July 30, 2010

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RE: Leaching system credit rating system

Mr. Scully,

The Northeast Precast Concrete Association commissioned SFC Engineering Partnership to research and evaluate the current leaching system credit rating process employed by the State of Connecticut Department of Public Health. This effort is undertaken in response to the invitation of the Code Advisory Commission dated January 4, 2010.

To undertake this project, SFC has:

- reviewed the Design Manual for Subsurface Disposal Systems for Households and Small Commercial Buildings, July 1998 (*Design Manual*)
- reviewed the Regulations and Technical Standards for Subsurface Disposal Systems, January 2009 (*Technical Standards*)
- reviewed other relevant documents found on the Connecticut Department of Public Health website:
  - A presentation entitled "Sizing Methodology for Subsurface Wastewater Infiltration Systems" by Dr. Kevin White

- December 7, 2009 letter prepared by Frank A. Schaub
- February 25, 2010 letter prepared by David Potts, Geomatrix Systems LLC
- March 19, 2010 document prepared by Frank Currivan, Cur-Tech
- April 7, 2010 letter prepared by Dennis F. Hallahan, PE, Infiltrator Systems

- □ interviewed Mr. David Ferris, Supervisor of the Alternative / Innovative Technologies Section of the Massachusetts Department of Environmental Protection, and reviewed section 15.280 of the State Environmental Code, Title V.
- □ interviewed Mr. Robert Tardif, Interim Administrator of the Subsurface Disposal Section of the New Hampshire Department of Environmental Services, and reviewed part Env-Wq 1024 of the NH Code of Administrative Rules.
- □ relied on our own experience of designing subsurface disposal systems for over 25 years.
- □ engaged in numerous internal discussions with SFC staff
- □ constructed a statistical database to identify the trends and effects of ELU ratings on other leaching system design criteria, and to evaluate specific products in relation to these criteria.

INTRODUCTION

Section 11 of the *Design Manual* enumerates three functions of a properly functioning leaching system. That list of functions follows:

1. The system must provide sufficient infiltrative surface to prevent excessive clogging by the biological slime which forms on the soil interface.

2. The system must be surrounded by an area of soil with sufficient hydraulic capacity to disperse the liquid volume without becoming saturated.

3. The system must contain sufficient hollow spaces within the stone or leaching structure to allow sewage to be stored during periods of heavy use, or when rainfall or subsurface flooding reduces the ability of the system to disperse liquid.

Connecticut's current system of rating the effectiveness of leaching products is based solely on the first of the three listed functions. ELU credits are awarded for product features that increase infiltrative surface.

We argue that the infiltrative surface is only one element of a total system. All elements of a leaching system must be balanced to create an effective process to treat effluent. The focus on infiltrative surface may have led to the assignment of unrealistic credit ratings and unachievable performance expectations.

DISCUSSION

Our discussion of the merits of the current rating system is organized in four parts. The first three address each of the three functions of a leaching system highlighted in the *Design Manual*. The fourth part discusses other factors to be considered.

#1 The system must provide sufficient infiltrative surface to prevent excessive clogging by the biological slime which forms on the soil interface.

Connecticut's current rating system is based on the size, and type of soil interface. As a result, manufacturers have sought to increase sidewall area to obtain increased ELU ratings.

Innovative leaching products employ different materials and configurations in order to increase the proportional surface area within a unit length of trench. The greater surface area allows the introduction of a greater volume of effluent within a unit length of trench.

The design of such devices may appear to be reasonable when the sole intent is to provide maximum infiltrative surface to prevent excessive clogging by the biological slime that forms on the soil interface.

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SECONDARY BIOMAT

Since leaching products with elevated ELU's feature increased infiltrative surface within unit trench lengths, greater volumes of effluent are introduced to trenches. The suggestion that a secondary biomat may form at the face of the soil (the outer limits of a trench) where leaching products are used could certainly limit leaching system efficiency.

A basic design principle for trench sizing is the LTAR of soils. Section 12 of the *Design Manual* specifies the maximum application rate for soils. A secondary biomat within a shortened trench, and therefore on a reduced soil application area, will indeed exceed LTAR application rates.

