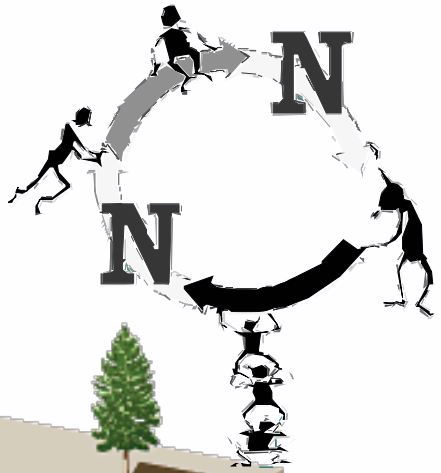
PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND HEALTHIER WASHINGTON

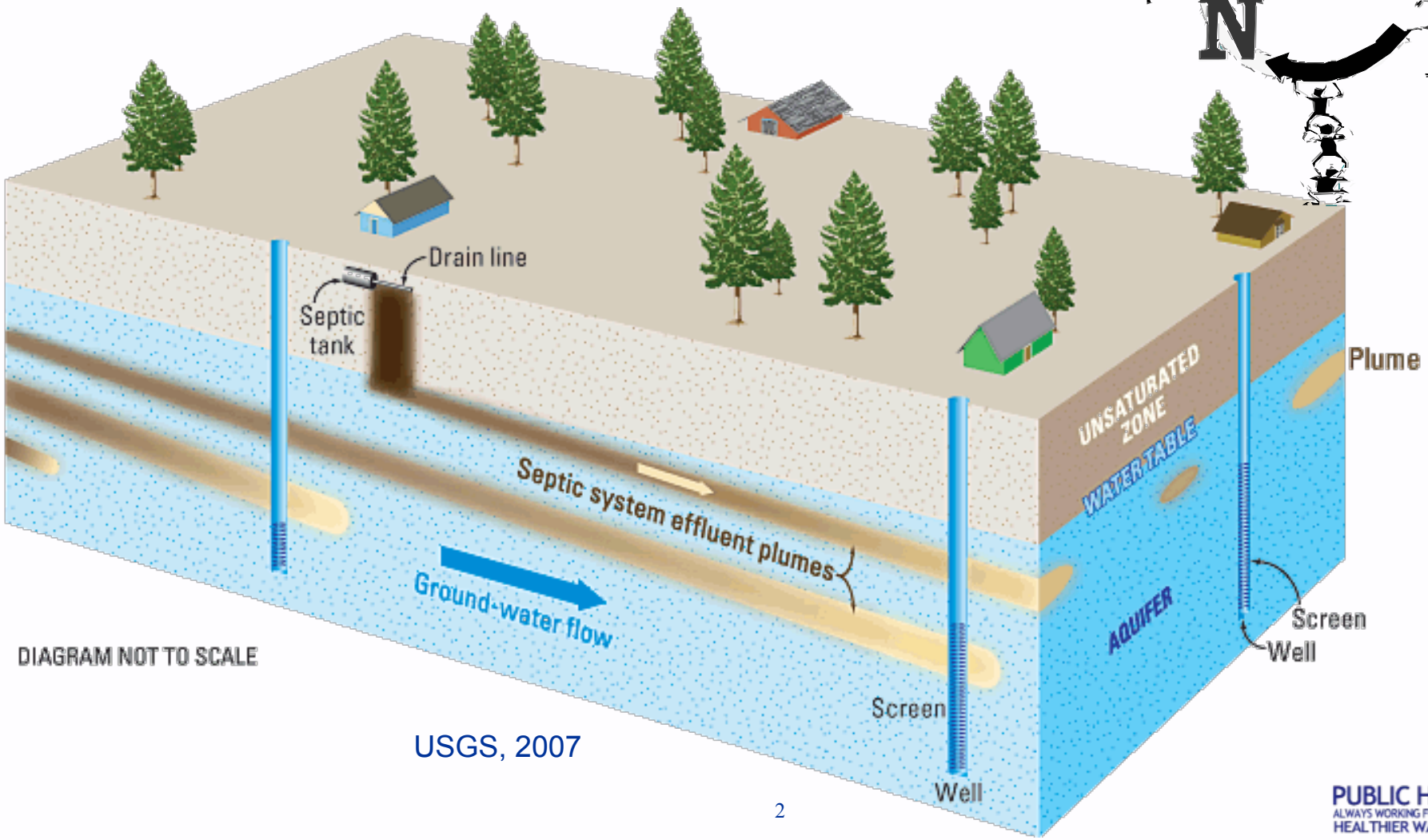
On-Site Sewage System Nitrogen Reduction Methods

Washington State Department of Health
March 6, 2013

John M. Eliasson, Wastewater Management Specialist
Office of Shellfish and Water Protection

Nitrogen Cycle
The Big Picture





USGS, 2007

Washington State Department of Health

Presentation Overview

- Nitrogen in wastewater
- On-site sewage nitrogen reduction methods
- Nitrogen reduction research project
- Questions and answers

Why is Nitrogen a Concern?

