PS Nutrient Forum

Meeting packet

March 27, 2025

Review

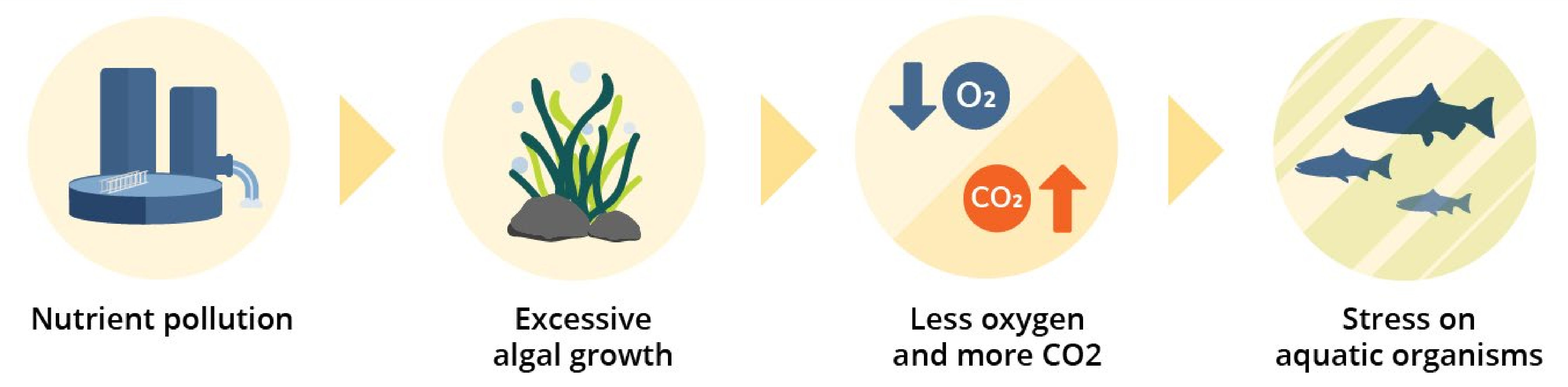
How we've gotten here

Why we’re doing this:

to restore Puget Sound.

The nutrient problem in Puget Sound

- Excess nutrients (nitrogen) from humans is harming Puget Sound
- Nutrient pollution leads to low dissolved oxygen, meaning aquatic life doesn't have enough oxygen to thrive



Puget Sound Nutrient Source Reduction Project

Goal:

- Meet dissolved oxygen (DO) water quality standards.
- Restore and protect healthy and robust aquatic species and communities.

How:

- Reduce human nutrients from local and regional point and nonpoint sources.
    - Prioritize where the largest nutrient reductions are necessary to maximize regional efforts.
    - Define the levels of nutrient reductions needed so that Puget Sound meets state water quality standards.
    - Identify watershed sources of nutrients so we can prioritize and support implementation of reduction strategies within the watersheds.

Addressing nutrients in Puget Sound

DEPARTMENT OF ECOLOGY
State of Washington

1990s

- Discovery of nutrient pollution in Budd Inlet
- LOTT plans and starts treatment to remove excess nitrogen

2000s

- Science and research confirms nutrient pollution from outside Budd Inlet contributes to low dissolved oxygen in Budd Inlet
- Large-scale modeling begins on how nutrient pollution from all sources affect water quality throughout Puget Sound

2010s

- Ecology's Puget Sound Nutrient Reduction Project begins
- Ecology holds public forums on the science and regulatory options
- Public processes to decide how best to regulate pollution leads to a general permit approach

2020s

- Ecology issues Puget Sound Nutrient General Permit
- Permit appeals and litigation follow
- Permittees begin optimizing infrastructure and planning for the future
- Modeling work continues

Puget Sound Nutrient General Permit Cycles

DEPARTMENT OF ECOLOGY
State of Washington

Permit Cycle 1

2022-2026

- **Optimize** current treatment processes to enhance nutrient reductions
- **Monitor** raw wastewater and the plant's discharge to evaluate nutrient reductions and optimization progress
- **Planning** begins or continues for future plant upgrades to control nutrients
- **Grant funding** from Ecology will be available for optimization and planning.

