Puget Sound Nutrient Forum

April 30th, 2019 10am-3pm

Ecology Headquarters

300 Desmond Dr. SE, Lacey

April 30 Forum Objective

This Forum will focus on how we will use the Salish Sea model to test different nutrient load scenarios and their impact on dissolved oxygen levels in the Puget Sound. Based on the results from the Salish Sea modeling in the Bounding Scenarios Report, we have proposed five major scenario runs to test in the next year of modeling. In preparation for this upcoming Forum, please read over this meeting packet to familiarize yourself with the proposed scenarios, upcoming modeling schedule, and to review our previous work with the Salish Sea model.

Included in this packet:

- Links to review
  - Previous Forum meeting resources
  - Bounding Scenarios Report
  - Salish Sea Model results webmap

Puget Sound Nutrient Forum Agenda

April 30, 2019 ~ 10:00 a.m. to 3:00 p.m.

Ecology Headquarters, Lacey

The Department of Ecology is hosting this Nutrient Forum meeting to discuss the optimization scenarios to be tested by the Salish Sea Model in the next year. We will present our draft optimization scenarios, explain the modeling schedule moving forward, and we look forward to feedback from the Forum.

To Participate:

This public meeting will be held at the Ecology Headquarters Office (300 Desmond Dr. SE, Lacey)**.** Due to the interactive nature of this meeting, there will be no webinar option. Please RSVP online to let us know how you will be attending.

Agenda

Note: Times may vary according to questions and discussion during topic presentations.

10:00 a.m.	**Welcome & Introductions (Gretchen Muller, Cascadia Consulting)** • Overview of Forum and purpose of today's meeting • Puget Sound Nutrient Source Reduction Project schedule • Explain format for today's breakout groups
10:30 a.m.	**Draft Model Scenarios Presentation** • Introduction to draft scenarios for Year 1 modeling • Description of scenario questions and objectives • Q&A
11:00 a.m.	**Facilitated Breakout Discussion Groups: Model Scenarios 1 & 2** Attendees will be assigned to discussion groups. • Scenario 1: Watershed source reductions by basin • Scenario 2: Marine point source reductions by basin
12:15 p.m.	**Break for Lunch** *(lunch will not be provided)*
1:00 p.m.	**Facilitated Breakout Discussion Groups Continued: Model Scenario 3** • Scenario 3: Annual vs. Seasonal nutrient load reductions
1:30 p.m.	**Group Activity: Fish Bowl Style Discussion on Scenarios 4 & 5** This discussion activity will be with the whole group. • Scenario 4: Future population growth and climate change • Scenario 5: Everybody, everywhere
2:45 p.m.	**Wrap-up and Adjourn (Dustin Bilhimer)** • Overview of how we will incorporate Forum feedback on draft scenarios and future communications to the Forum on modeling decisions. • Upcoming meetings in 2019.
3:00 p.m.	**Adjourn**

Additional Resources

Agency Contacts

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2019 Forum Schedule

☑ Feb 6, Bounding Scenarios

☑ March 6, Nutrient Management in Other States

☐ April 30, Optimization Scenarios

☐ June 4, Puget Sound Implementation Examples

☐ July 17, Marine Water Quality Update

☐ Aug 7, Costs and Creative Solutions

More Information

Puget Sound Nutrient Source Reduction Project Webpage

Bounding Scenario Report

Salish Sea Model Webmap

Nitrogen in Puget Sound Story Map

Join our Nutrient Project Listserv

Sign up here to receive email notices about the Forum and the nutrient project in Puget Sound. You can also access materials from our previous Forum meetings on our Puget Sound Nutrient Forum webpage.

Schedule & Objectives:

Timeline	Objectives
Year 1 Jul '19 – Jun '20	• Understand the significance of watersheds separate from marine sources. • Understand the range of future conditions, impacts, and potential improvements. • Define what it takes to meet water quality standards under existing conditions.
Year 1 Model Milestone Summer '20	• Ecology will release technical memo of first year modeling. • Ecology will share modeling results at Forum meeting. • Nutrient Forum will discuss next scenarios to model based on what we learned from Year 1 modeling. • Confirm next set scenarios.
Year 2 Jul '20 – Jun '21	• Evaluate new combinations of reductions from marine and watershed sources. • Evaluate remaining questions to inform decisions for facility planning and nutrient source reduction plan. • Evaluate a final set of nutrient load reduction targets for both marine and watershed sources that meet water quality standards.
Year 2 Model Milestone Summer-Fall '21	• Ecology will share modeling results at Forum meeting. • Ecology will publish a report of second year of modeling.
***Tentative* Plan Development Milestone** Summer '21-End of '22	• Develop Draft Puget Sound Nutrient Source Reduction Plan. • Public review

