Shubael Pond

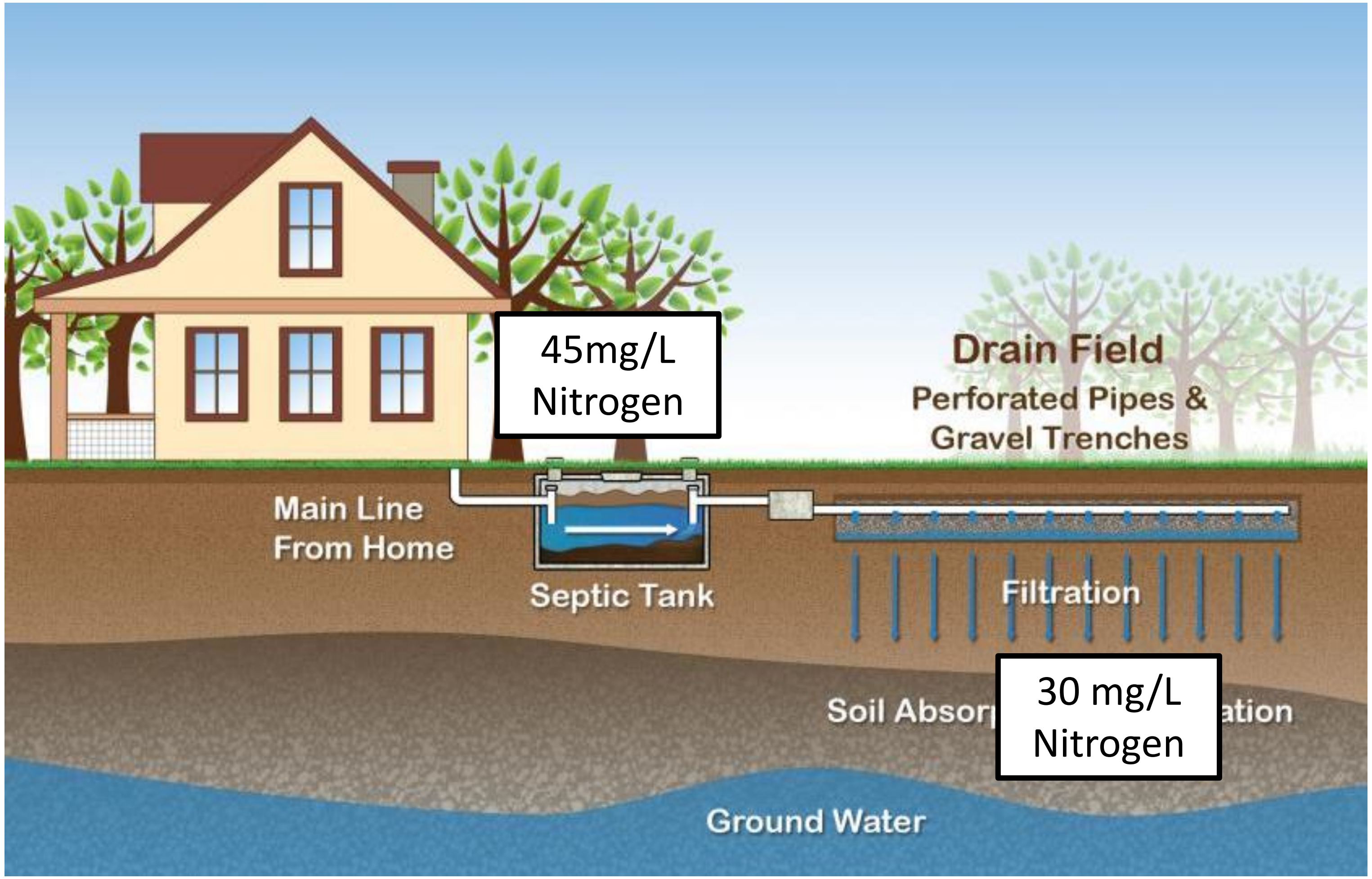
Septic tank monitoring results

MASSTC
The Massachusetts Alternative Septic System Technology Center

A Division of the Barnstable County Department of Health and Environment

If you prefer a formal report or a dataset that has undergone a more thorough qualification process, please contact the MASSTC Director, Brian Baumgaertel at bbaumgaertel@barnstablecounty.org or 508-375-6888. Please note that there will be additional fees for formal reports.