Public Process

Permit Cycle 2

2027-2031

- **Continue** adaptive management
- Set **nutrient limits**
- **Start compliance schedules** to achieve limits
- **Finalize plans** and designs, possibly start construction
- **Continue to provide** and find additional funds for infrastructure upgrades

Public Process

Permit Cycle 3

2032-2036

- **Upgrades** are happening
- Use adaptive management and feedback to **refine the permit** every 5 years
- Possible **Nutrient Trading Framework**
- **Continue to provide** and find additional funds for infrastructure upgrades

Past Nutrient Forums

Date	Agenda Topics	Materials
July 2023	Puget Sound Nutrient Trading	Puget Sound Nutrient Credit Trading Recommendations for Program Implementation Presentation slides: • Puget Sound Nutrient Trading
December 2022	Watershed Nutrient Monitoring & Modeling	Meeting agenda Presentation slides: • Related Project Updates and Watershed Nutrient Strategy Overview Presentation • Puget Sound Continuous Nitrogen Freshwater Monitoring • Seasonally dynamic SPARROW model for Puget Sound
February 2022	Next phase of Salish Sea Modeling: proposed Year 2 Optimization Scenarios	Meeting agenda Meeting packet Year 2 Optimization Scenario packet Presentation slides (and recording): • Next phase of Salish Sea Modeling
September 2021	Year 1 Optimization Scenario Model results	Presentation slides: • Comparing Salish Sea Modeling results to water quality standards and Optimization Scenario Tech Memo Results
March 2021	Refresher course: Clean Water Act, regulatory models, and using Salish Sea model to manage nutrients	Meeting agenda Presentation slides: • Puget Sound Nutrient Reduction Project Opening Slides • Regulatory Models & Salish Sea Model development • Salish Sea Model performance • Salish Sea Model & calculating meeting standards • Project Updates

March 2025 Nutrient Forum

Overview and resources

March 2025 Nutrient Forum agenda

Time	Item	Presenter
9:30 – 9:40 am	Introduction	Kate Loy
9:40 – 9:50 am	Puget Sound Nutrient General Permit update	Vincent McGowen Jeff Killelea
9:50 – 10:05 am	Puget Sound Nutrient Reduction Pan update	Jeremy Reiman Ben Rau
10:25 – 10:30 am	Break	
10:30 am – 12:00 pm	Salish Sea Model Optimization Scenario Phase 2 results update	Cristiana Figueroa-Kaminsky John Gala Anise Ahmed Teizeen Mohamedali
12:00 – 12:15 pm	Closing	Kate Loy

