Finding and evaluating septic systems using electromagnetic induction (EMI)

Brad Lee
Byron J. Jenkinson, James A. Doolittle, Richard S. Taylor, and J. Wes Tuttle

Abstract Text:

Locating existing septic systems and determining the extent of soil contamination after septic system failure can be destructive, time consuming, and a nuisance to homeowners. The objective of this study was to determine the effectiveness of noninvasive electromagnetic induction (EMI) for locating a failed septic system in fine-textured glacial-till-derived soils. Components of a failed septic system were located with a push probe, georeferenced with a theodolite, and surveyed with a dual receiver EMI sensor (DUALEM-2) in December 2001 (wet soil moisture condition) and July 2002 (dry soil moisture condition). Three transects located perpendicular to the soil absorption field trenches were sampled to a depth of 1.2 m and used to ground reference the EMI survey. Near-surface (1-m depth) apparent conductivity (ECa) was significantly correlated to unweighted average electrical conductivity from soil saturated paste extracts (ECsat; r = 0.79). The ECa below the soil absorption field was higher than the surrounding native soil under both dry and wet soil moisture conditions. Individual soil absorption trenches had a higher ECa than background ECa under both soil moisture conditions. A higher ECa
pattern that was apparent in December 2001 associated with discharge of wastewater at shallow depths was not evident in July 2002 after the system had been abandoned for 6 mo. While more research is warranted, results from this study suggest that electromagnetic induction is a promising technique to identify the location of septic system components, failed septic systems, and their associated effluent plumes.

Brief Biography:
Brad Lee is currently an Associate Professor and septic system Extension Specialist in the Agronomy Department at Purdue University. Brad earned his B.S. and M.S. degrees in Soil Science from Oklahoma State University and his Ph.D. degree in Soil and Water Sciences from the University of California - Riverside in 1999. Brad worked as an environmental consultant to the CALFED Bay Delta Authority before starting a career at Purdue University in 2001.

Membrane bioreactor (MBR) technology: The new kid on the onsite wastewater block

Sara Christopherson

Abstract Text:

MBRs were first developed in the 1960s, but have seen significant advances since the late 1990s. MBRs are a combination of two basic processes – biological degradation through the activated sludge (AS) treatment process and membrane separation – into a single process where suspended solids and microorganisms responsible for degradation are separated from the treated water by membrane filtration units which pull water through a membrane. Although there are many design of MBRs, there are typical characteristics of the MBR system commonly available. Most of the MBRs use ultra-filtration with a 0.02 to 0.05 micron pore size which traps solids on the outside. The membrane is typically made of polypropene, cellulose acetate, aromatic polyamides or thin-film composite. The AS process combined with the membrane is able to achieve very high removal efficiencies of organic material with >95% common for biochemical oxygen demand (BOD) and total suspended solids (TSS). MBRs with advanced removal process design have been found to eliminate 60-90% of total nitrogen and phosphorus in bench scale testing. In order to achieve these types of nutrient reductions special design considerations were required. These design modifications include varying aeration schemes and recirculation of effluent to an anaerobic mixing tank. Life expectancy, cost and maintenance needs and potential applicability for dwellings versus cluster systems are issues of current evaluation as this technology is being scaled back for the decentralized market.

Brief Biography:
Since 1998, as an engineer in the Onsite Sewage Treatment Program at the University of Minnesota, Sara Christopherson has been providing education and technical assistance to homeowners, small communities, onsite professionals and local units of government regarding onsite wastewater treatment.

Sara serves on the board and chairs the education committee of both NOWRA and the Minnesota Onsite Wastewater Association (MOWA). She is also the chair of the Minnesota State Advisory Committee on Decentralized Systems.

She has a MS in Water Resource Science (WRS) and a BS in Biosystems and Agricultural Engineering and is currently enrolled in a PhD program in WRS at the U of MN.

Water usage in rental communities: Design theory versus field realities

Gerry Curran

Abstract Text:

Many coastal environments are unsewered & rely on conventional septic tank/soil disposal systems & innovative onsite systems to treat the wastewater generated. A high percentage of properties in these coastal areas are rental homes. It has long been suspected that these rental properties are responsible for high wastewater production, above and beyond permitted design flow levels. It was proposed to monitor the water usage at a representative selection of beach resort properties. A two mile section of beach front dwellings on Ocean Boulevard West, Holden Beach, Brunswick County was selected. A total of 184 dwellings were monitored (479 – 849 Ocean View Boulevard West). 152 of the dwellings were rental homes; the remaining 32 homes considered private dwellings. Water meter readings were taken at various intervals over a 34-day monitoring period. Each water meter records water usage at the dwelling in increments of 1 unit. 1 unit is equivalent to 100 ft3 (cubic feet) or 747 gallons of water. Current N.C. State Regulations allow 120 g/bedroom/day. The permitted level of water usage per day at each dwelling was calculated using the following information:

- Permit information for that dwelling (if available).
- The no. of bedrooms at the dwelling according to property card or tax parcel info.
- The number of bedrooms advertised by the various realty & rental agencies.

It was also decided to determine how many of the dwellings monitored were in compliance with the new requirements of Rule 1970 (15 A NCAC 18 A. 1970) i.e. how many would have been in compliance from a water usage perspective with the new rule. Specifically, how many dwellings monitored exceeded 1.3 times design daily flow for any 7-day period and how many exceeded design flow for a 30-day average? As suspected, rental properties were by far the biggest culprits in terms of excess water usage, above and beyond permitted levels and outside on-site treatment system design boundaries. Conversely, private residences, for the most part, fell well within permitted water usage levels. The persistent production of excess levels of wastewater exerts a heavy toll on onsite treatment systems. This inevitably leads to problems, inefficient treatment and early system failure. Unfortunately, problems can be difficult to diagnose or even recognize until it’s too late. The protection of coastal environments from the effects of wastewater pollution should be the top priority of all concerned. Possible solutions are available but maybe difficult to implement.

Brief Biography:
Gerry has worked as an environmental consultant for both the private and public sector in Ireland. He spent 4.5 years working as Business Development Manager for Bord na Mona Environmental in Greensboro, North Carolina. He is currently employed by Bord na Mona Environmental Limited Ireland as Sales Manager for the company’s small-scale wastewater treatment business. Gerry holds a Bachelor of Science Degree from the University College Galway, a higher Diploma in Wastewater Pollution Assessment & Control from the Sligo Institute of Technology and a Masters in Applied Environmental Science from Queen’s University Belfast.

Relationships between soil morphology and field soil hydraulic conductivity in northeastern Indiana

Brad Lee
Kelli S. Hart, Philip J. Schoeneberger and Donald P. Franzmeier

Abstract Text:

There is little information regarding how topography influences soil hydraulic conductivity (Ksat) on a toposequence. The objective of this study was to characterize Ksat across an Epiaqualf-Argiaquoll toposequence on the Wabash moraine. In situ Ksat was determined by a compact constant head permeameter at five landscape positions, at four depths (surface horizon, upper argillic horizon, transition zone between the argillic horizon and till parent material, and till) in each position. For the upper three landscape positions, Ksat was slowest in the argillic horizon (summit, 0.0076 cm hr-1; shoulder, 0.0038 cm hr-1; backslope, 0.0108 cm hr-1). At the lower two landscape positions, Ksat was slowest in the Cd horizon (footslope, 0.0040 cm hr-1; toeslope, 0.0098 cm hr-1). T-tests ($P < 0.05$) were used to compare Ksat at each landscape position and within each pedon to determine if significant differences exist. When comparing the surface horizon across the landscape, there were few significant differences in Ksat. The only exception to this was the backslope, in which Ksat was significantly slower than the footslope and toeslope. In contrast to the surface horizons, the subsurface horizons showed many significant differences in Ksat across the landscape. For the subsurface horizons, the general trend across the landscape showed that Ksat for the upper three landscape positions differed from the lower two landscape positions. Within pedons the surface horizon Ksat was significantly faster than all subsurface horizons, with the exception of the shoulder in which the surface horizon Ksat (0.1341 cm hr-1) did not differ from the BCdtk (0.0328 cm hr-1) or Cdk2 (0.0192 cm hr-1) horizons. Within the summit, shoulder and backslope pedons, Ksat was significantly different between subsurface horizons. The footslope and toeslope landscape positions showed no differences between any of the subsurface horizons. A correlation between different soil physical properties and Ksat indicate that the percentage of clay is the most significant factor ($R2 = 0.38$) affecting the slow Ksat at this study site. Results from this study show that below the surface horizon, Ksat is influenced by topographic position.

