# Evaluation of the Nitrogen Treatment Efficiencies of 10 Septic Systems in Eastern North Carolina


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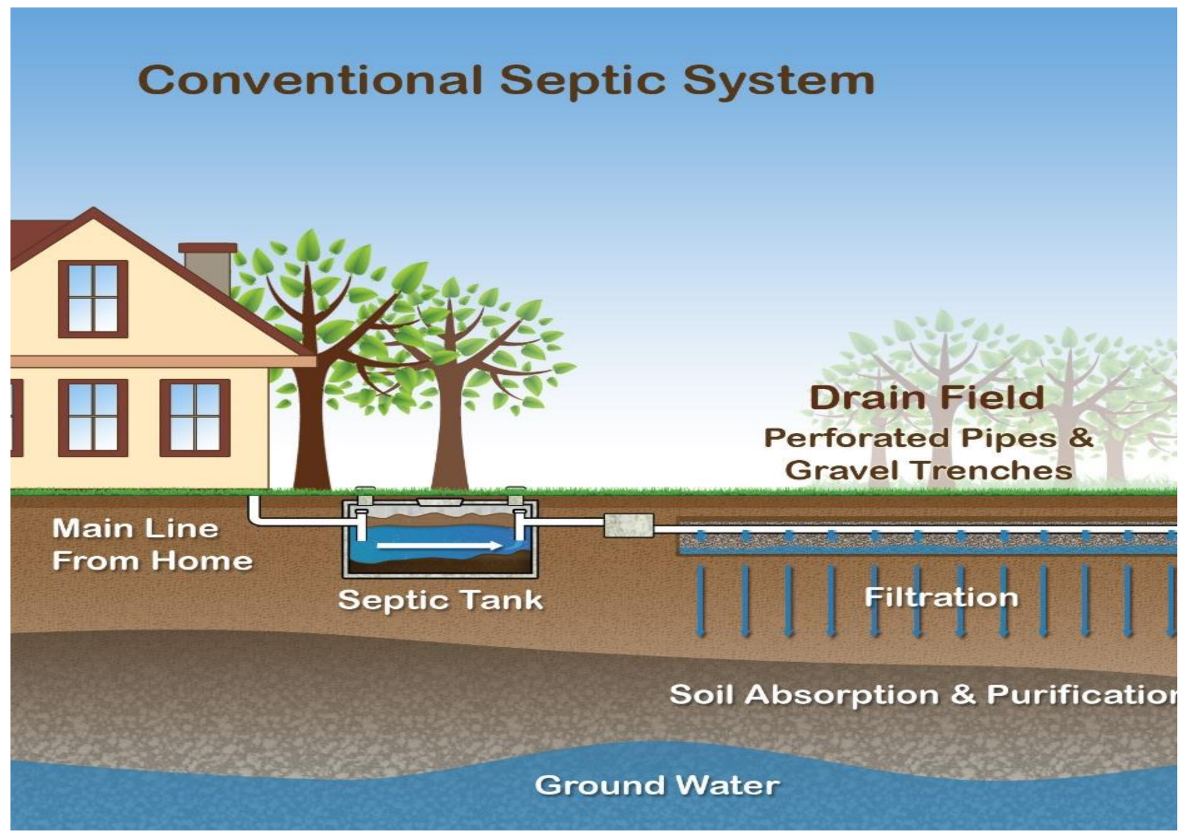
## Abstract

Excess loading of nitrogen to streams, lakes, and estuaries can lead to impairment of the water resources due to overstimulation and growth of aquatic plants and algae that can ultimately deplete dissolved oxygen levels. Septic systems treat wastewater that contains elevated concentrations of nitrogen, but most septic systems are not monitored for their nutrient treatment efficiency after they are installed. In this study, ten different septic systems across Eastern North Carolina were monitored for their nitrogen treatment efficiencies by comparing concentrations of nitrogen in groundwater collected from monitoring wells near the drain field trenches to concentrations in wastewater collected from the septic tanks. Other physicochemical parameters such as pH, specific conductance, and vertical separation distance (from trenches to groundwater) were also assessed over a year-and-a-half span at each site. The specific septic system technologies evaluated included gravity-fed conventional, pump-to-conventional, and low-pressure pipe systems. This poster will provide a review of the treatment efficiencies of the 10 systems.


## Introduction

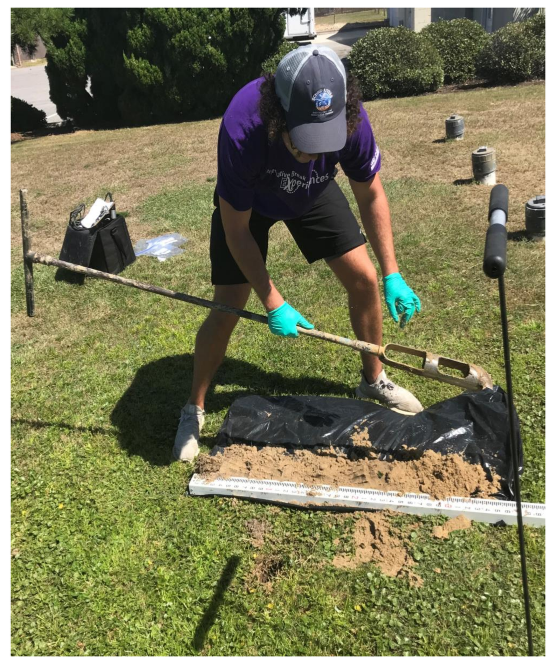
- Nitrogen (N) often limits primary productivity in surface waters
- Excess loading of N to surface water can stimulate algal blooms and eutrophication
- Some algal blooms produce toxins that are deadly to humans and animals
- Reducing N loading to surface waters is important for public and environmental health, recreation, the economy, and coastal tourism
- Wastewater contains elevated concentrations of N, so wastewater treatment systems must be efficient at reducing N concentrations prior to discharge




- Decentralized wastewater treatment technologies such as septic systems are commonly used in rural areas of coastal NC, but monitoring of their pollutant treatment efficiency is not required.
- The goal of this project was to compare N treatment efficiency of different types of septic systems in Central and Eastern North Carolina.