Human Health

- Drinking water limit of 10 mg/L NO_3
- Harmful algal blooms (HABs) – nitrogen and phosphorus

Washington State Department of Health

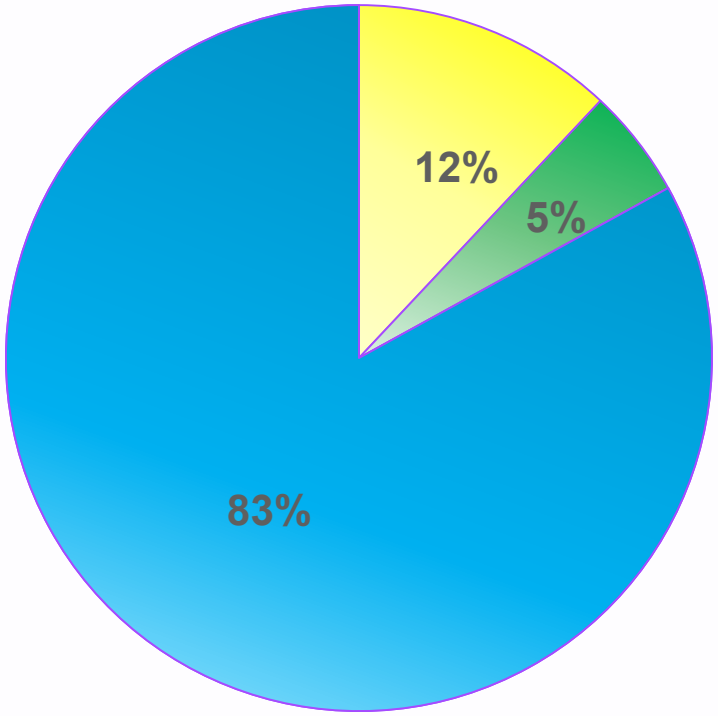
Why is Nitrogen a Concern?

Ecosystem Health

- N is the limiting nutrient for eutrophication of many coastal waters and some freshwater systems
- Increased nutrient loading can be linked to:
  - Algal blooms
  - Loss of eelgrass and other seagrass habitat
  - Low dissolved oxygen (hypoxia)

Nitrogen in Wastewater

Sources of Nitrogen in the Home



- Kitchen sinks, dishwasher, garbage disposal (1.7 grams/person/day)
- Bath & utility sinks, laundry, showers, bathtubs (0.8 grams/person/day)
- Toilet (12 grams/person/day)

Nitrogen in Garbage Disposal Waste

Parameter	Increase in Pollutant Loading (%)
Suspended solids	40-90
Biochemical oxygen demand	20-65
Total Nitrogen	3-10
Total phosphorus	2-3
Fats, oils, and grease	70-150