The current range of ELU rating permits effluent rates up to ten times above the acceptable LTAR referenced in the *Design Manual*. Any restriction on flow capacity caused by secondary biomat can cause failure in the system.

COMPETING BIOMAT and INTERNAL BIOMAT

Aggressive design of some leach products features narrow folds of infiltrative surfaces that resemble accordion folds. This "accordion" design has evolved to highly disproportional length of the folds or "fingers" compared to the width of the fingers or the space between each finger.

There is concern that the soil interface between each fold is super-restricted by the competing biomat forming on soil surfaces in very close proximity to each other. This accelerates the clogging effect.

Also, the receiving soil occurring between each fold is over-taxed by the volume of effluent passing into the thin soil area from two directions.

SFC also alerts of the failure of accordion design, not at the soil interface, but at the face of the accordion. Failure can occur where an internal biomat bridges across the accordion folds so that effluent is blocked from entry into the folds where biomat is intended to form. The anticipated advantage of the greater filtering surface is never realized because effluent is never exposed to the accordion folds.

SIDEWALL AREA AND BOTTOM AREA

An introductory paragraph in the *Design Manual*, states "As might be expected, disagreements are common when hydraulic analysis is used for regulatory purposes". The wisdom of this statement is no more apparent then in discussion of the effectiveness of sidewall versus bottom area. By example, Currivan argues that a larger ELU credit rating is warranted for bottom area because "the most effective part of a leaching system is the bottom area", Potts argued "...open bottom area is not as effective as first believed due to accumulation of TSS on the interface and subsequent persistence of water ponding over it". Further, in both New Hampshire and in Massachusetts, sidewall area is considered inconsistently. Sidewall is credited in trench design, but sidewall receives no credit in leach bed design.

SFC suggests that sidewall area must be managed to be effective. The travel path of effluent runs through a trench, or leaching product, then through the biomat interface and into the surrounding soil. In the surrounding soil, the predominant flow is downward. Not unlike the drip edge of a roof system, the rate of effluent passing vertically in the space just outside the perimeter wall of the trench can become much greater than the rate of effluent exiting through the bottom area. We suggest that a maximum height be regulated to minimize the stress on the hydraulic capacity of the soil at the bottom perimeter of the trench.

#2 The system must be surrounded by an area of soil with sufficient hydraulic capacity to disperse the liquid volume without becoming saturated.

Innovative systems provide increased infiltrative surface to prevent excessive clogging, however, once the effluent passes the soil interface, the size or configuration of the interface no longer matter. What does matter are the characteristics of the soil surrounding the perimeter of the system.

One of the primary design criteria of the leaching system is the percolation rate, a measure of the rate at which surrounding soil can accept effluent. Section VIII.F of the *Technical Standards* prescribes minimum leach system sizing based on percolation rate and sewage loading. These requirements specify the square feet of effective leaching area required for a given sewage load.

Elevated ELU ratings have the effect of introducing higher volumes of effluent into a smaller leaching footprint. We argue that the reduced leaching area stresses the ability of the surrounding soil to disperse the liquid volume.

SFC has constructed a statistical database to compare the design application rate of the soil (found in Table No. 8 of *Technical Standards*) to the actual application rate. The actual application rate is determined by dividing the design flow rate by the area of receiving soil. For this evaluation, the area of receiving soil is calculated by multiplying the required spacing between trenches times the length of the trench.

This database shows that ELU ratings above 14.0 consistently exceed the design application rate for the surrounding soils, regardless of the percolation rate.

GROUNDWATER MOUNDING

The second function of a properly functioning leaching system is to disperse the liquid volume without becoming saturated. To do this the system must be surrounded by an area of soil with sufficient hydraulic capacity.

When the application rate of effluent is greater than what the soil can accept, the effluent no longer disperses readily. Groundwater can build up within the aerated soil zone that surrounds the leaching system. The effect is called groundwater mounding. As described in the preceding section, elevated ELU ratings increase the application rate of effluent to the soil. This increases the likelihood of groundwater mounding.