Title 5 "Conventional" Septic System



NitROE from KleanTu

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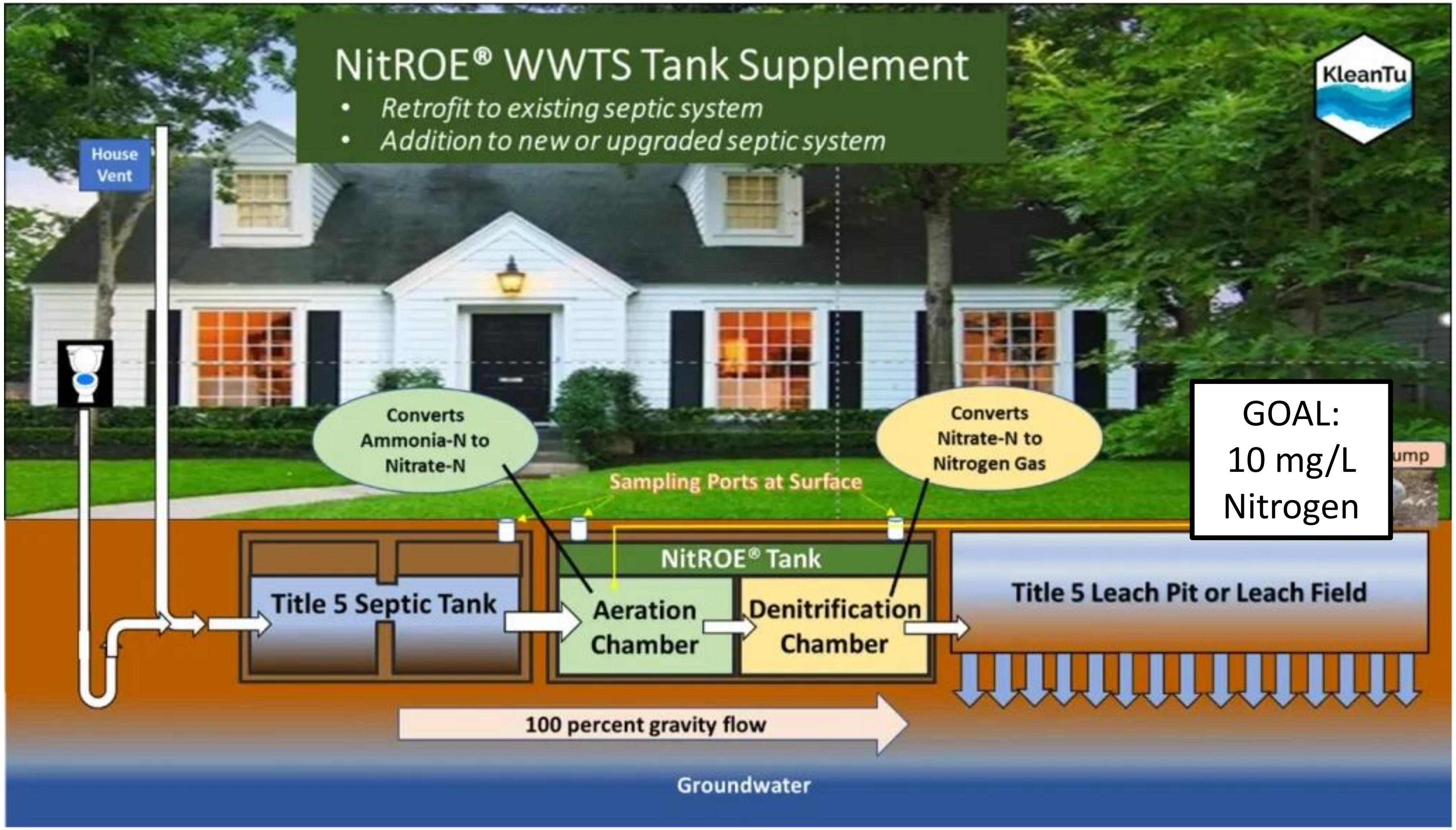
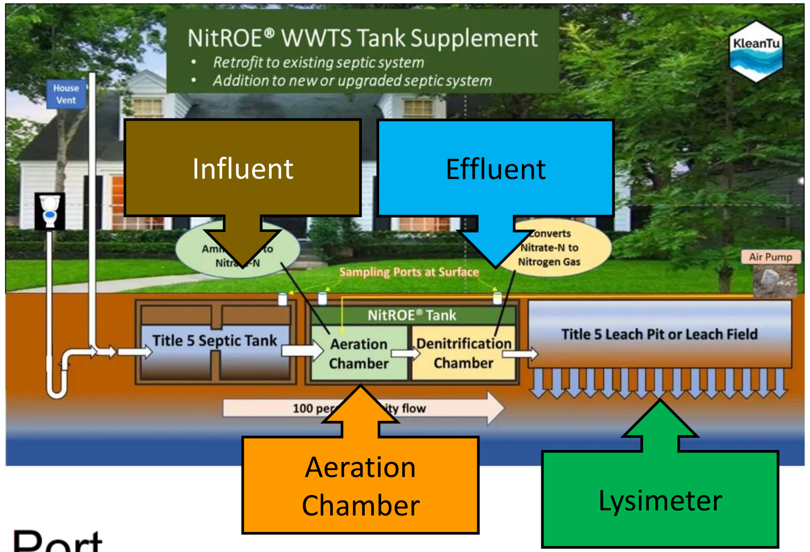


GOAL:
10 mg/L
Nitrogen

- Monthly Monitoring:
  - TN
    - TKN
    - NO3/NO2
  - TP
  - pH
  - DO
  - Temp
- Quarterly Monitoring:
  - NH4
  - BOD
  - TSS
  - Alkalinity
  - Turbidity
- Quarterly Operation and Maintenance

Total Nitrogen



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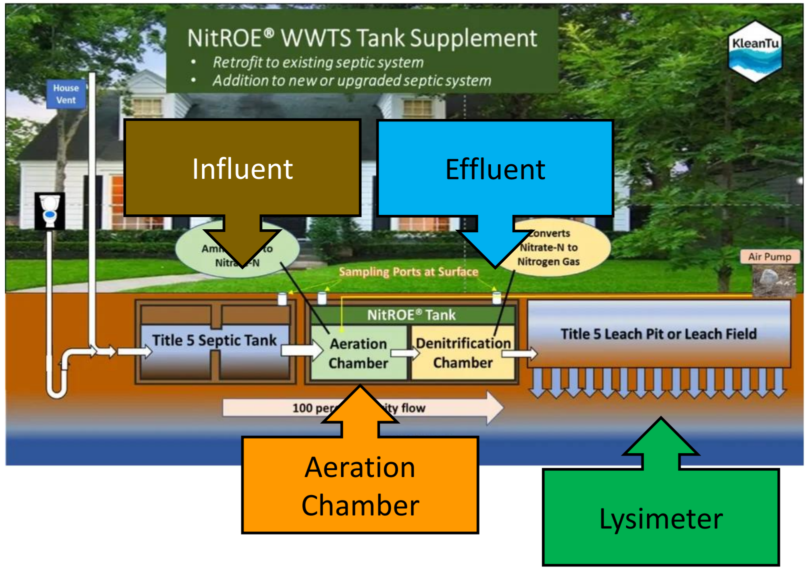
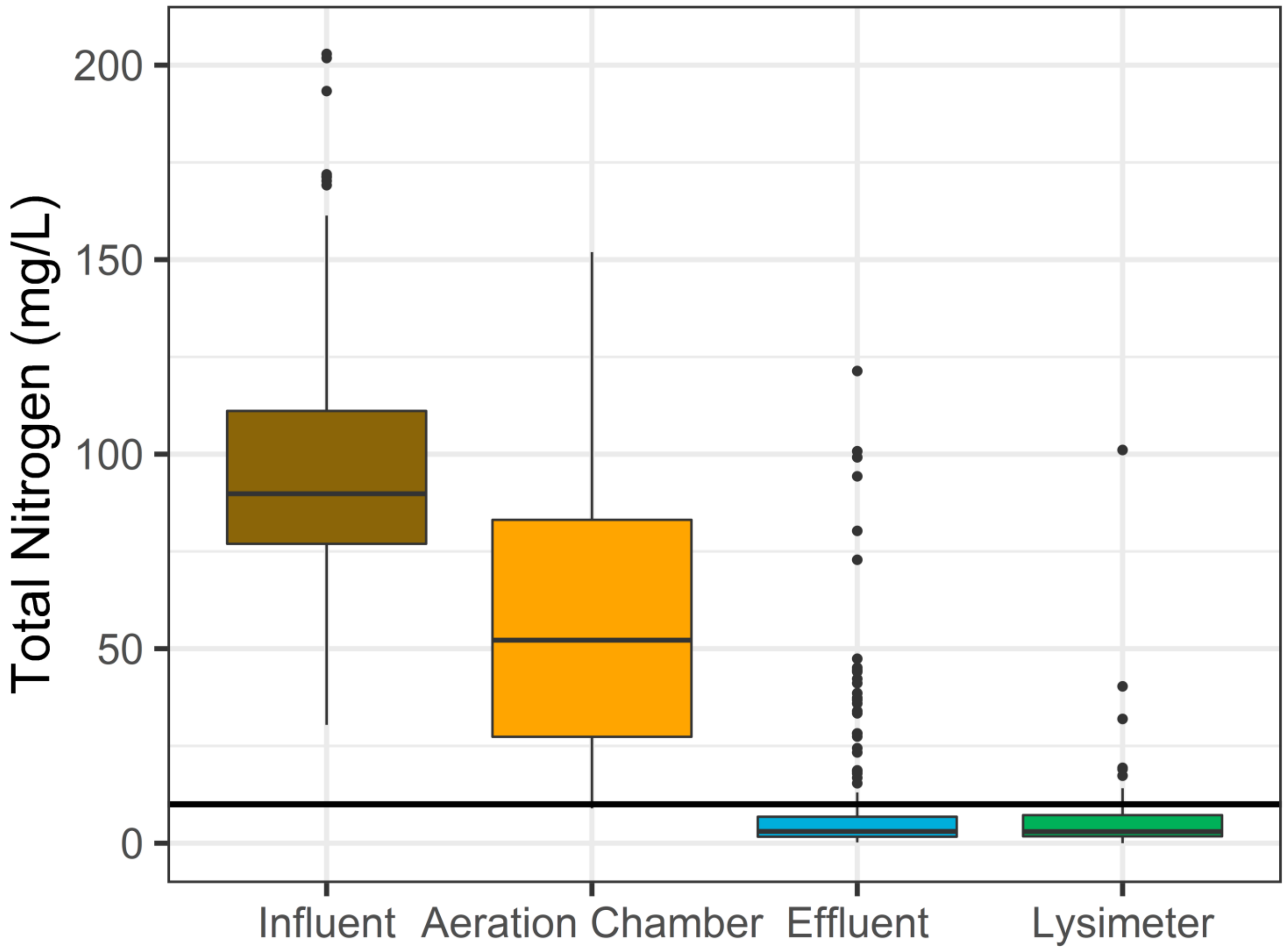
Total Nitrogen