Brief Biography:
Brad Lee is currently an Associate Professor and septic system Extension Specialist in the Agronomy Department at Purdue University. Brad earned his B.S. and M.S. degrees in Soil Science from Oklahoma State University and his Ph.D. degree in Soil and Water Sciences from the University of California - Riverside in 1999. Brad worked as an environmental consultant to the CALFED Bay Delta Authority before starting a career at Purdue University in 2001.

Correlation Between Hydraulic Conductivity and LTAR?

Kevin Martin, S&EC and Dr. Bob Uebler, NCDENR

Abstract Text:

Pretreatment systems: Where to use them and how to site them

Joe Lynn

Abstract Text:

What are the specific soil and siting criteria for numerous pretreatment systems?
What does Rule .1970 require?
What is the correct type of information needed?

Water Flow below Simulated Septic System Trenches

Aziz Amoozegar
David Lindbo, and Christopher Niewoehner

Abstract Text:

When designing a septic system, it is often assumed that wastewater infiltration from the trenches into the soil and water movement away from the drain field occurs uniformly through the soil in all directions. In general, however, soils are heterogeneous and are composed of various horizons. In addition, water movement through soil pores depends on the size and shape of the pores. The main objective of this paper is to demonstrate water movement from trenches into and through different soils. To assess movement of water and dissolved solutes from trenches, four separate experiments were conducted at three sites with different soils using water and a tracer solution (containing bromide and dye). Low-pressure pipe (LPP) distribution system was used to apply water or tracer solution to four 15-ft (4.5-m) long and 12-in (30-cm) wide parallel trenches that were installed along the contour lines on a side slope in each experiment. The depth of the trenches varied among the four experiments, and the distance between the trenches was 150 cm. To apply water or tracer solution to the trenches, an individual dosing system was attached to the open end of the perforated PVC pipe in each of the four trenches, and a portable reservoir supplied water and tracer solution to each dosing device. For each experiment, a total of 50 L of water was applied once a day through the dosing device to each trench for more than 15 consecutive days. Then, 50 L of a solution containing 5 mmol/L (645 mg/L) KBr and 500 mg/L Brilliant Blue FCF (Erioglaucine) as tracers was applied to each trench once a day for 14 additional days. The amount of water or solution applied to the trenches was equivalent to an area loading rate of 7.16 L/(m2 d) [equivalent to approximately 0.18 gal/(ft2 d)] for a comparable LPP system. Two days after the termination of tracer solution application, a 40-in (100-cm) wide and 60-in (150 cm) deep observation/sampling pit (hereafter referred to as sampling pit) was dug perpendicular to the middle part of the four trenches at each site using a small backhoe. The walls on both sides of each pit were picked by hand to remove smearing before the stained areas on the walls (around and between the trenches) were inspected visually and photographed. Then a series of soil samples were collected in the horizontal and vertical directions on a 15- by 15-cm grid from the sides and below of each trench on both walls of the sampling pit. The patterns of dye movement and distribution of bromide in the soil samples from around the trenches indicated that water flow and movement of dissolved chemicals from trenches through the soil are not uniform. For trenches dug into the Bt horizon, water movement was mainly through planar voids (e.g., ped faces) and tubular pores (e.g., root channels) instead of the matrix pores (i.e., preferential flow). When the trenches were dug in the A and E horizon above the Bt layer, on the other hand, water movement from the trenches into the coarse-textured materials was relatively uniform around the trenches, while little water entered the clayey Bt horizon. It appears that most of the water applied to the trenches installed in coarse-textured soil above clayey horizon moved laterally away from the drainfield along the slope of the land, while water movement in the Bt horizon under the coarse-textured layer was mainly through macropores. Based on our results, it is clear that in the absence of a biomat water flow from septic system trenches is not uniform. Also, it appears that water flow from the trenches installed in the sandy-

textured soils is through interparticle pores, whereas in clayey-textured soil water moves mainly through macropores (e.g., tubular root channels).

Brief Biography:

Current Position:	Professor of Environmental Soil Physics Soil Science Department, NC State University
Ph.D. Degree:	Soil and Water Science, University of Arizona, 1977
M.S. Degree:	Agricultural Chemistry and Soil, University of Arizona, 1974
B.S. Degree	General Agriculture, Ahvaz Agricultural College, Iran, 1968
University of Arizona:	1978-1983
NCSU:	1983-Present
Area of Expertise:	Water movement and transport of pollutants through soils On-site wastewater management systems Soil property measurements

Licensed Soil Scientist

Inventor of the Compact Constant Head Permeameter (also known as Amoozemeter)

Oxyaquic Conditions: Soil Wetness Beyond 2 Chroma

Dr. David Lindbo
Dr. Mike Vepraskas
Roy L. Vick Jr.
John A. Kelley

Abstract Text:

The term oxyaquic conditions has heard by many over the last 20 years but may not be well understood. Part of this confusion has to do with changes in definitions and interpretations. Originally, oxyaquic conditions referred to soil that were saturated but had no redox features, were not reduced and showed no reaction to άάdp. Currently, oxyaquic conditions refer to soils that can not be classified as having an Aquic moisture regime but have evidence of saturation within the upper 40 inches of the soil. The evidence of saturation includes redoximorphic features such as depletions (of any chroma) and/or concentrations. The soil may lack these features yet if there is an observed water table (saturation) for 20 consecutive days or 30 cumulative days in a year then it may also be classified as having oxyaquic conditions. Regardless of the original intent or the current interpretation, oxyaquic conditions are used to indicate saturation without 2 chroma depletions. The implication is that the use of 2 chroma colors in the current rules may be problematic in some cases.

Brief Biography:

Dr. Lindbo earned his PhD from University of Massachusetts, Plant and Soil Science Dept. a MS from University of Massachusetts, Geology Dept., a MS from University of New Hampshire, Forest Resources Dept., and a BS from University of New Hampshire, Institute of Natural and Environmental Resources. Dr. Lindbo is an Associate Professor and Soil Extension Specialist with the Department of Soil Science, North Carolina State University. Prior to joining NCSU Dr. Lindbo taught the Soil Evaluator Course for Title 5 in Massachusetts. He has authored over 20 refereed publications and presented at state and national conferences on on-site wastewater and wetland soil research. He has presented invited talks at state and regional conferences throughout the country on topics ranging from Training Center design and curricula to soil and site evaluation. He was a member of the USEPA-NODP V Expert Panel. He serves as NCSU Soil Science Department liaison to USDA-NRCS Cooperative Soil Survey, representative on the Soil Science Society of America Board of Directors, and Associate Editor for the Soil Science Society of America Journal and chair of the CIDWT Research Committee. He has over 20 years experience in soil science and on-site wastewater fields.

New Soil and Siting Requirements for LSS Reports By DWQ

Rich Hayes, NCDENR

The Ten Commandments of Design

Tricia Angoli
Mike Hoover

Abstract Text:

Provides ten steps for design of an on-site wastewater treatment and disposal system. The steps start with determining the design flow and finish up with plans, drawings, specifications, or any other paperwork required to finish the system design for permitting.

Brief Biography:

Tricia Angoli has Bachelors and Masters degrees in Civil Engineering from West Virginina University. She worked for the National Small Flows Clearinghouse for ten years, for a private consulting firm that dealt with onsite and small community subsurface wastewater systems, and is currently with the On-Site Wastewater Branch.

Designing Sampling for On-site System Technologies

Dr. Doug Joy

Abstract Text:

The sampling of on-site systems has become a fact of life in the on-site business. While in the past sampling was the sort of activity that only took place in research and technology development environments, it is becoming increasingly common for systems in place for normal use. This is a result of a variety of reasons including: more strict conditions under which the use of advanced treatment systems are used, the advancement of performance based codes, the increasing complexity of advanced treatment systems and the reduction of factors-of-safety inherent in many older codes that relied primarily on soils to provide the majority of the treatment.