Acknowledgements: Thanks to NC DEQ and NOAA for project funding, and NCSU partners for project guidance and support.


## Methods and Materials




Monitoring wells were installed between the drain field trenches of 10 septic systems in Eastern North Carolina. Groundwater samples from the wells were collected on 8 occasions during 2020-2021. Samples were analyzed for nitrogen concentration and various physiochemical properties, including pH, specific conductance, oxidation reduction potential, and temperature. Depth to groundwater and separation distance between drainfield trenches and groundwater were determined during each field event.




Wastewater samples from the septic tank at each site were collected during the field events. Wastewater samples were also analyzed for N and physicochemical properties. Differences in the concentrations of N between the wastewater and groundwater were used to assess treatment efficiency with regards to concentration reductions.

## Results and Discussion

| Location | System Type | Location | Soil Group | Vertical Separation (ft) Mean | pH | ORP | SC (uS/cm) | %TKN | %NO3 | TDN (mg $L^{-1}$) | TDN Treatment Efficiency % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BS-T | Conv | Dare | I | | 7.9 (0.5) | -151 (137) | 2799 (863) | 99.8 | 0.2 | 235.3 | 91.8 |
| BS-DF | | | | 5.7 (0.8) | 6.9 (0.5) | 6 (75) | 751 (511) | 7.9 | 92.1 | 19.2 | |
| JWS-T | Pump to Conv | Craven | II | | 7.2 (0.2) | -135 (106) | 1068 (425) | 99.8 | 0.2 | 66.06 | 47.2 |
| JWS-DF | | | | 14.7 (2.8) | 6.3 (0.5) | 80 (85) | 719 (276) | 12.7 | 87.3 | 34.86 | |
| OAK-T | Pump Conv | Pitt | III | | 6.9 (0.6) | -184 (75) | 823 (241) | 99.9 | 0.1 | 59.1 | 62.3 |
| OAK-DF | | | | 3.5 (2.2) | 3.7 (0.6) | 126 (98) | 270 (86) | 20.9 | 79.1 | 22.3 | |
| DP-Tank | LPP | Dare | I | | 8.1 (0.5) | -194 (49) | 2660 (1117) | 98.7 | 1.3 | 185.5 | 80.5 |
| DP-DF | | | | 2.4 (0.6) | 6.2 (0.5) | 49 (96) | 782 (370) | 17.3 | 82.7 | 36.26 | |
| MB-Tank | LPP | Dare | I | | 7.6 (0.4) | -181 (59) | 1554 (447) | 99.8 | 0.2 | 94.75 | 61.6 |
| MB-DF | | | | 2.9 (0.4) | 7.1 (0.5) | 41 (139) | 952 (439) | 3.2 | 96.8 | 36.43 | |
| WC-Tank | LPP | Craven | I | | 7.2 (0.5) | -139 (93) | 678 (306) | 99.3 | 0.7 | 33.2 | 56.0 |
| WC-DF | | | | 3.7 (1.1) | 6.2 (0.4) | 7 (78) | 330 (255) | 8.2 | 91.8 | 14.62 | |
| FL 100-T | Conv | Durham | II | | 6.94 (1.3) | -120 (118) | 1604 (1064) | 99.9 | 0.1 | 69.4 | 54.3 |
| FL 100 DF | | | | 3.1 (1.68) | 5.92 (1.0) | 211 (191) | 852 (482) | 7.3 | 92.7 | 31.7 | |
| FL 200 -T | Conv | Durham | II | | 7.01 (0.2) | -196 (99) | 1916 (429) | 99.9 | 0.1 | 62 | 64.7 |
| FL -200 DF | | | | 0.0 (.14) | 6.3 (0.2) | 5 (99) | 604 (138) | 50.0 | 50.0 | 21.9 | |
| FL 300-T | Conv | Durham | II | | 6.81 (0.2) | -200 (52) | 2592 (570) | 100.0 | 0.0 | 129.2 | 85.7 |
| FL 300-DF | | | | 1.0 (0.6) | 3.8 (0.3) | 164 (68) | 1100 (305) | 9.3 | 90.7 | 18.5 | |
| FL 400 T | Conv | Durham | III | | 7.3 (0.1) | -220 (55) | 1872 (419) | 100.0 | 0.0 | 77.3 | 94.6 |
| FL 400 DF | | | | 1.7 (0.7) | 4.2 (0.3) | 111 (101) | 345 (118) | 41.4 | 58.6 | 4.2 | |

Mean pH for wastewater was greater than groundwater at each site likely due to mixing with acidic groundwater and nitrification (loss of H from $NH_4$ conversion to $NO_3$). The mean ORP of wastewater was much lower relative to groundwater due to reducing conditions in the septic tank. Specific conductance of wastewater was also elevated relative to groundwater because of the higher concentrations of ions in wastewater.

Mean and standard deviation of physicochemical parameters for wastewater and groundwater displayed. TDN treatment efficiencies ranged from 47 to 94%. The gravity conventional systems had the highest mean TDN efficiency of 78% followed by low pressure pipe systems (66%) and pump to conventional (55%). Nitrate was the dominant N species in groundwater beneath the systems except for at FL-200 where TKN and NO3 were similar. FL-200 had the lowest mean separation distance to groundwater.