Overall Nitrogen Removal performance

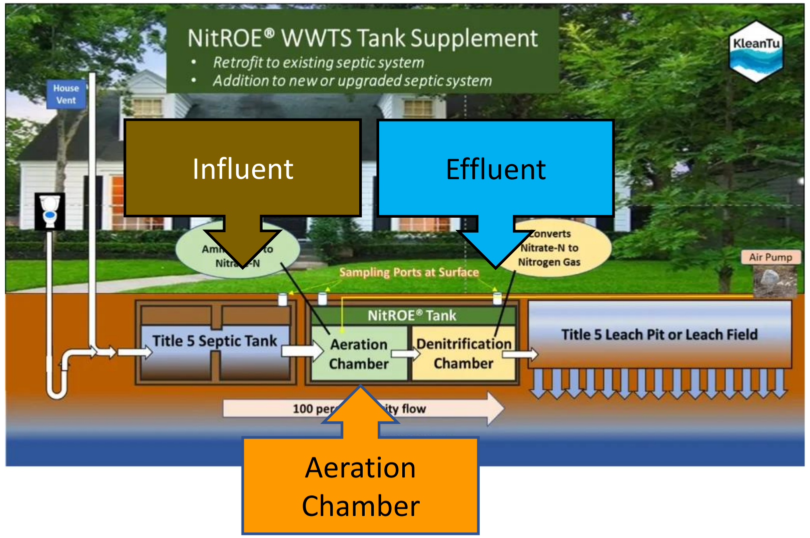
Median TN :

- Influent = 90 mg/L
  - Mean = 102 mg/L
- Effluent = 3 mg/L
  - Mean = 10 mg/L

TN % Removal:

- Median = 96%
- Mean = 86%

Total Phosphorus



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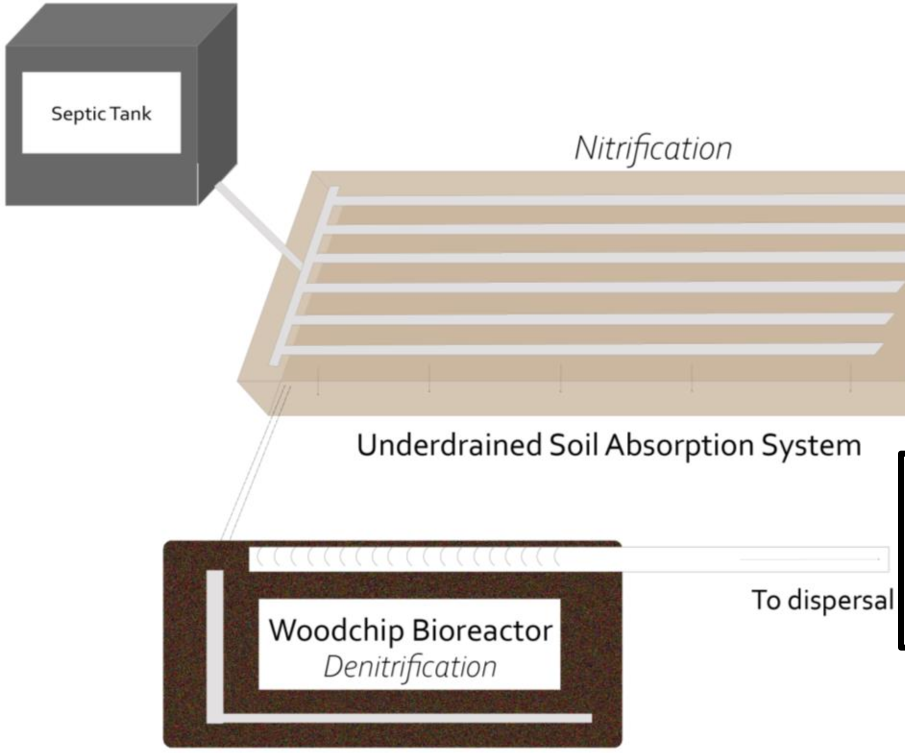
Woodchip Bioreactor/“Yankee 1”



GOAL:
10 mg/L
Nitrogen

The Massachusetts Alternative Septic System Test Center

Woodchip Bioreactor/"Yankee 1"

- System hydraulically struggling
  - Low DO/High BOD from sand bed
  - Surface squishy
  - High water use
  - Not nitrifying (TN removal ~10%)
- Overflow to standard leachfield now turned on
- What's going on?
- Next steps

Nitrogen Loading

- Neptune water meters collecting hourly water use from inside home
- Using to calculate load:
  - Keep is super simple?
    - $\text{N loading} = \ Nitrogen\ Concentration\ x\ Flow$
  - Something more complex?