Whereas in the past the use of an advanced treatment system may have involved the use of a simple aerator and a modest reduction in the soil system required, advanced treatment systems now may have aeration systems coupled with sophisticated timers and recirculation systems and as well as complex media. In addition they are likely accompanied by significant reductions in the requirements for the soil absorption system in terms of the size, locations where they might be allowed, and reduced vertical separation requirements.

With the promise, and requirement, for high levels of treatment, the methods used for sampling on-site systems become increasingly important in the consideration of the design and construction.

Sampling of in situ systems is generally required for one or both of two reasons:

1. Ensuring the particular installation is performing up the requirements of the design and associated operating permit, and
2. Ensuring the technology, and its general manufacture, components and installation, are meeting the standards they were approved for when used in the field.

In Ontario and elsewhere, for example, all advanced treatment systems must be sampled between every 1 and 4 years in line with reason 1, above. Technology verification, reason 2 above, is required in Quebec for system certified under the BNQ protocol by requiring a certain percentage of all systems in the province be sampled every year.

Questions that arise when establishing a sampling regime include:

1. How often is a sample required?
2. Where should the sample be taken?
3. Will a grab sample suffice or will a composite sample be necessary?
4. How much will it cost?
5. Once sampled, what should the sample be analyzed for?

These are generally issues that need to be solved at the regulatory level although practitioners and manufacturers of the various technologies will want input to the process for obvious reasons.

Some problems that must be solved when deciding to sample a particular system or technology includes:

1. Will there be enough material to sample and analyze?

Flow out of a treatment system, particularly for a home, can be slow and intermittent. This is particularly true for filter media based systems. Given the constraints of time it may be unreasonable to have a system that for many visits no material is available to sample and subsequently analyze. Provisions have to be made to ensure a sample can be taken quickly.

2. Will it be possible to take a representative sample?

The key to any sampling program is to take a sample that is representative of the effluent at that point over a reasonable period of time. With high treatment values even minor disturbances can cause significant problems, for example sloughing of material can give significantly skewed results.

3. Can the sampling location be accessed easily?

Sampling, if it is going to be done efficiently and cost effectively, cannot take large amounts of time. Thus it is imperative to ensure sampling can be accomplished within a reasonable amount of time, i.e. the location for sampling has to be accessible. Taking a day to take a sample is unreasonable.

4. Will the presence of the sampling port affect the results?

Many of the parameters being analysed for, especially things like e.coli. can be significantly affected by the sampling port design. System that have standing water for long periods of time can accumulate sediments that skew the results.

5. Will the sampling affect the performance of the system?

Sampling locations at the entrance to systems (i.e. before the septic tank) are especially problematic given the highly variable nature of the quality and consistency of the entering material. While it may be desirable to have a system that effectively mixes the material prior to sampling, concerns are often raised as to how this might affect the performance of the system because of the mixing.

This paper looks at the experiences over the past 15 years at the Ontario Rural Wastewater Centre while sampling dozens of systems both in the field and in testing facilities and some of the solutions used to overcome them. This includes sampling location and port design, use of grab vs composite samplers, methods for sampling inlet to systems, and lysimeters for filter and soil-based systems.

Brief Biography:

Doug Joy has been a faculty member in the School of Engineering, University of Guelph since 1988. Since 1997 he has been the Director of the Ontario Rural Wastewater Centre at the University. His research focuses on on-site systems, their performance and their impact on ground and surface waters. In addition he is actively part of the code development and application in Ontario and Canada.

Design of Gravel Filters for Large Systems

Darren Meyers, P.E.

Abstract Text:

Gravel filter wastewater treatment systems have existed in one form or other for over a century. In every instance, theses systems involve trickling unclean water over a rock medium harboring bacterial organisms in an attempt to obtain a purer result. From its inception through the present, our understanding of this technology has grown tremendously, but there is still much we do not know. Despite almost limitless variations in criteria such as media size, loading rate, and recirculation, the essential mechanism of gravel filter treatment has remained unchanged through the years. This presentation will explore the various design considerations available with these systems, as well as the expectations for treatment and maintenance.

Brief Biography:
Darren Meyers serves as the Application Engineer for Zoeller Pump Company. His position combines nearly all aspects of Onsite Wastewater System design, including pump and line sizing for community systems, controls, biology, and treatment rates. His experiences with design and application range over a wide variety of treatment technologies, from the conventional to the highly advanced. He holds a Bachelors Degree in Civil Engineering from the University of Dayton in Dayton, Ohio, and is a licensed Professional Engineer in the State of Kentucky. His experience in the water and wastewater arena includes commercial and municipal, as well as private and residential projects.

Septic tank design, function and performance

Victor D'Amato
Sarah Liehr

Abstract Text:

The results of a Water Environment Research Foundation (WERF) project on primary treatment units (septic tanks and grease traps) in onsite systems will be presented. Overall objectives of the project were to review the literature and summarize what is known, what is unknown and what research needs exist regarding the performance of septic tanks and grease traps.

Key factors affecting the performance of primary treatment units will be discussed, including such hot-button issues as compartmentation, inlet and outlet design, shape/dimensions, influent characteristics, pumping frequency, additives, water softener impacts and construction practices. Different approaches to primary treatment will be introduced in consideration of specific process objectives (e.g., sedimentation and digestion) in onsite systems. Additionally, the existing landscape of practice, including applicable regulations, guidance materials and industry standards will be discussed. Finally, research needs will be suggested and feedback from the audience solicited.

Brief Biography:
Victor D’Amato, PE, has been involved with decentralized wastewater management for his entire professional career, having worked for the North Carolina’s On-Site Wastewater Section for over three years after earning his MS in Environmental Engineering from the University of North Carolina at Chapel Hill. He has been a Project Engineer with ARCADIS in Durham, North Carolina for over seven years, where he manages applied research projects and designs onsite treatment and reuse systems.

Use of advanced technologies for repairing failing septic systems and replacing outhouses: Case studies from Virginia.

Anish Jantrania

Abstract Text:

With more than 25 million homeowners relying on onsite wastewater systems in the United States, repairing failing systems is becoming an essential task. There are about four hundred thousand homeowners in the U.S. who use outhouses and are looking to replace their outhouses. Technological advances in onsite industry offer various tools for both repairing and replacing inadequate onsite systems. A failing septic system typically suggests that the drain field is clogged due to buildup of bio-mat or the effluent is not evenly distributed within the drain field. In either case, inadequately treated wastewater appears on top of drain field area and in some instances wastewater backs up inside the house indicating failure of a septic system and a need for repair. Homes that do not have indoor plumbing rely on outhouses for disposing of human waste into ground. Government programs offer financial assistance to some homeowners without indoor plumbing to upgrade their living conditions by bringing indoor plumbing and connecting their homes to either an onsite wastewater system or to a centralized sewer system. Advanced technologies for onsite wastewater systems can be grouped into two major categories: wastewater treatment and effluent dispersal. This paper and presentation will discuss case studies from Virginia where advanced technologies have offered solutions for onsite wastewater management in areas where soil and site conditions have been traditionally viewed as unsuitable for use of any types of onsite wastewater systems. This paper will also present a case for the need to field verify assumptions and theories traditionally incorporated in rules for designing onsite wastewater systems.

Brief Biography:
Anish Jantrania is a Technical Services Engineer at the Virginia Department of Health in the Division of Onsite Sewage and Water Services. Dr. Jantrania has over 15 years of experience working with technical issues in Onsite Industry. Before joining the Virginia Department of Health, Dr. Jantrania worked at the National Small Flows Clearinghouse for four years as a technical program coordinator and he worked in Gloucester, MA as an environmental engineering consultant for the first national onsite demonstration project funded by the U.S. EPA. Dr. Jantrania received his B.E. in Agricultural Engineering from India, M.S. in Agricultural Engineering from the Ohio State University, Ph.D. in Agricultural Engineering from Clemson University and M.B.A. from West Virginia University. Dr. Jantrania is a registered professional engineer in Virginia, Massachusetts, and West Virginia. He has served on the technical review committee for revising the U.S. EPA Onsite Design Manual and is currently serving on the NOWRA Model Performance Code primary committee and evaluation committee. Dr. Jantrania has co-authored a book “Advanced Onsite Wastewater Systems Technologies” published by the CRC Press.

