



SILENT SPRING INSTITUTE



RESEARCHING THE ENVIRONMENT AND WOMEN'S HEALTH

Emerging Contaminants in Cape Cod Bay Estuaries

Laurel Schaider, Ph.D.
Silent Spring Institute

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June 5, 2017

Collaborators



Center for Coastal Studies
Amy Costa



University of Rhode Island
Rainer Lohmann, Rachel Miller



U.S. Geological Survey
Pat Phillips, Dana Kolpin,
Edward Furlong, David Alvarez

Funded by



Contaminants of Emerging Concern

Contaminants

- Widely detected in water

Emerging

- Improved analytical capabilities
- Production of new chemicals

Concern

- Hormone disruption in aquatic life
- High exposures linked to human health effects, low dose effects unknown



What's in your wastewater?



Examples of emerging contaminants



hormones



pharmaceuticals



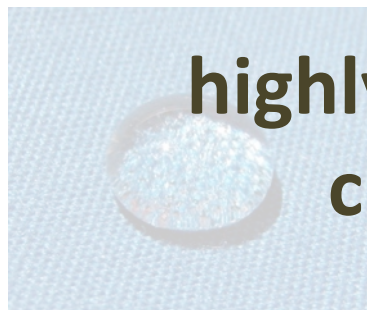
antimicrobials



preservatives



detergents



**highly fluorinated
chemicals**



fragrances



**flame
retardants**



**artificial
sweeteners**

How do CECs get into the waters of Cape Cod?



Cape Cod drinking water supplies are vulnerable

- 85% of homes have septic systems
- Sand and gravel sole source aquifer
- Rapid development
- All residents rely on groundwater, 20% have a private well

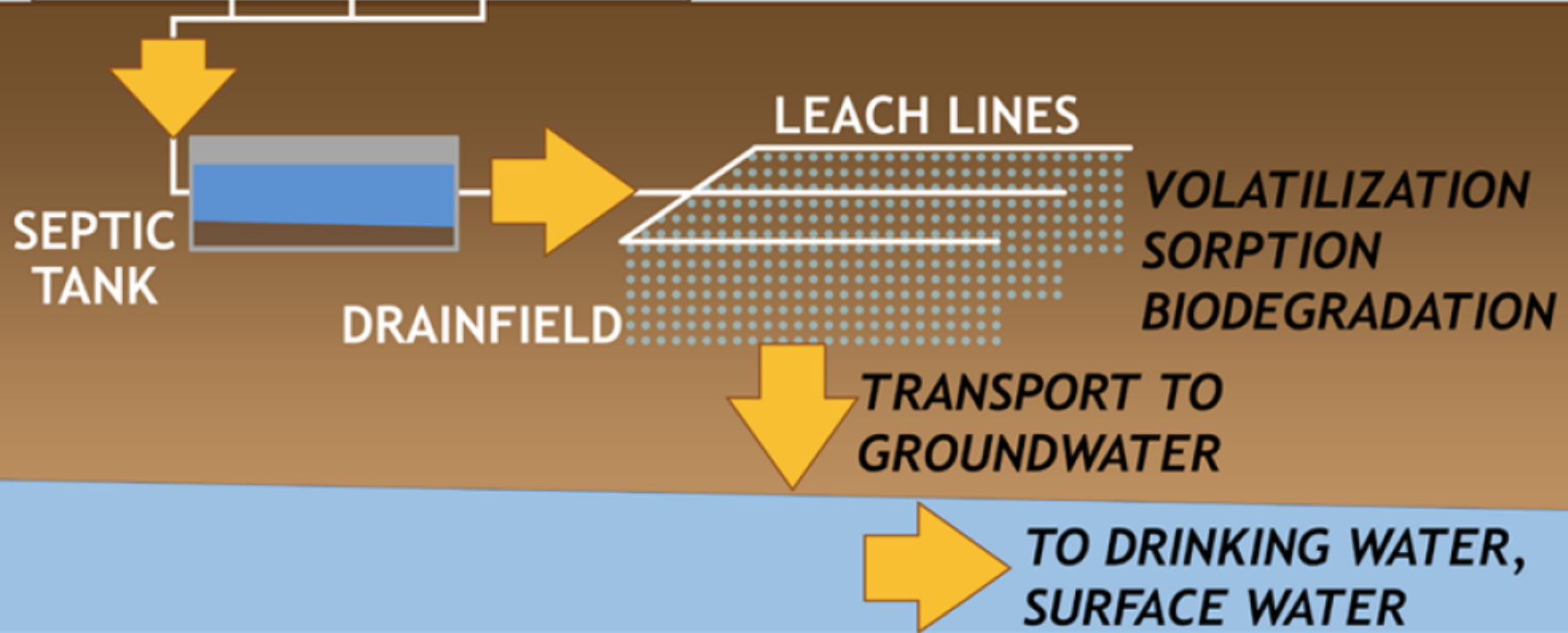
Silent Spring Institute water quality research



- Measure hormone disruptors and other CECs in drinking water,^{1,2} groundwater,³ and ponds⁴
- Evaluate septic systems as sources of CECs and characterize subsurface transport^{3,5,6}
- Identify factors associated with CECs (N, land use)
- Inform Cape wastewater management and drinking water protection decision-making

¹Schaider et al. 2014, ²Schaider et al. 2016, ³Swartz et al. 2006, ⁴Standley et al. 2008, ⁵Rudel et al. 1998, ⁶Schaider et al. *in press*

Some CECs are effectively removed by septic systems, while others are not well-removed



CEC concentrations

Non-prescription
pharmaceutically
active compounds

Alkylphenols

Personal
care
products

Flame retardants /
plasticizers

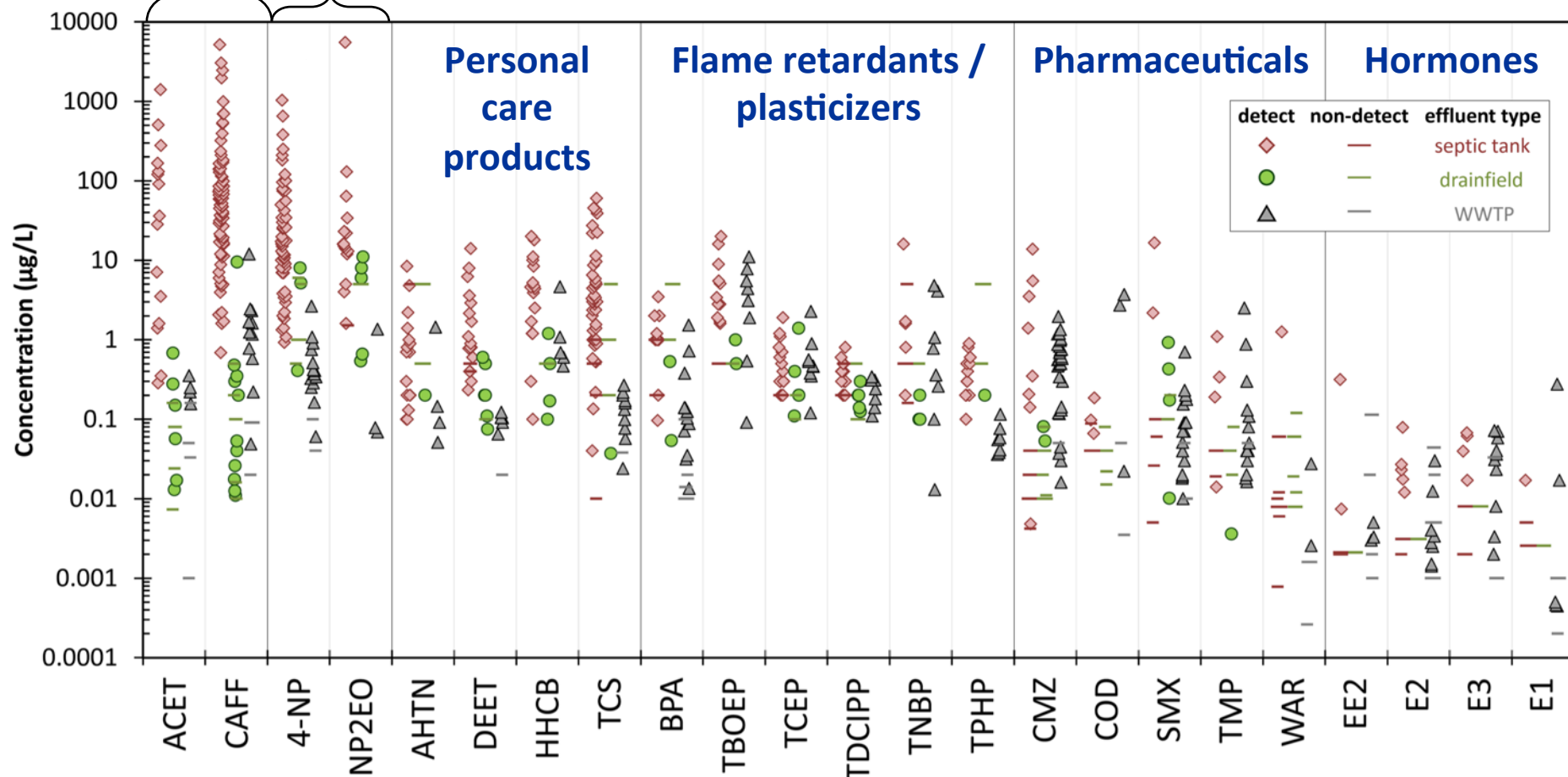
Pharmaceuticals

Hormones

◆ Septic tank effluent

● Drainfield leachate

▲ WWTP effluent



Why study CECs in estuaries?

