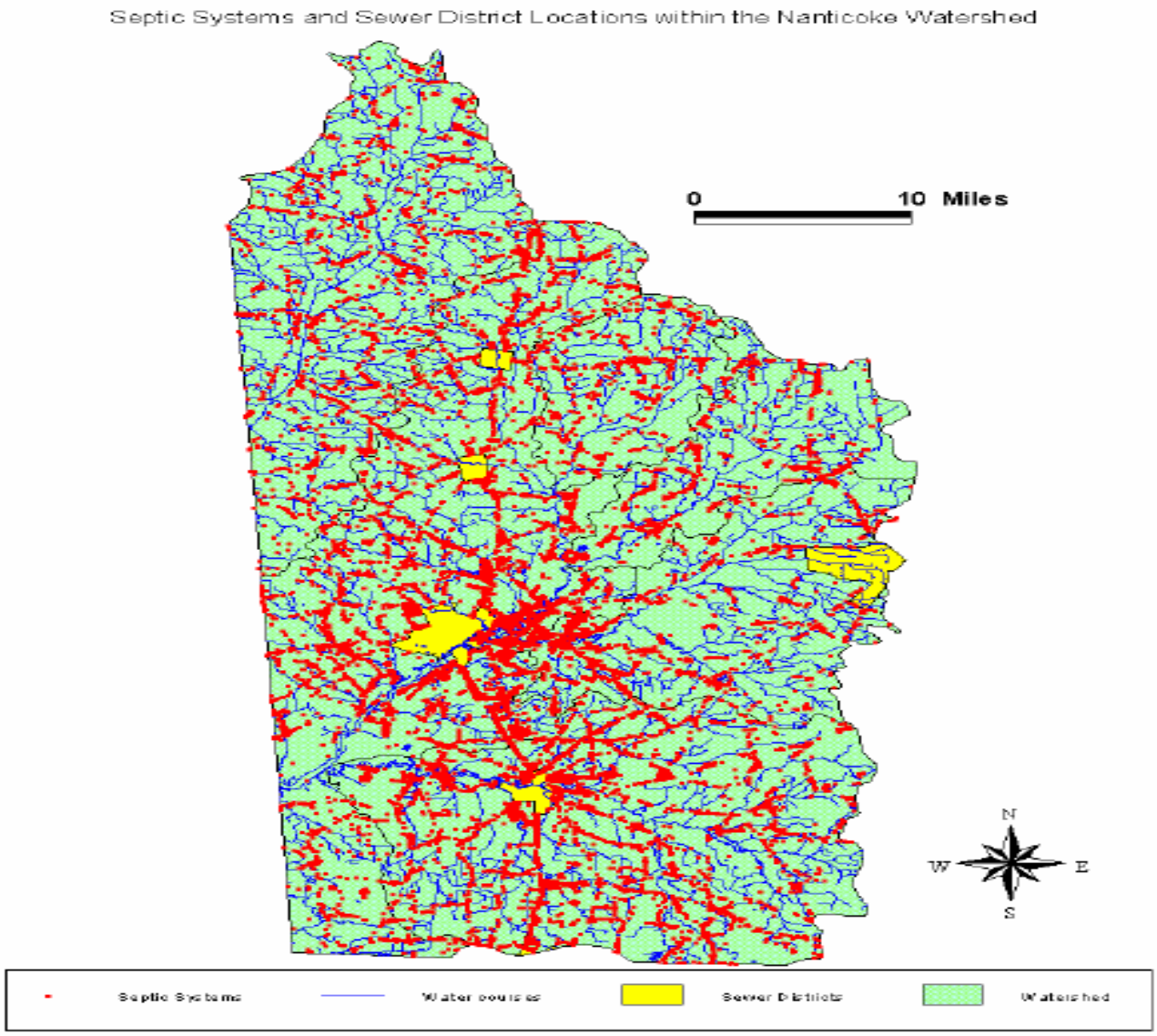
SEPTIC SYSTEMS AND NITROGEN AND PHOSPHORUS LOADING



Issue Definition

Septic systems (or onsite wastewater disposal systems) are mini-wastewater treatment plants buried in your backyard. Even if property maintained, these systems are a source of nutrient pollution to both ground and surface waters. Currently, 15,000 septic systems serve homes and other structures in the Nanticoke watershed (which includes the Broad Creek and Marshyhope). [1]

In Delaware, surface and ground water are directly connected; so what gets in the groundwater will eventually surface in rivers and streams. In the summer, surface water flow comes primarily from groundwater seeping into the stream. So, nutrients from septic systems will reach the surface water through the groundwater.