EPA, 2002

Nitrogen in Toilet Wastes

Urine

80%- 90% Nitrogen

~10.9 grams per day

~ 9 lbs/year

Feces

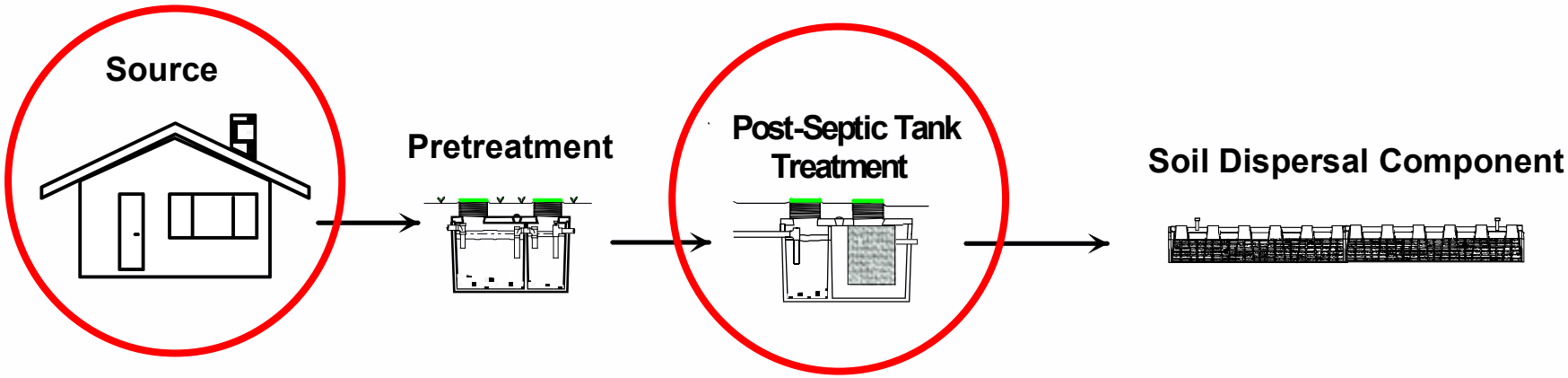
10%-20% Nitrogen

~1.1 grams per day

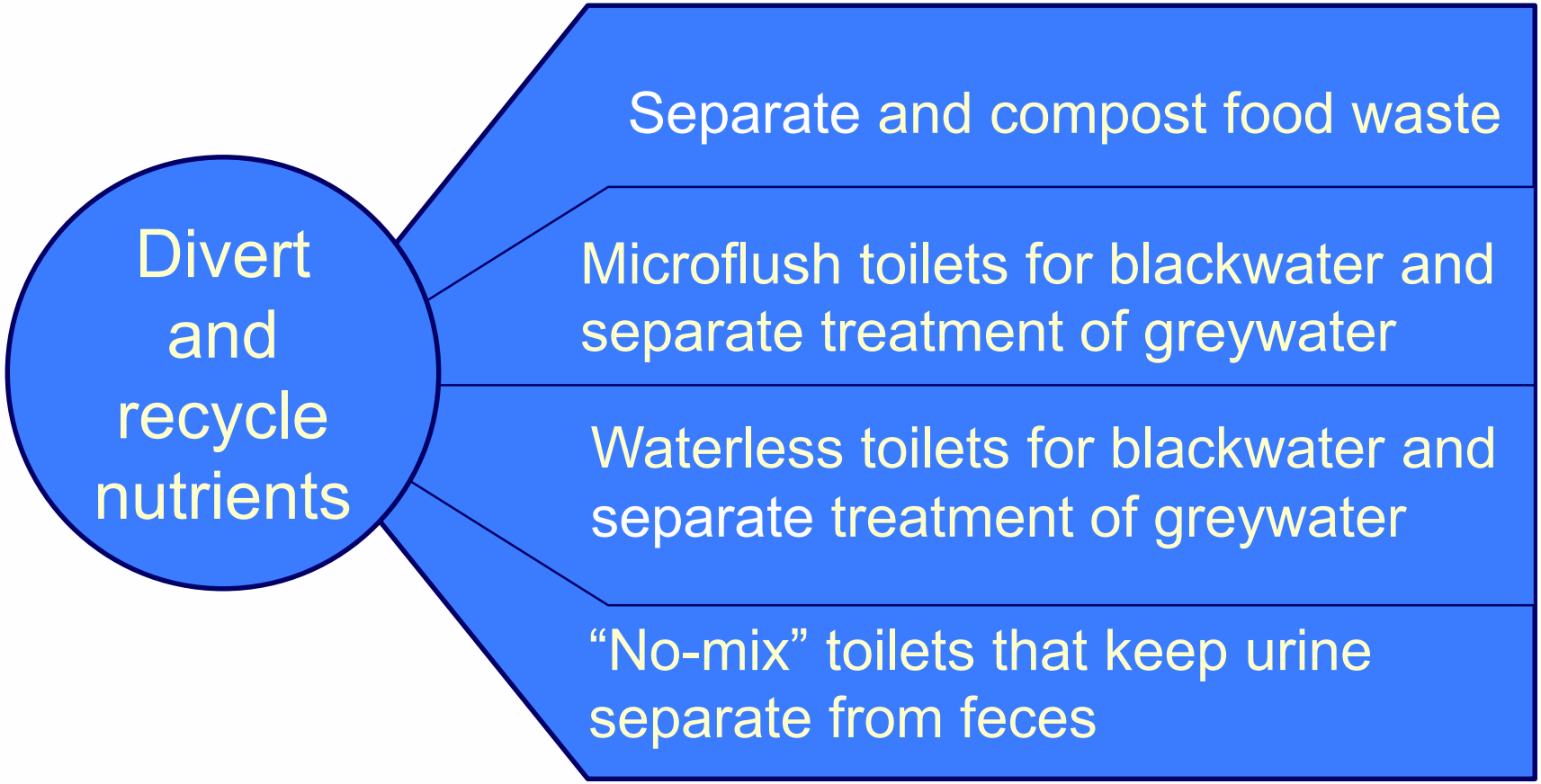
~1lb/year

Wastewater Nitrogen Management Approaches

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



Source Diversion



Source Diversion: Food Waste Separation

Screen kitchen sink drain

Compost food waste

Don’t use garbage grinders

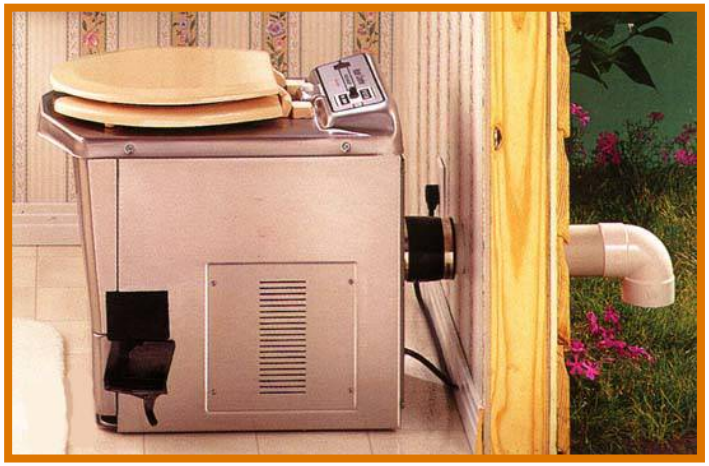
Source Diversion: Microflush Toilets

- Use small amount of water; air transports the feces, urine, and toilet paper
- Usually connected to holding tank
- Household applications more common in Scandinavia
- Maintenance required
- Can divert up to 80% of nitrogen

Source Diversion: Waterless Toilets

Courtesy of Clivus Multrum, Inc.

Courtesy of Sun-Mar Corp.



Courtesy of Research Products/Blankenship

- Waste composted or burned in the toilet system or collected and retained for treatment elsewhere
- Many designs and models available
- Maintenance required
- Can divert up to 80% of nitrogen