Puget Sound
Nutrient Source Reduction Project

Volume 1: Model Updates and Bounding Scenarios

DEPARTMENT OF
ECOLOGY
State of Washington

January 2019
Publication No. 19-03-001

Executive Summary

Low levels of dissolved oxygen have been measured throughout Puget Sound and the Salish Sea. In numerous places, seasonal oxygen levels are below those needed for fish and other marine life to thrive, and water quality standards are not being met. Nutrient pollution from human activities is worsening the region's naturally low oxygen levels. Areas most affected are poorly flushed inlets, including Penn Cove, Quartermaster Harbor, and Case, Carr, Budd, Sinclair, and Dyes Inlets.

Many Puget Sound locations are listed on the U.S. Environmental Protection Agency's Clean Water Act Section 303(d) list as "impaired." Federal law requires states to identify sources of pollution and develop water quality improvement plans for waters listed as impaired.

Excessive nutrients flowing into marine waters can lead to profound consequences for the ecosystem. In addition to low levels of oxygen, some effects include:

- Acidification, which can prevent shellfish and other marine organisms from forming shells.
- Shifts in the number and types of bottom-dwelling invertebrates.
- Increases in abundance of macroalgae, which can impair the health of eelgrass beds.
- Seasonal reductions in fish habitat and intensification of fish kill events.
- Potential disruption of the food web.

Figure ES1. Salish Sea Model area (orange grid).

Washington State Department of Ecology (Ecology) recognizes the need to manage human sources of nutrients in the Puget Sound region. To understand the significance of these sources and identify potential solutions, Ecology used a peer-reviewed, state-of-the-science computer modeling tool called the Salish Sea Model. It models conditions in the Salish Sea, extending into the coastal waters of southwest British Columbia, Washington, and northwest Oregon (Figure ES1). This report shares the findings of the first set of modeled scenarios; it will inform discussions and guide the next round of modeling, to begin in 2019.

Excessive nutrients in rivers and from point sources flowing into the Sound, such as municipal wastewater treatment plants, deplete dissolved oxygen below the water quality standards.

In this report, Ecology evaluated changes in marine dissolved oxygen due to reducing nitrogen and carbon at municipal wastewater plants.

The years 2006, 2008, and 2014 were modeled to represent a range of climate and ocean conditions affecting Puget Sound. Model scenarios tested the impacts of:

- Current levels of nutrient pollution from rivers and wastewater treatment plants discharging directly to marine waters.
- Reduced nitrogen and carbon at all municipal wastewater treatment plants discharging to marine waters.
- Reduced nitrogen and carbon at only midsize and large municipal wastewater treatment plants discharging to marine waters.
- Reduced nitrogen and carbon at only large municipal wastewater treatment plants discharging to marine waters.

Only the 79 municipal wastewater treatment plants that discharge directly into the United States portion of the Salish Sea were simulated with lower nutrient levels. Canadian and industrial treatment plants remained at current loadings in all the scenarios tested. Plants were grouped into three categories: all plants, midsize, and large. Midsize plants include Chambers Creek, Tacoma Central, Brightwater, Everett outfall in the Snohomish River, Everett-Marysville, and Bellingham. Large plants are South King County and West Point.