- Ecological health effects
 - Endocrine disrupting compounds
- Food web accumulation and human exposure
 - Shellfish, fish
- Integrated measure of land use impacts
 - Understand associations between land use, nitrogen, and emerging contaminants



Center for Coastal Studies found pharmaceuticals and personal care products in Nantucket Sound



13 detected in water samples, 10 detected in oysters, including:

- Carbamazepine (anticonvulsant)
- Cotinine (nicotine metabolite)
- DEET (insect repellent)
- Estrone (estrogen hormone)
- Gemfibrozil (lipid regulation)
- Meprobamate (anti-anxiety)
- Sulfamethoxazole (antibiotic)
- Triclosan (antimicrobial)

Research questions

- What are the levels of CECs from septic systems and other sources in Cape Cod Bay estuaries?
- Are these levels associated with
 - Nitrogen concentrations?
 - Land use in watershed areas?
 - Salinity?

10 sampling locations

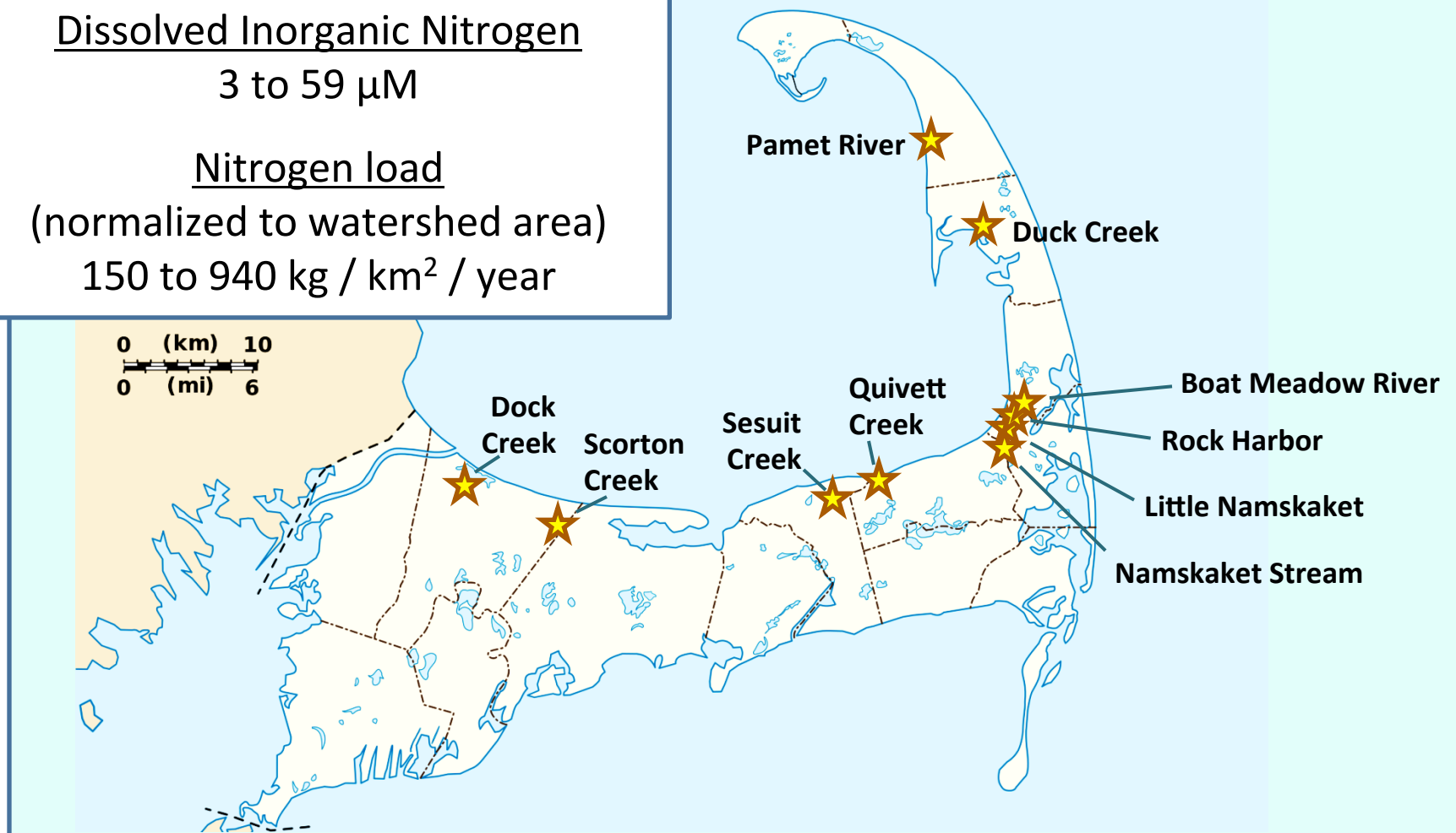
Dissolved Inorganic Nitrogen

3 to 59 μM

Nitrogen load

(normalized to watershed area)

150 to 940 $\text{kg} / \text{km}^2 / \text{year}$



Sample analysis and collection

- At each location:
 - Sediments
 - Water samples
 - Passive samplers (time-integrated)
- Sample analysis:
 - Wastewater compounds: USGS
 - PFASs: University of Rhode Island
 - Nutrients: Center for Coastal Studies