Helpful resources

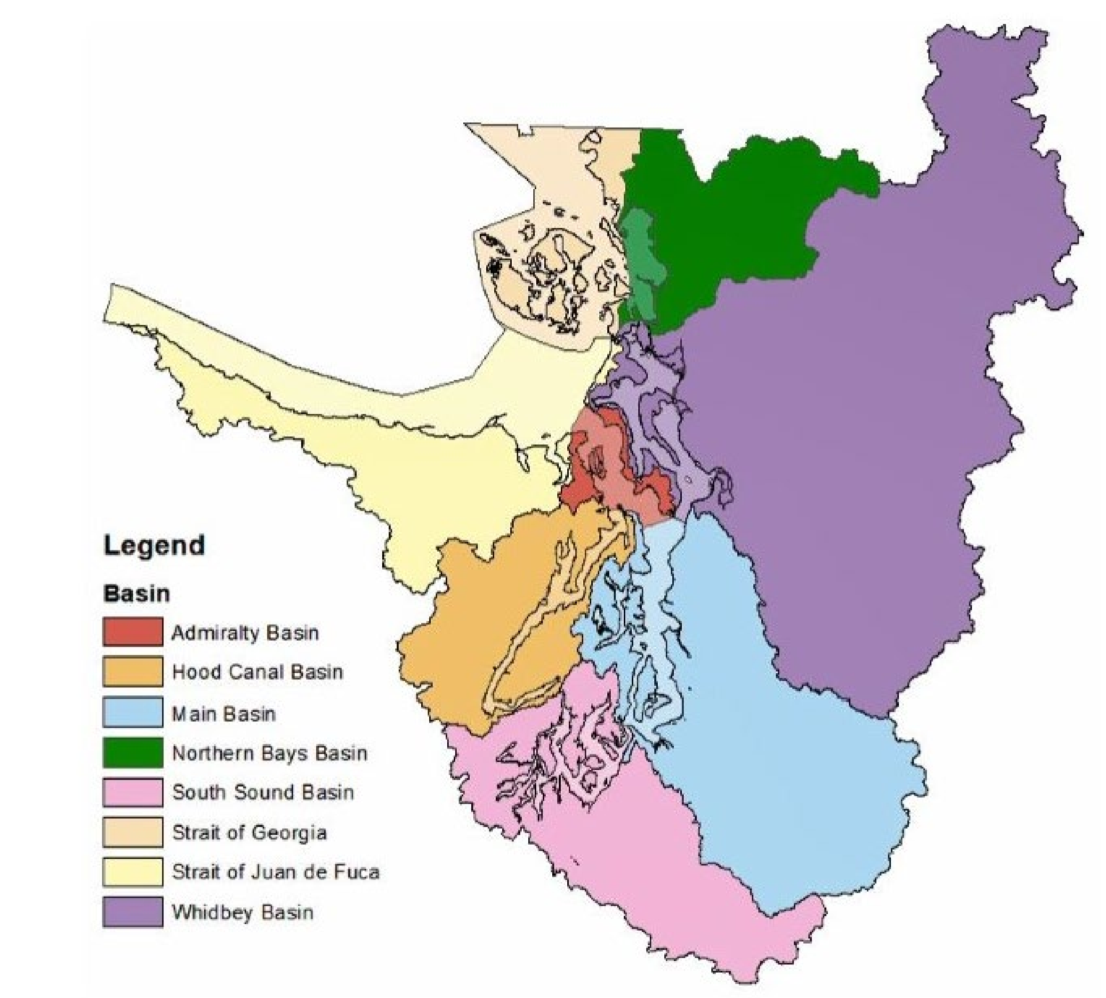
- Focus on: Puget Sound Nutrient Reduction Strategy
- Puget Sound Nutrient Source Reduction Project. Volume 1: Model Updates and Bounding Scenarios
- Puget Sound Nutrient Source Reduction Project Phase II - Optimization Scenarios
  - Optimization Scenarios results webmap
- Phase 2 Optimization Scenario packet

Salish Sea Model (SSM) Phase 2 - Glossary

- **Basin:** Term used to describe distinct marine areas within WA waters of the Salish Sea, generally separated by shallow sills.
- **BNR:** General term for a wastewater treatment process that removes nitrogen through the manipulation of oxygen within the treatment train to drive nitrification and denitrification. Nitrogen removal efficiency depends on site-specific conditions, such as treatment processes, climate, and the overall strength of the raw wastewater. BNR8, BNR5, and BNR3 refer to BNR treatment process resulting in no more than 8 mg/L, 5 mg/L and 3 mg/L DIN (respectively) and no more than 8 mg/L carbonateous BOD in WWTP effluent.
- **Framework:** Alternative ways to distribute TN and TOC mass loads from WWTPs and watersheds. There are WWTP frameworks and watershed frameworks.
- **Region:** Groupings of marine geographic areas within WA waters of the Salish Sea.
- **Scenario:** For Year 2 modeling, a scenario is equal to the combination of one WWTP Framework and one Watershed Framework
- **Total Nitrogen (TN):** Both dissolved organic and inorganic forms of nitrogen.
- **TN Load Target:** The cumulative anthropogenic total nitrogen (TN) load attributed regionally to WWTP discharges and the anthropogenic fraction from all watershed inflows in the region or an individual basin. All total nitrogen (TN) mass load targets are expressed as the mass load per unit of time (i.e. kg/day or kg/year).
- **Target Range:** The range of total anthropogenic load that the scenarios need to be within to be included in the Year 2 scenario list.
- **Watershed:** Freshwater inputs in the Salish Sea Model. Each input represents the cumulative nutrient load from human and natural sources draining to that input. Watershed nutrient load reductions refer to the cumulative point and nonpoint nutrient sources within the watershed

