The Development of a Guideline on the Sampling/Testing of Innovative/Alternative Disposal Technologies for Sewage Treatment and Disposal

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Principle Investigators

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Problem and Research Objectives

Individual sewage disposal systems (ISDS) have been implicated as a potential cause of degraded water quality in salt ponds, Wickford Harbor, Mount Hope Bay, Narrow River, as well as in many other tributaries to the Narragansett Bay. After years of total dependence on individual groundwater wells as a prime source for drinking water supply, the community of Hope Valley Village in Hopkinton, RI had to install a water distribution system fed from public water well at Richmond. This is primarily attributed to groundwater quality impact by failing septic systems.

More septic/leaching field system will be built in rural areas of Rhode Island. Many of the installations are the newly innovative/alternative sewage disposal system which potentially use less leaching area and more efficient in pollutant removal. These innovative/alternative individual sewage disposal system (I/A ISDS) also will be used more and more to replace the failing septic systems in Rhode Island and in other New England states. The permit section of many state regulating agencies including the one in RI Department of Environmental Management is in the process of establishing an approval list of the I/A ISDS. In preparation of the approval list, it is necessary to provide critical review of the technologies based on their performance history, design adequacy, sound construction, and proper operation/maintenance effort.

While the documentation of the system construction and installation and the instruction of operation/maintenance requirements for many I/A ISDS is adequate, there is a lack of performance data that can convincingly back up the claims made by the I/A ISDS industry. Most performance testing was poorly designed. The testing was carried out sporadically with no systematic approach, no quality control, and with the test period too short to yield a meaningful result. At times the data submitted lead to more questions rather than to demonstrate the successful performance of the technology.

Methodology

Presently twenty-two (22) I/A ISDS systems have been submitted to the New England states for approval. For each technology the design of the system components as well as the system as a whole be examined. Instructions on operation/maintenance will be reviewed critically to see if the technology can be operated and maintained properly to give the system performance it is designed for. Performance can be tested with procedures depending on the specific designed function of the system component and the system as a whole.

For system components intended for biological removal of pollutants, tests of BOD, TOC, DO, total suspended solids, volatile solids, total Kjeldahl nitrogen, ammonia nitrogen, nitrite/nitrate nitrogen are potential candidates for measurement. Each technology is specific such that testing will be specifically

Most I/A ISDS technologies claim better treatment of the sewage which leads to their claim of the requirement of a smaller leaching field. The correlation of a better sewage treatment and the smaller leaching field requirement is not established quantitatively. An effluent with lower BOD and nitrogen but applied at a higher loading rate (more gallon per day per square feet of leaching area if a smaller leaching field is used would in effect apply the same or larger amount of pollutant to the soil, resulting in a more dense biomat and lower leaching rate. It is therefore necessary to monitor the hydraulic conductivity or the percolating rate of the field periodically. If the correlation of a better sewage treatment and the requirement of a smaller leaching field can be quantitatively established, a proper design procedure can be derived for leaching field sizing using the tested I/A ISDS.

The performance testing carried out by reputable and independent testing firms also will be reviewed carefully. Coupled with the considerations alluded to previously, a list of the performance testing can be prepared for each system or system component for which the designed functions are known. Also sampling protocol and testing methods will be recommended.

As a member of the Technical Review Committee for the I/A ISDS systems for the Rhode Island Department of Environmental Management, the principal investigator of this transfer project worked closely with all members of the committee in data collection, technical review and discussion of all technologies. The members of the committee consist of environmental engineers, town public work directors, planners, ISDS installers, ISDS designers, citizen group representative, university researchers, and state regulating agency representatives. The collective knowledge, experience, and their connections with some outside experts of ISDS systems are valuable in this information transfer project. Consultation with the New England developed state regulating agencies and the New England Interstate are Water Pollution Control Commission was also sought from time to time.

Principal Findings and Significance

The guideline for I/A ISDS sampling and testing in a draft form of a booklet is being prepared. The document is divided into two parts. The first part addresses the critical

issues of sampling and testing for all I/A ISDS technologies. The following issues are included:

1. BOD and nitrogen removal in the septic tank ----- location for sampling, frequency of solid pumpout, and grab sampling versus composite sampling.

2. Denitrification and nitrification removal ----- Most vendors and many regulating agencies arbitrarily use 50 percent total-N removal as an evidence of denitrificatiion. This is not consistent with the definition of denitrification which is aerobic nitrification of ammonia nitrogen to nitrate followed by anoxic reduction of nitrate to nitrogen gas. Solid pump-out from septic tank alone can remove 50% of total nitrogen which does not have to go through the nitrification-denitrification processes. Also nitrogen is not removed from the system if only nitrification is taking place.

3. Nitrogen analysis ----- All vendors did not report the protocol of nitrogen analysis. However, the result of nitrogen analysis can be significantly different depending on if the sample is filtered or not. Also many a vendor mistakenly uses the TKN change to imply that denitrification is taking place.

4. Leach field size reduction ----- Special consideration should be given to the septic tank effluent BOD and TSS concentrations. If they different from 150 mg/l, the leach size reduction using Laak's formula should be adjusted.

5. Phosphate removal ----- Similar to nitrogen removal, only the system provides the aerobicanoxic- aerobic arrangement can a biological P removal be expected. No credit of P removal should be given to the I/A ISDS system if the aerobic-anoxic-aerobic arrangement is not provided.

6. Number of sample/test ----- The volume of data of test results submitted by vendors varies from voluminous to sporadic. No statistical analysis is presented. There is a need to establish the minimum allowable amount of data and statistical analysis to be submitted for review. A log-probability plot of performance with 3 to 5 years data is sufficient to show the probability of the system performance meeting the expected result claimed by the vendor. The second part of the guideline is to divide the I/A ISDS technologies into five (5) different categories:

(1) I/A trench/chamber/bed with no treatment enhancement, (2) I/A trench/chamber/bed with treatment enhancement, (3) I/A technology following a septic tank prior to

leaching field application, (4) I/A technology as a stand-alone treatment system without a septic tank, (5) Others. The functions and mode of operation of each technology in each category are described. The sampling requirement and analytical protocol are specified. All together 4 technologies in category 1, I technology in category 2, 8 technologies in category 3, 3 technologies in category 4, and 2 technologies in category 5 have been reviewed and included in a completion report. More I/A ISDS systems will be added and updated as time and resources allow in the future.

Utilization of Result:

The project is carried out in close cooperation with the Technical Review Committee for the I/A ISDS of Rhode Island Department of Environmental Management. The project is completed in February 1999 with all I/A ISDS technologies in the market or proposed to go into the market reviewed. A completion report providing the guideline for I/A ISDS system sampling/testing will be the finished product available to the public and the vendors, environmental and public work planners, state regulators, the New England Interstate Water Pollution Control Commission, Region 1 Office of USEPA, RI Coastal Resources Management Council, Narragansett Bay Water Quality Management Commission, US Conservation Service, RI Audubon Society, Save the Bay, and other citizen groups.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Poon, Calvin P. C., Completion Report, Guidelines on the Sampling/Testing of Innovative/Alternative Disposal Technologies for Sewage Treatment and Disposal.

Conference Proceedings

Other Publications