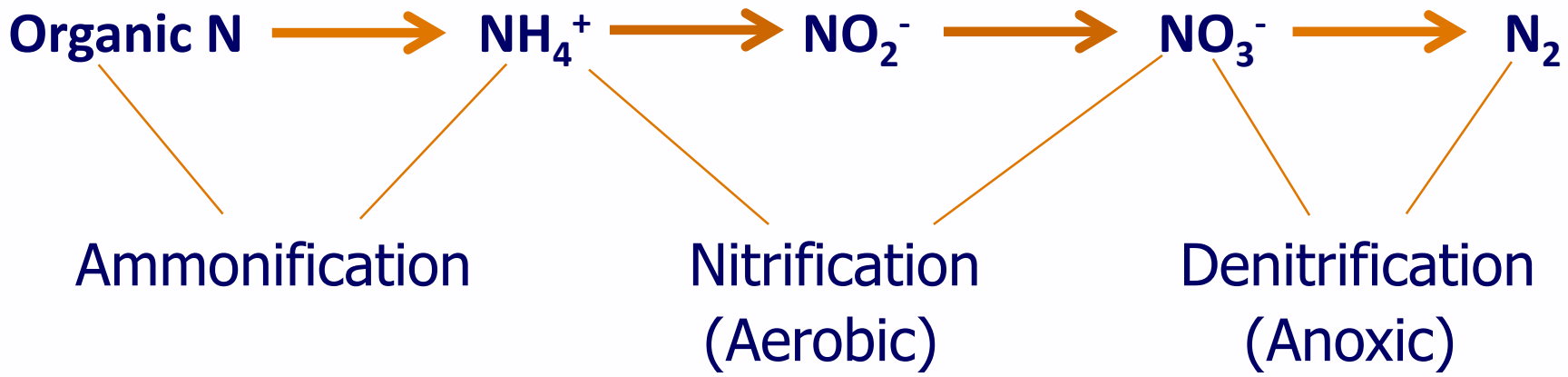
Source Diversion: “No-mix” Toilets

- Separate bowls for urine and feces; urine diverted to separate holding tank
- Urine can be recycled to agriculture
- Proven track record in Europe
- Maintenance required
- Can remove up to 80% of nitrogen

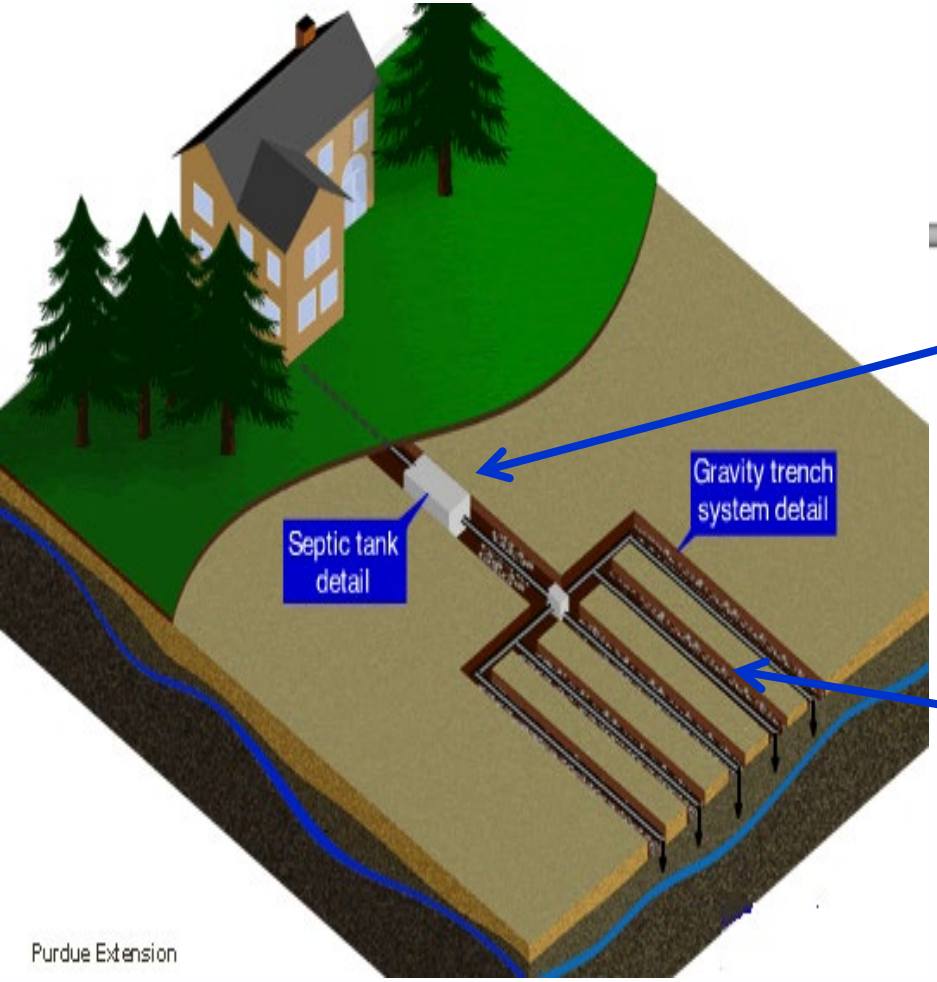
On-site Wastewater Treatment: Nitrogen Removal

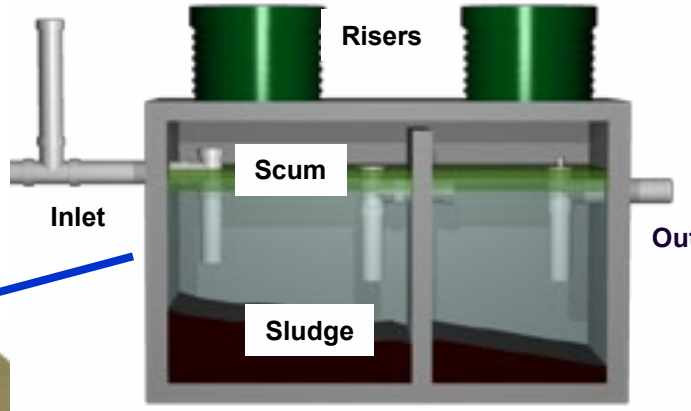
Two step process:

1) "nitrify" nitrogen compounds to NO_3 (nitrification)
2) "denitrify" NO_3 to nitrogen gas (denitrification)

