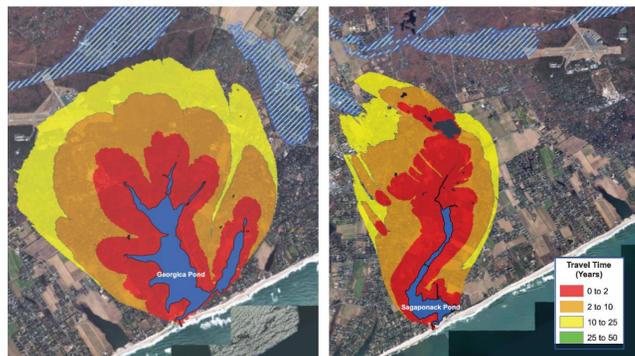


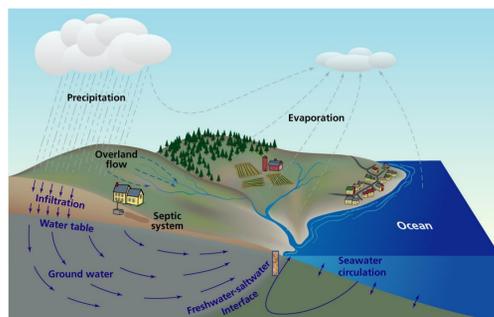
Identifying and Reducing Groundwater Nitrogen Input into Georgica and Sagaponack Ponds

by the Peconic Land Trust in collaboration with Cornell Cooperative Extension of Suffolk County

Background on Groundwater Seepage and Potential Nitrogen Mitigation Technology called a Permeable Reactive Barrier



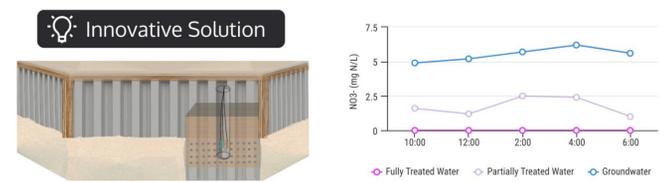
- Groundwater contributing areas from Suffolk County Subwatershed Plan (SCSWP) show the travel time of groundwater contributing to the ponds ranges from 0 to 25 years.
- This means nitrogen that was added to the groundwater 20 - 25 years ago, or "legacy nitrogen" has not entered the pond yet.
- Groundwater travel is relatively slow, thus legacy nitrogen will continue enter surface water for decades.



- Groundwater enters surface water like Georgica and Sagg Pond through submarine groundwater discharge (SGD), thus inland land use and chemical makeup of groundwater within the watershed is critically important for local surface water quality.
- Long Island sandy soils are susceptible to leaching nutrients like nitrogen and other pollutants, making the underlying groundwater vulnerable to contamination.
- Groundwater is contaminated with nitrogen from several sources including septic, fertilizers, and the atmosphere

Permeable Reactive Barrier Technology

- Passive groundwater treatment
- No above-ground structures
- Microbes exist naturally in the soil
- Woodchips promote conditions which allow microbial transformation of contaminant into a harmless end product



- A promising solution for treating groundwater N is PRBs installed at the shoreline to intercept and remediate contaminated groundwater before it enters surface water.
- PRBs can treat nitrate from all N sources.
- The reactive media in the barrier is typically woodchips mixed with either gravel or sand. This coarse media is more permeable than surrounding soil to promote water flow through the treatment zone.

- PRBs have previously been used in the US and globally to treat agricultural tile drainage and septic plumes.
- The first full-scale Long Island PRB was installed behind a bulkhead in Hampton Bays in 2020.
- Results from the October 2020 sampling revealed that groundwater entering the barrier had concentrations ranging from 1 to 7 mg N/L and the treated water had less than 0.1 mg N/L in almost all samples, suggesting the barrier is performing well.

Methods used in Georgica and Sagaponack Pond Survey

- Using the Trident instrument, porewater, or the water within the sediment, and surface water parameters are measured.
- Specifically, the Trident measures temperature and conductivity contrast between porewater 1 ft below the sediment-water interface and surface water 1 ft above the sediment-water interface.
- During summer months, high contrast areas with relatively low temperature and conductivity values in the porewater are conditions indicative of SGD.



- When the temperature and conductivity signal indicate presence of fresh groundwater, samples are collected for laboratory nutrient analysis. Porewater nutrient concentrations discharging from the sediment directly impact surface water nutrient concentration in areas with SGD.



- In addition to temperature and conductivity measured by the Trident, oxidation reduction potential, total dissolved solids, dissolved oxygen and pH are measured at every station with a Myron Ultrameter and DO meter.
- Additionally, at each sampling station a description of the sediment bottom type, surface water column height, shoreline characteristics, and GPS location are recorded.
- This ancillary information is relevant for remediation such as living shoreline and bioextraction.

- Georgica and Sagg Pond's bottom type varies from sandy with gravel to fine clay.
- Areas with sand and gravel oftentimes have higher groundwater seepage rates.

- The survey includes identifying unique shoreline features such as the one pictured, where it appears that iron-rich sediment is naturally leaching iron (orange) at the surface
- Areas which are identified as nitrogen-impacted are further characterized using a patented UltraSeep meter (Paulsen et al. 2001, Paulsen et al. 2004).
- SGD rate is measured with the UltraSeep meter at selected locations for a 1-2 hours or 1-2 days to quantify groundwater discharge flow depending on whether there is tidal influence at the site.

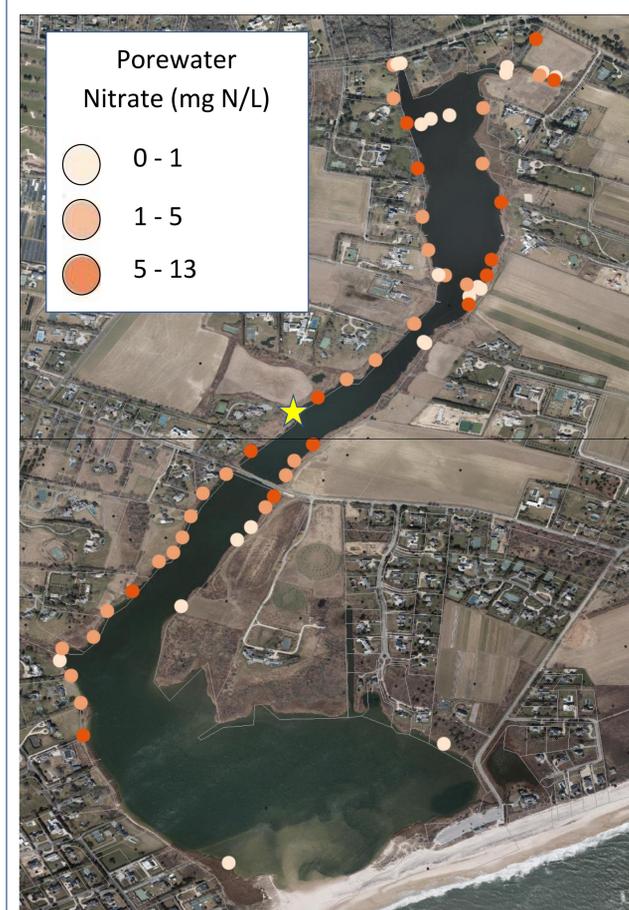


- Upgradient of areas which are a high priority for future remediation, inland groundwater wells are installed using a Geoprobe.
- Groundwater wells facilitate collection of hydrogeological information such as groundwater velocity and direction to be determined, which are parameters needed for PRB design.

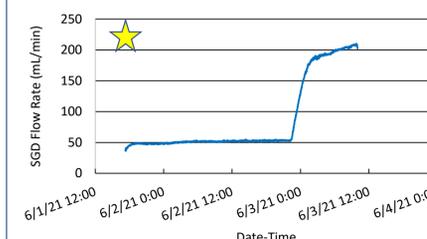
Porewater Nitrate Results from Survey at Georgica Pond (Feb. - March 2021) and Sagaponack Pond (April 2021 - present)



- The survey revealed porewater nitrate concentrations ranged from < 0.4 to 5.96 mg N/L
- Surface water nitrate concentrations ranged from 0.73 - 1.4 mg N/L taken from multiple locations within the upper western tributary.
- The SCSWP used 0.32 mg N/L as a reference threshold for surface water of undrained fresh waterbodies, including Georgica Pond, thus surface water concentrations within the tributary were above acceptable levels even in the winter season when fertilizer-derived nitrogen was likely at a minimum.



- Porewater nitrate along the Smith Corner Preserve ranged from 0.04 - 5.8 mg N/L.
- Porewater nitrate in other areas of the pond ranged from 1.4 - 12.3 mg N/L.
- 70% of the porewater samples collected at Sagg Pond thus far had greater than 2 mg N/L indicating substantial nitrogen input from groundwater.
- Surface water nitrate ranged from 0.8 - 5.2 mg N/L taken from multiple locations within the pond.
- Highest surface water nitrate concentrations were measured at the northern tributaries.
- All surface water samples contained higher nitrogen than is considered healthy.
- Despite relatively high water levels in the pond during the measurements, the groundwater seepage rates were consistently positive meaning there is groundwater seeping into the pond.
- Rates were generally higher on the western side of the pond due to a greater groundwater drive.



- SGD flow rate was being measured (located by the yellow star) during the recent June Sagg Pond ocean inlet opening.
- Flow rate spike was observed just before 12am on 6/3/21.
- Flow rate increased to 4 times the previous rate when the ocean inlet opened and the water level in the pond dropped.
- The pressure gradient between inland groundwater table and pond water level increased, which increased the water flow rate.