Engineering and practical design of membrane bioreactors (MBRs) for small flows

Shane Keaney

Abstract Text:

The presentation will cover an overview of the different types of membrane technology
How Membrane Bioreactor systems work
What degree of pretreatment is necessary
What wastewater treatment performance can be expected
Life expectancy, cost and maintenance needs for membrane systems
Design considerations
Nutrient removal with membranes
Performance history and lessons learned
Examples

Brief Biography:
Shane Keaney is a Vice President with Bord na Mona Environmental Products US responsible for Business Development. Shane has recently moved to America having worked for Bord na Mona in Ireland and has over 15 years experience in the design, construction and project management of municipal wastewater treatment works and more recently in wastewater treatment for the on-site sector.

Prior to joining Bord na Mona Shane has worked for Degremont one of the worlds largest water / wastewater companies and South West Water one of the privatized water companies operating in the UK. Shane is an Engineering Graduate of the Queens University of Belfast.

Determining the effects of septic system vertical separation distance on groundwater quality in coastal, NC

Charles Humphrey
Dr. Michael O'Driscoll, ECU, Dr. Max Zarate, ECU

Abstract Text:

Approximately 60% of residences in coastal, NC currently rely of on-site systems for wastewater treatment and disposal and the population of Coastal Area Management Act (CAMA) counties is expected to grow 20.5% by 2020 (Tillman 2004). Much of the future growth of coastal NC will also be accommodated by on-site systems, meaning greater discharges of wastewater to the subsurface environment. Domestic wastewater that is piped to on-site systems contains many constituents (bacteria, viruses, nutrients, etc.,) that pose public and environmental health risks if they are not properly treated and disposed. In coastal NC the potential for ground and surface water contamination by human wastewater constituents is great, due to sandy (and conductive) soils, the shallow water tables, and development adjacent to surface waters such as rivers, estuaries, or the ocean. Thus, given the high percentage of the population that rely on septic systems and the soil and site conditions, the potential risk of affecting the quality of drinking water, recreational waters, shellfisheries, coastal ecology, and tourism is high. Recent studies (Nearhoof and Cahoon, 2000; Corbett et al., 2001; Borchardt et al. 2003;) have confirmed the potential for on-site systems to contribute pollutants to ground and surface waters, but there is a lack of knowledge concerning the efficiency of wastewater treatment with varying depths of soil, and the effect that system age and soil particle size distribution have on treatment in settings typical of coastal, NC. This research project aims to provide important information regarding system design, location, and zoning that can impact policy in coastal regions.

The overall goal of this project is to develop a better understanding of the relations between septic system age, vertical separation distance from system to water table, and soil particle size distribution on shallow groundwater quality. Groundwater quality adjacent to 16 septic systems is currently being monitored and compared to background groundwater conditions. Monitoring will continue for one year and will include determining the nitrogen, total coliform, E.coli and chloride concentrations in groundwater adjacent to septic systems in various settings typical of coastal areas. Bacteriological analysis of water samples will be performed quarterly, and nitrogen and chloride analysis will be performed monthly. In addition, environmental parameters including dissolved oxygen, pH, electrical conductivity, temperature, oxidation-reduction potential, and depth to water will be measured monthly for one year. We will assess the effects that separation distance (from trench bottom to water table), system age and soil particle size distribution have on wastewater treatment and shallow groundwater quality. The research project will help in determining if "subsurface treatment failures" of septic systems, in relation to state and federal water quality standards, are common in coastal areas of North Carolina.

Brief Biography:

Nitrate transport and persistence above the water table

Sergio Abit
Aziz Amoozegar, Michael Vepraskas, Chris Niewoehner

Abstract Text:

Nitrates from point sources are generally assumed to move dove downward through the vadose zone and that their horizontal transport takes place only below the water table. Laboratory studies, however, indicate that water movement and transport of pollutants can also take place in the capillary fringe (CF) above the water table (WT). This study evaluated the fate of NO3- in the CF and shallow groundwater (SGW) at a drained sandy site. The study was conducted in a sandy soil (Aeric Alaquod) with a shallow water table. Ten L of a solution containing approximately 18 mmol L-1 nitrate [2.66 g L-1 Mg(NO3)2] and 77 mmol L-1 bromide (9.12 g L-1 KBr) were applied to a small volume of soil above the CF. The movement of both NO3- and Br-was monitored for 84 days by using tension lysimeters installed at depths between 45 and 105 cm at radial distances of 20, 60, 120, 220 and 320 cm from the application point. Nitrate and Br- plumes that entered the CF from the unsaturated zone stayed and moved horizontally in the CF until they were partially carried into the groundwater by the fluctuating WT following rain events. Normalized concentrations of both NO3- and Br- remained comparable as they moved horizontally in the CF up to 320 cm from the tracer application spot. However, below the WT the detected normalized concentration of Br- was higher than that for NO3- indicating nitrate loss, perhaps due to denitrification. When monitoring subsurface NO3-, solely relying on collection of groundwater samples may lead to an underestimation of the extent of NO3- contamination and transport in the subsurface.

Brief Biography:
PhD candidate in Soil Science student at NCSU

Finished Masters at NCSU under the direction of Dr. Aziz Amoozegar and Michael Vepraskas

Solid Accumulation and Septic Tank Pumpout Frequencies

Sushama Pradhan
Michael T. Hoover

Abstract Text:

Although substantial digestion of waste occurs in septic tanks, the rate of digestion does not usually exceed the rate of solids delivery to the tanks from the household residents. Hence, septic tanks pump out on a periodic basis is an integral maintenance component to keep on-site wastewater treatment systems functioning properly and to protect environmental quality. Sludge and scum accumulation rates were studied in 48 full-scale, functioning septic tanks for over 14 months. Sludge accumulation rates averaged 2.7 in/yr for 1000-gallon septic tanks or 20 gallons/C/yr on a volumetric per capita basis for all 48 tanks. Scum accumulation rates were minimal, approximately 0.016 in/C/yr. Hence, 4.3 years or approximately four years was calculated as a reasonable average pumpout frequency across all 48 tanks. However, these very large variations in sludge depths (CV = 122%) and scum thickness (CV = 9,407%) for the 48 septic tanks indicate, therefore, that the actual needed pump out frequency intervals vary substantially from individual septic tank to septic tank. Hence, annual to biannual field inspection of solids (sludge and scum) accumulation within septic tanks is a recommended management strategy for all septic tanks. This approach assures that tanks are pumped out as needed but minimizes unnecessary tank pumpouts and the resultant environmental impacts of these.

Brief Biography:
Sushama Pradhan is a Post Doctoral research associate in the Soil Science Department at North Carolina State University. She has been involved in assessment of potential nitrogen loading from on-site systems using GIS at a watershed scale and predicting fate and transport of nitrogen derived from on-site systems using hydrologic model. Dr. Pradhan received her B.S. in Microbiology and Chemistry from Nepal, Ph.D. in Soil Science from North Carolina State University.

Standardizing On-site Terminology: Development of a National Glossary

Nancy Deal
John Buchanan, Kitt Farrell-Poe, Mark Gross, David Gustafson, David Kalen, Bruce Lesikar, David Lindbo, George Loomis, Randy Miles and Courtney O'Neill

Abstract Text:

Onsite/decentralized terminology historically originated and evolved on the state or regional level in conjunction with regulatory or Agricultural Extension activities. Consistency of terminology is a barrier to acceptance of nationally-developed training materials and guidance documents. Local regulators continue to express concern about acceptance of nationally-developed materials because of inconsistency with their local terminology. Inconsistency in published materials has compounded the problem.

To promote standardized terminology, the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) developed a glossary by gathering terms and definitions from a variety of sources. With funding provided by the Environmental Protection Agency (EPA) through the Water Environment Research Federation (WERF), CIDWT began an intensive project that will result in a glossary of commonly-used terms in the field of onsite/decentralized wastewater treatment. Standardization of terms and definitions will facilitate the continued exchange of information within both the academic and field practitioner realms.

This paper will discuss the project concept and goals as well as provide insight into the initial development of the glossary. It will also present an overview of the rigorous review process used to refine the terminology and definitions. It will describe the extensive scope of the stakeholders invited to participate in this exercise and provide on the status of the project.