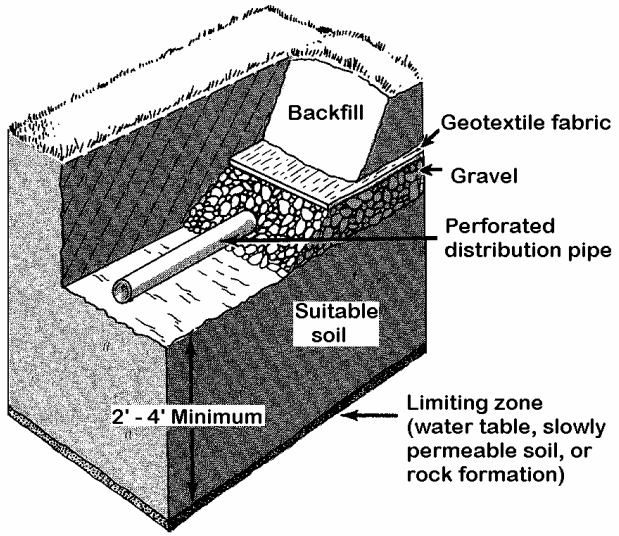


Conventional On-Site Sewage Systems (OSS)





(27-119 mg/L)
Avg. 64 mg/L
TN

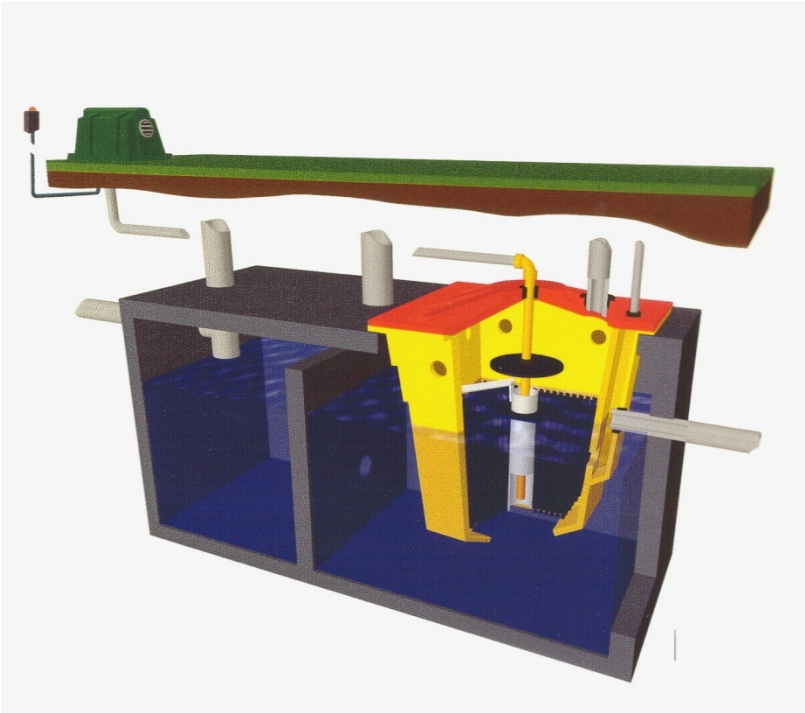


SeptiTech
Wastewater Treatment System

- Recirculating biological polystyrene trickling filter
- EPA ETV: avg. 64% TN removal
- Effluent TN: avg.14 mg/L
- Costs: $9,000

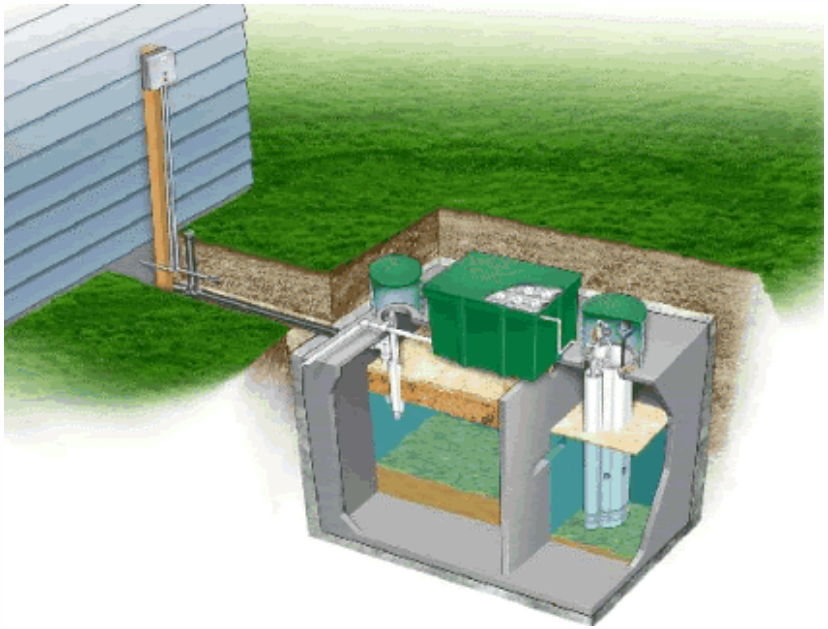
MicroFAST Wastewater Treatment System

- Fixed-film activated sludge system
- EPA ETV: avg. 51% TN removal
- Effluent TN: avg. 19 mg/L
- Manufacturer promotes at 70% TN removal
- Costs: $6,000



