.0%	30.2%	0.00%	0.00%	6.16%
Kent	0.00%	0.00%	0.00%	20.4%	53.7%	33.6%
Kent School District	0.40%	0.00%	1.66%	0.00%	0.00%	0.68%
King County Unincorporated	52.7%	48.9%	52.2%	34.2%	3.67%	36.7%
Maple Valley	4.49%	23.5%	0.00%	0.00%	0.00%	0.00%
Renton	0.00%	0.00%	0.00%	0.00%	0.00%	11.1%
WSDOT	1.08%	3.54%	2.20%	3.05%	5.04%	0.23%
Remaining non-MS4 area	28.9%	7.11%	13.8%	36.6%	9.77%	11.5%

Notes: Gray cells identify MS4s that do not have any area within that subbasin.

The percentages in Table E-7 were used to distribute the loading capacity as WLAs between all the MS4 permittees as well as LAs for the remaining areas in each subbasin outside of the MS4 boundaries. For example, the percentages in the ‘Covington’ (second) column in Table E-7 represents how the remaining Covington loading capacity (after assigning WLAs to non-MS4 permittees) was distributed between each MS4 permittee in the subbasin, as well as the proportion assigned to LAs. All WLA tables are in the main report in tables 7-15.

Load Allocations

Load allocations were established for all areas within the watershed not covered by any NPDES permits. Since the loading capacity is based on TSS loads under the forested condition model run, the load allocations are essentially equivalent to the natural background TSS load for these areas. LAs are included in the main report in Table 17.

References

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Mohamedali, T. 2024. *Soos Creek Watershed Modeling and Analysis to Address Bioassessment Impairments for the Soos Creek Fine Sediment TMDL*. Washington State Department of Ecology. https://apps.ecology.wa.gov/publications/documents/2403003.pdf.

Schueler, T.R. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's.* Publication No. 87703, Metropolitan Washington Council of Governments, Washington, D.C.

Appendix F. Assessment Units with no Current Fine Sediment Listings

Table F-1. AUs in Soos Creek with no current fine sediment listings

Assessment Unit Number
17110013000387_001_001
17110013000388_001_001
17110013000390_001_001
17110013002019_001_001
17110013002023_001_001
17110013000391_001_001
17110013000396_001_001
17110013000393_001_001
17110013000401_001_001
17110013000395_001_001
17110013000400_001_001
17110013000404_001_001
17110013000405_001_001
17110013000410_001_001
17110013000414_001_001
17110013008058_001_001
17110013007347_001_001
17110013000502_001_001
17110013000578_001_002
17110013008776_001_001
17110013007384_001_001
17110013008652_001_001
17110013008797_001_001
17110013007565_001_001
17110013008554_001_001
17110013008714_001_001
17110013007567_001_001
17110013002333_001_001
17110013007411_001_001
17110013008601_001_001
17110013007579_001_001
17110013000515_001_001

Assessment Unit Number
17110013007557_001_001
17110013008699_001_001
17110013007391_001_001
17110013007591_001_001
17110013008787_001_001
17110013000491_001_001
17110013007563_001_001
17110013002271_001_001
17110013007407_001_001
17110013000524_001_001
17110013007406_001_001
17110013007601_001_001
17110013008555_001_001
17110013007393_001_001
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17110013007559_001_001
17110013007566_001_001
17110013000477_001_001
17110013007408_001_001
17110013008702_001_001
17110013000553_001_001
17110013008701_001_001
17110013008791_001_001
17110013008692_001_001
17110013000098_001_001
17110013007398_001_001
17110013007363_001_001
17110013000476_001_001
17110013008697_001_001
17110013008775_001_001
17110013000560_001_001
17110013008694_001_001
17110013008742_001_001
17110013007394_001_001
17110013007560_001_001
17110013007399_001_001

Assessment Unit Number
17110013000100_001_001
17110013000104_001_002
17110013007748_001_001
17110013007403_001_001
17110013008608_001_001
17110013007607_001_001
17110013008551_002_002
17110013007425_001_001
17110013008698_001_001
17110013002340_001_001
17110013000505_001_001
17110013007584_001_001
17110013007562_001_001
17110013008778_001_001
17110013008394_001_001
17110013000174_001_001
17110013000102_001_001
17110013007594_001_001
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17110013007397_001_001
17110013000169_001_001
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17110013007586_001_001
17110013000475_001_001
17110013000489_001_001
17110013000545_001_001
17110013007349_001_001
17110013007585_001_001

Assessment Unit Number
17110013008715_001_001
17110013007588_001_001
17110013007377_001_001
17110013008807_001_001
17110013007596_001_001
17110013008587_001_001
17110013008792_001_001
17110013007386_001_001
17110013000579_001_001
17110013007357_001_001
17110013008773_001_001
17110013008602_001_001
17110013007593_001_001
17110013007404_001_001
17110013007375_001_001
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17110013007568_001_001
17110013008557_001_001
17110013002335_001_001
17110013000167_001_001
17110013000152_001_001
17110013007564_001_001
17110013008700_001_001
17110013007381_001_001
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