How Nitrogen from Septic Systems Can Harm Water Quality

Washington State Department of Health

Why do we care?

Septic systems, also known as on-site sewage systems (OSS), are designed to reduce pollution by treating the solids, pathogens, organics, and ammonium (a form of nitrogen) in human waste before it is discharged to the soil. By design, bacteria consume ammonium and convert it to nitrate either in the drainfield or through aeration.

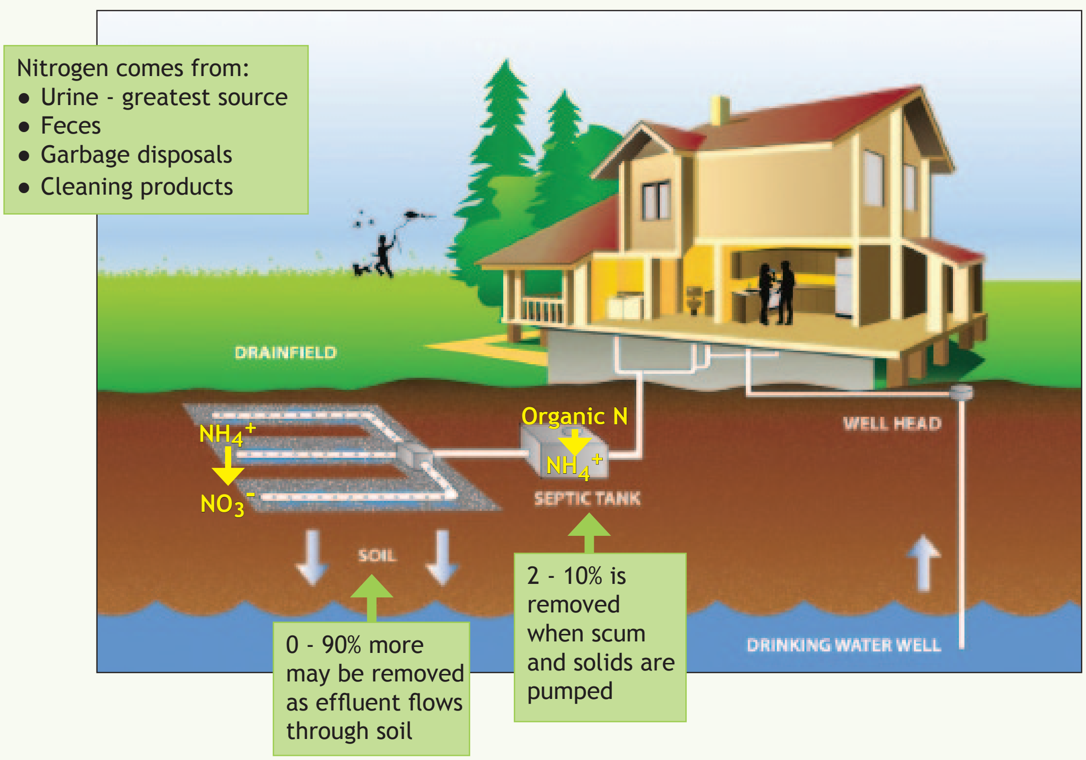
Wastewater treated by a properly functioning OSS generally contains significant amounts of nitrate. After leaving a properly functioning drainfield, nitrified effluent flows through soil. What happens to nitrates in soil is highly variable. It may be used by plants, flow to ground or surface water, or be consumed by bacteria. The amount of nitrate removed after leaving the drainfield varies between 0 and 90% depending on site conditions.

An improperly functioning OSS can result in excessive ammonium/ ammonia or nitrates discharged to the soil, where it can flow to groundwater or surface water and cause problems.

Moderate levels of nitrate in drinking water can cause [blue baby syndrome and other adverse health effects](). Excess nitrate can also harm the environment by increasing algal growth and decreasing oxygen levels in [Puget Sound and lakes]().

How do on-site systems treat nitrogen from human waste?

Nitrogen removal in wastewater varies depending on the type and concentration of the waste and the type of OSS used to treat it. Nitrogen concentrations are generally between 50 and 60 milligrams per liter (mg/L) in domestic wastewater but can be higher if a home uses low-flow fixtures or if the waste is coming from a school, campground, or office building. The drawing below shows nitrogen transformations as effluent flows through an OSS.



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Some nitrogen that enters the septic tank is removed when the scum and solids are pumped from the tank. In most OSS, oxygen loving bacteria convert ammonium to nitrate in the drainfield. This process is called "nitrification" and the effluent becomes "nitrified."

Advanced systems that aerate and recirculate wastewater can remove even more nitrogen (up to 60 percent). In the Puget Sound region only about 20 percent of OSS are advanced systems. Systems that include oxygen-free conditions in part of the treatment process can remove over 90 percent of nitrogen through a process called denitrification. Denitrification converts nitrate to nitrogen gas which is released to the air. Denitrification requires a type of bacteria that grow in oxygen-free conditions. Very few nitrogen reducing systems are used in the Puget Sound region. Some advanced systems are registered to remove nitrogen.

A properly designed drainfield can also increase nitrogen removal. Characteristics such as the size of the drainfield, the rate wastewater is released to soil, the depth of soil, how the wastewater is applied and distributed (such as drip irrigation or trenches, gravity or pressure), and vegetation management over the drainfield can all influence what happens to the nitrogen once it enters and eventually leaves the drainfield.

What is the role of soil?

Nitrogen removal in the soil is highly variable. Denitrification and plant uptake of nitrates are the two ways soil can remove nitrogen from wastewater. A deeper, moist, finer textured soil will generally remove more nitrogen than a shallow coarse soil. Nitrates move slower through fine soils and have more opportunity to be used as food by plants. Fine moist soils also allow the growth of bacteria required for denitrification. This is especially true in the wet climates of western Washington and Puget Sound.

Denitrification treatment system study

Recognizing the need for more treatment options to affordably reduce nitrogen in wastewater, we collaborated with the University of Washington to study the performance of three public domain treatment systems.

The 2013 study evaluated the effectiveness of the three systems listed in the table below and the recirculating gravel filter (RGF) as a stand-alone system with the goal of reducing total nitrogen concentrations in wastewater below 20 mg/L. For more details on the study go to our Denitrification Verification Project web page.

The three treatment processes reduced effluent nitrogen concentrations well below the goal of an annual average of 20 mg/L and the RGF achieved a 51 percent reduction to levels just above the target concentration.

Treatment Process	Average Total Influent Nitrogen Concentration	Average Effluent Nitrogen Concentrations				Total Nitrogren Removal
		NH3-N (mg/L)	NOx-N (mg/L)	Organic N (mg/L)	Total N (mg/L)	
Recirculating Gravel Filter (RGF)	48.6 mg/L	0.7	20.9	2.2	23.9	51%
Vegetated RGF		4.1	9.5	1.6	15.1	69%
Enhanced RGF		6.8	0.6	1.3	8.6	82%
Vegetated Woodchip RGF		0.5	2.4	1.1	4.0	92%

The Pacific Northwest Salmon Center installed an RGF woodchip bed systems to further document their long-term performance. To learn more about PNSC's project go to their OSS nitrogen reduction web page.

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To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).