Impact of large-scale soil-based wastewater treatment systems on surface water quality in Vermont

Bruce Douglas, P.E.

Vermont Department of Environmental Conservation

Drinking Water and Groundwater Protection Division

2024 Onsite Mega-Conference, October 2024, Spokane, Washington

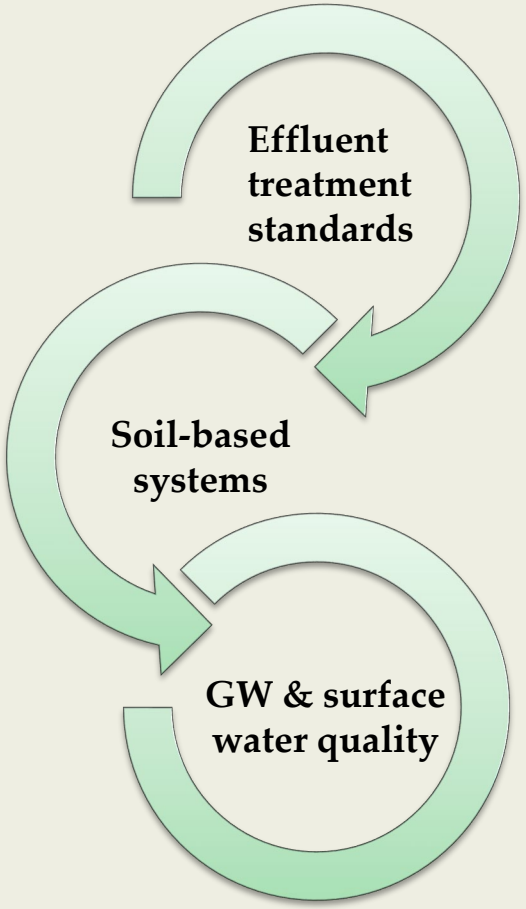
VERMONT

Objective

Hypothesis:

Will an evaluation of long-term performance data of representative community wastewater systems provide a rationale to revise regulations of indirect discharges to surface water?

Relevance of the design criteria and methods of demonstration of compliance with the effluent standards



Present the results of a data-driven evaluation of the impact of medium to large scale soil-based wastewater treatment systems on the quality of surface water in Vermont.

VERMONT

Vermont Environmental Protection Rules - Chapter 1
(Soil-based systems)

Subdivision, Public Building, Campground and Health Dept Rules

Design flow < 40,000 gpd

Prior to 1986

Discharge Permits for On-Site Systems

Design flow ≥ 40,000 gpd

VERMONT

Vermont Wastewater Regulations
(Soil-based systems)

Wastewater System & Potable Water Supply Rules
EPR Chapter 1

Design flow < 6500 gpd

Since 1986
"No Significant Impact on Aquatic Biota"