Flow, Concentration and Load

Site	Median Daily Flow (Gal)	Median TN effluent (mg/L)	Median TN influent (mg/L)	N Load- Kg N/year effluent	Kg N/year influent (mg/L)
Site A	117.8	4.4	79.5	0.7	12.9
Site B	64.1	1.6	87.9	0.1	7.8
Site C	71.7	1.4	87.8	0.1	8.7
Site D	155.8	3.6	96.7	0.8	20.8
Site F	67.9	8.9	146.7	0.8	13.8
Site G	28.2	2.7	73.3	0.1	2.9
Site H	122.9	3.1	98.5	0.5	16.7
Site I	137.9	2.8	101.3	0.5	19.3
Site J	54.9	3.0	171.9	0.2	13.1
Site K	18.7	2.9	97.2	0.1	2.5
Site L	76.9	1.1	38.5	0.1	4.1
Site M	336.9	37.7	48.4	17.6	22.5

Shubael Pond - Great Case for an RME!

- MASSTC working as the maintenance provider, Piloting a Regional Management Entity (EPA Funded)
- Issues identified:
  - Cracked air pipes
  - Leaking weep hole
  - Poorly graded components
  - Leaky toilet
  - Maximized system performance (in collaboration with KleanTU)

Update on Groundwater Monitoring in the Sand Shores Neighborhood

Enhanced Septic Demonstration Study

Tim McCobb – USGS New England Water Science Center
Dr. Laura Erban– US EPA Office of Research and Development
7/26/2023

USGS science for a changing world

EPA United States Environmental Protection Agency

Monitoring well network

- Wells of various types at 21 locations (79 well screens)
- Depth to water (12 – 49 ft)
- Nitrate is primary form of N in GW (>80% of TN)

  Initial sampling rounds showed:
  - 53% water-table wells > 1 mg-N/L Nitrate
  - 35% water-table wells > 5 mg-N/L Nitrate
- As of June 2023, nine quarterly sampling rounds

Key partners

Barnstable Clean Water Coalition

EPA

USGS science for a changing world

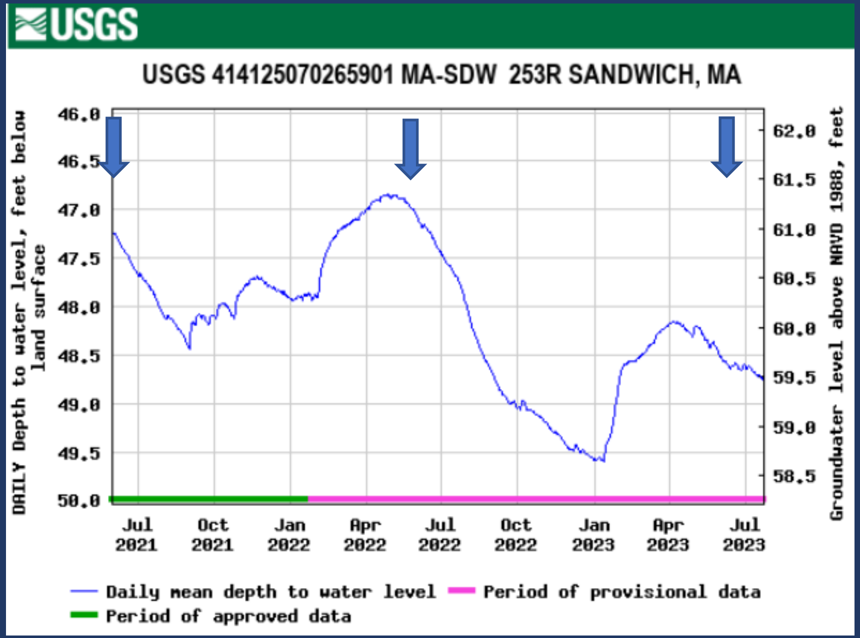
MASSTC The Massachusetts Alternative Septic System Test Center