In 1994, scientists studied nitrate content of the groundwater under 31 homes near Moores Lake, located in the St. Jones watershed[2]. The data shows that it takes 19 years for nitrates to leave the groundwater after property owners remove septic systems. The groundwater lost nitrates at a rate of 0.33 mg/l per year over the course of the study. Thus, nitrate contributions from septic systems take years to leave the ground and surface water systems.

Water Quality Impacts & Typical Loadings

Each septic system in the Nanticoke watershed contributes nutrients to the groundwater--about 0.05 lbs of total nitrogen (N) and 0.002 lbs of total phosphorous (P) per day (18.25 of N and 0.7 lbs of P per year). This means that the following

[1] Determined by Whole Basin Study Chesapeake Team

[2] Blaier, Scott. 1994. Moores Lake: A study of the effect of septic systems on groundwater quality. Delaware Department of Natural Resources and Environmental Control.

amounts of N and P from septic systems could enter the Nanticoke:

- 16% of the nonpoint total N load (785 lb per day)
- 25% of the nonpoint total P load (29.3 lb per day)

These loads were calculated using a model published by several researchers[5]. The model used hydrogeological conditions in the watershed, septic system numbers and various parameters from several studies that are cited within this fact sheet.

What Affects the Amount of Nutrient Loading?

1985 Septic System Regulations

These regulations require larger drainfields resulting in a lower effluent loading rates for the soil (gallons of effluent per square foot of drainfield) and a vertical separation from the ground water table. Lower loading rates allow the soil more time to renovate the effluent—thus, reducing the amount of nutrients that reach groundwater.

Septic system pump-outs

Scientists have determined that 48% of total phosphorous is removed from the nonpoint source through routinely pumping the septic tank[3]. Consequently, only 52% of the total phosphorous in the effluent could leach into the soil beneath the drainfield.

Soil Type & P Absorption

The Red Mill Pond study demonstrated that approximately 85% of the phosphorous is absorbed by the soil under the drainfield[1]. This watershed has soils that are very similar to the soils around Red Mill Pond.

Distance to Water Table & Soils

Of the existing septic systems within the Nanticoke watershed, 30% of these systems are on soils with water tables shallower than 20 inches and 73% of them are on soils shallower than 4 feet. The soils in this watershed do not have the best assimilation capacity for phosphorus and will easily transmit nitrogen into the groundwater due to the shallowness of the water table. Very sandy soils occur along the main stem of the Nanticoke River and Broad Creek. These soils cannot retain much nitrogen or phosphorous, so nutrients have a better chance to seeping into groundwater and ultimately surface water.

Distance to Surface Water

Although all septic systems discharge into groundwater and then surface waters and pollute the River, septic systems that are close to an actually water body discharge more pollutants since there is less space and time for nature to remove the nutrients. Within the Nanticoke watershed 17 % of the existing septic systems are within 250 feet of a waterbody. 38% are within 500 feet of a watercourse. In fact, 71% of the septic systems in the watershed are within 1000 feet of a waterbody. Within 500 feet, septic systems may virtually directly feed their effluent into the surface waters.

Due to the soils within the watershed and the proximity of the septic systems to groundwater, septic systems could be a significant source of nutrient to the watershed.

Other Techniques to Reduce Nutrients

Through regularly having septic systems pumped out (for example, every 3 years) the annual rate of nitrogen influx will be decreased. Septic systems discharge water with 59mg/l of nitrogen while wastewater treatment facilities discharge nitrogen at 10 mg/l. Regular septic system pumping would eliminate approximately 14 lbs of phosphorous. This would cost about $175 per pump-out.

Other measures that homeowners could take to reduce nitrogen would be to use low flow fixtures, reducing the amount of water being put into the septic system (but increasing the nitrogen concentration of the effluent in the system).

