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Evaluation of OSS Nitrogen Removal Technologies

Deschutes Advisory Group
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Washington State Department of Health

Study Partners

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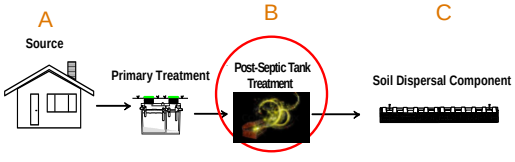
Wastewater **Nitrogen Management** Approaches

A. Source diversion
B. Post-septic tank treatment
C. Design of the soil dispersal component (drainfield)



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OSS Nitrogen Removal Project Design

- Problems:
  - N reduction in OSS is highly variable
  - Limited treatment options
  - Regional environmental and water source affects on N removal not well-known

Biological System
Changes Nitrogen from soluble to gaseous

Nitrogen In → → Nitrogen Out

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OSS Nitrogen Removal Project Design

- Objectives:
  - Maximize N removal efficiencies
  - Verify performance objective (<20 mg/L TN full test avg.)
  - Expand reliable, affordable options

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OSS Nitrogen Removal Project Design

- Methods: Partner with UW & Ecology to:
  - Use ETV Nutrient Reduction Protocol
  - Develop standards & guidance
- 12 Month Evaluation

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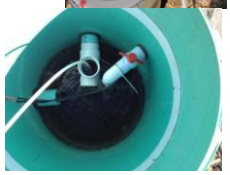
ETV-Nutrient Reduction Protocol

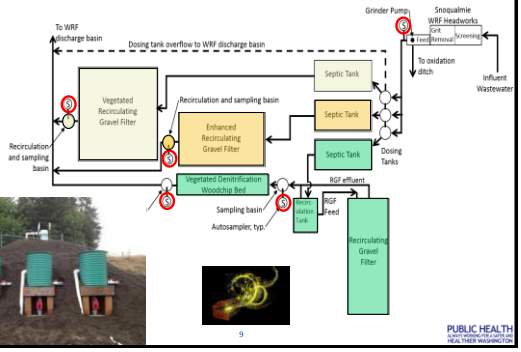
- Performance Parameters:
  - Total N, NH_3-N, NOx-N (NO_3+NO_2), Total P, CBOD, COD, TSS/VSS, alkalinity
  - Site Grab for lab: fecal coliform
  - In-situ samples: dissolved oxygen, pH, temperature



Snoqualmie WWTP Test Site

Snoqualmie WWTP Test Site

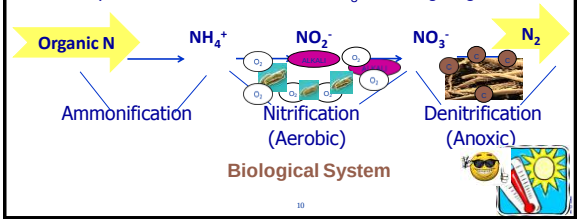
w/autosampler locations



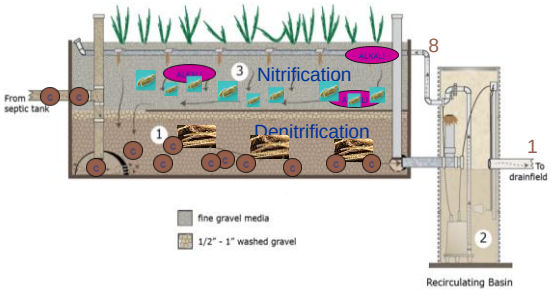
Nitrogen Biochemical Transformations

Two step process:

1) Nitrification - nitrifies NH_4^+ to NO_3^-
2) Denitrification - reduces NO_3^- to nitrogen gas

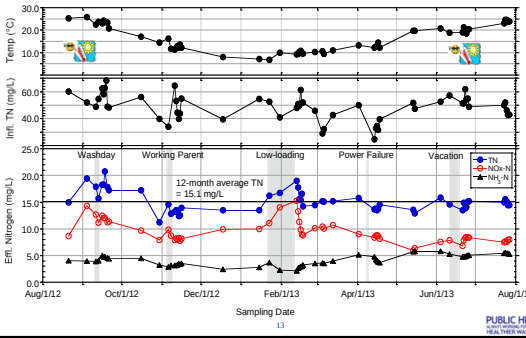


Vegetated Recirculating Gravel Filter (VRGF)



VRGF

VRGF Influent and Effluent Nitrogen Over 12-Month Test Period



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Average Performance for VRGF Over 12-Month Test (68.9% TN Removal)

Parameter	units	Influent	Effluent
Total N	mg/L	48.6 (9.5)	15.1 (1.9)
NH_3-N	mg/L	29.3 (5.3)	4.1 (1.0)
NOx-N	mg/L	-	9.5 (2.1)
Org-N	mg/L	-	1.6 (0.9)
BOD/CBOD*	mg/L	314 (98)	5.6 (1.8)
TSS	mg/L	354 (137)	3.2 (2.0)
VSS	mg/L	324 (131)	2.9 (1.7)
COD/SCOD*	mg/L	715 (223)	21.0 (7.2)
Total Phosphorus	mg/L	5.8 (1.3)	3.5 (1.1)
Fecal Coliform**	CFU/100 mL	8.4E+6	2.3E+5
Alkalinity as $CaCO_3$	mg/L	231 (36)	153 (23)
pH		7.4 (0.3)	6.8 (0.2)