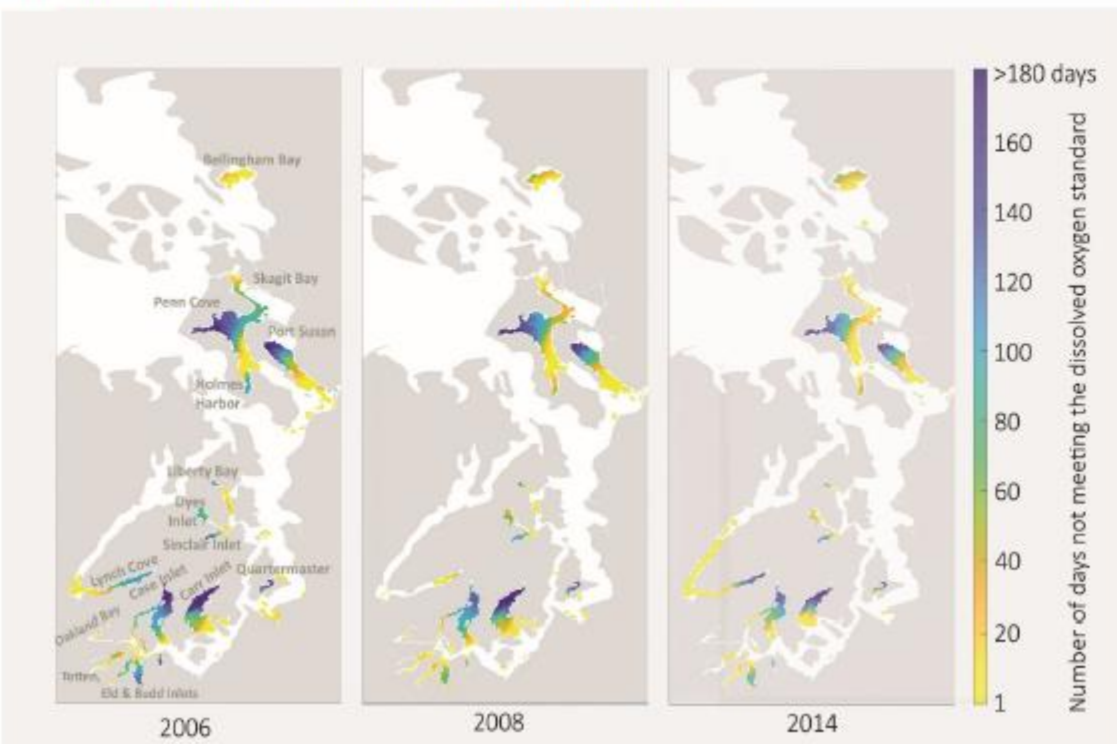

Figure ES2. Number of days not meeting the dissolved oxygen water quality standards for the years 2006, 2008, and 2014.

During all three years under the current nutrient loads, dissolved oxygen standards were not met. For example, Figure ES2 shows the number of days per year that water quality standards were not met, and where the noncompliance occurred. Complete details and results of the scenarios are complex and begin on page 72 of this report.

Ecology found that implementing nutrient reduction at wastewater treatment plants would achieve significant improvements toward meeting the dissolved oxygen water quality standards. The model estimates improvements in the number of days (Table ES1) and area (Table ES2) not meeting the standards.

Table ES1. Improvement in the number of noncompliant days due to nutrient reduction at wastewater treatment plants.

Year	Improvement in dissolved oxygen (% reduction in noncompliant days)		
	All plants	Mid & large plants	Large plants
2006	51%	43%	31%
2008	61%	49%	33%
2014	51%	42%	22%

Table ES2. Improvement in noncompliant area due to nutrient reduction at wastewater treatment plants.

Year	Improvement in dissolved oxygen (% reduction in noncompliant area)		
	All plants	Mid & large plants	Large plants
2006	47%	37%	23%
2008	51%	41%	24%
2014	42%	33%	13%

Under existing conditions, approximately 20% of the area in the greater Puget Sound does not meet the dissolved oxygen standards. If reductions are made at all municipal wastewater treatment plants as modeled, approximately 10% of the greater Puget Sound would not meet the standards. This represents roughly a 50% improvement in compliance area for the dissolved oxygen standards.

The results of the first phase of modeling conducted in 2018 confirm that human sources of nutrients are having a significant impact on dissolved oxygen in multiple Puget Sound embayments. It is clear from the modeling study that it will take a combination of nutrient reductions from wastewater treatment plants and other sources of nutrient pollution in watersheds to meet marine water quality standards.

Therefore, future evaluations of nutrient reduction strategies will need to include a comprehensive suite of measures. These measures should include nutrient load reductions from both wastewater treatment plants and watersheds to comply fully with Washington's marine water quality standards for dissolved oxygen.

To address this complex issue, evaluations of different combinations of marine and watershed source reductions are planned for the next phase of modeling, beginning in early 2019.

Year 1 Draft Modeling Scenarios

Scenario 1: Watershed Source Reductions by Basin

Question: What is the significance of nutrient inputs from watersheds in one Puget Sound basin relative to watersheds in other Puget Sound basins?

Objective: Understand the significance of watersheds on dissolved oxygen (by basin) relative to other watersheds.

We need to understand the relative influence of different basin watersheds to see if there are basins that may require more/less reductions from watersheds. This may help us prioritize watersheds for nutrient reduction work or for future modeling.