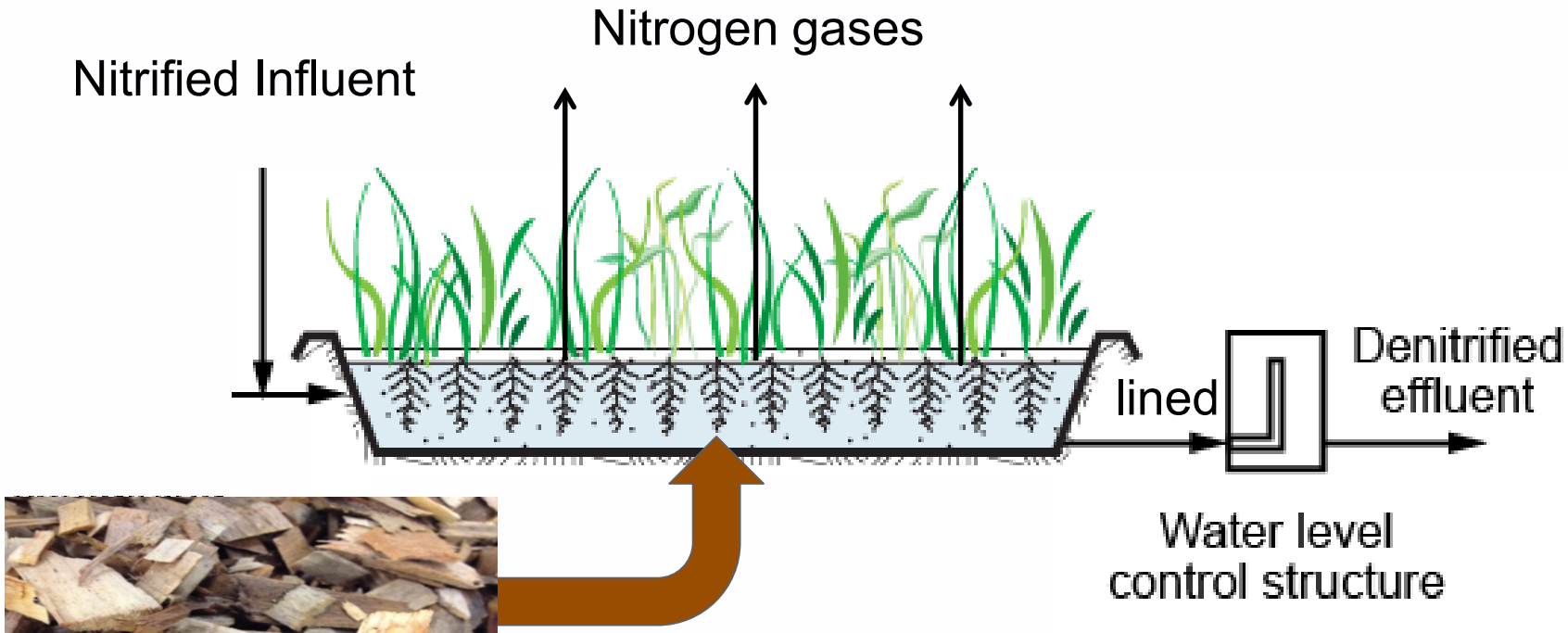
AdvanTex Wastewater Treatment System

- Recirculating attached growth textile filter
- 70% TN removal
- Effluent TN: avg. 13-20 mg/L in field
- Costs: $6,500



Biological Nitrogen Removal:

Simplest form – Denitrification bed



Washington State Department of Health

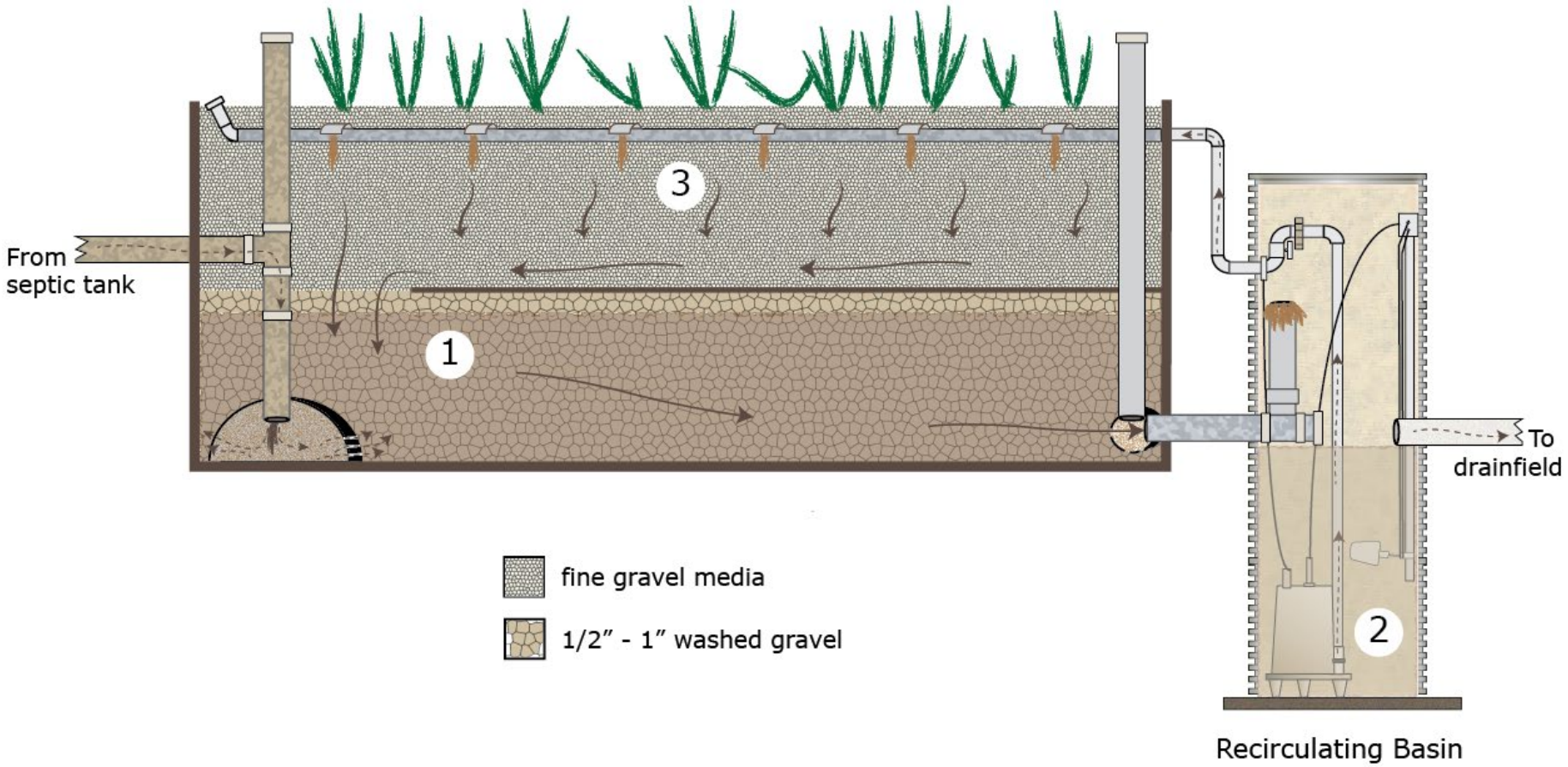
Denitrification Project Design

- Problem:
  - N removals OSS are highly variable
  - Limited treatment options
  - Regional environmental and water source affects on N removal not well-known
- Objectives:
  - Maximize N removal efficiencies
  - Verify performance objective (>75% TN removal)
  - Expand reliable, affordable options
- Methods: Partner with UW & Ecology to:
  - Use ETV Nutrient Reduction Protocol
  - Develop standards & guidance