SSM Phase 2 Scenarios - Map

Map of basins in Washington Waters of the Salish Sea, and their associated drainage areas, for SSM Phase 2



SSM Phase 2 Scenarios - Overview

- Goal: find the nutrient reduction scenario (or set of scenarios) that results in the highest predicted compliance with Dissolved Oxygen (DO) standards in the Washington waters of the Salish Sea
- Scenarios represent different frameworks for reducing wastewater treatment plant (WWTP) discharges *and* human nutrient sources
- Scenarios help address three questions:
  1. Will DO compliance improve if we make bigger reductions near predicted-noncompliant areas?
  2. How do smaller sources further away from noncompliant areas impact DO?
  3. What are the DO improvements from different WWTP seasonal limits throughout the year?

SSM Phase 2 - Approach

General approach for development of Phase 2 scenarios:

1. Identify the most optimal watershed framework by pairing each watershed framework with one WWTP framework
   - To determine “most optimal” we first identified the frameworks with the largest reductions in noncompliance areas. We chose the scenario with the smaller nutrient reduction if two frameworks had similar noncompliance reductions.
2. Identify the most optimal WWTP framework by pairing each WWTP framework with the watershed framework selected in step 1
3. Further adjust the selected watershed and WWTP frameworks to identify scenarios that meet water quality standards (test out further reductions in the areas that continued to show noncompliance with the standards)

SSM Phase 2 – Watershed Frameworks

Summary of Watershed Anthropogenic TN Reduction Frameworks.

Basin	Basin #	Draft 2014 Watershed Annual Anthropogenic TN Loads (thousands kg/yr)									
		Existing	Framework F			Framework G			Framework H		H1 Refined
			F1	F2	F3	G1	G2	G3	H1	H2	
Northern Bays	1	1,330	610	650	650	450	470	470	450	450	450
Whidbey	2	2,460	1,110	1,190	920	820	860	680	820	820	820
Main	3	1,690	800	850	840	590	630	610	590	590	540
South Sound	4	1,260	689	529	729	509	389	529	509	509	469
Hood Canal	5	407	256	274	272	190	204	198	190	407	137
Admiralty	6	37.3	23.5	25.2	24.9	17.4	23.4	22.7	17.4	37.3	17.4
SJF - US	7	238	150	161	159	111	149	145	238	238	238
SOG - US	8	419	263	282	280	195	262	254	419	419	419
Regional Watershed TN Load		**7,841**	**3,902**	**3,961**	**3,875**	**2,882**	**2,987**	**2,909**	**3,233**	**3,470**	**3,090**
Total Percent Reduction		-	**50%**	**49%**	**51%**	**63%**	**62%**	**63%**	**59%**	**56%**	**61%**
Framework Variations		2014 existing anthropogenic watershed loads	**F1**: Increase reductions in basins with bigger impact (1-4) **F2:** start with F1, with extra reduction in South Sound **F3:** start with F1, with extra reduction in Whidbey			**G1:** Increased reductions in basins with biggest impact (1-4) **G2:** Start with G1, with extra reduction in South Sound **G3:** start with G1, with extra reduciton in Whidbey			**H1:** Start with G1 for Basins 1-6, puts Basins 7-8 at existing **H2**: Start with G1 for Basins 1-4, puts Basins 5-8 at existing		Start with H1, except 90% reductions to sub-watersheds draining to recalcitrant bays/inlets
What this tests		Existing load that must be reduced	Estimated minimum load reduction with spatial variation			Estimated maximum TN load reduction with spatial variation			DO sensitivity to loads in the Straits, Hood Canal, and Admiralty Inlet		DO response to reducing loads in recalcitrant bays/inlets

Draft loads. Basin-level loads rounded to 3 significant figures. Regional loads rounded to nearest whole number.