Sample analysis and collection

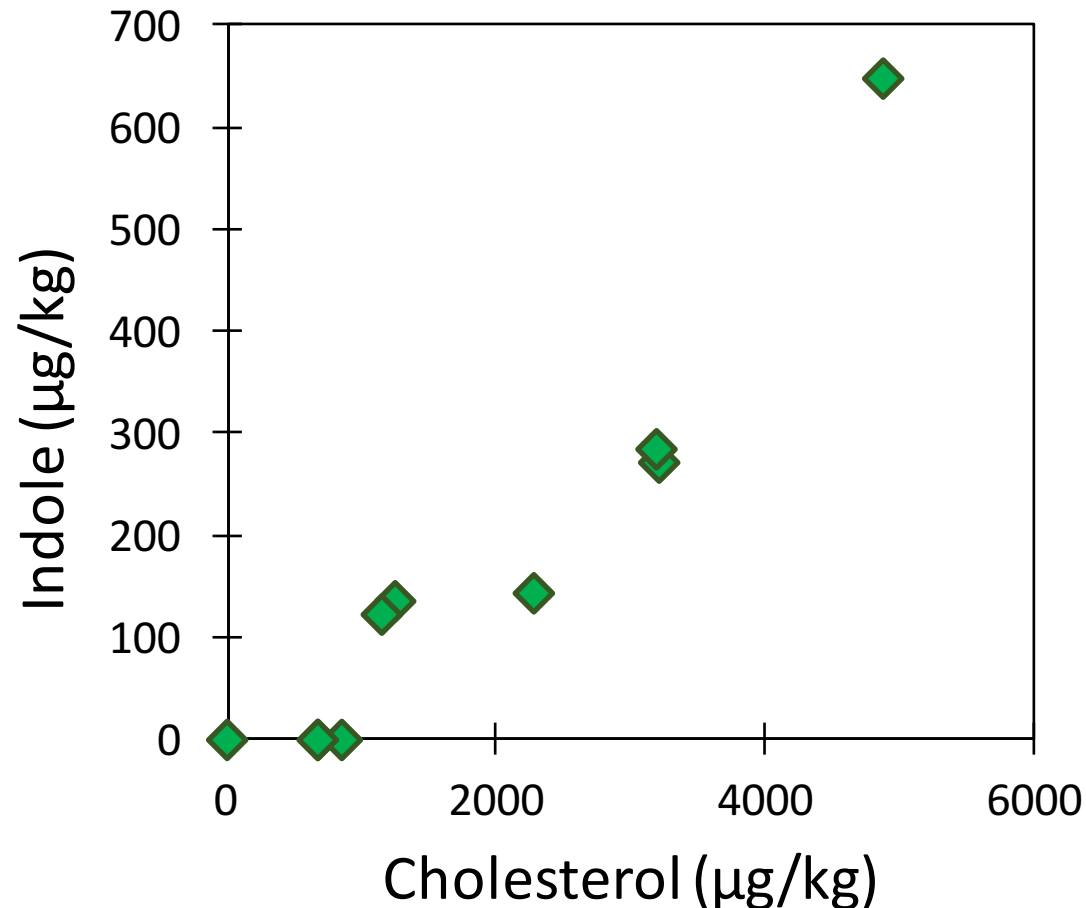
- At each location:
 - Sediments **Hormones and wastewater compounds**
 - Water samples **PFASs**
 - Passive samplers (time-integrated)
- Sample analysis:
 - Wastewater compounds: USGS
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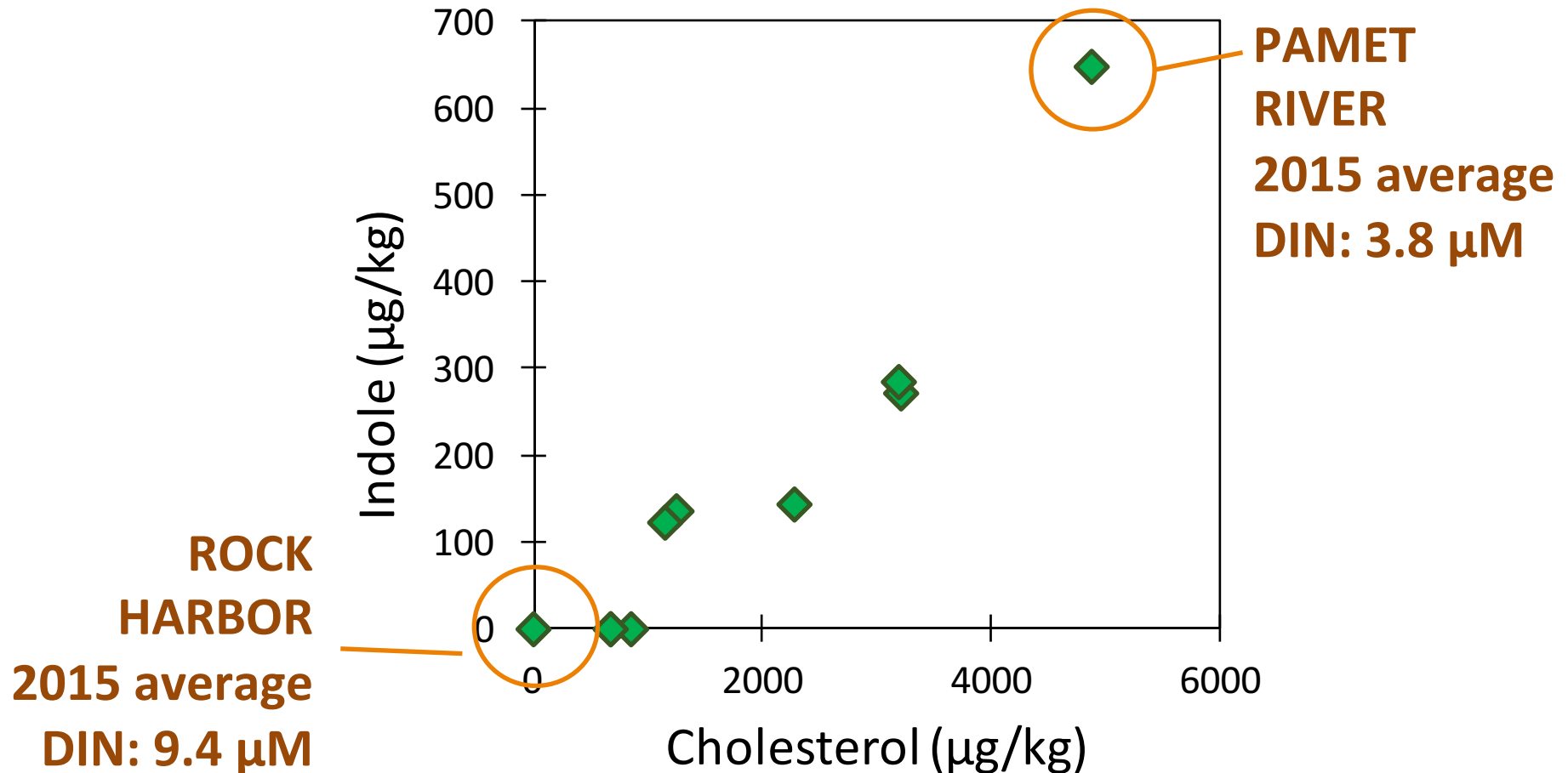
Wastewater chemicals in sediments

	Chemical	% Detected	Reporting limit (µg/kg)	Max. conc. (µg/kg)
Plant & animal biochemicals	Indole	100%	200	650
	Cholesterol	90%	500	4,870
	Skatole	60%	100	30E
	b-Sitosterol	40%	1000	4,650
	b-Stigmastanol	30%	1000	1,330
	3-β-Coprostanol	20%	1000	220E
Personal care & domestic use	d-Limonene	50%	100	36E
	4-Cumylphenol	10%	100	130
Hormones	Estrone	20%	0.5	0.8

Correlation between CECs associated with human waste

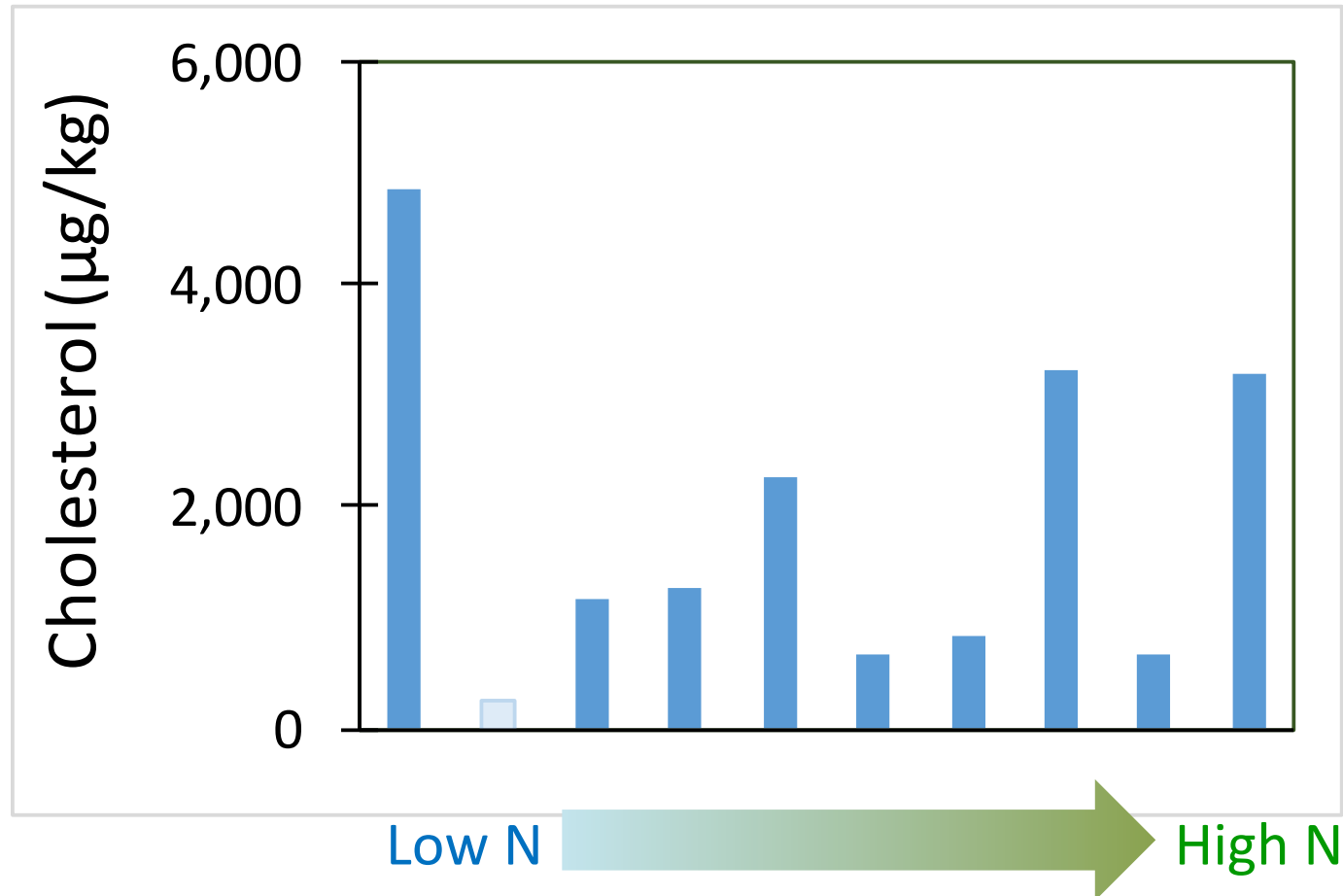


Differences among sites cannot be accounted for by average DIN in water



Relationship with dissolved inorganic N

2015 DIN average concentrations



PFAS analyses in water samples

- 2 samples per site (Sept, Oct 2016)
- PFASs (*per- and polyfluoroalkyl substances*)
 - Non-stick, stain-resistant, and water repellent consumer products
 - Firefighting foams (AFFF) for fuel fires
 - Various commercial/industrial sources
- Some have been phased out, newer replacement compounds