Scenario Runs:

- Keep marine point sources to existing levels.
- Evaluate impacts of watersheds by keeping watershed loading into one basin at existing loads and set watershed loadings into other basins to reference conditions. Repeat for each basin:
    - South Sound
    - Main Basin
    - Whidbey Basin
    - Hood Canal
    - Admiralty Inlet, Strait of Georgia, and Strait of Juan de Fuca
    - Padilla/Samish/Bellingham Bay
- Calculate anthropogenic impact of watersheds with the 2006 reference condition

Scenario 2: Marine Point Source Reductions by Basin

Question: What is the impact of marine point source discharges within individual Puget Sound basins?

Objective: Understand the effect of marine point sources on dissolved oxygen (by basin) and to organize marine dischargers into similar oceanographic basins.

Marine point sources discharging to certain basins may have different water quality impacts than others. By grouping marine point sources by the Puget Sound basin they discharge to, we hope to better understand the spatial relationship between nutrient loads in certain basins and the impact to water quality across Puget Sound.

Scenario Runs:

- Set watershed sources to existing conditions.
- Set marine point sources discharging into one basin at existing conditions and set marine point sources discharging into all other basins at reference. Repeat for each basin:
    - South Sound
    - Main Basin
    - Whidbey Basin
    - Hood Canal
    - Admiralty Inlet, Strait of Georgia, and Strait of Juan de Fuca

    - Padilla/Samish/Bellingham Bay
- Calculate anthropogenic impact with the 2006 reference condition

Scenario 3: Annual vs. Seasonal Nutrient Load Reductions

Question: Do we get greater improvement in dissolved oxygen levels from annual load reductions vs. seasonal load reductions from marine point sources?

Objective: Understand wastewater seasonal nutrient load reductions compared to reductions in annual loading and the resulting improvement to water quality.

We want to understand both where and *when* nutrient reduction is most important for improving water quality. Scenario 3 addresses the “when” factor so that we can make strategic decisions about how and when to reduce nutrients at marine point sources to meet standards during all parts of the year.

Scenario Runs:

- Set marine point sources to assumed specific level of dissolved inorganic nitrogen (DIN) reduction (and commensurate dissolved organic carbon (DOC) reduction) with operational levels year-round.
- Compare to bounding scenario runs (seasonal treatment levels of 8mg/L or better if existing) OR compare to runs from Scenario 5 (advanced wastewater treatment levels lower than 8mg/L) if that scenario evaluates seasonal treatment.

Scenario 4: Future Population Growth & Climate Change

Questions: What impacts will future regional population growth and climate change have on dissolved oxygen in 2040?

Objectives: Understand the range of future conditions, impacts, and potential improvements.

We want to understand how population growth and climate change will impact dissolved oxygen levels in the future. This scenario will help us understand these impacts to create a nutrient reduction plan that addresses potential nutrient source increases due to 1) increases in wastewater flows due to population growth and, 2) changing watershed hydrology due to climate change effects on precipitation.

Scenario Runs:

- Set a baseline condition scenario with marine and watershed sources at reference levels of DIN.
- Use climate-impacted watershed hydrology, and marine wastewater effluent flows with population growth at 2040 levels under the ‘high’ population growth projections from Office of Financial Management (OFM).
- Use climate-impacted watershed hydrology, and marine wastewater effluent flows with population growth at 2040 levels under the ‘low’ population growth projections from OFM.

Scenario 5: Everybody, Everywhere

Question: What is the total nutrient reduction we need from both marine point sources and watersheds to improve dissolved oxygen in Puget Sound?

Objective: Understand the total nutrient reductions needed to meet DO criteria in Puget Sound through testing the improvement from estimated maximum nutrient reductions between marine point sources and watershed sources.

We learned from the bounding scenarios that reductions from both WWTP and watersheds are needed to meet water quality standards. We want to understand if further reductions from marine point sources and watersheds will meet the DO criteria in Puget Sound.

Scenario Runs:

- Set marine point sources at advanced nutrient removal levels (3 or 5 mg/L TIN (or DIN))
- Set watershed total anthropogenic DIN load reductions at a reasonable maximum (50 or 75% reduction)
- Compare to reference condition for 2006 and bounding scenarios to see if this combination meets standards.

Number of Models Runs for Draft Scenarios

This document provides a scope of the number of associated model runs required for each draft scenario. Some scenarios require more runs than other depending on the number of changes to model inputs required. For example, when testing the impacts of different basins (i.e. watersheds by basin or marine point sources by basin), an individual model run is required for each basin to be tested. Other scenarios that test more broadly based impacts across the Puget Sound may require less model runs.