TOWN OF BARNSTABLE

LOCAL RESIDENTS

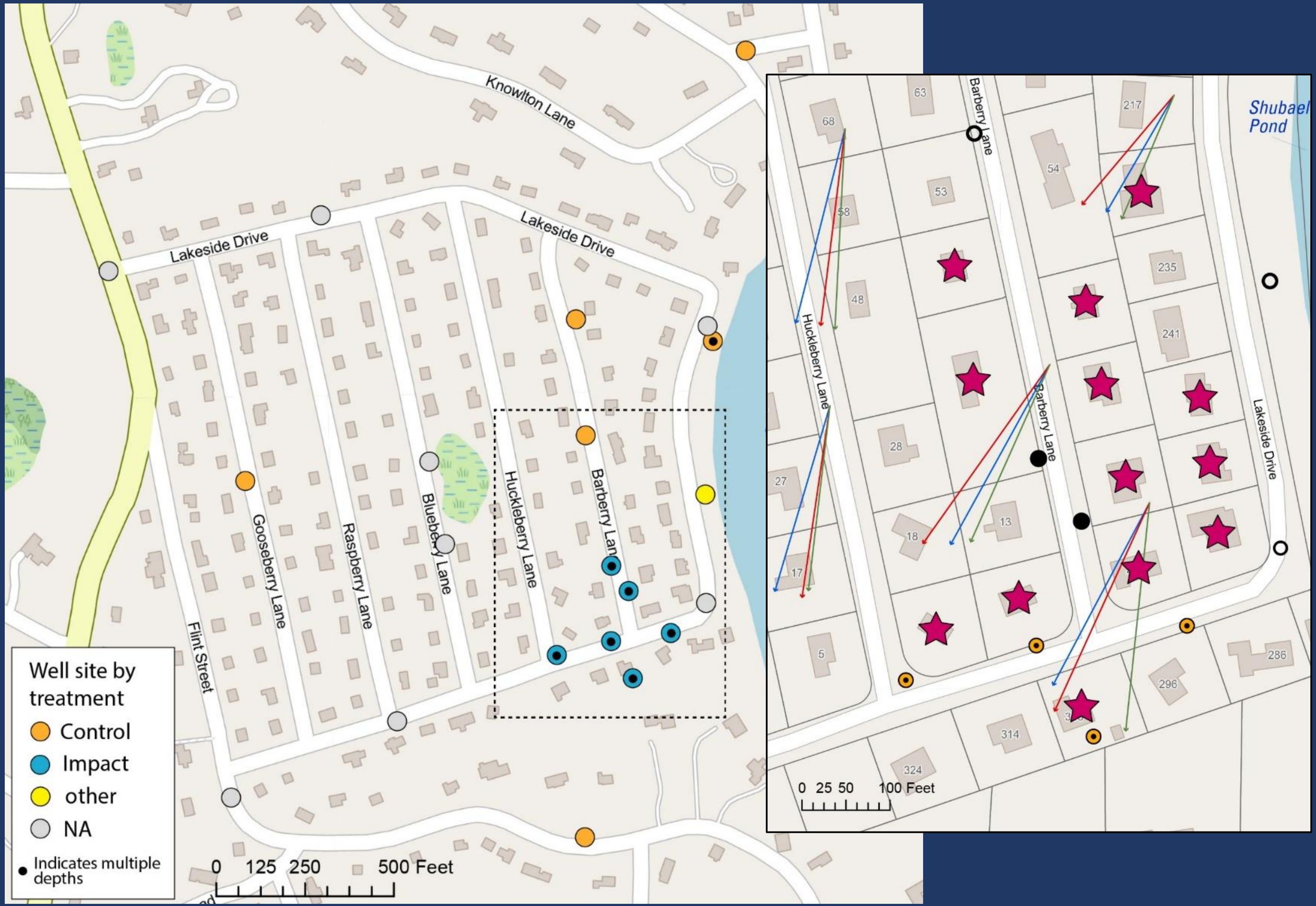
Hydraulic Gradient and Traveltime

- Water levels measured multiple snapshots
- Flow directions varies up to 10 degrees
- Average linear velocity estimated to be 0.6 to 1.1 ft/day
- Estimated traveltime pond to Lakeside south ranges 1.2 – 2.3 years



