

REPORT ON THE POTENTIAL NEED FOR IMPROVEMENTS IN SEPTIC SYSTEM DESIGN, OPERATION AND SITING STANDARDS IN THE FALLS LAKE WATERSHED

Purpose

Session Law 2009-486 (Senate Bill 1020) was enacted to restore and protect water quality in the Upper Neuse River Basin, particularly Falls Lake. In addition to implementing more stringent sedimentation control standards and encouraging early adoption of nutrient reduction measures in the Falls Lake watershed, the bill directed the Department of Environment and Natural Resources, in consultation with the EMC, to identify improvements needed in the design, operation and siting of septic tank systems in order to reduce excess nutrient loading from such systems into Falls Lake. The Department is required to report its findings and recommendations for specific changes to septic system standards adopted by the Commission for Public Health pursuant to G.S. 130A-355 to the Commission for Public Health and to the Environmental Review Commission. The Department has interpreted the legislative direction to focus on the question of whether new septic systems in the Falls Lake watershed should be required to meet more stringent design and/or siting standards.

Modeling Nutrient Loading from Septic Systems

The Division of Water Quality used the Watershed Analysis Risk Management Framework (WARMF) model to estimate contributions of various potential sources of nutrients to the Falls Lake Watershed. As part of this modeling effort, DWQ estimated that about half of the population of more than 200,000 in the Falls Lake watershed relies on an on-site wastewater system -- predominantly septic systems. The modeling efforts were concentrated in the five tributary basins to the Upper Falls Lake (Little, Eno, Flat, Knapp of Reeds and Ellerbee Creek). These are called calibrated watersheds and comprise about 55 percent of the septic system population.

The WARMF Model estimates that approximately 9 percent of the phosphorus and 14 percent of the nitrogen reaching the lake could be attributed to on-site wastewater systems during the 2004-2007 time period. These percentages represent potential nutrient inputs from failing septic systems; properly functioning septic systems; and residential sand filter systems that are permitted to discharge to surface waters. (See Section 3.9 of Falls lake WARMF report.) As a result, the total contribution estimated by the model includes both septic systems and residential systems designed to discharge wastewater.

The Division of Environmental Health, On-site Water Protection Section (OSWPS), has reviewed the results of the WARMF Model with local health departments that permit septic systems in the Falls Lake Watershed. The OSWP Section and the county health departments believe the nutrient contribution assigned to on-site wastewater systems by the WARMF Model is high. In part, this may result from assumptions used in the model about the amount of phosphorus and nitrogen discharged

from a septic system that actually reaches Falls Lake. Phosphorus is known to have limited mobility in the soils common to the Falls Lake Watershed. Nitrogen is water soluble and the potential for its movement in soil and groundwater is well documented. However, little research is available on nitrogen migration in the soils common to the Falls Watershed.

The WARMF model assumes a 15% failure/poorly functioning rate based on the Environmental Protection Agency's Onsite Wastewater Treatment Systems Manual. Some local data suggests that the rate may be high at least with respect to more recently installed septic systems. In 2003, Wake County conducted a survey of septic systems that were installed between 1982 and 2002. Wake County found a county-wide failure rate of 9.7%, (30 failures out of 310 inspections); in the Falls Lake watershed, the survey found a failure rate of only 6.3% (seven failures of 111 inspections). An Orange County survey of systems that involved pumping to conventional lines found a 4.3% failure rate of systems that were less than eight years old (35 failures out of 820 inspections) and a 9.5% failure rate (43 failures of 452 inspections) of systems that were older. The failure rate may well be higher with respect to septic systems that are older and located on very small lots. Finally, it is important to remember that the estimated nutrient load in the model included systems that are permitted to discharge to surface waters as well as septic tank systems that discharge subsurface. All of these factors would be expected to produce a higher estimated nutrient load than would be associated with properly functioning septic systems.

Findings

The OSWPS, in its review of all available data, found no basis for concluding that properly functioning septic systems significantly contribute to nitrogen and phosphorus levels on the Falls Lake Watershed. However, failing or malfunctioning septic systems and surface water discharging systems pose continuing problems and contribute to increasing nutrient levels in the watershed.