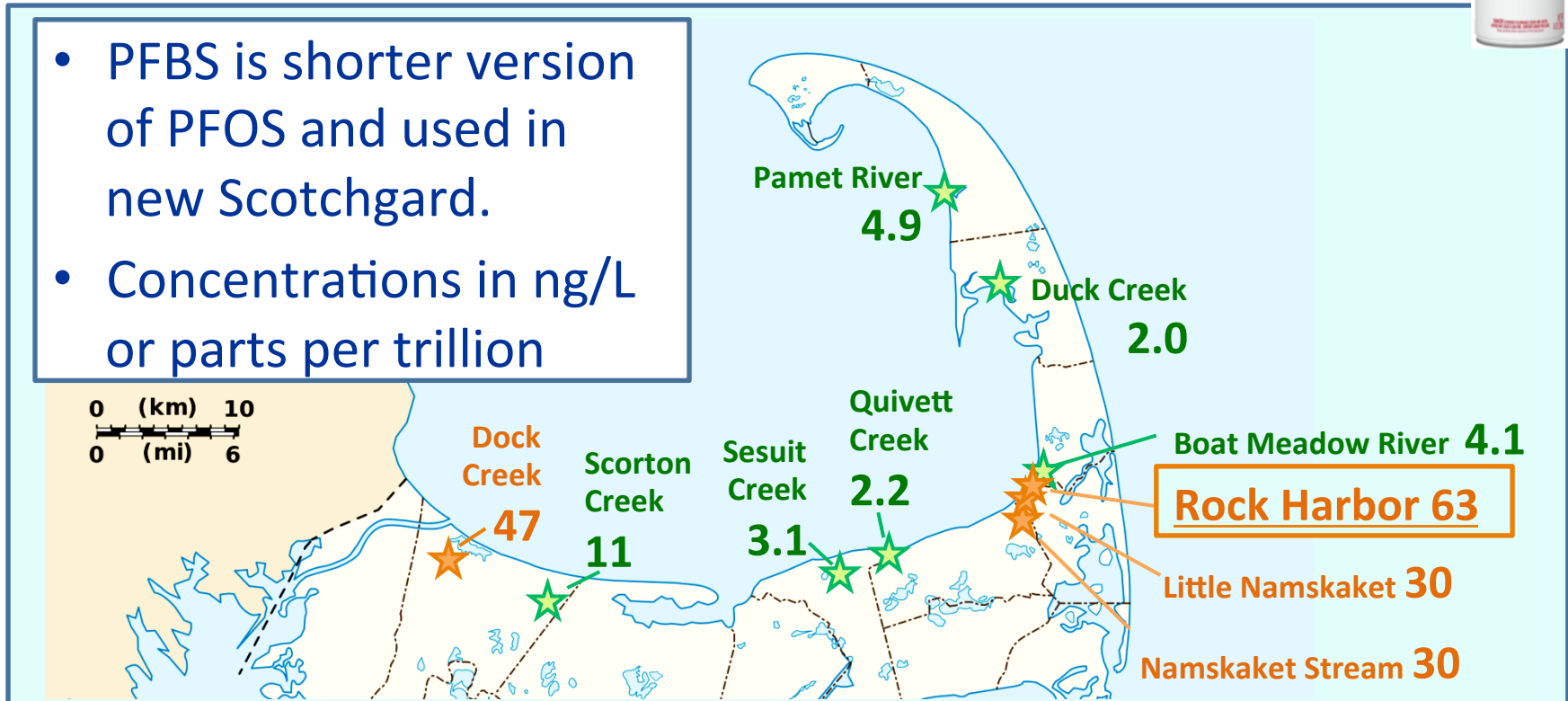


PFBS concentrations in water

September 2016



- PFBS is shorter version of PFOS and used in new Scotchgard.
- Concentrations in ng/L or parts per trillion