Microbial Septic Tank Sampling :When a Tank Appears to be \"Dead\"

Dr. Barbara Hartley Grimes

Abstract Text:

Often when septic systems fail, malfunction, or sewage backs up into the home, attention is focused on the septic tank. The septic tank is the first part of the sewage treatment process, where solids settle and anaerobic digestion occurs. Homeowner practices significantly affect this process and the ecology including the microbial populations. Many professionals can spot problems by the color, smell, and solids seen in the tank. Often the tank appears to be “dead” without an obvious cause. In NC the county EHS will consult with state regional staff and state office to investigate. This need and the desire to prevent/remedy failures prompted the development of the septic tank sampling kits for microscopical examination . These kits have been developed, tested, and refined over the last 2 years. The kits are distributed and analyzed by the author – free of charge in NC. Many tanks (and some drainfields) have been microscopically examined, including influent, effluent and sludge layers. The samples can be easily and safely (infectious materials) obtained and handled)). In nearly all cases the causes and solutions to the problem could be determined by examining under the microscope in Raleigh or the field. Homeowner practices were also are determined – important in the study. Often the solution was really simple and inexpensive. For example, microscopy revealed that at a home - the filter was clogging – not due to the practices of the household- but due to the molting of the significant population of sewage flies in the tank. The solution was to simply clean the filter more often. At another site, microscopic paper towel fibers were found in great abundance in the drainfield biomat although the homeowner did not mention the use of the towels. Additionally – normally functioning septic system tanks have also been examined. It was found that the septic tank contains a wide range of waste treatment organisms, beyond bacteria. Protozoan populations can be found in significant numbers; Oligochaete worms, and nematodes can be quite abundant. The experiences, sampling techniques, and their significance will be discussed. (Funded by EPA 319 Author’s Base Program)

Brief Biography:
Education: Associate Liberal Arts St Mary’s and BS, MS, PhD from NCSU. Currently an EPA 319 NPS Coordinator (2000) coming from NCSU as a teaching and research faculty member since 1979. Interagency cooperation and emphasizing sound science based practices are a top priority in protecting human and environmental health. Areas of expertise include: microbiology, zoology, ecology, environmental issues, human health, MST, and wastewater treatment technologies. Activities include: Conducting 50-100/yr workshops; Initiating, writing, administering grants; Publishing and Conducting Research; Serving as liaison and committee member to 319 and DWQ. Has enriched life - as a poet, artist, and musician, with one son graduating this year in Civil Engineering NCSU!

Remote Monitoring and Remote System Operation Overview

Tricia Angoli

Abstract Text:

An overview of remote monitoring, including: what remote monitoring is; the difference between remote monitoring and remote operation; and when remote monitoring might be a good option for a site.

Brief Biography:
Tricia Angoli has Bachelors and Masters degrees in Civil Engineering from West Virginina University. She worked for the National Small Flows Clearinghouse for ten years, for a private consulting firm that dealt with onsite and small community subsurface wastewater systems, and is currently with the On-Site Wastewater Branch.

NSF Onsite Monitoring Program

Paul Jackson

Abstract Text:

It has long been recognized that advanced onsite wastewater treatment systems significantly improve effluent quality, primarily of biochemical oxygen demand, total suspended solids, and/or nutrients over that of conventional systems. However, advanced systems require routine maintenance to deliver this superior performance. In the past regulators have lacked an effective means of monitoring maintenance, leading to questions of proper system performance. NSF International has aided this process for many years with its certification of advanced treatment systems whereby service is required for the first two years. NSF has now expanded its support of the regulatory community by providing a means to measure this for the life of the system, applicable to certified and non-certified systems. The NSF Onsite Monitoring Program is a secure web-based database verification program that utilizes an inexpensive communication device installed on system's control panel. It enables service providers, regulators, and homeowners to monitor the service and alarm status of onsite wastewater treatment systems through computer access to the web. When alarms are triggered the system provides real-time email, pager, and cell phone text notification. NSF has designed the system primarily for use with advanced onsite treatment systems, however the program also features many convenient uses for recording and tracking information related to conventional systems as well, either with or without the telemetry component. NSF offers access to the website and data at no charge for regulatory public health officials.

During this course attendees will learn the value of regularly scheduled maintenance of advanced systems, how to track and monitor maintenance activities, and how to track and monitor alarm status of systems remotely.

Brief Biography:
Mr. Jackson has over 30 years experience in the environmental monitoring and laboratory testing fields as business unit manager, project and program manager, and laboratory/field sampling analyst. His experience includes developing and managing large scale industrial, government agency, and water and wastewater treatment system environmental compliance monitoring programs. Education: Chemistry and business studies, University of Maryland.

Practical use of Remote Monitoring for Public Health Protection

Tom Konsler

Abstract Text:

In many instances, agencies may have a need to permit pump-and-haul systems as a temporary or as a permanent solution to failing septic systems. The traditional pump-and-haul has little assurance of proper operation, even with an on-site alarm installed. This session will explore the evolution of the traditional pump-and-haul system to an affordable and reliable method utilizing remote notification and assurance of service by the pumper. Several examples will illustrate how this technology has been incorporated into specifications to address unique situations in Orange County. Local design standards now require remote notification of the contract pumper and the health department for any pump-and-haul system that is permitted. Two stage notification allows for regular maintenance notification to the pumper and emergency notification of the Health Department and backup pumper if the first notification is ignored. A live link through the web will allow us to view the live records of pump-and-haul activities for several of these systems.

This session explores only one application of remote monitoring. An additional practical use of remote monitoring will illustrate how remote alarm notification can significantly reduce the required size of pump tanks by reducing the emergency storage requirements.

Brief Biography:

Tom began his career as a sanitarian in Randolph County. In 1984, he joined Orange County Environmental Health and has served as an environmental health specialist, a program specialist, a supervisor, and is currently the Environmental Health Director. He participates in numerous committees involving training and rule development. He has served as reviewer and co-author in national projects sponsored by Consortium of Institutes for Decentralized Wastewater Treatment. He is currently a member of the NSF International Joint Committee on Wastewater Technology, chairs a Standard 46 Task Group, and chairs the NC I&E committee. He attended NCSU and has a BSPH from UNC Chapel Hill.

Vericomm Remote Monitoring and System Operation Technologies

Steve Barry

Abstract Text

Remote monitoring technologies for large systems

Tom Ashton

Abstract Text:

Discussion of large system remote monitoring technologies
Discuss database systems (such as Carmoody system)
Explain system with live demo possible??

County Remote Monitoring Program for Advanced On-site Technologies in Harris County, Texas

John Blount

Abstract Text:

Harris County has unique geomorphic and climatic features, which result in the majority of on-site sewage facilities being installed, with secondary treatment, disinfection, and perpetual maintenance. Insuring that proper maintenance is conducted is a challenge with over 12,000 on-site systems currently being monitored. Harris County incorporated an electronic record keeping and maintenance verification system in order to manage this immense problem. After converting data from an existing database and implementing an electronic maintenance report filing system, Harris County has been able to effectively track maintenance report submittal. The County is currently phasing in a system that ensures maintenance providers actually visit the site.

Brief Biography:
John Blount, is a registered professional engineer employed by Harris County, Texas. He has twenty years of onsite wastewater regulatory experience. John began his career inspecting onsite systems and gradually moved up to be the County Building Official. He is currently Deputy Director of Planning and Operations for the Harris County Public Infrastructure Department.

Mr. Jackson has over 30 years experience in the environmental monitoring and laboratory testing fields as business unit manager, project and program manager, and laboratory/field sampling analyst. His experience includes developing and managing large scale industrial, government agency, and water and wastewater treatment system environmental compliance monitoring programs. Education: Chemistry and business studies, University of Maryland.

Field performance of Type IV systems (LPP systems) over the past 15 years: Inspection and monitoring

George Pendergrass

Abstract Text:

How well do Type IV systems work (from the field assessment perspective) now that we have certified operator O&M of them?
What have we learned about system performance, operation and maintenance over the past 15 years since the certified operator system started in 1992?
How well are the systems working?
What are the most significant inspection and monitoring issues observed in the field for Type IV systems?
Give the Environmental Health perspective on single-family advanced system function and performance
What can the typical Environmental Health Specialist do next week to improve function and reliability of Type IV systems?