SSM – Phase 2 WWTP Initial Frameworks

Summary of initial WWTP anthropogenic reduction frameworks.

Basin	Basin #	Draft 2014 Basin WWTP Anthropogenic Annual TN Loads (thousands kg/yr)					
		Existing	Framework A	Framework B	Framework C	Framework D	Framework E
Northern Bays	1	474	221	219	199	199	271
Whidbey	2	1,380	569	565	502	502	687
Main	3	10,000	3,380	3,340	2,920	2,920	3,980
South Sound	4	1,180	442	432	396	396	405
Hood Canal	5	0.371	0.306	0.291	0.282	0.371	0.282
Admiralty	6	24.1	20.8	21.1	20.5	24.1	20.5
SJF - US	7	105	66.4	67	62	105	75.8
SOG - US	8	251	186	185	180	251	192
Regional WWTP TN Load		**13,414**	**4,886**	**4,829**	**4,280**	**4,397**	**5,632**
Total Percent Reduction		-	**64%**	**64%**	**68%**	**67%**	**58%**
Seasonal Biological Nitrogen Reduction levels tested		2014 loads from WWTP marine discharges	Cool = BNR8 Warm = BNR8 Hot = BNR5	Cool = Remainder Warm = BNR5 Hot = BNR3	Cool = BNR8 Warm = BNR5 Hot = BNR3	Basins 1-4 = Framework C Basins 5-8 = Existing	Framework C but combined systems at existing levels during cool months
What this tests		Existing load that must be reduced	Estimated minimum TN reduction with treatment	Estimated minimum that allows more load during cool months	Estimated maximum nitrogen reduction	Improvement without WWTP reductions in basins 5-8	Existing impact from combined WWTPs
Seasonality			Cool = Nov-Mar | Warm = Apr-Jun, Oct | Hot = Jul-Sep				

Draft loads. Basin-level loads rounded to 3 significant figures. Regional loads rounded to nearest whole number. Loads represent total loads from WWTPs and industrial point sources.

SSM – Phase 2 Refined WWTP Frameworks (1/2)

Summary of final refined WWTP frameworks/scenarios

All "Opt2" scenarios were paired with watershed "H1 refined" framework

Final frameworks continue on next slide

Basin	Basin #	Draft 2014 Basin WWTP Anthropogenic Annual TN Loads (thousands kg/yr)					
		Existing	Opt2_1	Opt2_2	Opt2_3	Opt2_4	Opt2_5
Northern Bays	1	474	199	199	199	199	199
Whidbey	2	1,380	502	505	502	502	505
Main	3	10,000	2,920	2,920	2,880	2,920	2,920
South Sound	4	1,180	396	400	396	396	400
Hood Canal	5	0.371	0.282	0.371	0.282	0.371	0.371
Admiralty	6	24.1	20.5	20.5	20.5	24.1	24.1
SJF - US	7	105	62	62	62	105	105
SOG - US	8	251	180	180	180	251	251
Regional WWTP TN Load		**13,414**	**4,280**	**4,287**	**4,240**	**4,397**	**4,404**
Total Percent Reduction		-	**68%**	**68%**	**68%**	**67%**	**67%**
Seasonal Biological Nitrogen Reduction levels tested		2014 loads from WWTP marine discharges	**All:** 8/5/3	**Very small:** existing **All others:** 8/5/3	**Sinclair:** 3/3/3 **All others:** 8/5/3	**Basins 5-8:** existing **All others:** 8/5/3	**Very small:** existing **Basins 5-8:** existing **All others:** 8/5/3
What this tests		Existing load that must be reduced	What is the overall level of BNR reductions that approaches DO compliance?	What is the effect on compliance of very small WWTPs set at existing 2014 loads?	What is the effect on noncompliance of increasing BNR treatment for those WWTPs discharging within or near Sinclair Inlet?	What is the effect on compliance of WWTPs discharging into Straits of Juan de Fuca and Georgia, Admiralty Inlet and Hood Canal set at existing 2014 loads?	What is the combined effect on compliance of 1) setting very small WWTPs and 2) setting WWTPs discharging into Straits of Juan de Fuca and Georgia, Admiralty Inlet and Hood Canal at existing 2014 loads?
Seasonality		Cool = Nov-Mar | Warm = Apr-Jun, Oct | Hot = Jul-Sep					

Draft loads. Basin-level loads rounded to 3 significant figures. Regional loads rounded to nearest whole number. Loads represent WWTP and industrial sources.