Groundwater mounding diminishes the effectiveness of the leaching system because it decreases the depth of the aerated soil zone where unsaturated flow entraps and removes pathogens, organics and pollutants before they reach the ground water.

MLSS

SFC evaluated MLSS (Minimum Leaching System Spread) in relation to leaching product ratings. Other site factors – percolation rate, hydraulic gradient and depth of receiving soil - influence MLSS as much, if not greater than ELU.

While elevated ELU ratings signal a demand for the designers' attention to address MLSS criteria, ELU can be managed to insure that the system layout meets MLSS requirements.

#3 The system must contain sufficient hollow spaces within the stone or leaching structure to allow sewage to be stored during periods of heavy use, or when rainfall or subsurface flooding reduces the ability of the system to disperse liquid.

Aside from the warnings of Potts (storage volume can be a liability if it creates anaerobic conditions), storage volume is commonly considered an advantage in a leaching system. Storage volume offsets the effect of rainfall, accommodates dosing volumes, and retains effluent as it filters slowly through a mature biomat.

Logic prevails that since an elevated ELU will allow shorter trench lengths, the available storage volume is also reduced. The characteristics of each leaching product should be considered to determine the actual storage volume and its effect on storage during periods of heavy use, or when rainfall or subsurface flooding reduces the ability of the system to disperse liquid.

SFC points out that the merits of storage volume, one of the three primary functions of a leaching system, are not considered when determining leaching product efficiency.

#4 Other factors to be considered

OXYGEN

Oxygen is important in a leaching system to satisfy biological oxygen demand, and to maintain hydraulic conductivity of the biomat. BOD reduction occurs at the biomat and continues with soil contact in the aerated soil zone above the ground water table. The current ELU rating system does not consider this factor.

Any provision to promote the free aeration of the leaching system and the aerated soil zone below it are critical factors that should be encouraged.

Innovative design that features venting, shallow system depths, or free airflow should be awarded leaching system credit for effective design.

OTHER NEW ENGLAND STATES

In the three New England states that we investigated, we found that alternative and innovative leaching products may be awarded reduction in system size and separation to ground water if earned by successful demonstration of the candidate products. We note that evaluation criteria are different in each of these states.

New Hampshire requires testimony of system performance from applicants and "based on its evaluation of the available information, it [NHDES] makes its best engineering judgment that the proposed technology will... be at least as protective of the environment as conventional technology". This preliminary approval is followed by performance testing in field applications prior to final approval.

Massachusetts requires "relevant technical data including...field performance of the proposed alternative system in other states or data obtained by independent testing organizations".

Connecticut, of course, evaluates new products based solely on the dimension and type of infiltrative surface, in sharp contrast to the performance evaluation required in other states.

It is also critical to point out another comparison between these three New England states. Using conventional systems as a baseline, each state allows maximum size reductions as follows:

STATE	MAXIMUM SIZE REDUCTION
Massachusetts	40%
New Hampshire	60%
Connecticut	83%*

* comparative size requirements between ELU rating of 3.0 and 29.9

The generous reduction allowed in Connecticut is much more liberal than in the other states. If the other states operated with Connecticut's ELU rating system, the maximum ELU rating in Massachusetts would be 8.0, in New Hampshire, 10! (these figures are based on a standard trench with a 3.0 ELU)

Also note that, in some cases, leach size reductions are not allowed for commercial uses in New Hampshire or Massachusetts.

CONCLUSIONS

SFC suggests that the current leaching system credit rating system employed by the State of Connecticut Department of Public Health can be improved. The current, singular focus on leaching product dimensions and configuration fails to consider total system function. As a result, the total leaching system may be unbalanced and ineffective because of inadvertently overtaxing one of the other elements of the system. Specifically, the efforts to increase soil interface area of leaching products have led to smaller leach system sizes, while receiving soil may be incapable of processing effluent at these higher rates.