Indirect Discharge Rules
EPR Chapter 14

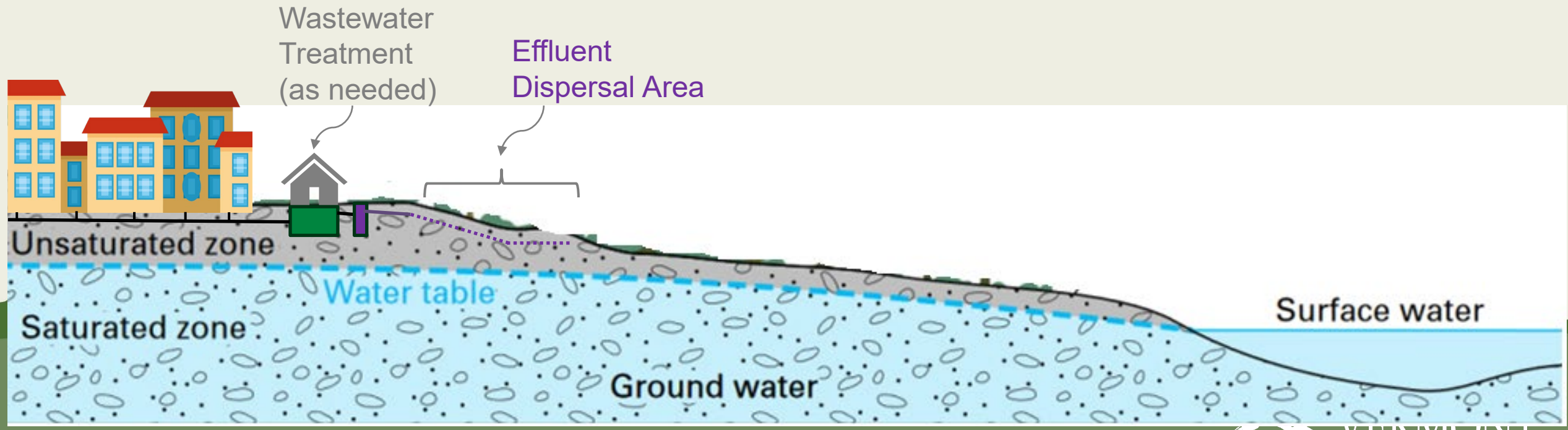
Design flow ≥ 6500 gpd

VERMONT

What's Indirect Discharge?

Indirect Discharge: any discharge to groundwater, whether subsurface or land-based.

Indirect Discharge systems refer to soil-based domestic sewage treatment and disposal systems with design flow/capacity equal or larger than 6,500 gpd.



Indirect Discharge systems in Vermont

Ski areas

Developments

Mobile Home parks

Public schools

182 systems
Design flow/capacity ≈ 4.8 M gpd

Municipalities

Campgrounds

VERMONT

Indirect Discharge Rules Water & WW Quality requirements

Depending on the design flow, disposal method and system specificities, the IDRs may require:

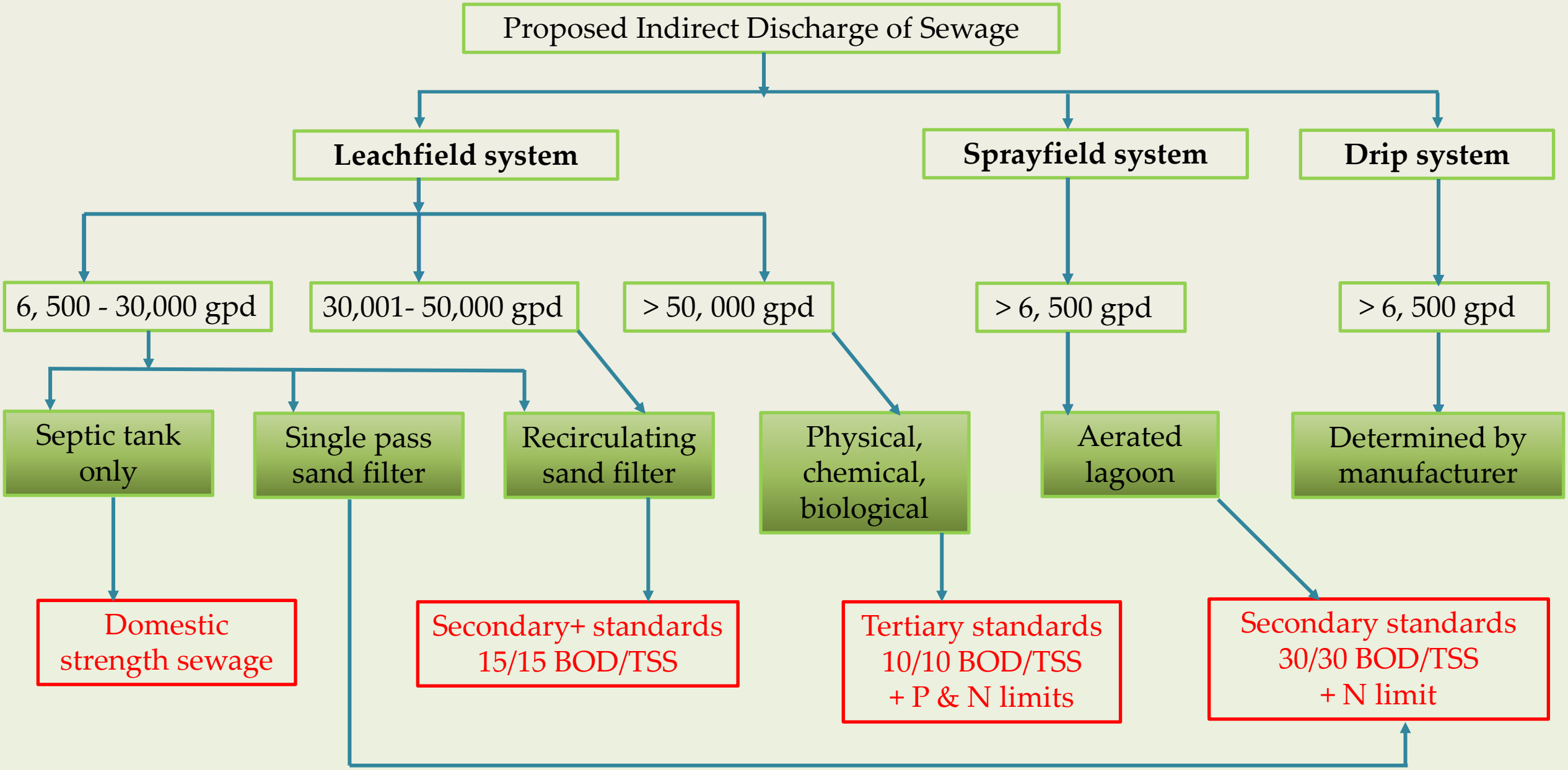
- Minimum sewage treatment requirements
- Sampling and analysis: Effluent, groundwater and surface water (receiving stream)
- Aquatic biota monitoring in the receiving stream (Periphyton, macroinvertebrates (EPT) and fish)