Capillary Flow of Pollutants above the Water Table in Simulated Septic Systems

Aziz Amoozegar
David Lindbo, Christopher Niewoehner, and Sergio Abit

Abstract Text:

Wastewater applied to the soil in the trenches of septic systems generally moves vertically down in the unsaturated zone below the trenches. If a water table exists below the trenches, it is commonly assumed that wastewater percolating through the soil enters the water table before moving laterally within the ground water (i.e., below the water table). Based on this assumption, groundwater samples are commonly collected from various depths below the water table to assess transport of pollutants from various waste disposal facilities, including septic systems. Capillary fringe immediately above the water table, however, may impede vertical transport of pollutants into the ground water. A series of laboratory column experiments was conducted to simulate water movement from a septic system trench through the unsaturated and saturated zones in the drain field. A 4-ft (120-cm) tall, 8-ft (240-cm) long and 3-in (8 cm) wide column, with its front made from a clear polycarbonate sheet, was packed with clean, fine sand. Two sections of 2-inch perforated well casing were installed at the two sides of the column to simulate drainage ditches. A zone of saturation at the bottom of the column was created by maintaining constant levels of water in the two simulated drainage ditches. The water level in the left ditch was maintained at a few cm higher than the right ditch to force lateral flow in the saturated zone in the column. Seven outlets were installed at the bottom of the column and used as piezometers to determine water table level. In one simulation two trenches filled with gravel were installed on top of the column. The distance between the two trenches from center to center was approximately 36 in (90 cm). A blue tracer dye solution was applied to the left side trench and a red tracer dye solution was applied to the right trench in one-L doses for several applications. In two other simulations, one gravel filled trench was installed at the top of the left half of the column. In one of these simulations, a 1-L dose of a blue tracer dye solution was applied to the trench followed by other 1-L doses of water for several days. In the second simulation a red dye solution was applied continuously at a low rate to five locations at the bottom of the trench that was installed on the left half side of the column. Using time-lapsed photography, a video of the movement of dye solutions through the saturated and unsaturated zones within the column was recorded for several days. Under all scenarios, the tracer dye solution applied to the trenches moved vertically down until reaching the capillary fringe. However, once the dye solution entered the capillary fringe, it started moving laterally with little interaction with the saturated zone below the water table. The dye moved laterally within the capillary fringe until it was forced vertically down by percolating water applied to the surface as rainfall/irrigation or through a neighboring trench. If these laboratory observations hold true under field conditions, new protocols must be developed to sample the soil solution below the trenches in areas with shallow water table.

Brief Biography:

Current Position:	Professor of Environmental Soil Physics Soil Science Department, NC State University
Ph.D. Degree:	Soil and Water Science, University of Arizona, 1977
M.S. Degree:	Agricultural Chemistry and Soil, University of Arizona, 1974

B.S. Degree	General Agriculture, Ahvaz Agricultural College, Iran, 1968
University of Arizona:	1978-1983
NCSU:	1983-Present
Area of Expertise:	Water movement and transport of pollutants through soils
	On-site wastewater management systems
	Soil property measurements

Licensed Soil Scientist
Inventor of the Compact Constant Head Permeameter (also known as Amoozemeter)

Field evaluation of rock filled and Infiltrator chamber trench systems in Minnesota

Sara Christopherson
Dan Wheeler, Jessica Wittwer and Tim Haeg

Abstract Text:

Due to actions of the Minnesota State Legislature, systems utilizing chambers and synthetic drainfield distribution media are allowed to be designed and installed up to 40% smaller than the standard or conventional trench system area, under provisions of a special "Warrantied System" category. If approved for "Warrantied System" sizing, manufacturers can receive reduced sizing guidelines in exchange for offering a five-year performance warranty and technical information. There has been debate among regulators, professionals and manufacturers about the long-term hydraulic longevity of systems that use the reduced-area trenches for final treatment and dispersal. A project was designed to identify whether there is a statistical difference in performance between chambered and rock-filled trench systems. This was achieved by a large-scale survey of over 100 selected onsite systems of both rock-filled trenches and chambered trenches across seven Minnesota counties. Each system type was studied within three major soil permeability categories (fast, medium and slow) utilizing soil texture classes. In addition to a general evaluation of the system and homeowner survey including questions on usage and maintenance frequency, the percentage of the system in use at the time of the site visit was determined. This was possible because a majority of trench systems in Minnesota utilize drop box or sequential distribution which loads the trenches in a particular order so that one trench is loaded to a specific level before the subsequent trenches are utilized. Adjusting both types of systems to a standard size datum, the ponding levels were compared. Surprisingly nearly 60% of the systems visited during the study of the ages 5 -10 years did not have any ponding observed at the end of the first trench segment. When the amount of ponding was compared between rock-filled and chambered systems the data was not able to prove the hypothesis that chambered systems of a similar age as rock-filled systems utilize 25% less area than the rock systems at 10% significance level. To the contrary, the results indicate that rock-filled trench systems were utilizing less soil treatment area than the chambered systems due in part to the smaller area per trench of the chamber systems. More mature trench systems of both types need further investigation and analysis to more fully evaluate this issue.

Brief Biography:

Since 1998, as an engineer in the Onsite Sewage Treatment Program at the University of Minnesota, Sara Christopherson has been providing education and technical assistance to homeowners, small communities, onsite professionals and local units of government regarding onsite wastewater treatment.

Sara serves on the board and chairs the education committee of both NOWRA and the Minnesota Onsite Wastewater Association (MOWA). She is also the chair of the Minnesota State Advisory Committee on Decentralized Systems.

She has a MS in Water Resource Science (WRS) and a BS in Biosystems and Agricultural Engineering and is currently enrolled in a PhD program in WRS at the U of MN.

Effects of siting, design, system age, operation and maintenance on failure rates of on-site systems

Dr. Mike Hoover
Everette Lynn, Dr. Larry King, Suzanne Harris, Steve Bristow, Tricia Angoli, Wright Lowery and Kent Daeke

Abstract Text:

This paper reports on a field study of on-site wastewater systems (310 randomly selected septic systems) conducted in Wake Co., NC to determine the wet season surface hydraulic failure rate. The primary focus was on operation and maintenance, but siting and design impacts were also assessed.

The study sample was installed during a 20-year period (1982-2001) and had a wet season failure (malfunction) rate of 9.7% in spring, 2003. Siting and design both affected failure. Gravel trench systems and alternative trench systems had similar failure rates. Operation and maintenance substantially affected system performance. Professional maintenance of low-pressure pipe systems reduced failure rates. Age had minimal significance and was poorly related to failure. Hence properly sited, designed and operated systems can have a 20-year lifespan.

Surface water removal, vegetation control and drain field protection were important site maintenance factors that reduced failure rates. Shaping the ground surface in the drain field area (crowning it) to enhance surface water removal and protecting drain fields from structures (e.g., outbuildings) built over them reduced failure rates. Siting and site maintenance interactions dramatically increased failure at less-suited sites.

Adult population in the home was related to failure (failure rate increased with increasing number of adults in the home), but the total number of occupants was not. The need for better management including post-installation inspections, performance tracking, failure remediation and homeowner educational programs was documented.

Brief Biography:
Mike is Professor of Soil Science at NC State University and Extension Soils Specialist for North Carolina Cooperative Extension. He has 32 years experience working in the on-site wastewater field having started as an SEO (Sewage Enforcement Officer) in Pennsylvania in 1975 and getting all three of his degrees from Penn State. From there he served for a year as Visiting Assistant Professor of Civil Engineering at the University of Cincinnati and joined the NCSU faculty in 1983. Mike serves as Chair of the NSF International Wastewater Technology Joint Committee and is on the NSF Council of Public Heath Consultants (CPHC). He has served in the past as Program Chair of the ASABE National On-Site Wastewater Conference, Chair of the Consortium of Institutes for Decentralized Wastewater Treatment and President of the NC Soil Science Society.

Pump to conventional and pressure manifold system performance

Greg Grimes

Abstract Text:

Orange County\'s Wastewater Treatment & Management Program was started in 1992 with Environmental Health Specialist conducting inspections of Type IIIb systems every 5 years in accordance with Table .1961. This presentation will show the results of our inspection program and how well pump conventional systems are performing based on actual field inspections and suggested ways to improve the system performance.