*Note: For Scenarios 1-4, the input year for weather, hydrology and circulation is to be determined between 2006 or 2014 data.

Scenario 1: Watershed Source Reductions by Basin

Run 1- Impact of South Sound Basin watersheds	
Marine Point Sources	All marine point sources at existing conditions
Watershed Sources	South Sound Basin at existing yields.
	All other basins at reference conditions.
Run 2- Impact of Main Basin watersheds	
Marine Point Sources	All marine point sources at existing conditions
Watershed Sources	Main Basin at existing yields.
	All other basins at reference conditions.
Run 3- Impact of Whidbey Basin watersheds	
Marine Point Sources	All marine point sources at existing conditions
Watershed Sources	Whidbey Basin at existing yields.
	All other basins at reference conditions.
Run 4- Impact of Hood Canal Basin watersheds	
Marine Point Sources	All marine point sources at existing conditions
Watershed Sources	Hood Canal at existing yields.
	All other basins at reference conditions.
Run 5- Impact of Admiralty Inlet and Straits Basins watersheds	
Marine Point Sources	All marine point sources at existing conditions
Watershed Sources	Admiralty Inlet (and Strait of Juan de Fuca) at existing yields.
	All other basins at reference conditions.
Run 6- Impact of Padilla/Samish/Bellingham Bay watersheds	
Marine Point Sources	All marine point sources at existing conditions
Watershed Sources	Padilla/Samish/Bellingham Bay at existing yields.
	All other basins at reference conditions.

Scenario 2: Marine Point Source Reductions by Basin

Run 1- Impact of South Sound Basin marine sources	
Marine Point Sources	South Sound Basin marine point sources at existing conditions
	All other marine point sources at reference conditions
Watershed Sources	All watershed sources at reference conditions
Run 2- Impact of Main Basin marine sources	
Marine Point Sources	Main Basin marine point sources at existing conditions

	All other marine point sources at reference conditions
Watershed Sources	All watershed sources at reference conditions
Run 3- Impact of Whidbey Basin marine sources	
Marine Point Sources	Whidbey Basin marine point sources at existing conditions
	All other marine point sources at reference conditions
Watershed Sources	All watershed sources at reference conditions
Run 4- Impact of Hood Canal Basin marine sources	
Marine Point Sources	Hood Canal Basin marine point sources at existing conditions
	All other marine point sources at reference conditions
Watershed Sources	All watershed sources at reference conditions
Run 5- Impact of Admiralty Inlet and Straits Basins marine sources	
Marine Point Sources	Admiralty Inlet (and Strait of Juan de Fuca) marine point sources at existing conditions
	All other marine point sources at reference conditions
Watershed Sources	All watershed sources at reference conditions
Run 6- Impact of Padilla/Samish/Bellingham Bay marine sources	
Marine Point Sources	Padilla/Samish/Bellingham Bay Basin marine point sources at existing conditions
	All other marine point sources at reference conditions
Watershed Sources	All watershed sources at reference conditions

Scenario 3: Annual vs. Seasonal Nutrient Load Reductions

Run 1- Annual marine source reductions	
Marine Point Sources	All marine sources at year-round advanced treatment levels (TBD)
Watershed Sources	All watershed sources at reference conditions
Run 2- Seasonal marine source reductions	
Marine Point Sources	All marine sources at advanced treatment levels (TBD) on seasonal basis
Watershed Sources	All watershed sources at reference conditions

Scenario 4: Future Population Growth & Climate Change

Run 1- Future Reference Condition	
Marine Point Sources	All marine point sources at reference conditions
Watershed Sources	All watershed inputs at reference concentrations
Year for Weather, Hydrology, Circulation	2040 regionally scaled climate change projection
Future Population Growth	Human sources set to reference concentrations
Run 2- Future growth (high estimate) with advanced treatment and watershed improvements	
Marine Point Sources	All marine point sources at reference conditions
Watershed Sources	All watershed inputs set at maximum expected improvement
Year for Weather, Hydrology, Circulation	2040 regionally scaled climate change projection

Future Population Growth	Office of Financial Management high estimate of population growth for 2040 and either future effluent flow estimation method
Run 3- Future growth (low estimate) with advanced treatment and watershed improvements	
Marine Point Sources	All marine point sources at reference conditions
Watershed Sources	All watershed inputs set at maximum expected improvement
Year for Weather, Hydrology, Circulation	2040 regionally scaled climate change projection
Future Population Growth	Office of Financial Management low estimate of population growth for 2040 and either future effluent flow estimation method

Scenario 5: Everybody, Everywhere

Run 1- Watershed and Marine sources at estimated total reductions	
Marine Point Sources	All marine WWTPs and industrial at advanced treatment levels of 3 mg/L or 5 mg/L DIN.
Watershed Sources	All watersheds inputs at 50 or 75% reduction

General questions for the Forum

This Forum will include smaller breakout discussion groups. We will have facilitators to lead these discussions, but as you read through our draft modeling scenarios, please begin to think about the following questions:

- Are we asking the right questions for the model to answer in the next year?
- How much more do we need to know to define the problem and create a plan?
- Are we grouping nutrient sources in a reasonable framework?
- Are our model inputs and assumptions reasonable and/or can participants provide additional quality data to improve our inputs?
- How do we better understand near-field and far-field impacts?
- If we have to prioritize these scenarios for the first year, which sequence do we want?
- Are there other things we should be thinking about that are not included in these scenarios or schedule over the next two years?

Puget Sound Basin Map:

Note: Admiralty basin to include inputs from Washington State sources discharging to the Strait of Juan de Fuca and Strait of Georgia.

Glossary of Terms

Biological nitrogen removal (BNR)

BNR is a general term for a wastewater treatment process that removes nitrogen before it is discharged into a water of the state. The treatment process removes nitrogen sequentially by nitrification under aerobic conditions and denitrification under anoxic conditions.

Dissolved inorganic nitrogen (DIN)

Refers to the most bio-available form of nitrogen used by marine algae. DIN is the sum of nitrate, nitrite, and ammonium - three different forms of inorganic nitrogen. DIN is a 1:1 ratio of total inorganic nitrogen (TIN) so we equate DIN and TIN in our Salish Sea modeling.

Dissolved organic carbon (DOC)

Refers to a fraction of total organic carbon (TOC) dissolved in water, which typically comes from aquatic plants or algae, or from soils and terrestrial plants.

Existing conditions

Existing conditions are model outputs based on a historical model run (2006) that compares model results against past observed conditions.

Future conditions

Estimate of future nutrient loading based on how future population growth and climate change will affect future WWTP influent flows and watershed hydrology. County population growth estimates from the Office of Financial Management (OFM) will be used to estimate how each WWTP's future service population will change their influent flow. Regionally-downscaled global climate model projections will be used to estimate future watershed flows based on predicted changes in precipitation and it's effect on watershed hydrology. The watershed flow and WWTP effluent flows are multiplied with DIN or DOC concentration values to calculate loading over time. We are considering 2040 as the future year to model.

Marine point source

Point sources that discharge directly to marine waters of the Salish Sea and used as explicit model inputs including: municipal wastewater treatment plants (WWTP) and industrial facilities.

Anthropogenic Dissolved oxygen (DO) depletion

DO depletion is the reduction of DO concentrations compared to an estimated reference condition that is due to human sources. It is calculated as the difference from reference conditions and existing conditions at each model grid cell including all water column layers.

Model run

A model run refers to a specific set of inputs to be tested by the Salish Sea Model. Some scenarios require multiple runs. Each model run changes at least one input (in some cases multiple inputs will be changed) to test the water quality response to that change, while other inputs stay the same.

National Pollutant Discharge Elimination System (NPDES) permits:

National Pollutant Discharge Elimination System (NPDES) Discharge Permits regulate direct discharges to surface water from publicly owned treatment works (POTWs) or commercial industry. These permits are a requirement of the federal Clean Water Act and can be issued individually or through general permit coverage.

Nonpoint source

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 NPDES program.

Nutrient load

Nutrient (nitrogen and carbon) loads quantify the amount of a nutrient entering Puget Sound in a given time period, where load = concentration x flow (e.g., lbs/day).

Reference conditions

Reference conditions are characterized by: existing ocean boundary and hydrologic conditions and setting marine and watershed source inputs to estimated natural conditions. The reference condition helps calculate anthropogenic (human caused) DO depletion by providing a comparison to runs that use the same ocean boundary and hydrologic conditions but include human sources in marine and watershed inputs.

Scenario

A scenario refers to one model run or a set of model runs that when evaluated with the Salish Sea model informs the answers to a specific nutrient management question.

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.

Watershed source

Specifically refers to the watershed input to the Salish Sea model. Watershed sources include both non-marine point and nonpoint nutrient sources and natural sources.