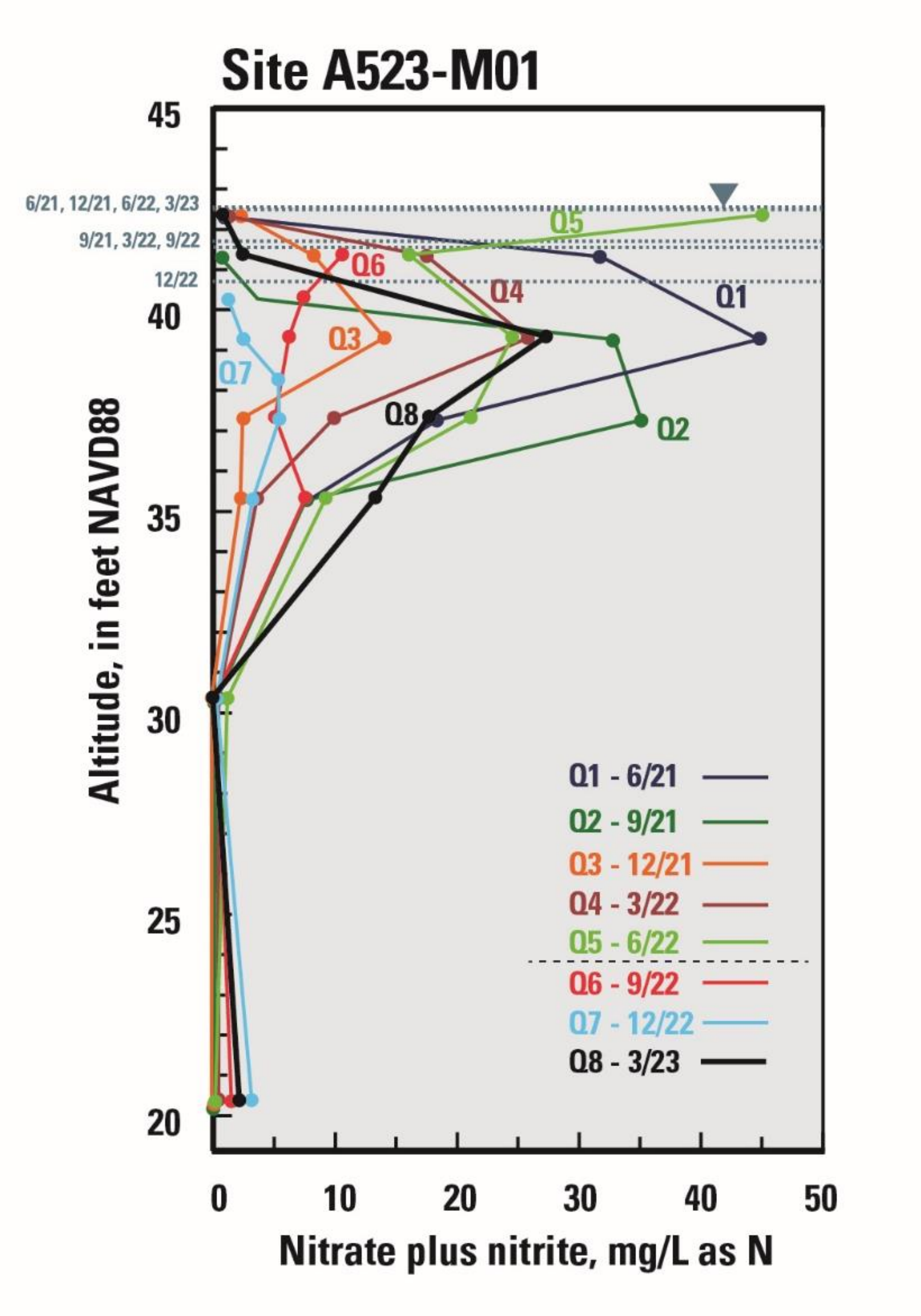
Quarterly GW Sampling

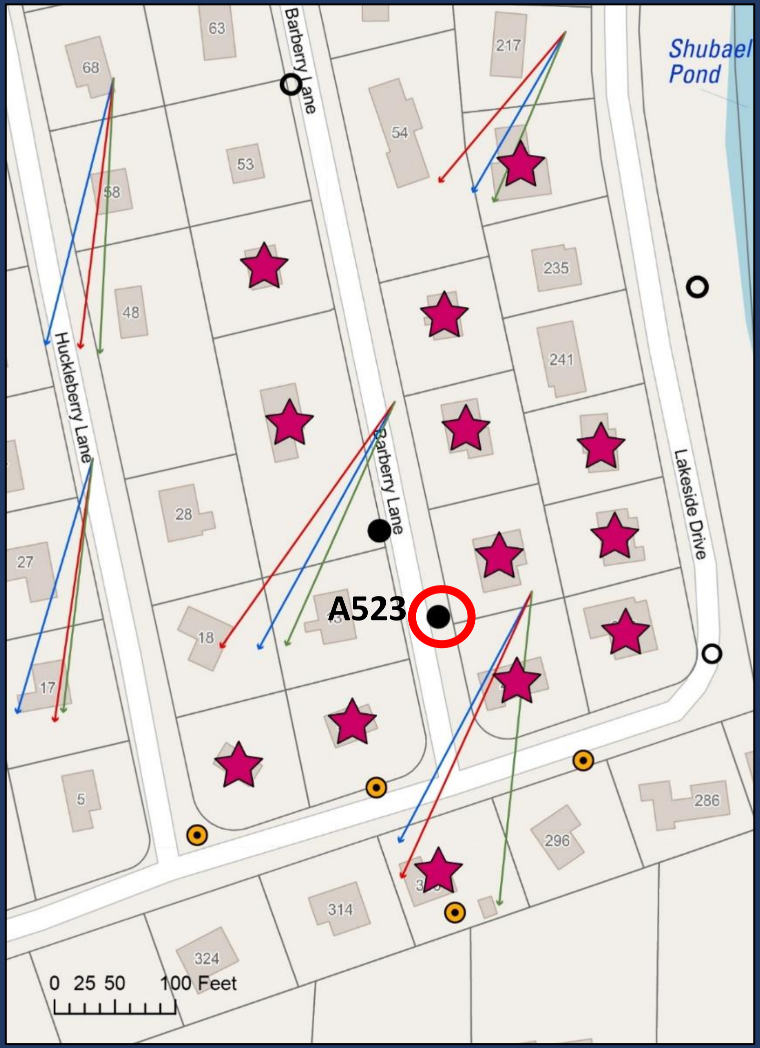
- Well screens (n = 42)
  - Upgrade impact area (n = 30)
  - Control (n = 12)
- Parameters
  - Field parameters (DO, SpC, pH, T)
  - Inorganic nitrogen species (Nitrate plus nitrite, nitrite, ammonium)
  - Total nitrogen (selected screens)
  - Orthophosphate (selected screens)
  - CECs
  - Water levels
- Nine quarterly rounds complete (June 2021 – June 2023)



- 13 septic upgrades completed (Aug 2021 – Aug 2022)

Quarterly GW Sampling – MLS profile

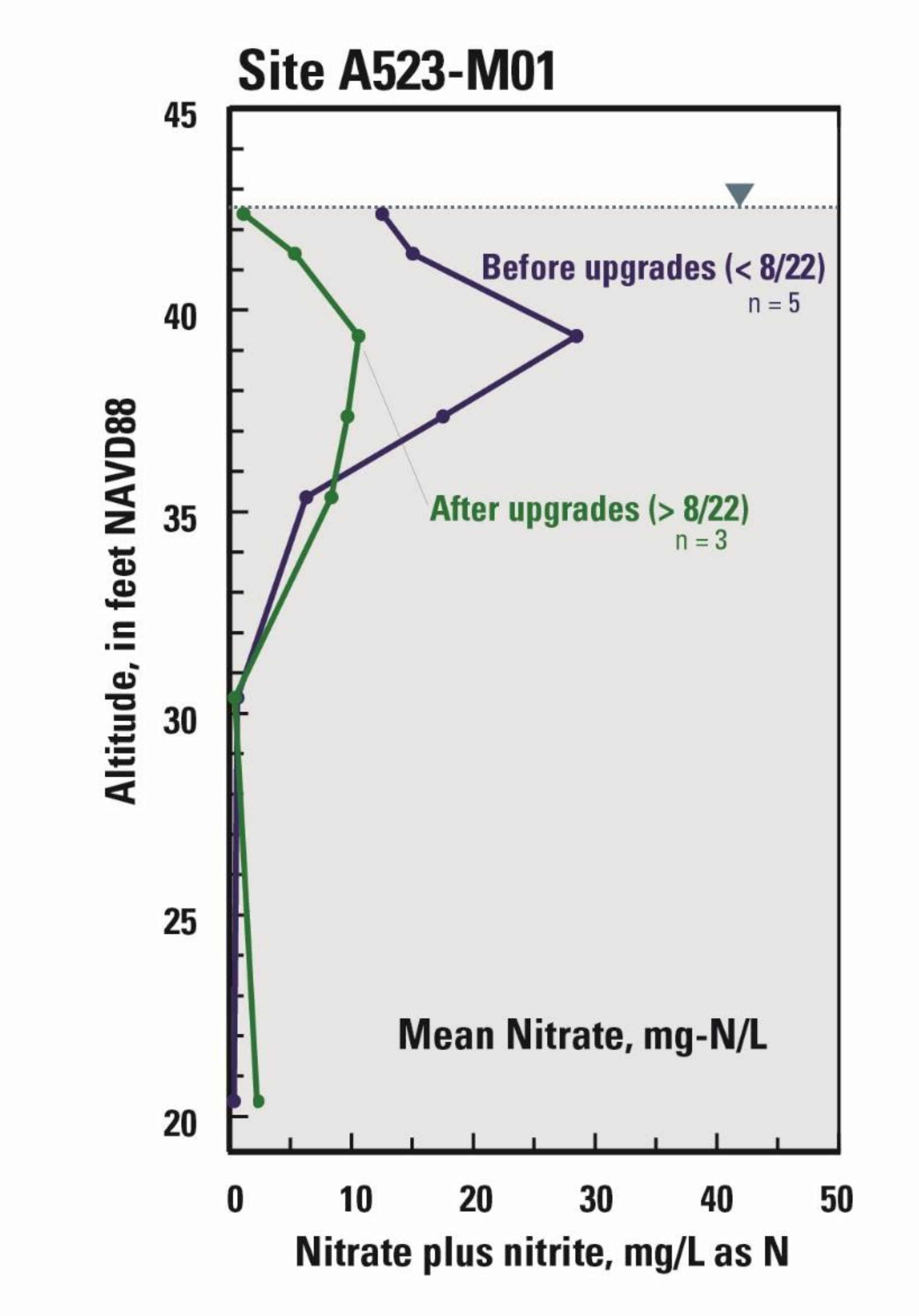


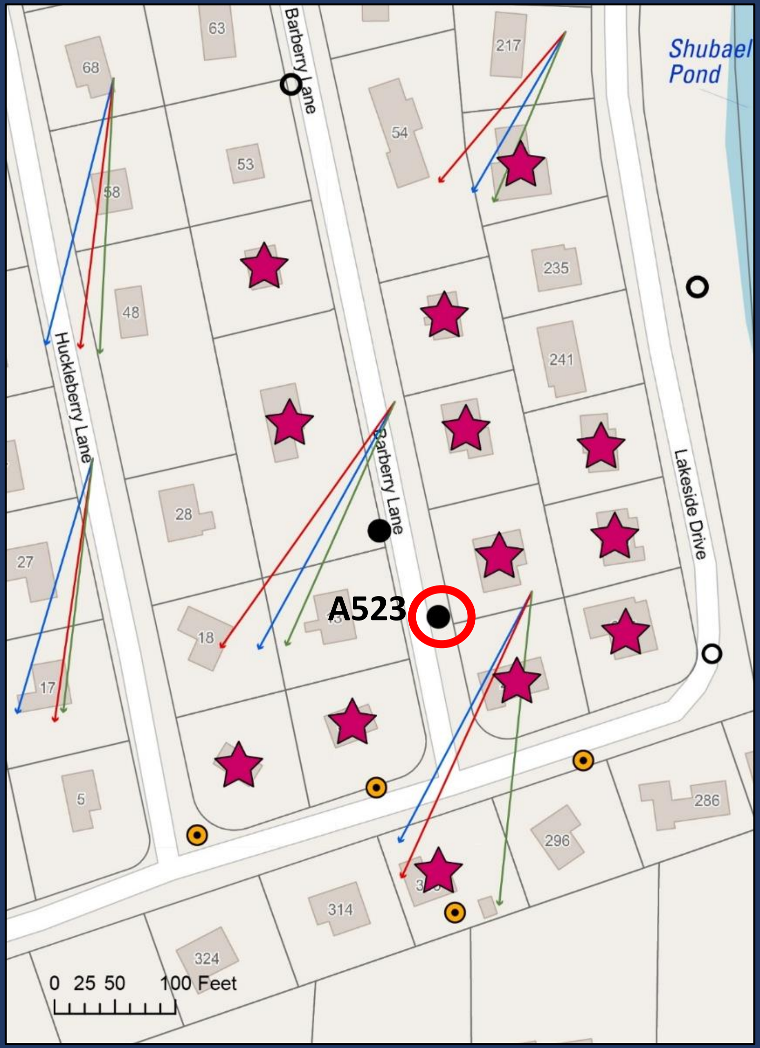


*Ammonia not detected after Q4

Quarterly GW Sampling – MLS profile

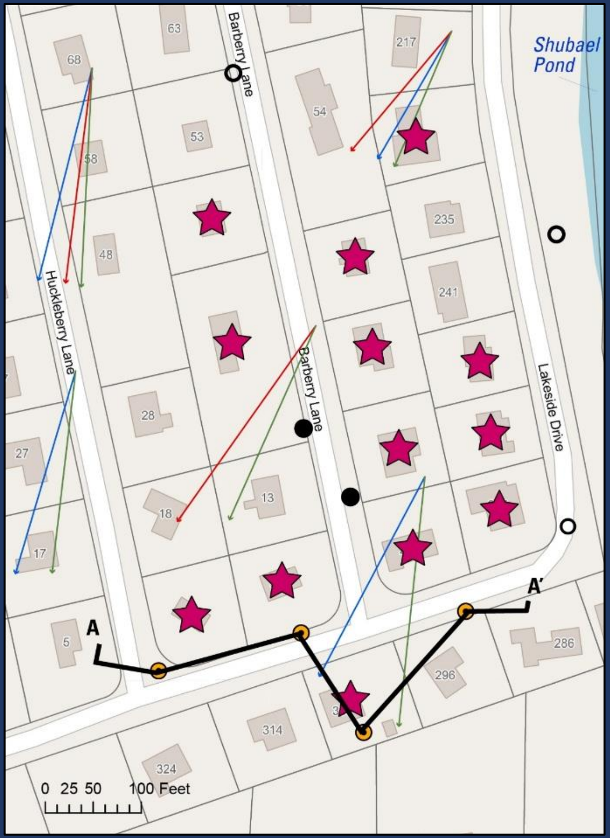
Pre-upgrade vs. post-upgrade periods

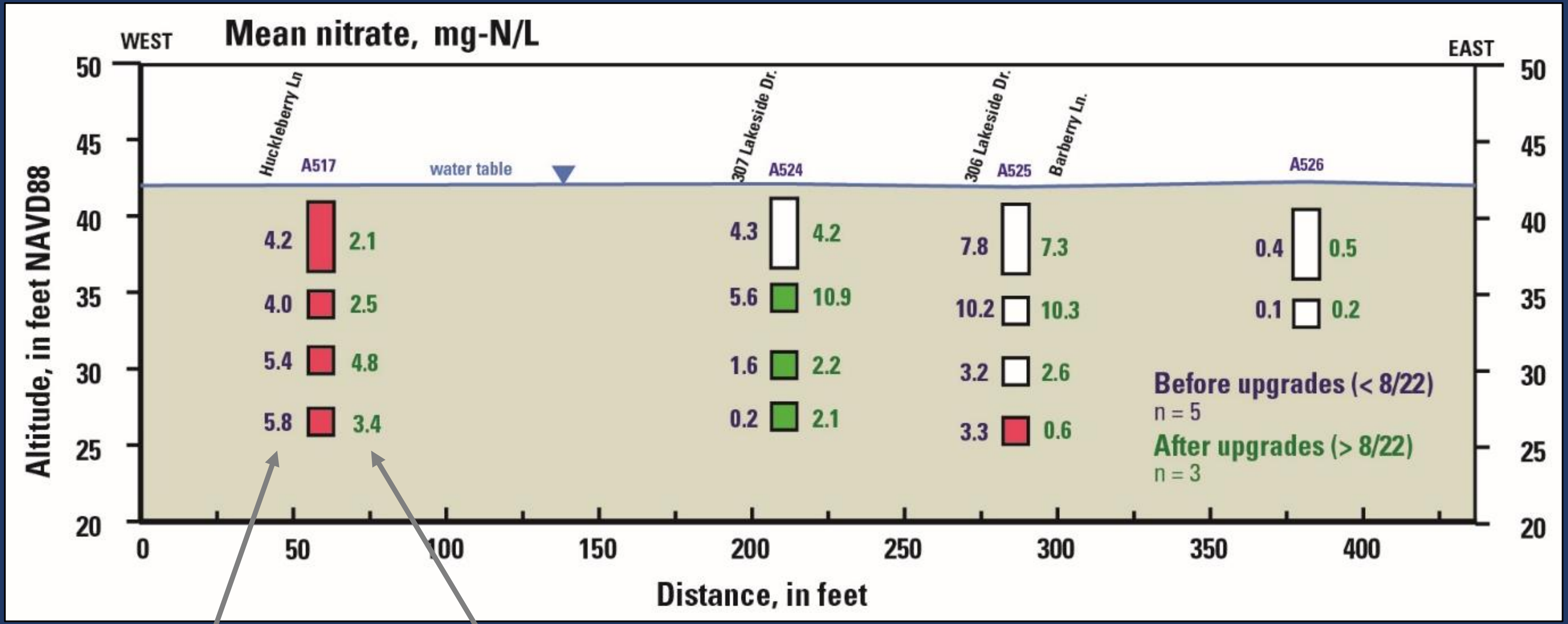




Cross section along Lakeside Dr. (south)

Mean nitrate for before and after 8/2022





Before Upgrades (n=5)

After Upgrades (n=3)

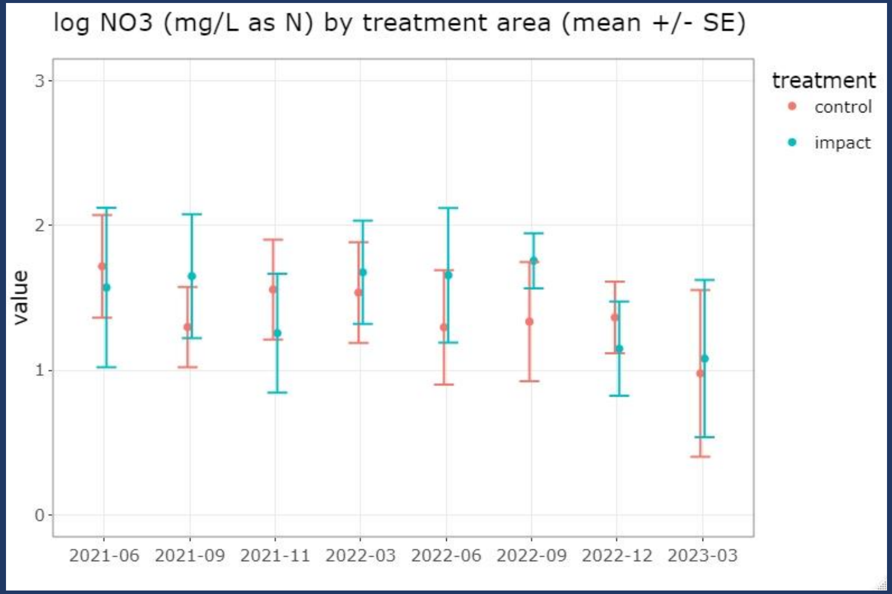
Nitrate in groundwater

Considerations and complications

Some impact sites may not show improvement, in the near or longer term because of:

- upgradient parcels that have not received septic upgrades
- final effluent disposal sites that have moved
- systems that don't achieve full design performance
- other sources of nutrient loading

Control sites vs. impact sites over time



Summary

- Eight quarterly sampling rounds show spatial and temporal variability in nitrate
- Nitrate decreases at least at two locations
- Complexities could be slowing evidence of improvements
- June 2023 (Q9) results may show additional reductions(?)

Contacts:
Tim McCobb (tmccobb@usgs.gov)
Laura Erban (erban.laura@epa.gov)

Data available online in USGS NWIS database at:
https://maps.waterdata.usgs.gov/mapper/index.html

USEPA/USGS Research on CECs in Septic Systems

Office of Research and Development
Center for Environmental Solutions and Emergency Response

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What to do to reduce on-site septic nutrient contributions?

Remove Septic Systems

↓

Falmouth, MA

Replace Septic Systems

↙ ↘

Barnstable, MA

Massachusetts Alternative Septic System Test Center (MASSTC)

Falmouth Analytes

- **113 Pharmaceuticals**
- **Sucralose**
- 16 Per-and polyfluoroalkyl substances (PFAS)
- Bacteria- culture, qPCR, and sequencing

Barnstable, MA

- Instead of removing on-site septic, systems will be upgraded.
- Analyte list expanded to include hormones and bioassays.
- Comparison between locations will provide information on management strategies.
- Conducted sampling before installation of I/A systems June 2021
- Continued June 2022 and beyond

Massachusetts Alternative Septic System Test Center (MASSTC)

- Facility with full size test systems fed with untreated community wastewater (including a prison). Systems have sampling ports at the end/ below the treatment bed and some with sampling ports after treatment steps
- Traditional systems
  - Standard stone trench with sampling points both at the full 4’ percolate and at only 1’ below the surface (4’ Stone).
  - Drip dispersal system disposal in the active bio-zone underneath the turf but in the root zone of the plants (Drip)
- I/A systems
  - Wood based layered system (aka “big layer cake”; BLC)
  - Wood Bioreactor following a nitrifying bed (“Nitrex™” equivalent; NY2)
  - NitROE™ Wood Based Denitrification (NWBD)

Methods and Analytes

- **USEPA sucralose**
- USEPA per- and polyfluoroalkyl substances (PFAS)- 23 PFAS and precursors
- USEPA CECs and EDCs- 20 different endocrine disrupting chemicals and other common CECs.
- USEPA inorganics- 33 inorganic chemicals, including nitrate, nitrite, and phosphate
- USEPA bioassay- measurement of endocrine, androgen, and glucocorticoid activities
- USEPA microorganism- combination of traditional plating, qPCR, and sequencing techniques to determine bacteria in samples
- USEPA microplastics
- **UMASS-Lowell Illicit Drugs- 15 drugs of abuse**
- **USGS pharmaceuticals- 113 analytes mix of prescription and nonprescription**
- **USGS hormones- 32 endocrine active chemicals**
- **USGS antibiotics- 33 antibiotics including fluoroquinolones, sulfonamides, tetracyclines and macrolides**
- USGS glucocorticoids- method under development to complement the bioassay analysis

Conclusions

- On-site septic treatment releases nutrients and CECs into the environment.
- Due to complex hydrology, fewer attenuation pathways, and slower subsurface processes, the effects of switching from septic to sewer will take years to realize.
- Groundwater CEC concentrations in areas with dense septic can be equivalent to those of wastewater effluent (or higher). This has potential implications for private wells in such areas.
- Both traditional and I/A septic systems demonstrate removal of CECs.
- Removal is treatment and chemical dependent.

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