Examples of Macroinvertebrate larva observed in a stream in Vermont

Photo by: Bruce Douglas

VERMONT

Generalized Flowchart of IDR Effluent Treatment Levels for Proposed Discharges



Demonstration of Compliance with the Aquatic Permitting Criteria for Surface water (Receiving stream)

Compliance with Aquatic Permitting Criteria (APC)

- The Aquatic Permitting Criteria are numerical permitting limits, which are allowable in-stream concentrations:

  - For nutrient parameters: Total Dissolved Phosphorus (TDP) and Nitrates (NO_3-N)

  - pH

  - Must also demonstrate that Total Phosphorus (TP) will not exceed the Vermont Water Quality Standards

Aquatic Permitting Criteria for Surface water (Receiving stream)

Parameter	Standard
Total Dissolved Phosphorus (TDP)	In-stream increase of < 0.001 mg/L above existing background at point of compliance and at the Low Median Monthly Flow
Nitrates (NO_3-N**)**	2 mg/L maximum, including background in-stream concentration at point of compliance and at the Low Median Monthly Flow
pH	Downstream mean value inside background range
Note: for indirect discharges to lakes or ponds, these limits must be met in groundwater downgradient of the system.	

VERMONT

Methodology

1. System selection: Seven Vermont on-site subsurface wastewater treatment systems were selected because sufficient data existed for each system, and the sites reflected a range of design flows, treatment levels and geographical locations.

2. Data collection: Effluent quality and receiving surface water quality data were collected from periodic inspection and monitoring reports of the selected Indirect Discharge systems.

Selected systems

System	Type	Design flow (gpd)	Treatment	Years of data
A	Residential	12,960	Secondary plus	9
B	Resort	92,000	Tertiary	19
C	Ski area	72,000	Primary	32
D	Ski area	79,210	Tertiary	14
E	Homes + Businesses	30,000	Primary	15-17
F	Ski area	92,000 -230,000	Tertiary	17-33
G	Resort	6,600	Secondary plus	15