[3] "Integrated Risk Assessment/Risk Management as Applied to Decentralized Wastewater Treatment: A High-Level Framework" edited by Daniel Jones of Oak Ridge Research Laboratory (May 2000).

MANAGEMENT TECHNIQUES & TYPICAL REDUCTIONS

- By mandating routine pumping of septic tanks in the watershed, approximately 14 lbs of phosphorous could be eliminated. This would cost about $175 per pump-out.
- Require any new or replacement septic system within the Nanticoke watershed to have alternative technology that reduced nutrients. No loads have been calculated.
- Retrofit all septic systems in the watershed with technology that reduces nutrients. Approximately 400 lbs of total nitrogen could be eliminated.

NUTRIENT LOADING TABLES

AQUIFER PARAMETERS USED TO ESTIMATE SEPTIC SYSTEMS LOADS *

Size of Nanticoke Watershed	315,000 ac
Hydraulic Conductivity [a] of Aquifer [b]	80 ft/day[1]
Hydraulic gradient [c] of Aquifer	0.0015 ft/ft[1]
Aquifer mixing thickness	50 feet[2]
Aquifer width	88704 feet

[1]Hydraulic conductivity is the rate at which water can move through permeable aquifer.
[b]Aquifer is a geologic formation that is saturated and is sufficiently permeable to transmit water to wells.
[c]Hydraulic gradient is the driving force that moves the water through the aquifer.
1 Determined by Whole Basin Study Chesapeake Team
2 Denver (1986) Chesapeake Basin Assessment

SEPTIC SYSTEM PARAMETERS USED TO ESTIMATE LOAD FROM SEPTIC SYSTEMS

# of Septic Systems	15000[a]
Average Effluent Generated from Single Dwelling	221 gal/day [b]
Average Nitrate Load in Effluent	59.3 mg/l NO_3-N [bc]
Average Total Phosphorous Load In Effluent	15.7 mg/l [b]

[a] Determined by Whole Basin Study Chesapeake Team
[b] Final Report Red Mill Pond (1994)- Non-point Study on Septic Systems loading to Red Mill Pond (Two sites in New Castle County were included in a 319NPS protect. [A project (1997) to Renovate Failing Gravity Septic Systems with Earthworms.] These two sites average water usage was 190 and 287 gallons per day.
[c] EPA Estimate is 63 mg/l NO_3-N

HYDROLOGIC PARAMETERS USED TO ESTIMATE SEPTIC SYSTEM LOADS

Median Nitrate Concentrations in Groundwater	4.4 ppm [1]
Average Total Phosphorous Concentrations in Groundwater	0.08 ppm[1]
Average Nitrate Concentrations in Precipitation	2.0 ppm
Average Total Phosphorous Concentrations in Precipitation	0.00 ppm
Groundwater Recharge by Precipitation	14 inches per year

[1] Chesapeake Basin Assessment (2001)

ESTIMATED SEPTIC SYSTEM LOADING FOR TOTAL NITROGEN AND PHOSPHOROUS TO GROUNDWATER

Parameter	lbs/ day
Nitrate Loads From Existing Conditions with Septic Systems	6499
Nitrate Loads From Existing Conditions with No Septic Systems (Comparison) [1]	242
Potential Nitrate Loads Septic Systems (Assuming no loss through biological processes)	**785**
Total Phosphorous Loads From Existing Conditions with Septic Systems	33.6.
Total Phosphorous Loads From Existing Conditions with No Septic Systems (Comparison)	4.4
Potential phosphorous load from septic systems (Assuming no loss through by soil absorption)	**29..3**

[5]Calculations were done using a model published (Estimating Ground-Water Quality Impacts from On-Site Sewage Treatment Systems by B. J. Bauman and W. M. Schafer) in On-Site Wastewater Treatment- Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems held at New Orleans, Louisiana, December 10-11, 1984.

NANTICOKE WATERSHED

This fact sheet was prepared by the Delaware Department of Natural Resources and Environmental Control's Whole Basin Team, at the request of the Nanticoke Tributary Action Team for citizens and stakeholders.

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