Washington State Department of Health

Snoqualmie WWTP Test Site

Vegetated Recirculating Gravel Filter

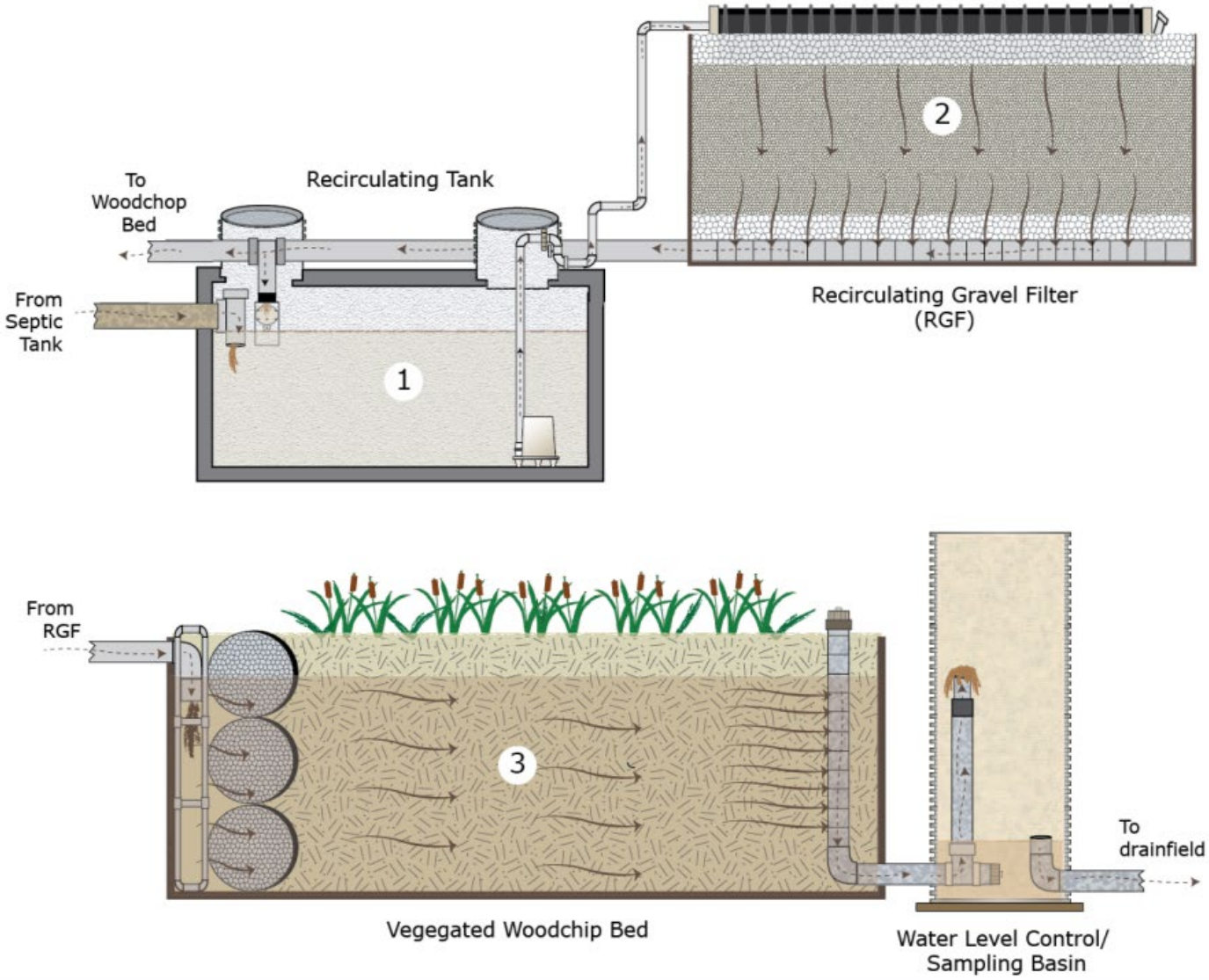


Washington State Department of Health

Vegetated Recirculating Gravel Filter

Washington State Department of Health

Recirculating Gravel Filter & Woodchip Bed

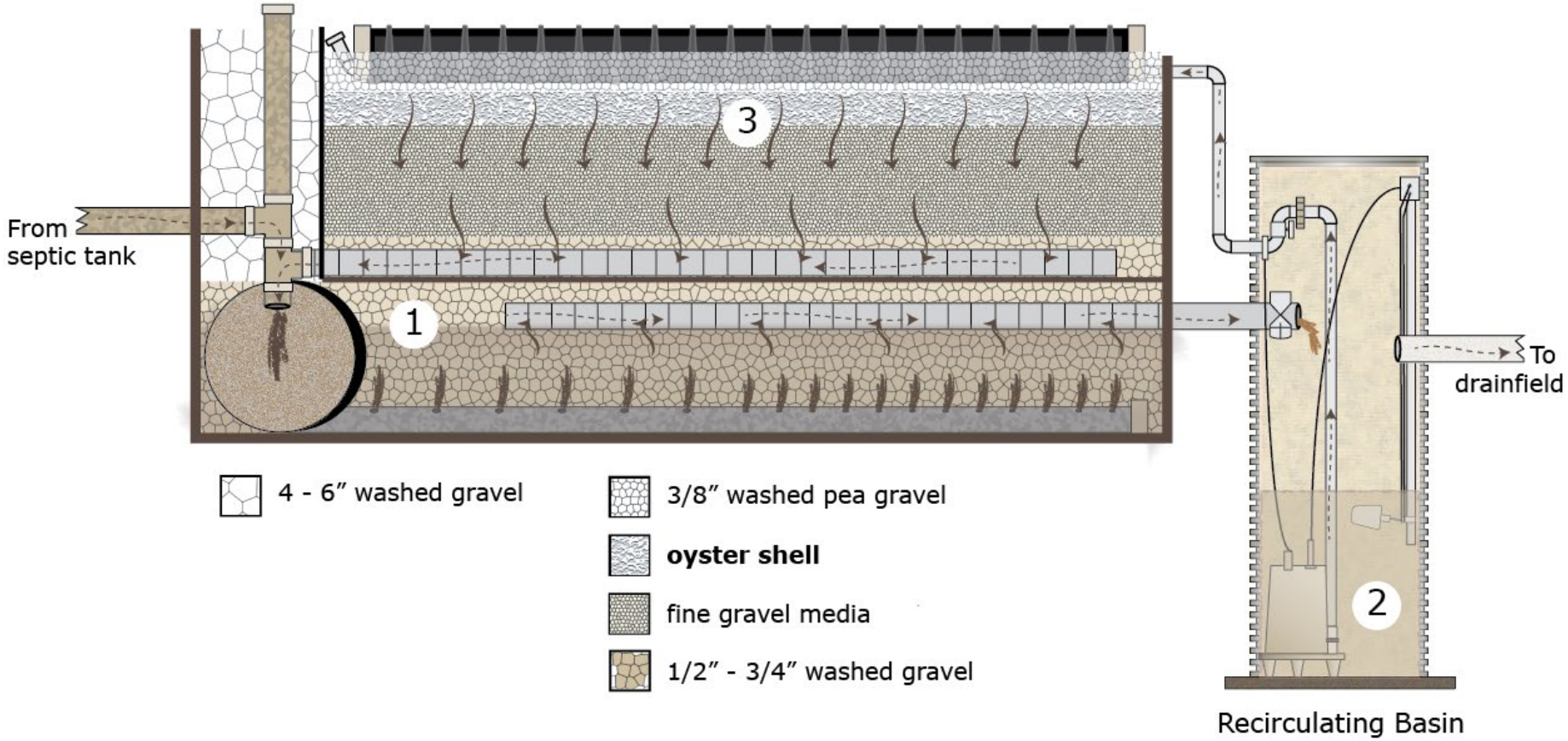


PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND HEALTHIER WASHINGTON

Washington State Department of Health

Recirculating Gravel Filter & Woodchip Bed

Enhanced Recirculating Gravel Filter



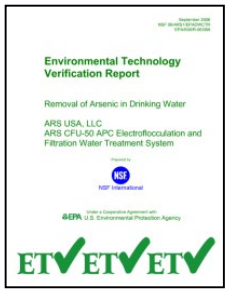
Washington State Department of Health

Enhanced Recirculating Gravel Filter

PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND HEALTHIER WASHINGTON

Successful Results Would Provide:

- OSS designs that achieve nitrogen removal similar to sewage treatment plants
- Cost effective systems that are reliable and user-friendly
- Nitrogen reduction in areas where nitrogen has been identified as a contaminant of concern and public sewers are not feasible



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

search for Denitrification

PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND HEALTHIER WASHINGTON

PUBLIC HEALTH

ALWAYS WORKING FOR A SAFER AND HEALTHIER WASHINGTON