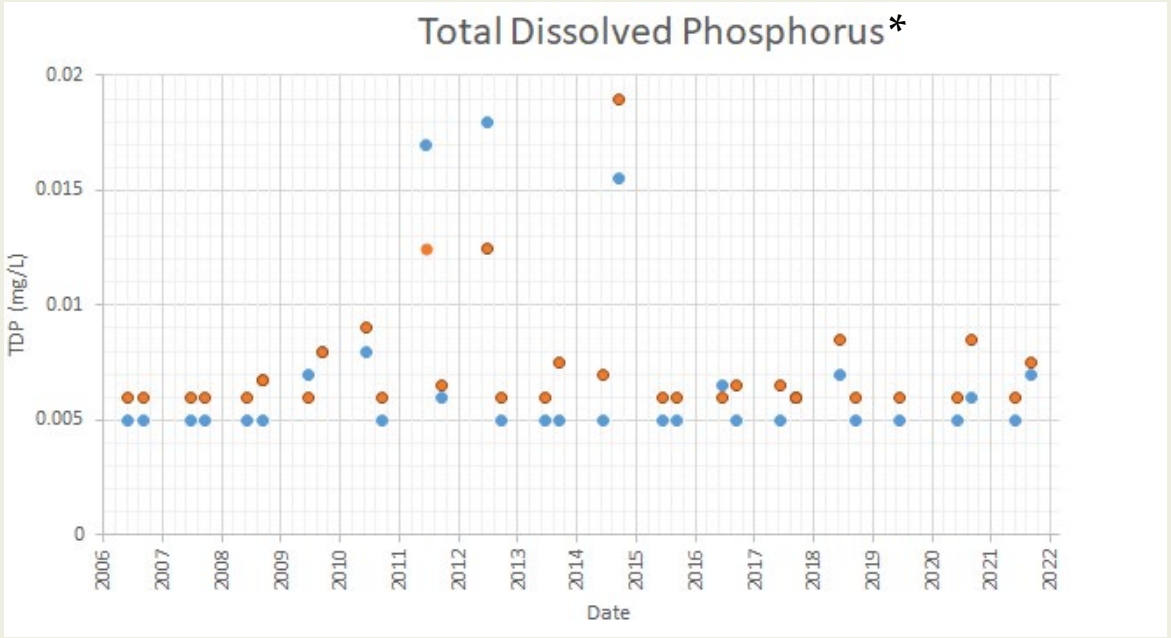
VERMONT

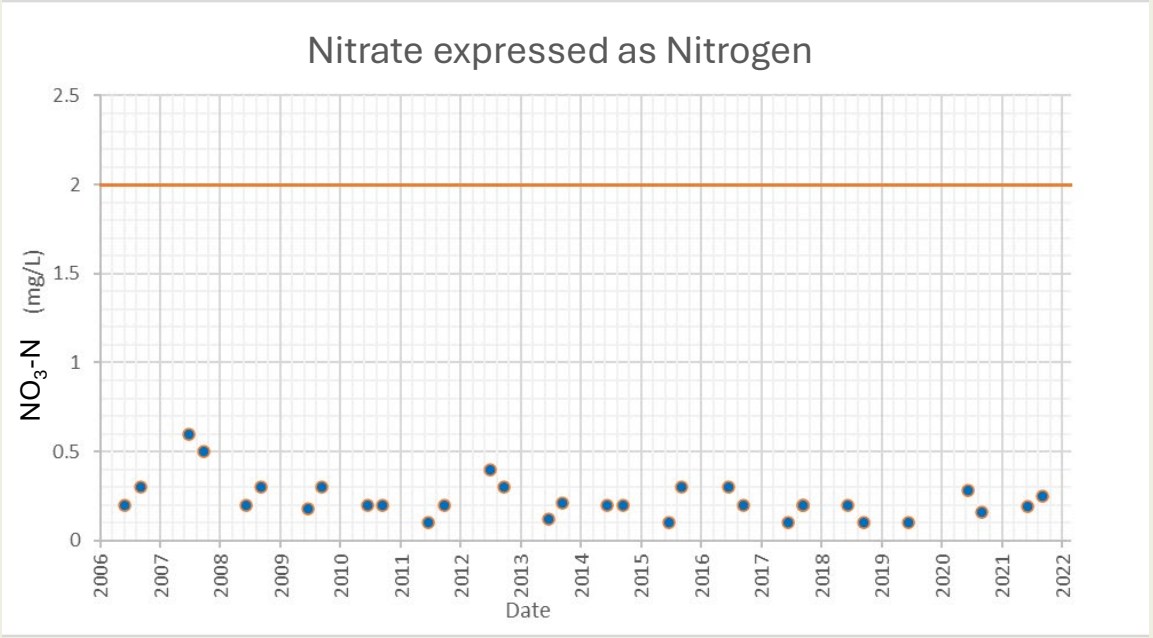
Water Quality standards analysis

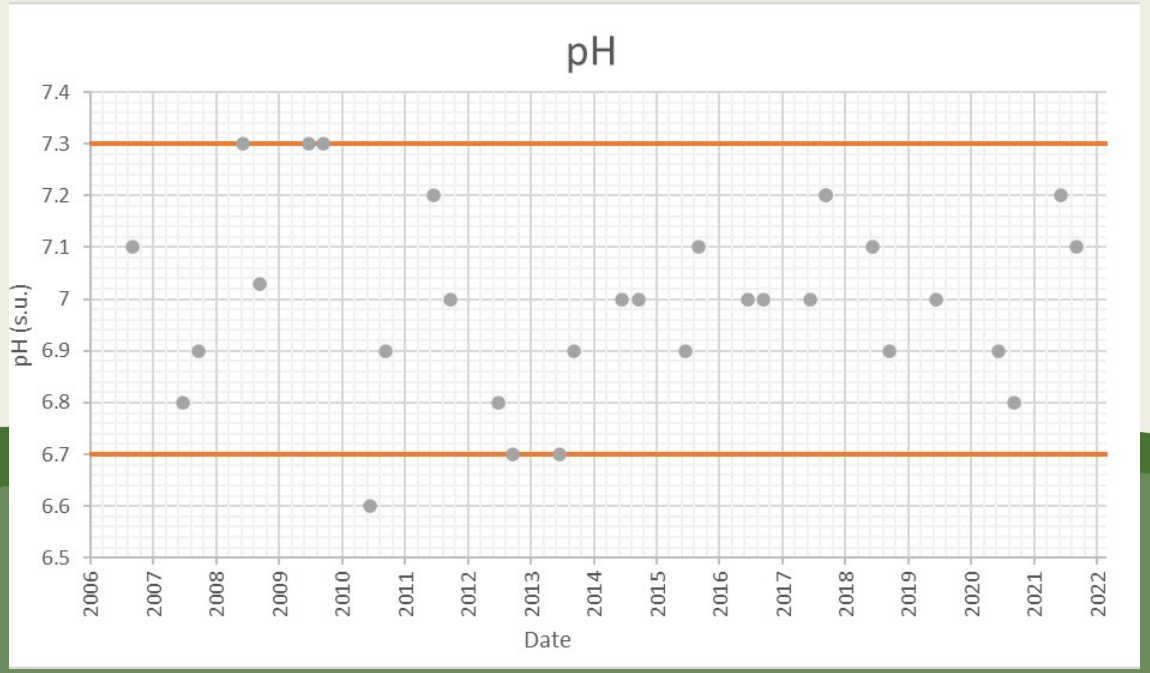
System	Type	Design flow (gpd)	Treatment	Years of data	APC standards met?
A	Residential	12,960	Secondary +	9	Yes
B	Resort	92,000	Tertiary	19	N/A*
C	Ski area	72,000	Primary	32	Yes
D	Ski area	79,210	Tertiary	14	Yes
E	Homes + Businesses	30,000	Primary	15-17	Yes
F	Ski area	92,000 - 230,000	Tertiary	17-33	Yes
G	Resort	6,600	Secondary +	15	Yes

* Permitted as an Existing System

VERMONT







Aquatic Permitting criteria monitoring results for System E

(30,000 gpd; 17 years of data)

*Blue dots represent upstream TDP & red dots represent downstream TDP

VERMONT

Conclusion

- All the six systems required to meet the Aquatic Permitting Criteria (APC) do so, providing evidence of successful treatment of the effluent through the subsurface soil, and protection of surface water quality.

Further Research needed:

- to better understand the Groundwater-Surface water interactions
- to assess the potential impact of the nutrients in wastewater on the aquatic biota
- to develop efficient analyses of large performance data sets to inform decisions on regulatory changes

Acknowledgements

- Mary O'Leary, *Professor at Vermont State University – Randolph*
- Bryan Harrington, *Former Indirect Discharge Program Supervisor*
- Edward Greiner, *Former Environmental Analyst at the Indirect Discharge Program*
- Nathan Kie, *Indirect Discharge Program Supervisor*
- Achouak Arfaoui, *Environmental Analyst at the Indirect Discharge Program*

VERMONT

Thank you for your attention