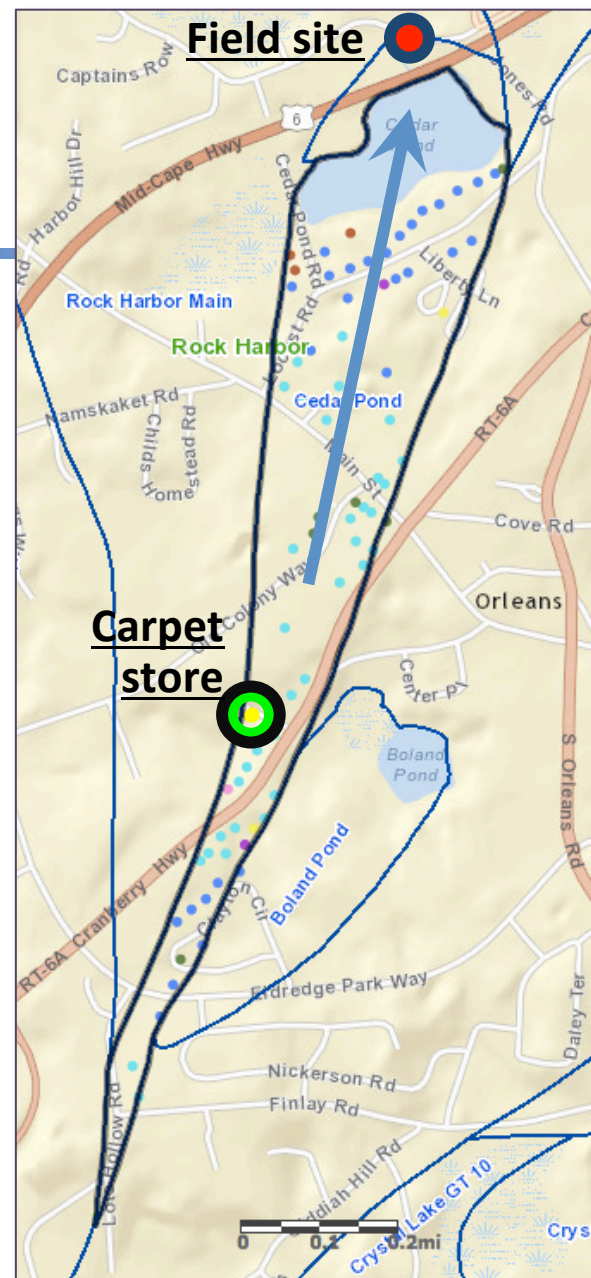


Rock Harbor

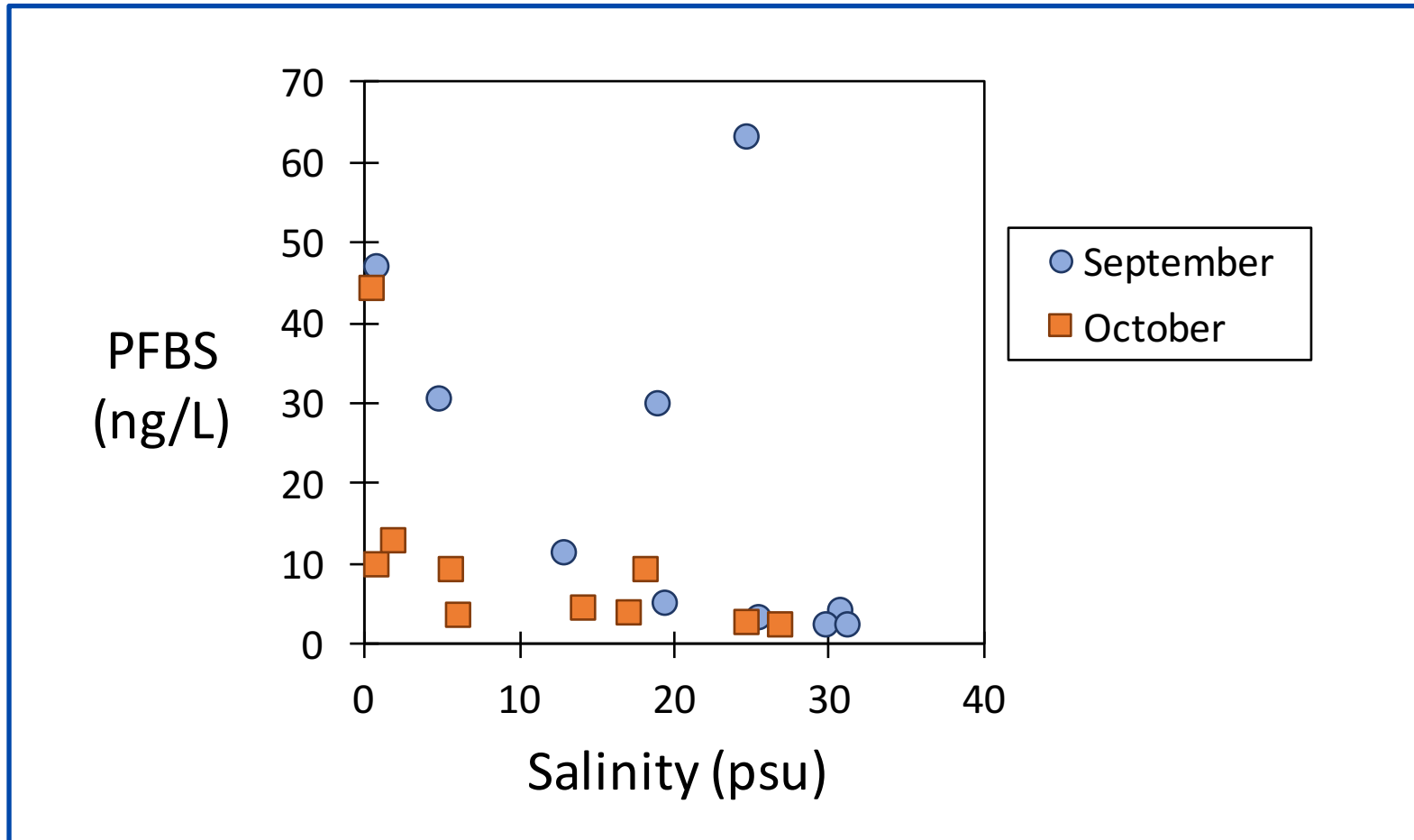
Summary Legend

Land Use

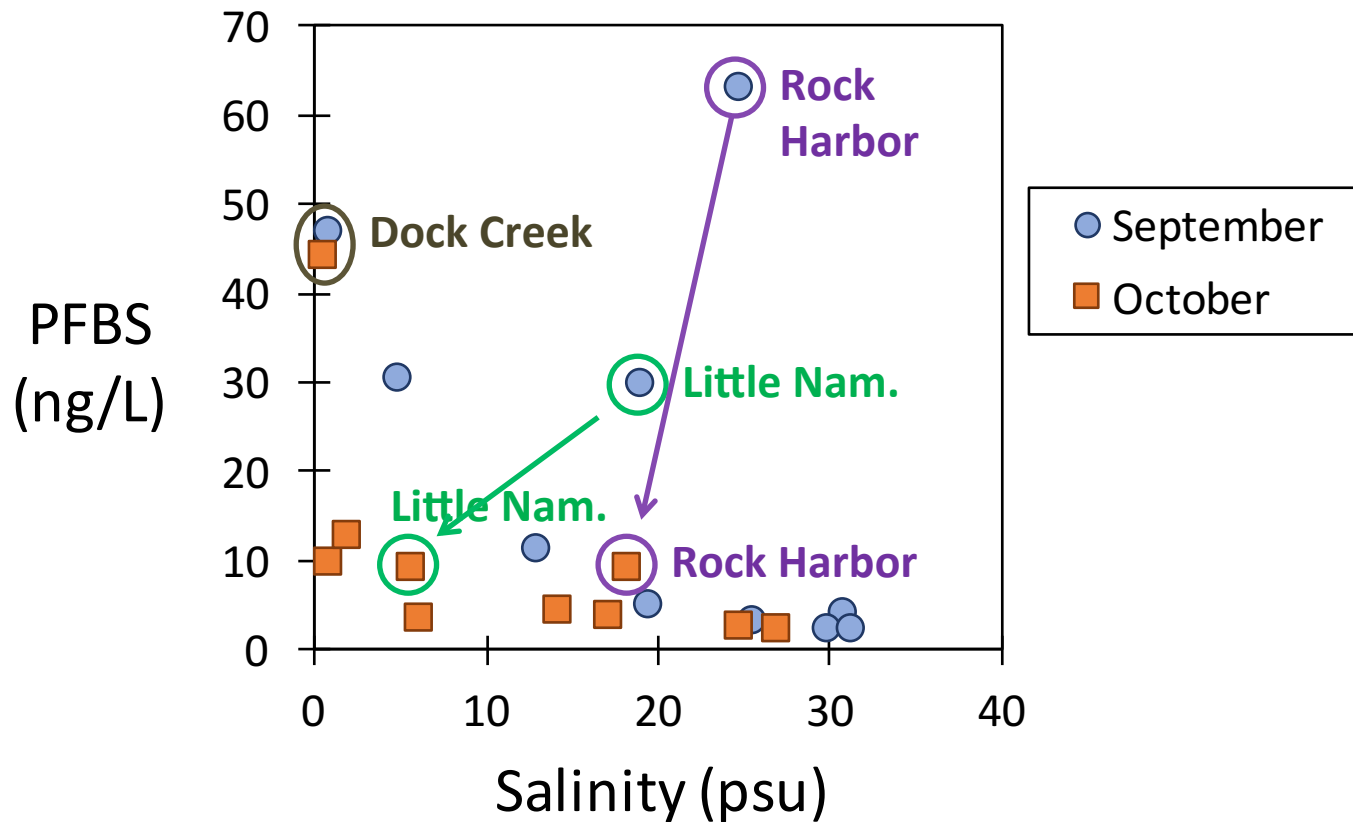
- Residential Single Family
- Commercial
- Industrial
- Other Developable
- Other Non-Developable
- Residential Condo/Apartments
- Residential Multi Family
- Vacant Developable Land
- Vacant Non-Developable Land



Variations over time and as a function of salinity



Range of temporal variability and interaction with salinity



Conclusions



- Septic systems are sources of CECs
- Elevated nitrogen in water can indicate presence of CECs
- PFASs may come from commercial and industrial sources
- Holistic water quality protection should consider CEC sources and transport



Why wait for our water to be tainted?

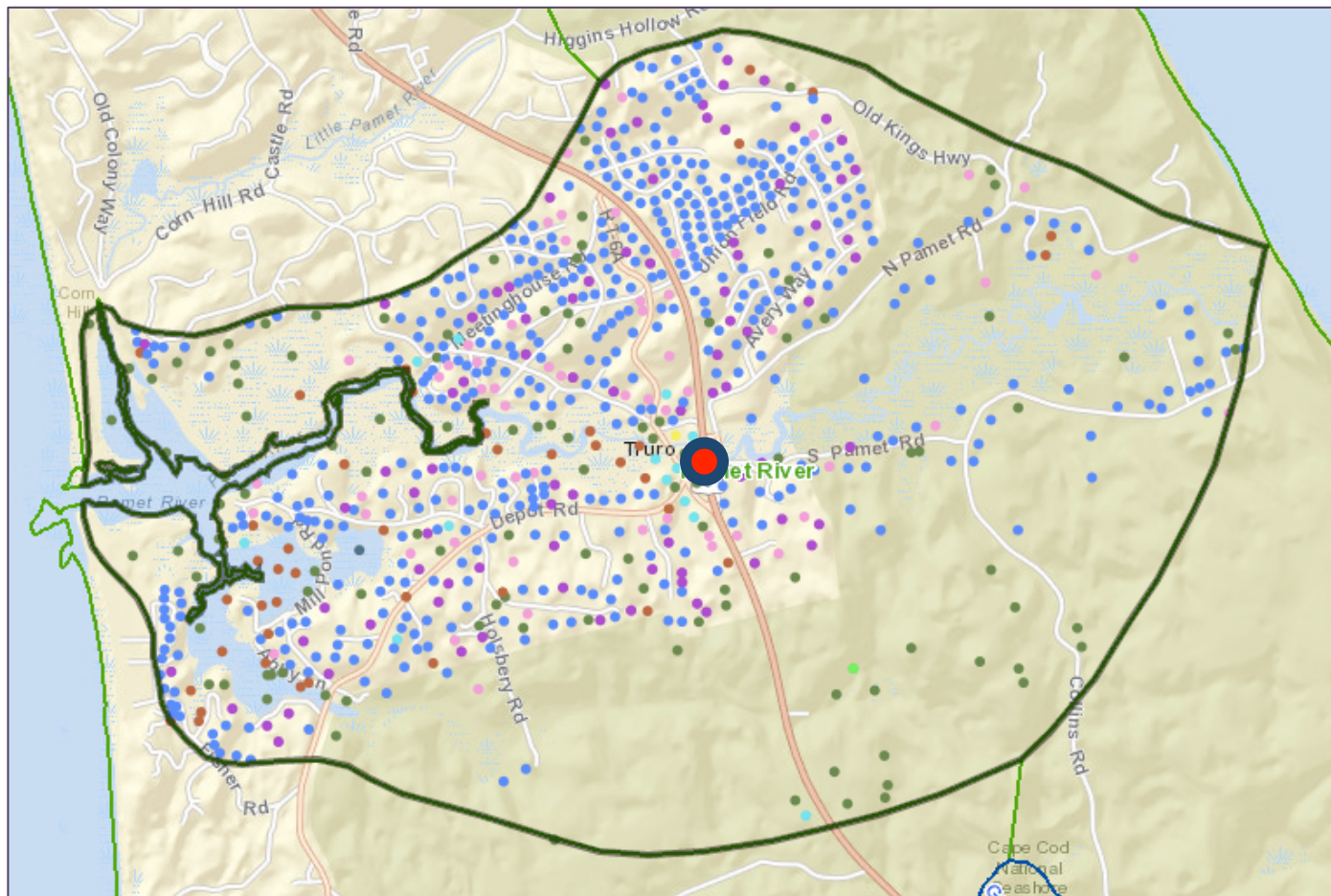
By Laurel Schaider and Cheryl Osimo
September 16, 2016

Many of the wells with PFASs, pharmaceuticals, or other emerging contaminants have other signs of degradation:

- Perchlorate or VOCs
- Dense development
- Elevated nitrate

“Even without exceeding health guidelines, who wants landfill leachate, firefighter foams or wastewater in their drinking water? The big question is how to address all these different emerging contaminants that have the potential to enter our drinking water and cause health effects, including cancer and developmental and reproductive problems.”

Pamet River

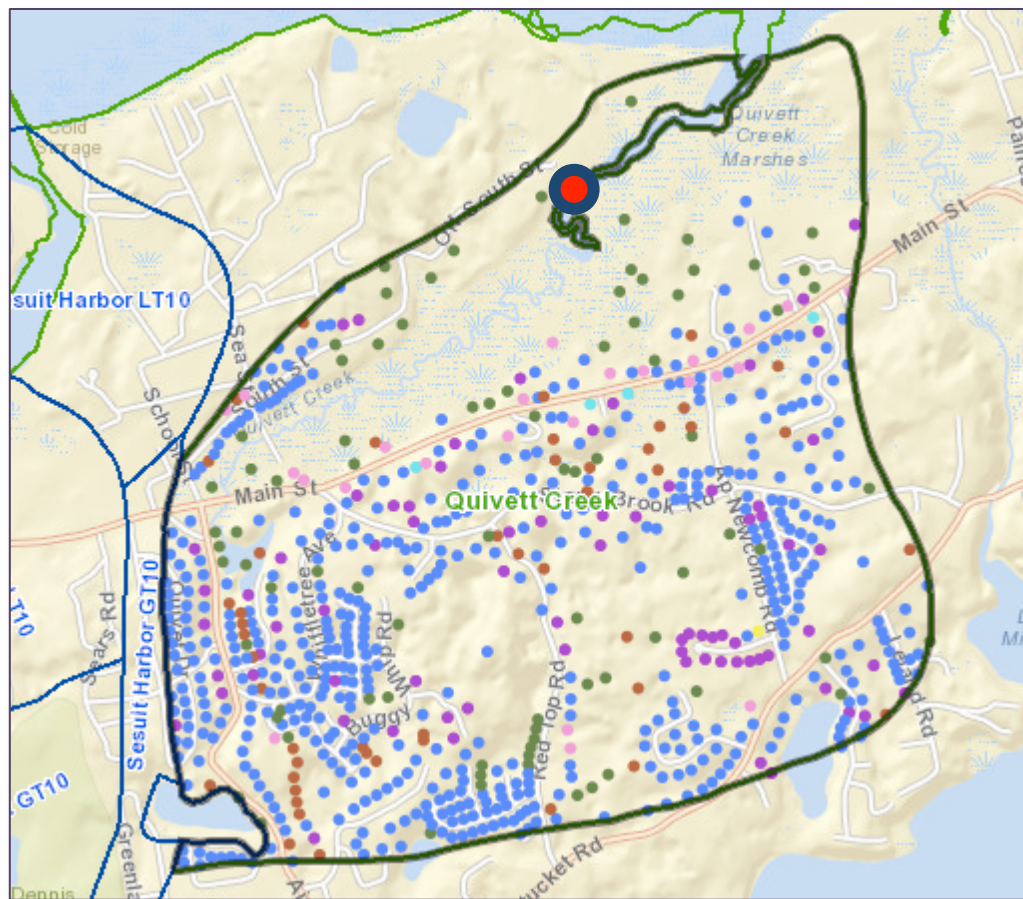


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Quivett Creek

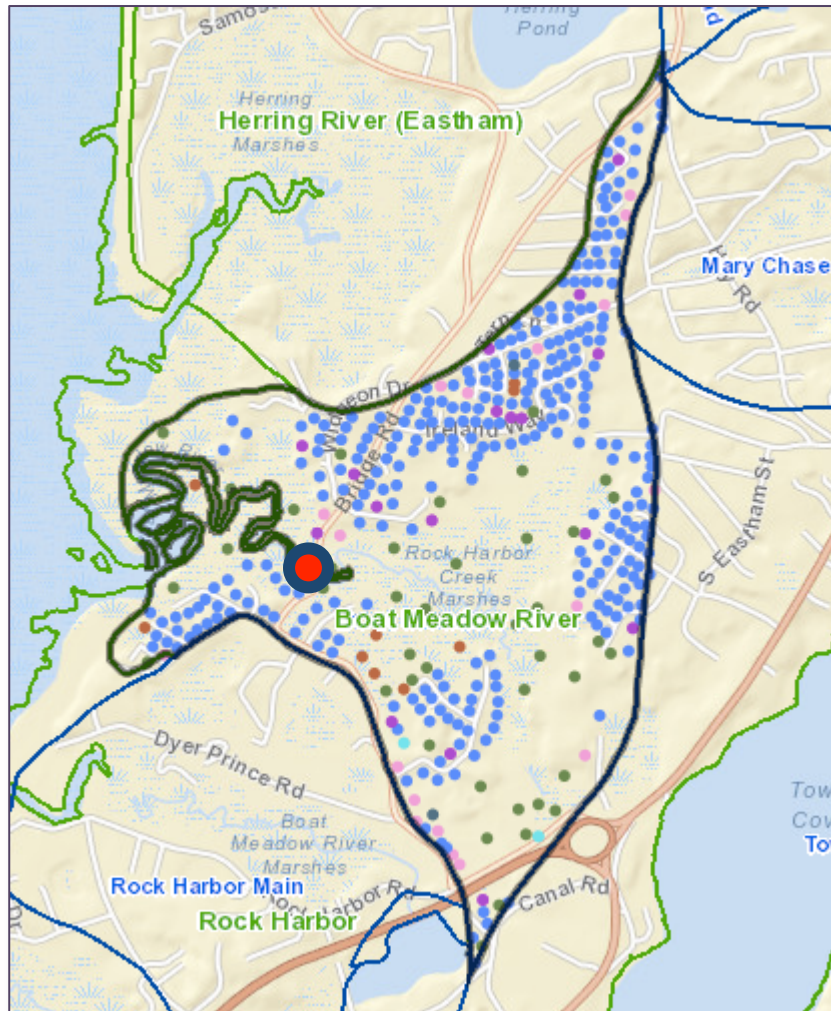


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Boat Meadow River

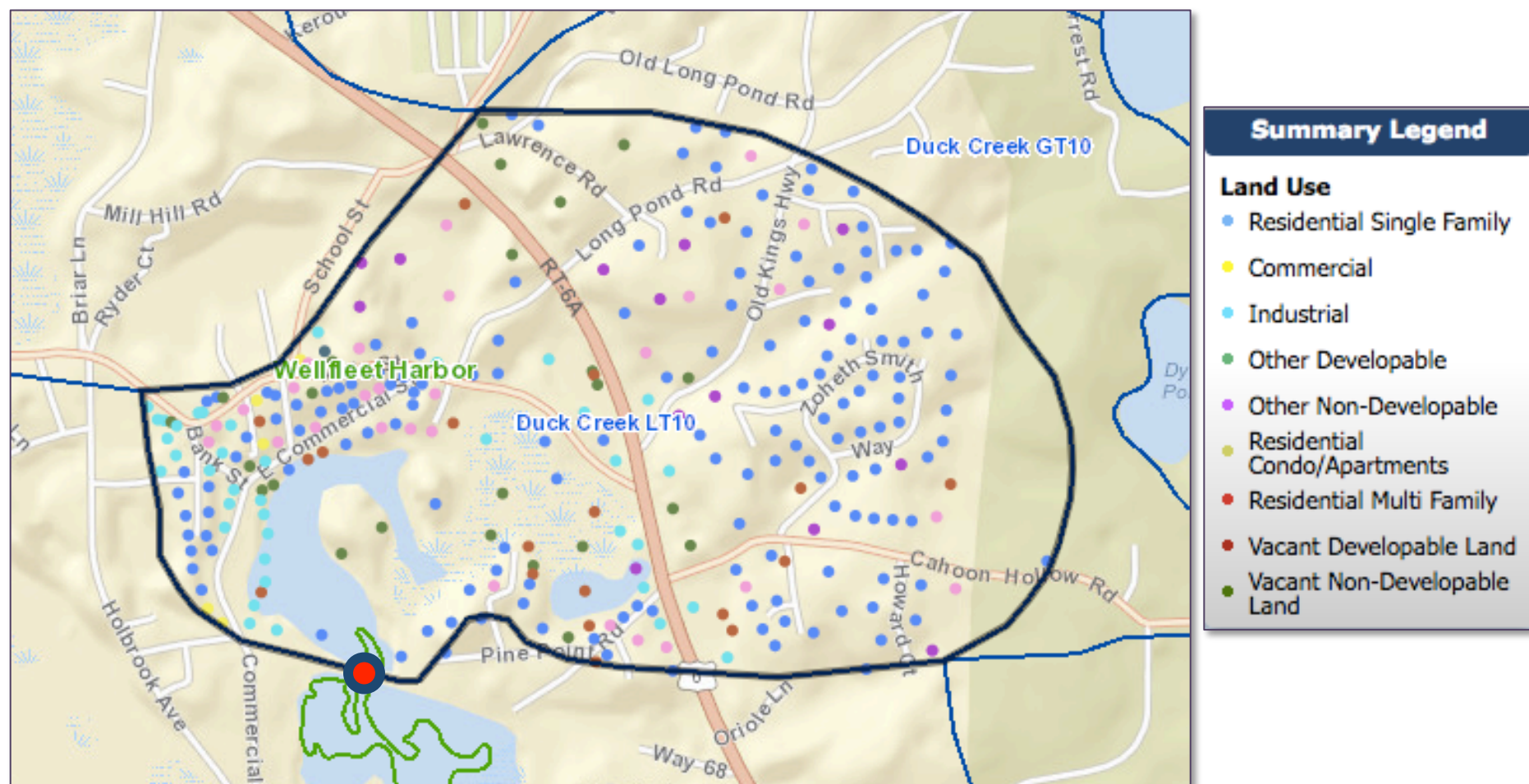


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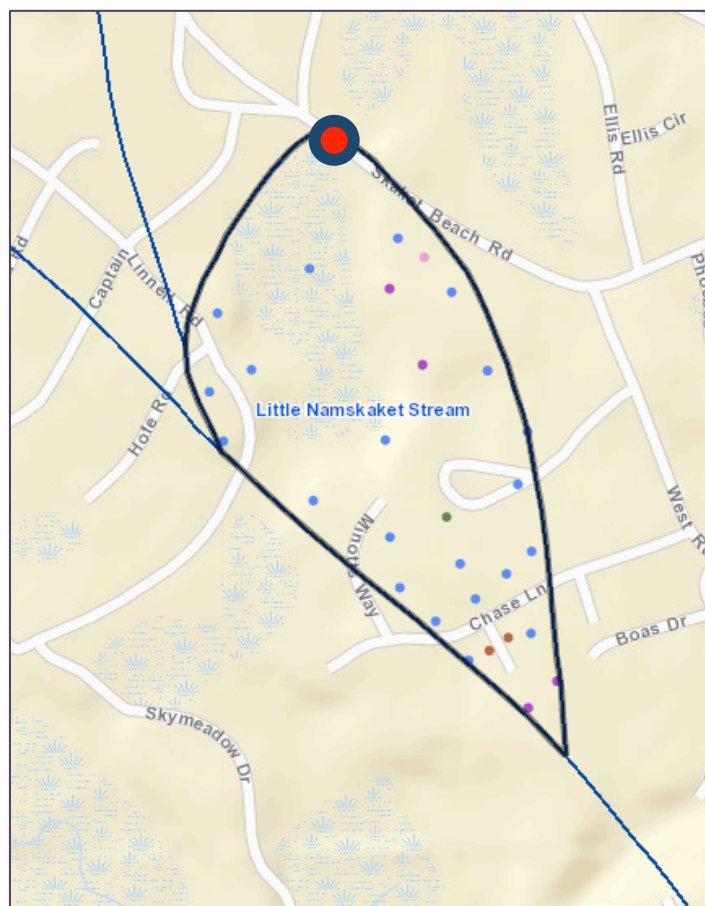
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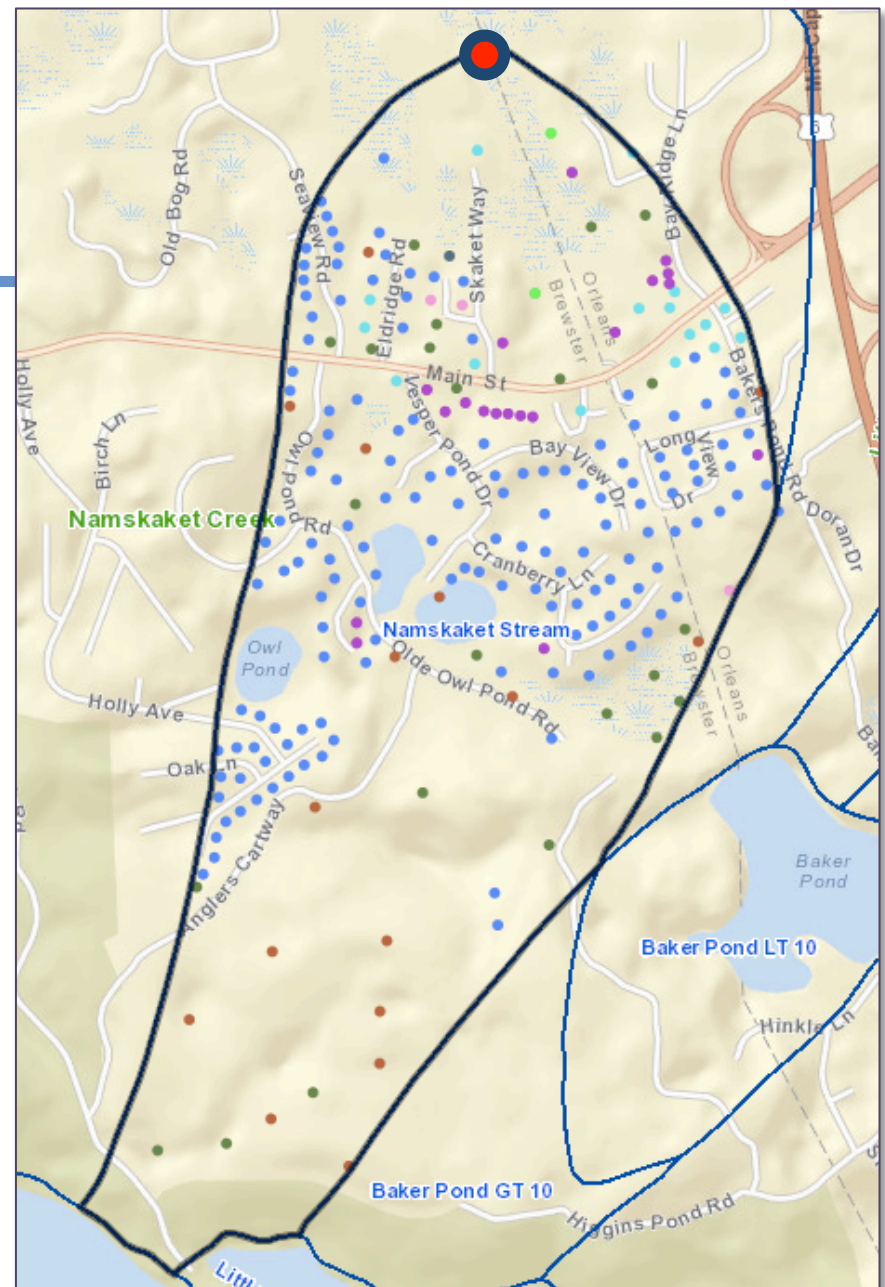
Duck Creek

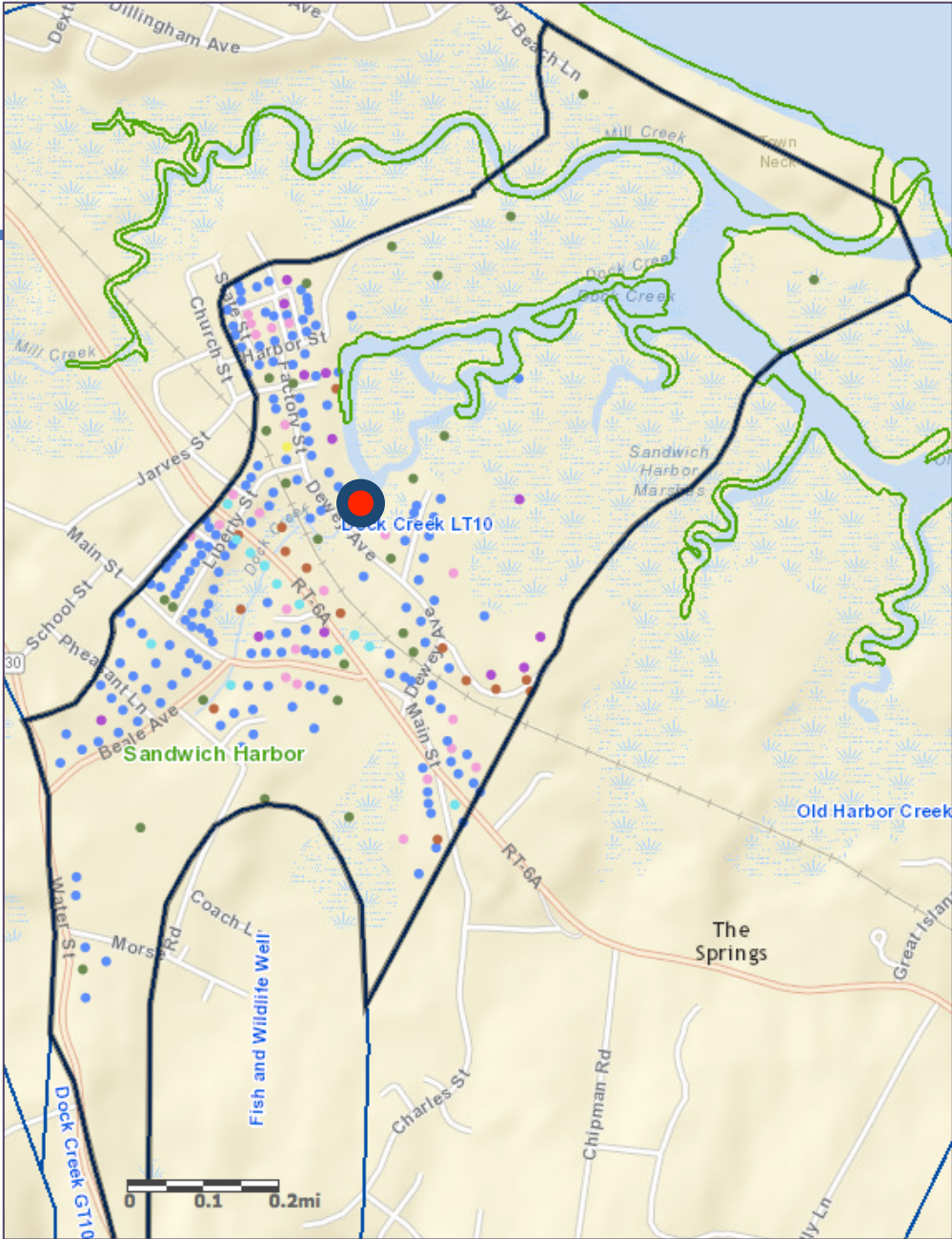


Little Namskaket

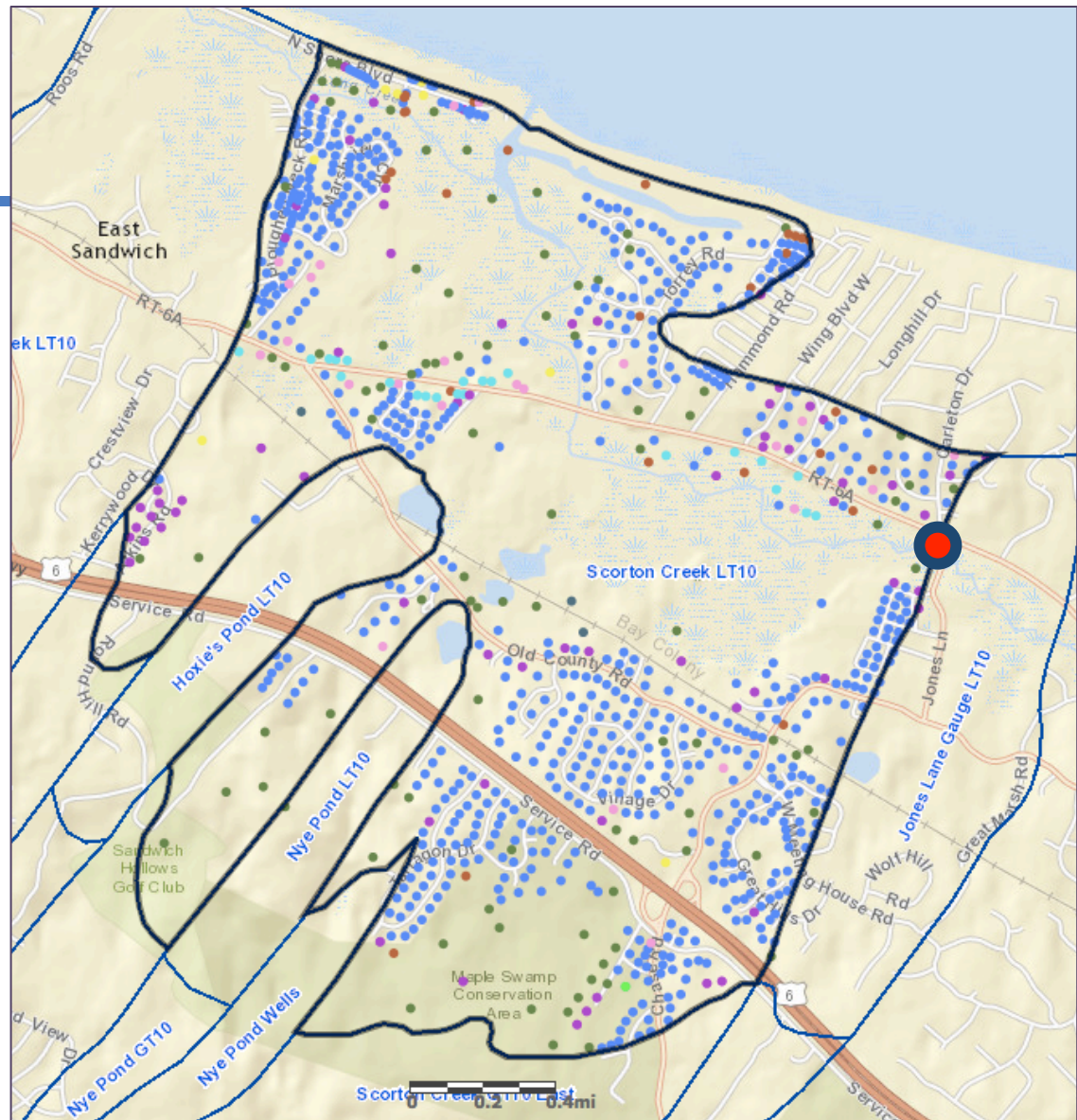


Namskaket Creek





Scorton C.



Sesuit Creek