*Effluents, **Geometric mean, ( ) is standard deviation

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VRGF Clogging Problem

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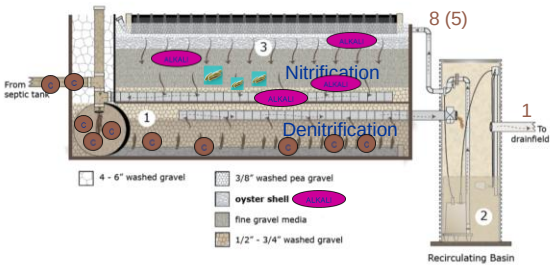
Enhanced Recirculating Gravel Filter (ERGF)



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ERGF

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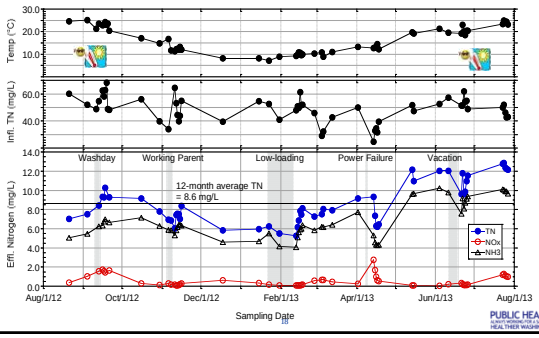
ERGF Influent and Effluent Nitrogen Over 12-Month Test Period



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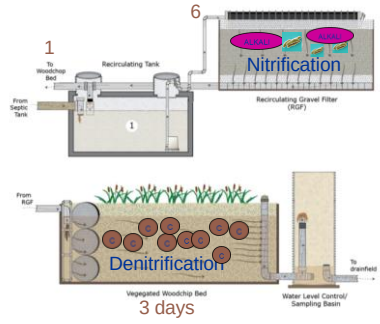
Average Performance for ERGF Over 12-Month Test (82.3% TN Removal)

Parameter	units	Influent	Effluent
Total N	mg/L	48.6 (9.5)	8.6 (2.2)
NH_3-N	mg/L	29.3 (5.3)	6.8 (1.9)
NOx-N	mg/L	-	0.6 (0.6)
Org-N	mg/L	-	1.3 (0.5)
BOD/CBOD*	mg/L	314 (98)	8.6 (1.9)
TSS	mg/L	354 (137)	5.3 (2.2)
VSS	mg/L	324 (131)	4.4 (2.0)
COD/SCOD*	mg/L	715 (223)	24.6 (5.7)
Total Phosphorus	mg/L	5.8 (1.3)	3.5 (1.4)
Fecal Coliform**	CFU/100 mL	8.4E+6	4.6E+5
Alkalinity as $CaCO_3$	mg/L	231 (36)	203 (27)
pH		7.4 (0.3)	6.9 (0.2)

*Effluents, **Geometric mean, ( ) is standard deviation

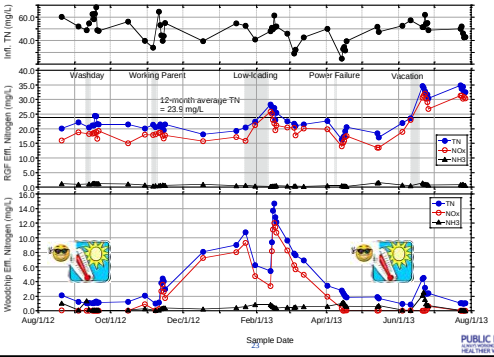
Recirculating Gravel Filter (RGF) & Woodchip Bed - Two Stage System



RGF & Woodchip Bed

RGF & Woodchip Bed

Nitrogen Removal in RGF and Woodchip Bed Over 12-Month Test Period



Average Performance for RGF-Woodchip Bed Over 12-Month Test Period

(91.8% TN Removal and 960 CFU/100 mL effluent fecal coliform)

Parameter	units	Influent	RGF Effluent Average	Woodchip Effluent
Total N	mg/L	48.6 (9.5)	23.9 (5.4)	4.0 (3.8)
NH_3-N	mg/L	29.3 (5.3)	0.7 (0.4)	0.5 (0.5)
NOx-N	mg/L	-	21 (5.5)	2.4 (3.7)
Org-N	mg/L	-	2.2 (1.2)	1.1 (0.3)
BOD/CBOD*	mg/L	314 (97.8)	4.7 (2.6)	10.8 (14.1)
TSS	mg/L	354 (137)	10.1 (12.7)	2.1 (2.0)
VSS	mg/L	324 (131)	5.8 (5.5)	0.9 (2.3)
COD/SCOD*	mg/L	715 (223)	21.6 (5.5)	37.6 (20.7)
Total Phosphorus	mg/L	5.8 (1.3)	-	3.4 (1.9)
Fecal Coliform**	CFU/100 mL	8.4E+6	1.6E+05	0.96E+03
Alkalinity as $CaCO_3$	mg/L	231 (36)	84 (28)	154 (36.6)
pH		7.4 (0.3)	6.8 (0.3)	6.6 (0.2)

*Effluents, **Geometric mean, ( ) is standard deviation

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Comparison of the 3 Nitrogen Removal Systems

Parameter	Unit	Vegetated RGF	Enhanced RGF	RGF/ Woodchip Bed
Total Area	ft^2	256	180	221
Treatment Media Depth	ft	3.5	3.5	2.0-RGF 2.8-Woodchip Bed
Average Effluent TN	mg/L	15.1	8.6	4.0
Average TN removal	%	68.8	82.3	91.8

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Project Outcomes

1. Post ETV Reports summarizing the results from the 3 systems
2. Provide technical support for Hood Canal On-site Sewage System Nitrogen Reduction (HCOSSNR) demonstration project
3. Complete RS&Gs for the RGF/Woodchip Bed and the VRGF systems

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Acknowledgements from Health

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To learn more about the project go to
www.doh.wa.gov

search for Denitrification

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