Properly Functioning Existing Septic Systems

Monitoring data from sub-watersheds in the Falls Lake Basin that are predominately populated by homes on septic systems, though limited, has been evaluated to assess the actual contributions of properly functioning septic systems. Properly functioning systems have no direct surface water discharge and primarily contribute to the base flow of the streams draining into the basin, as opposed to stormwater discharge which is dominated by surface runoff. Available nitrogen and phosphorus data collected from surface waters in small streams in seven Falls Lake sub-watersheds show nutrient loads at or only slightly elevated above levels measured in forested or very low density catchments. Based on measurements in these monitored watersheds, the percentage of nitrogen and phosphorus that is reaching the streams from properly functioning septic systems is generally lower than the loading predicted for the upper five calibrated sub-watersheds using the WARMF model.

The table below shows measured loads in the Falls Lake watershed. The data comes from monitoring programs undertaken by the United States Geological Survey and by Wake County under a grant from the Department of Environment and Natural Resources. The first subbasin shown on the chart, Rhodes Creek in Duke Forest, has no population on septic systems and represents background levels.

The population on septic systems generates approximately 12.8 pounds of nitrogen and 1.64 pounds of phosphorus per person per year. This estimate is used to determine the percentage of septic system-generated nitrogen and phosphorus actually delivered into the respective streams. The measured nutrient loads, taken from Wake County and U.S. Geological Survey monitoring, show the actual

nutrient levels in each stream. This number, divided by the amount of nitrogen and phosphorus generated by the population, provided the percentage of those nutrients delivered into the streams.

The “delivered to stream” percentage in the last two columns assumes that all of the measured nitrogen and phosphorus load in these streams comes from the septic systems in each respective watershed. The WARMF Model estimated that septic systems account for between 4 percent and 28 percent of the nitrogen and between 2 percent and 17 percent of the phosphorus reaching Falls Lake. The calculations below make a more conservative assumption than the WARMF model (i.e., these calculations assume that all of the measured nitrogen and phosphorus in the streams came from septic systems), but the percentage of stream-delivered nutrients is consistently less than the WARMF-projected septic system loads.

Measured Nutrient Loads in Falls Lake Watershed Catchments Compared to Septic System Generated Loads

Basin	Population Area, mi ²	Population on Septic (pop/mi ²)	Septic-Generated Nutrients (lb/d/mi ²)		Measured Load in Stream (lb/d/mi ²)		Delivered to Stream (% Septic Generated)	
Rhodes Cr.** (background)	0.19	0 (0)	-	-	0.57	0.012	-	-
Seven-Mile Cr.**	0.13	113 (869)	30.4	3.90	0.139	0.0068	0.46	0.18
Cabin Branch**	0.12	103 (858)	30.2	3.86	0.57	0.0178	1.89	0.46
Crooked Cr.**	0.64	492 (769)	27.0	3.45	1.53	0.0286	5.67	0.83
Beaverdam Cr.*	2.42	264 (109)	3.83	0.42	0.20	0.024	5.1	5.7
New Light Cr.*	12.31	1645 (134)	4.68	0.60	0.37	0.033	8.0	5.4
Honeycut Cr.*	1.62	718 (443)	15.5	1.99	0.33	0.025	2.2	1.3
Cedar Cr.*	1.50	1271 (847)	29.7	3.81	0.66	0.039	2.2	1.0

*Wake County 319 Monitoring Sites (2008-09, biweekly and monthly sampling, total load est.)

**US Geological Survey Study (Base-flow monitoring data, mean of five sample days, 2004-05)

On a pounds-per-square mile basis, these watersheds show minimal increases in nutrient loads in their streams, compared to the background basin with no homes (Rhodes Creek in Duke Forest). The population density on septic systems in six of these seven watersheds monitored in the table above are similar to or higher than the average population density population density in the Falls Lake Watershed, which is 138 people per square mile. Four of these basins (Seven Mile, Cabin, Crooked and Cedar) have among the highest septic system densities of any of the Falls Lake catchments.

Malfunctioning Existing Septic Systems

Malfunctioning or failing septic systems and older surface-discharging systems can be an additional source of nutrients. These systems are primarily located in older housing developments with small lots and poor soil conditions. The majority of these systems were either permitted prior to the start of the statewide on-site wastewater program in 1977 or before septic system standards required a repair area (1982).

Malfunctioning on-site systems and older permitted surface-discharging systems have more potential to contribute nutrients to the watershed than properly functioning systems. This occurs because the discharge follows a more direct route into surface waters, with little or no attenuation by passage through the soil which occurs with properly functioning systems. This would be one of the reasons that both the WARMF Model and water quality monitoring data in the Falls Lake basin reflect the greater significance of nutrient loading received during storm events. High concentrations of nutrients and bacterial contaminants have also been measured from discharging sand filters by the City of Durham and DWQ.