SSM – Phase 2 Refined WWTP Frameworks (2/2)

Basin	Basin #	Draft 2014 Basin WWTP Anthropogenic Annual TN Loads (thousands kg/yr)					
		Existing	Opt2_6	Opt2_7	Opt2_8	Opt2_9	Opt2_10
Northern Bays	1	474	199	199	199	199	199
Whidbey	2	1,380	502	505	505	505	505
Main	3	10,000	2,880	2,880	2,790	2,710	1,990
South Sound	4	1,180	396	400	400	400	400
Hood Canal	5	0.371	0.371	0.371	0.371	0.371	0.371
Admiralty	6	24.1	24.1	24.1	24.1	24.1	24.1
SJF - US	7	105	105	105	105	105	105
SOG - US	8	251	251	251	251	251	251
Regional WWTP TN Load		13,414	**4,357**	**4,364**	**4,274**	**4,194**	**3,474**
Total Percent Reduction		-	**68%**	**67%**	**68%**	**69%**	**74%**
Seasonal Biological Nitrogen Reduction levels tested		2014 loads from WWTP marine discharges	**Basins 5-8:** existing **Sinclair:** 3/3/3 **All others:** 8/5/3	**Very small:** existing **Basins 5-8:** existing **Sinclair:** 3/3/3 **All others:** 8/5/3	**Very small:** existing **Basins 5-8:** existing **Sinclair:** 3/3/3 **Main Basin Dominants w/o West Point:** 8/3/3 **All others:** 8/5/3	**Very small:** existing **Basins 5-8:** existing **Sinclair:** 3/3/3 **Main Basin Dominants:** 8/3/3 **All others:** 8/5/3	**Very small:** existing **Basins 5-8:** existing **Sinclair:** 3/3/3 **Main Basin Dominants:** 3/3/3 **All others:** 8/5/3
What this tests		Existing load that must be reduced	What is the combined effect on compliance of 1) setting WWTPs discharging into Straits of Juan de Fuca and Georgia, Admiralty Inlet and Hood Canal at existing 2014 loads and 2) increasing BNR treatment for those WWTPs discharging within or near Sinclair Inlet?	What is the combined effect of 1) setting very small WWTPs and WWTPs in the Straits, Admiralty Inlet, and Hood Canal at existing 2014 loads and 2) increasing BNR treatment for those WWTPs discharging within or near Sinclair Inlet?	Can DO compliance be achieved everywhere with largest (dominant) WWTPs in the Main Basin at BNR 8/3/3 and those in the vicinity of Sinclair Inlet at BNR 3/3/3 but West Point (a dominant facility treating combined sewers) at 8/5/3?	Can DO compliance be achieved everywhere with largest (dominant) WWTPs in the Main Basin at BNR 8/3/3 and those in the vicinity of Sinclair Inlet at BNR 3/3/3?	Can DO compliance be achieved everywhere with largest (dominant) WWTPs in the Main Basin and those in the vicinity of the most difficult compliance location at BNR 3/3/3?
Seasonality		Cool = Nov-Mar | Warm = Apr-Jun, Oct | Hot = Jul-Sep					

Draft loads. Basin-level loads rounded to 3 significant figures. Regional loads rounded to nearest whole number. Loads

Looking ahead

Next steps

Looking ahead

We look forward to hosting the next Nutrient Forum as this work continues.

We anticipate our next forum will focus on the Puget Sound Nutrient Reduction Plan when the draft becomes available for public review.

To learn more about this work, visit our webpage

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