Brief Biography:
Greg Grimes is an Environmental Health Program Specialist with the Orange County Health Department. He has 26+ years of on-site wastewater experience and heads up the department\'s wastewater monitoring program. Greg graduated from East Carolina University in 1980.

Video Technology for Locating and Assessing Septic System Function

Ben Kane

Abstract Text:

Video cameras have been used finding Septic tanks and with finding out if systems need complete drain field replacement or just roots clogging the lines.

Brief Biography:

Ben Kane RS
Carteret County Health department/ Environmental Health

A Submerged Attached Growth Bioreactor For Decentralized Wastewater Treatment

Philip Pedros
Keith Dobie

Abstract Text:

INTRODUCTION
The Amphidrome® process is a submerged attached growth bioreactor (SAGB) process that has been used in Massachusetts, Connecticut, Rhode Island and New Jersey for small decentralized wastewater treatment systems ranging from 440 gpd to 150,000 gpd. The two primary advantages of a SAGB are the small volume requirement and the elimination of downstream clarification. Five years of data from four plants operating in Massachusetts are presented below. Each facility was designed to treat a domestic wastewater to an effluent BOD5 ≤ 30 mg/l, TSS ≤ 30 mg/l, and total nitrogen ≤ 10 mg/l. The process is described and the performance, including loading and removal rates, at the four treatment plants is presented. The results indicate 1) 97% nitrification at an organic loading of 2.5 kg-BOD5/m3-day, and 2) a nitrification rate of 0.427 kg-N/m3-day and a denitrification rate of 0.410 kg-N/m3-day each at a total ammonia loading of 0.434 kg-N/m3-day.
THE SAGB PROCES
This SAGB system was specifically designed for the combined oxidation of carbonaceous matter, nitrogen removal and suspended solids removal in a single-unit single-zone biofilter. It provides low visibility, since all tanks are installed underground, compact footprint, effective nutrient removal, and minimal effect from cold air temperatures. The design criteria were based on the typical effluent limits for discharge to groundwater applied to small treatment plants in Massachusetts and are listed in Table 1.

Table 1. Effluent Standards for Discharge to Groundwater

Constituent	Effluent Limit	Regulatory Basis
BOD	30 mg/l	Massachusetts DEP
TSS	30 mg/l	Massachusetts DEP
Total Nitrogen	10 mg/l	Massachusetts DEP

The system shown in Figure 1, operates as a sequencing batch reactor in which the waste water is cycled back and forth through the filter. The biofilter is intermittently aerated to achieve both the aerobic environment required for the oxidation of organics and nitrification and the anoxic environment required for denitrification.

RESULTS
The ammonia loading varied between 0.004 - 0.434 kg-N/m3-day and the organic loading from 0.11 – 3.53 kg BOD5/m3-day. The effect of total organic loading (TOL) on nitrification is illustrated in Figure 2. The results indicate that a nitrification efficiency of 97% was achieved at a TOL of 2.5 kg-BOD5/m3–day, which corresponds to the 98% efficiency at 3.5 kg-bCOD/m3–day reported by Rogalla et al. (1990) with a BAF designed for oxidation of organics and nitrification. The results also indicate that near complete nitrification is possible at a TOL up to 1 kg-BOD5/m3–day. This is higher than the TOL limit suggested in the USEPA Nitrogen Control Manual (1993), which suggests that to achieve 90% nitrification in a single BAF, the TOL should not exceed 1 kg-BOD5/m3–day.

The effect of total ammonia loading (TAL) on reactor performance is illustrated in Figure 3. Excluding the elevated total nitrogen (TN) effluent values which were due to operational problems, the results indicate that during the five year period the effluent total nitrogen concentration at each of the plants was below the required 10 mg/l. For the highest loading of 0.434 kg-N/m3–day the effluent total nitrogen was 5.4 mg/l. The ammonia loading and nitrification rates presented in Figure 4, illustrate a nitrification rate of 0.180 kg-N/m3–day at an ammonia loading of 0.187 kg-N/m3–day. This is in agreement with Yoshinobu et al. (1997), who reported a nitrification rate of 0.18 kg-N/m3–day at an ammonia loading of 0.19 kg-N/m3–day.

The relationship between denitrification rate and ammonia loading is illustrated in Figure 5. The denitrification rate ranged from 0.002 kg-N/m3–day at a ammonia loading of 0.0171 kg-N/ m3–day to 0.410 kg-N/m3–day at an ammonia loading of 0.434 kg-N/m3–day. These rates are low in comparison with rates (0.29 to 1.6 kg-N/m3–day) reported in the EPA Manual for Nitrogen Control (1993) for full-scale denitrification filters. Two operating conditions likely contributed to the higher rates reported by the EPA: 1) the cited filters were separate unit processes dedicated strictly to denitrification and thus had no aerobic cycle and 2) methanol was used as a supplemental organic carbon source. In this SAGB process the influent organic carbon was utilized for much of the denitrification process. Although small quantities of methanol were added, the use of sewage as the organic carbon source would tend to reduce the denitrification rate.

CONCLUSIONS

The SAGB process is an effective biological nitrogen removal process that offers low visibility (all tanks are underground), and compact footprint. As with most SAGBs it requires less area then many other types of biological treatment processes because of the high concentration of viable biomass within and because downstream clarification is eliminated. In addition, the system can be constructed in concrete tanks, below grade, resulting in a small control building and much lower construction costs. The effluent requirements of BOD5 ≤ 30 mg/l, TSS ≤ 30 mg/l were achieved at all four plants during the five year period (data not presented). Excluding operational problems the effluent total nitrogen limit ≤ 10 mg/l was also achieved. At a total ammonia loading of 0.434 kg-N/m3-day an effluent total nitrogen of 5.4 mg/l was obtained. The nitrification rates at the four SAGB plants examined were comparable to those reported in the literature (Andersen et al. 1995 and Holbrook et al. 1998).

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Rogalla, F. and M. Bourbigot, 1990. New Developments In Complete Nitrogen Removal With Biological Aerated Filters. Wat. Sci. Tech., 22(1-2), 273-280.

United States Environmental Protection Agency, Office of Research and Development and Office of Water. 1993. Manual for Nitrogen Control. EPA/625/R-93/010.

Yoshinobu, T., N. Takashi, I. Masumi and H. Morio, 1997. Feasibility Study on Nitrogen Removal Process By Biological Aerated Filter. Water Environment Federation, 70th Annual Conference & Exposition, 1, 641-652.

Brief Biography:
This paper describes a system designed for nitrogen removal and is particularly suited to small decentralized wastewater treatment plants. The technology has improved the environment by providing a realible BNR process to be implanted for small onsite systems.

Addressing Issues of Nitrogen Removal

Mark Lubbers

Abstract Text:

Increasingly, Biological Nutrient Removal (BNR) is being required by regulatory agencies in response to excessive nitrogen loading of ground and surface waters. Decentralized treatment systems have unique characteristics that must be considered in the design, operation and maintenance of BNR plants. Attached growth processes offer stable, easy to operate & effective BNR treatments. Proper operation & maintenance of these systems is critical to permit compliance.

Decentralized wastewater treatment may be defined as any system where the treatment process and discharge are at or near to the source of the wastewater. They typically have modular components, compact, small diameter collection systems that may be gravity or pressure. Systems may be as small as a home, or large clusters of homes, commercial shopping centers, offices, schools, nursing homes, hospitals or small communities.

As nitrogen reduction has increasingly become the issue for on site & decentralized treatment systems and as we pursue lower and lower effluent nitrogen concentrations, the issues related to design, installation, operations & maintenance are becoming increasingly important and must be considered together if a system is to perform as required.

Brief Biography:
Vice President of Sales
Aquapoint, Inc.

On-site Wastewater Treatment Systems in North Carolina on Macro, Meso and Micro Scales

Sushama Pradhan
Michael T. Hoover

Abstract Text:

The potential nitrogen loadings from on-site wastewater treatment systems (septic systems) to North Carolina's river basins have long been ignored. Yet the potential for these systems to have significant impact on surface water exists. This study assessed nitrogen inputs from septic systems on macro (large watershed) meso (medium watershed) and micro (small watershed) scales. Due to the lack of wastewater treatment information from the 2000 census, cumulative potential nitrogen loadings from on-site systems to North Carolina's 17 river basins and 134 major sub-basins were estimated using the 1990 census data.