#1 Based on trends demonstrated in the statistical database, and supported by practice in other states, **the range of leaching system credits extends too high**. We suggest reducing the upper end of the range of ELU to 14.0. Our data shows that ratings above this value surpass an acceptable application rate of effluent into the surrounding soil.

#2 Features that promote **all functions of a healthy leaching system should be considered** when determining the effectiveness of an innovative leaching product. Dr. Kevin White, in his presentation on sizing methodologies for subsurface wastewater infiltration systems advises that design should optimize infiltration and treatment. He encouraged that one consider LTAR, organic loading, trench geometry, fines minimization, oxygen availability, and storage.

#3 SFC emphasizes that no one of these factors can be optimized, and used as a yardstick of leaching product performance, without consideration of the whole treatment system**. The system can perform only as well as the most critical element.**

Thank you for the opportunity to offer our comments on Connecticut's current leaching system credit rating process.

Sincerely,

SFC ENGINEERING PARTNERTSHIP, INC.

George R. Fredette, P.E.

COMMERCIAL ELU CALCULATIONS

DESIGN FLOW:	1500
PERC RATE:	15
HYDRAULIC GRADIENT:	3
RS DEPTH:	24

CONSIDERATIONS RELATED TO PERC RATE IN UNSATURATED SURROUNDING SOILS (Tech Standards, Table No. 8)

leaching area should be no less than	application rate should be no greater than
1250.0 SQ.FT.	1.2 GPD / SQ.FT.

CONSIDERATIONS RELATED TO LTAR AT INFILTRATIVE SOIL FACE (Design Manual, pg 54)

WP x LENGTH should be no less than	effluent rate should be no greater than
3750 SQ.FT.	0.4 GAL/SF/DAY

CONTROL CALCULATIONS

SYSTEM RATING				DESIGN CALCULATIONS		CALCULATED PERFORMANCE			CALCULATED PERFORMANCE			MLSS CALCULATION					
DEPTH	WIDTH	ELU	SPACING	TLR	TOTAL LENGTH	basal area (sf) = total length x spacing	actual rate= design flow / basal area		actual wetted perimeter = (2D+ W) x L	actual rate= design flow / basal area		HF	FF	PF	MLSS		WINDOW
24	36	3.0	7	1250.0	417	2916.7	0.51		2917	0.51	X	48.0	5.00	1.5	360		720
24	36	4.0	7	1250.0	313	2187.5	0.69		2188	0.69	X	48.0	5.00	1.5	360	x	720
24	36	6.0	9	1250.0	208	1875.0	0.80		1458	1.03	X	48.0	5.00	1.5	360	x	720
24	36	8.0	9	1250.0	156	1406.3	1.07		1094	1.37	X	48.0	5.00	1.5	360	x	720
24	36	10.0	9	1250.0	125	1125.0	1.33	X	875	1.71	X	48.0	5.00	1.5	360	x	720
24	48	12.0	12	1250.0	104	1250.0	1.20		833	1.80	X	48.0	5.00	1.5	360	x	720
24	48	14.0	12	1250.0	89	1071.4	1.40	X	714	2.10	X	48.0	5.00	1.5	360	x	720
24	48	16.0	12	1250.0	78	937.5	1.60	X	625	2.40	X	48.0	5.00	1.5	360	x	720
24	48	18.0	12	1250.0	69	833.3	1.80	X	556	2.70	X	48.0	5.00	1.5	360	x	720
24	48	20.0	12	1250.0	63	750.0	2.00	X	500	3.00	X	48.0	5.00	1.5	360	x	720
24	48	22.0	12	1250.0	57	681.8	2.20	X	455	3.30	X	48.0	5.00	1.5	360	x	720
24	48	24.0	12	1250.0	52	625.0	2.40	X	417	3.60	X	48.0	5.00	1.5	360	x	720
24	48	26.0	12	1250.0	48	576.9	2.60	X	385	3.90	X	48.0	5.00	1.5	360	x	720
24	48	28.0	12	1250.0	45	535.7	2.80	X	357	4.20	X	48.0	5.00	1.5	360	x	720