Information varies on the extent and distribution of malfunctioning systems. A recent county-wide survey conducted in Wake County attempts to capture this information, but the survey was limited to systems permitted since 1982. Most of the systems surveyed in the Falls Lake Watershed portion of the county for this study were relatively young systems in excellent soils. No survey information is available on the malfunction rates of older systems (e.g., pre-1982) in the triassic soils of the Falls Lake Basin, which are suspected to be the most likely sources of significant septic-system generated nutrients in the watershed.

Conclusion and Recommendations

Existing information does not support a finding that new septic systems are a significant contributor of nutrient loading in the watershed. Refinements to septic system standards in recent years and increasing lot sizes (for a variety of reasons, including requirements associated with other regulatory programs) tend to reduce the risk that newer systems will fail. Nutrient loads from onsite wastewater systems by category—older malfunctioning septic systems versus recently installed septic systems or discharging sand filter systems—have not been established, but available data indicates that septic systems sited on lots that meet current standards are not a significant contributor to nutrient loading in the Falls Lake watershed. As a result, the Department does not have a recommendation for changes in septic system standards at this time.

The Department has identified measures that should be taken to gain a better understanding of the nutrient contribution of properly functioning septic systems and to reduce excess nutrient loading from failing septic systems and discharging sand filter systems:

1. Additional efforts should be made to determine the potential effects of properly functioning septic systems on nutrient levels in the lake, including an extensive literature review focused on data from other areas with soils similar to those in the Falls Watershed; research on the amount of nitrogen that leaves a septic system; and research on the rate of movement of nitrogen through different soil types in the watershed. This research would provide a better basis for evaluating the potential contribution of properly functioning septic systems to nutrient levels in the lake and may identify the need for limitations on septic system use in some types of soil.
2. The Department, in cooperation with local governments and other agencies, should continue monitoring instream nitrogen and phosphorus levels in the watershed. The estimated percentage contribution from properly functioning septic systems should be updated on some regular basis as more and better information is developed on the amount of nitrogen loss from a properly functioning system; the contribution from failing or discharging systems; and movement of nitrogen and phosphorus through different soils.

3. Enhanced efforts are needed within the Falls Lake Watershed to identify malfunctioning septic systems and systems that were permitted to discharge to surface waters and to have those systems repaired or connected to sewer. Legislation may be needed to clarify jurisdiction over some of the systems permitted to discharge prior to 1977 in order to require appropriate repairs or replacement.
4. Wastewater system maintenance should be considered for all septic systems in the Falls Lake watershed. Certified operators are currently required to inspect more complex on-site systems and those with treatment units, but similar inspections are not required for conventional systems or small systems permitted by Division of Water Quality. A more systematic approach to operation and maintenance of all on-site systems would assure that the systems function as designed. Regular maintenance would also prolong the system's life. The On-site Water Protection Section in Division of Environmental Health recommends that septic systems be inspected at least every five years by a certified Point of Sale inspector under G.S. 90A-70 through G.S. 90A-79. Any failures identified should be reported to the local health department.

Examples of comprehensive operations and maintenance programs can be found in a number of states, including California, Minnesota, Wisconsin, Iowa, Tennessee, New Jersey and Washington. Many of these programs are modeled on the Environmental Protection Agency's management guidance manual and incorporate elements such as public education and participation; planning; operation and maintenance and financial assistance.

Operation and maintenance programs can take different forms – some are mandatory and others are voluntary and incentive based. Mandatory O & M programs may require the septic system owner to have a contract with a management entity permitted to operate the system. In other cases, the septic systems are actually owned and operated by the management entity.

In North Carolina, the Town of Nags Head has a voluntary maintenance program for septic systems. Under the program, septic system owners can receive free inspections. If the owner has the septic tank pumped as a result of the inspection, the Town provides a credit voucher worth \$30 towards the cost of water service on the owner's water bill based on proof of pump out. The septic inspection reports are entered into a town operated database to track failures, site use, age of system, size of tank, location of system in relation to surface waters, among other items. To assist property owners with failing septic systems, the Town also offers a low interest loan program to owners of malfunctioning systems in need of repair or replacement.

5. Educating septic system owners about the proper use and operation of an on-site system is critical to minimizing the effects of septic systems on the Falls Lake watershed. Educational information such as brochures or door hangers could be made available to homeowners through realtors, lending institutions, local health departments, cooperative extension services or schools. Educational material should address issues affecting the performance of a septic system, including the use of garbage disposals and water softener on system and the effects of grease on drainfields. Educational information could also address the advantages of low flow fixtures and the importance of system maintenance.