A Geographic Information System (GIS) based area-driven normalization procedure was developed and implemented to estimate potential nitrogen loadings on the macro and meso scales. Septic system density ranged from 14 to 53 systems/sq.mi at a river basin level and 5 to 229 systems/sq.mi at a sub-basin level. Total potential nitrogen loading from on-site systems was approximately 31.6 million lbs/yr statewide. This GIS procedure is useful in helping to prioritize sub-basins where comprehensive modeling should be useful.

The Soil and Water Assessment Tool (SWAT) model developed by USDA/ARS was used to predict the fate and transport of nitrogen derived from on-site systems. Nitrogen exports to surface waters were quantified on a micro scale. The model estimated that 95% of the septic system derived nitrogen was removed by denitrification and plant uptake prior to stream discharge for a small watershed in the lower coastal plain. Even so, future increases in density will substantially increase the mass load of N delivered to surface waters. The SWAT model is routinely used by state agencies to determine TMDL (Total Maximum Daily Loads) for regulatory decisions, but has not incorporated septic system impacts until this research.

Brief Biography:
Sushama Pradhan is a Post Doctoral research associate in the Soil Science Department at North Carolina State University. She has been involved in assessment of potential nitrogen loading from on-site systems using GIS at a watershed scale and predicting fate and transport of nitrogen derived from on-site systems using hydrologic model. Dr. Pradhan received her B.S. in Microbiology and Chemistry from Nepal, Ph.D. in Soil Science from North Carolina State University.

Emerging Contaminants (EDCs & PPCPs) : Comparison of Waste Treatment Systems and Research in NC

Dr. Barbara Hartley Grimes - OWPS, NCDENR
Ms. Gloria Ferrell USGS

Abstract Text:

Emerging NonPoint Source Pollution and Wastewater Treatment issues now include Endocrine Disrupting Chemicals (EDCs) and Pharmaceuticals & Personal Care Products (PPCPs). Researchers have identified these pollutants in human and animal wastewater as well as surface and groundwater across the nation & globally. The environmental and human health effects of EDCs and PPCPs have been documented and are the subject of intensive research activities. This topic is further complicated by the fact that some PPCPs are also EDCs. Some examples of the many effects that have been documented with as a result of exposure to some emerging contaminants include: “gender bending” and environmental antibiotic resistance to one or more antibiotics. Although some of these contaminants are documented to pass through human (POTWs) and animal wastewater systems, few studies have examined onsite wastewater systems (septic systems) and the fate and transport of these chemicals through soil dispersal systems. The first study comparing septic systems to POTWs was conducted from 2002 –06 in NC. The potential NPS contributions of EDCs and PPCPs in selected streams served by residential sewers or septic systems in the Upper Neuse River, NC were compared. Also sampled were upstream, at discharge point, and downstream of a municipal wastewater treatment plant (as well as background samples). Traditional pollutants as well as selected emerging contaminants were examined and compared to the presence of nontraditional tracers (optical brighteners) from the PPCP list to document if they are useful in tracing waste and if they correlate with traditional pollutants. This first study is in the data analysis phase. Additional spatial and temporal studies currently underway will be described. These studies are funded by the NC EPA 319 Program to the Onsite Wastewater Branch (NCDENR) and are conducted in collaboration with USGS (Gloria Ferrell).Other researchers involved in the completed project were: Drs. Chuck Hagedorn (Virginia Tech), Bill Kirby-Smith (DUML) and Gerald LeBlanc (NCSU).Additional researchers and their expertise have been added to the project currently underway.

Brief Biography:
Education:Associate Liberal Arts St Mary’s and BS, MS, PhD from NCSU. Currently an EPA 319 NPS Coordinator (2000) coming from NCSU as a teaching and research faculty member since 1979. Interagency cooperation and emphasizing sound science based practices are a top priority in protecting human and environmental health. Areas of expertise include: microbiology, zoology, ecology, environmental issues, human health, MST, and wastewater treatment technologies. Activities include:Conducting 50-100/yr workshops; Initiating, writing, administering grants; Publishing and Conducting Research; Serving as liaison and committee member to 319 and DWQ. Has enriched life - as a poet, artist, and musician, with one son graduating this year in Civil Engineering NCSU!

Aerobic Micro Organism Technology

John Campbell

Abstract Text:

Big Fish Environmental, the first commercial septage receiving and treatment facility in Michigan, provides a viable, cost effective, and environmentally sustainable alternative to the land application of septage. With minimal infrastructual input and low operational costs, the Big Fish prototype can process 10,000 gallons of residential septage per day. The innovative methodology uses aerobic devices which culture proprietary micro-organisms. These devises aerate, mix and continuously inoculate the mixed liquor. Other system components include an organics washer, equipment to remove inert material, on-line pH monitoring, flow measurement, treatment tanks, and pumps. After sixteen months of operating data, the Big Fish process has proven to be effective at BOD, TSS, Ammonia and total solids reduction. As such, it is an important technological public health intervention, as it reduces the harmful land application of untreated septic sludge, recycles waste, and creates chemical free irrigation water and fertilization for farms and fields.

Brief Biography:
By respecting the principles embedded in natural systems, the aerobic technology developed by Big Fish Environmental to treat septic sludge (septage) has proven to significantly reduce total suspended solids, ammonia, nitrogen, and phosphorous levels found in conventional wastewater treatment discharge, thereby creating an environmentally sound by-product that can be easily reused. This is a low-cost, environmentally sustainable process that has been approved and endorsed by local and state public health, environmental and wastewater treatment officials.

On-site wastewater technology: The Canadian experience

Doug Joy

Abstract Text:

Overview of technology as used in Canada
What technologies are common and which ones are emerging as highly valued in Canada (or Ontario)?
Performance history and lessons learned
What type (level) of wastewater treatment is expected (eg. removal of BOD, TSS, nitrogen, phosphorus, pathogens, etc)
What degree of pretreatment is required?
Life expectancy, cost and maintenance needs

Brief Biography:

Doug Joy has been a faculty member in the School of Engineering, University of Guelph since 1988. Since 1997 he has been the Director of the Ontario Rural Wastewater Centre at the University. His research focuses on on-site systems, their performance and their impact on ground and surface waters. In addition he is actively part of the code development and application in Ontario and Canada.

Navigating the OSWP Website

Kae Arrington

Abstract Text:

How can the OWPS web help you keep track of new products approved for use in NC?
Septic and pump tanks
Risers and effluent filters
RWTS (old term - ATUs) approvals
Pretreatment and trench product approvals
Accepted, Innovative, Controlled Demonstration and Experimental System Approvals
Design aids
Live demo - Demonstration of how to find your way through the OWPS website for the information you need
How to give feedback to the OWPS regarding the website

Brief Biography:
I earned my Master of Science in Environmental Systems Engineering from Clemson University, specializing in environmental chemistry. I worked for eleven years with the Henderson County Health Department On-Site Wastewater Program at field and supervisory levels.
I have been with the On-Site Section for eleven years. I started the Wastewater Discharge Elimination Program for the Section and then became the first member of the Program Improvement Team. In addition to working as a quality assurance specialist in NC's on-site program, I teach at Centralized Intern Training, maintain the Section's web page, and manage our local program activities database.

I have an incredibly wonderful husband, three children – all in college, and three brindle bullmastiffs. We live on a farm in the mountains of Mitchell County.

New septic tank installer and inspector certification requirements

Gene Young

Abstract Text:

What, when, where and how
Levels of certification
Amount of training needed for each level (initial training requirements and continuing ed needs)
Cost
Grandfathering in your certification – what can and can not be grandfathered?
Installers vs. inspectors vs. operators – Installer Certification Board interface with WPCSOCC certified state subsurface system operators

Brief Biography:

What the Field Practitioner Needs to Know for Tomorrow about the New Rule .1970 and Use of Pretreatment Systems

Anne Lowry
Trish Angoli

Abstract Text:

A brief overview of the impact of Rule .1970 on pretreatment systems. Actual experiences, from the Chatham County Health Department, about what changes Rule .1970 has made in their maintenance and monitoring program.

Brief Biography:

New statewide well statute and how it will affect county programs

David Eudy, NCDENR

Abstract Text: