BORD NA MÓNA
ENVIRONMENTAL PRODUCTS U.S. INC.

PURAFLO® PEAT BIOFILTER

VIRGINIA DEMONSTRATION PROJECT REPORT

December 1999

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Background

Bord na Móna (the Irish Peat Board) has extensive expertise in peat harvesting and peat-based technology. The progressive research and development program in Bord na Móna's Environmental Division has produced several peat-based technologies/products, including the Puraflo® peat biofilter. Puraflo® was developed in the early 1980's to provide advanced secondary treatment to domestic strength (septic tank) effluent. In January 1994, Bord na Móna established a U.S. company to introduce Puraflo® to the United States and serve the onsite market.

Introduction

Although it had considerable test data on the performance of the Puraflo® system from Ireland and Alabama, in August 1994 Bord na Móna Environmental Products proposed an experimental protocol to the Virginia Department of Health (VDH) to test the Puraflo® peat biofilter (Puraflo®.) The protocol was designed to be in accordance with Section 2.25 of the VDH Sewage Handling and Disposal Regulations. On June 9, 1995 VDH issued GMP #69 to permit and process applications for Puraflo® in accordance with the terms and conditions of a revised and mutually agreed upon experimental protocol.

The first test site under the new GMP was installed in August 1995 and Old Dominion University (ODU) in Norfolk, Virginia was engaged to conduct sampling and analysis.

Purpose and Objectives of the Demonstration Project

The purpose of the project was to demonstrate that Puraflo®'s highly treated effluent could be safely dispersed into the receiving soil with a reduced stand-off distance between the bottom of the gravel disposal pad or trench and the seasonal high water table or rock. The performance of conventional systems with VDH-required (unreduced) stand-off distance would be used as a comparative performance standard. Higher hydraulic loading rates were also proposed in the protocol to demonstrate the soils' increased hydraulic capacity with pre-treated effluent. Proposed loading rates typically reduced the required drainfield area by 50%.

In addition to a reduced unsaturated zone and higher loading rates, the project was designed to demonstrate/verify the expected treatment performance of the peat filter and evaluate any product-specific elements of the treatment and disposal system design. Substantial prior research and test data were available to support the objectives of this demonstration project. Hence, the project was not designed with scientific research in mind but rather to test the performance of the product and observe the system performance in a representative number of real life applications.

The letter accompanying GMP#69 from VDH outlined the primary objective as follows:

"To the greatest extent possible, the Division is interested in assuring that the Puraflo[w] system, with reduced stand-off distances, can perform as well or better than a conventional system in terms of risk to public health and longevity. To the greatest extent possible, the research we are funding at Virginia Tech will be used to establish this standard. In order to define a standard of performance, we used data from an ongoing research project that is evaluating the performance of onsite systems. The initial standard is stringent. Upon completion of this research, the department may wish to relax the performance standard, if data indicates the initial standard is too stringent."

Methodology - Proposed

Treatment Standards:

The protocol proposed that average fecal coliform samples collected from unsaturated soil horizons would average 10 cfu/100ml or less with no single sample exceeding 200 cfu/100ml. It was agreed later by the Health Department, Bord na Móna and Old Dominion University that fecal counts would be expressed in terms of geometric mean in accordance with common industry practice. "Unsaturated soil horizons" primarily refers to the drainfield or gravel pad wells which were intended to provide an effluent sample from 12 inches beneath the drainfield trench/pad. These drainfield wells were not part of Bord na Móna's original proposal but were an added VDH requirement. The original proposal called for sampling wells immediately adjacent to the drainfield but not in the actual drainfield.

This fecal coliform standard was proposed to measure sufficient treatment at a specified depth beneath the drainfield trench/pad. The protocol called for samples to be taken from unsaturated soil conditions "For the purpose of evaluating test results, only samples collected from collection ports installed above seasonally saturated soil horizons shall be used."

To ensure domestic strength waste is being treated/evaluated, influent (septic tank) BOD_5 must have an average of 150 mg/l or greater. Individual samples must be greater than 100 and less than 300 mg/l. Six of the 24 sites reported an average BOD_5 influent of less than 150 mg/l but none were less than 112 mg/l. However, 6 sites also reported an average BOD_5 influent *in excess* of 300 mg/l with the highest being 512 mg/l. Most sites experienced a wide range of BOD_5 waste strength. So, one quarter of the test sites had influent in excess of the standard domestic effluent strength going into the Puraflo® system.

The GMP also said that "Any system that shows surfacing of effluent shall be considered a failure" and that "Ponding depth within the absorption area shall be monitored on a monthly basis." These criteria were included to determine the life expectancy of systems loaded with pre-treated effluent at higher application rates (reduced drainfield size).

Site Selection:

To study the effects of higher hydraulic loading rates with pretreated effluent and the effects of final treatment in different soils, it was agreed that of the 24 test sites, 6 systems would be installed in each of the 4 major Soil Texture Groups. Sites were selected on this basis. Due to difficulty in securing suitable Group IV sites and VDH interest in piedmont soils, two of the Group IV sites were replaced with piedmont sites, which necessitated a considerable delay in beginning sampling at those locations.

Sample Points:

Per the experimental protocol, the well 12 inches beneath the drainfield was the primary sampling point. Septic tank effluent and Puraflo® effluent samples were also included on a less frequent schedule to establish waste strength and level of treatment from the Puraflo® units. This was not required by the protocol.

During the course of the demonstration project, samples were taken from the septic tank, Puraflo® sample chamber, drainfield well, down-gradient well and background well whenever possible. The number of wells exceeded the sampling points required by the protocol.

Test Parameters:

Per the experimental protocol, the drainfield well was to be tested for fecal coliform bacteria, pH and chlorides and the septic tank and Puraflo® system was to be tested for BOD_5 only. Nitrate-nitrogen testing and testing of Puraflo®-treated effluent in the sample chamber was optional.

During the first phase of the demonstration project (July 1997 through September 1998), all sample points were tested on a monthly basis for a full range of parameters (BOD_5, TSS, NH_3, TKN, Total-N, $NO_{3,2}$-N, Total-P, Chloride, DO, pH, temperature and Fecal Coliform). Between September 1998 and August 1999, all sample points were tested for the full range of parameters on a quarterly basis and fecal coliforms, pH and chlorides on a monthly basis. After August 1999, all sample points were tested for fecal coliforms, pH and chlorides on a monthly basis.

Testing Frequency and Duration:

Per the experimental protocol, sites were to be sampled on a monthly basis for 18 months.

Due to the specific nature of the site selection process and the realities of selling a "new" septic system to property owners, a much larger number of installations than anticipated were required in order to select sites with the appropriate characteristics. The lack of experience by both VDH and Bord na Móna with a project of this size and scope delayed the start of the project from 1995 until July 1997. To minimize the impact, testing began as soon as 12 of the 24 sites were available. The remaining systems were brought on line at later dates. Most of the test systems serve new construction. A significant time delay was encountered between site evaluation/design and dwelling construction/system installation/use.

In addition, due to the nature of the test wells, well samples were only collected/available approximately 50 percent of the time. When samples were available it tended to be in the wet season under saturated conditions or after significant rain events. Due to dry conditions, sampling was suspended in July and August of 1998 with the approval of the VDH. A revised testing/sampling schedule was proposed by Bord na Móna in September 1998 to address the impact of dry weather on data availability. (At that point the relevance of the data being collected under saturated conditions was not considered.) The new proposal was not approved by VDH until December 1998 and then not implemented until January 1999.

For the above reasons, some limited testing will continue until April 2000 in order to secure 18 sample events for all sites, although the quantity of data collected thus far exceeds the requirements of the experimental protocol on many levels. A clear benefit of the extended testing duration and dry weather delays is that the performance of many of the systems will be observed over a 30-month period. The extended testing duration will provide useful information on the consistency and longevity of the treatment process.

Well Design and Installation:

VDH in conjunction with Bord na Móna and ODU (see drawing, Appendix A), designed the groundwater wells at each of the 24 sites. The wells were located strategically as follows:

1. One up-gradient of the area to measure background groundwater quality;
2. One within the treated wastewater absorption area, and
3. One ten feet down gradient of the wastewater disposal area.

Groundwater gradient was based on topography and/or direction to the nearest groundwater discharge point. This method of groundwater gradient determination was used because three points of reference were not available at most of the sites and groundwater mounding is possible in the absorption area that would create an artificial gradient.

Borings were advanced using a mechanically driven power auger or by hand auger resulting in a 4 to 6 inch bore-hole. The up-gradient and down-gradient borings were terminated once groundwater was encountered or at a maximum depth of 5.5 feet below ground surface. The boring located beneath the footprint of the absorption area was terminated at approximately 24 inches below the bottom of the bed or trench. After boring completion, monitoring wells were installed by placing, in each bore-hole, a 2-inch inside diameter, schedule 40 PVC pipe, 12-inch length screen with a minimum of 0.010-inch slots, an end cap and flush joint casing. The annular space between the pipe and the bore-hole wall was backfilled with a washed filter type sand to a minimum of six-inches above the screen. A one-foot minimum bentonite seal was placed above the sand. Where appropriate, a grout cement seal was placed from the top of the bentonite to ground surface. In some instances the bentonite seal was placed all the way to ground surface. Water-tight caps and protective covers were installed to minimize damage from traffic, mowers, domestic tampering and surface infiltration. General industry monitoring well construction standards and decontamination procedures were followed during installation.

Sampling Protocol and Practice:

Effluent samples were taken from the pump tank with the use of a bailer (tube with spigot) with the exception of the one re-circulated system (sample was taken from the septic tank.)

Puraflo® effluent samples were taken from the sample chamber for pad disposal systems or from a drop box for trench disposal systems. In general, an unforced, free running sample should be taken from the end of the sample pipe in the sample chamber. This is not always possible since it is dependent on the activity (water consumption) of the occupants prior to sampling. In reality, samples were collected as free unforced running/grab samples; forced (pump activated) running/grab samples; and as composite samples from a left-in-place bucket or directly from the base of the sample chamber.

Forced (pump activated) samples were taken by the researchers by running the pump manually for 30 seconds, waiting 5 minutes, and then taking a sample out of the bucket.

Taking composite samples from left-in-place buckets was the most common method of collection. Unfortunately, this method tended to yield artificially high TSS counts due to accumulation in the collection bucket and buckets that were not cleaned between sampling.

Groundwater samples were collected on a monthly schedule at each of the sites. The sampling was conducted using the following protocol.

First, all wells were checked for any odors or adverse conditions and the static water level recorded on that date. Prior to securing a water sample, each well was purged by hand bailing a minimum of three casing volumes or until dry. The groundwater was then allowed to recharge to equilibrium and the samples collected. All tools and equipment were thoroughly cleaned prior to entering the wells. The samples were poured into the designated sample bottles, labeled, preserved according to required protocols, placed on ice and delivered to the laboratory within the specified holding time with chain-of-custody attached.

Method of Analysis

The laboratory analysis for all of the parameters was conducted using the Standard Methods for Examination of Water and Wastewater Handbook. ODU used the membrane filtration method to test for fecal coliforms. With approval of VDH, figures for these tests were revised during the project to comply with the Hampton Roads Sanitation District's guidelines, accepted by the Virginia Department of Environmental Quality (see ODU notes, *Appendix B*).

Discussion of Methodology and Interpretation of Results

The results show that the Puraflo® system is a robust system capable of consistently producing a high quality effluent under a wide range of real-life applications. The requirements of the protocol were demonstrated with respect to influent (septic tank) waste strength and increased hydraulic loading on the drainfield with highly treated effluent. Organic (BOD_5) loading of the Puraflo® system ranged from 112 to 512 mg/l.

Another performance requirement in the protocol identified ponding as a "failure." No ponding was observed at any of the test sites and except for a temporary surfacing of treated effluent at a site in Virginia Beach (which later was disappeared naturally), no ponding was observed at any of the other 236 installations as of 12/1/99. Systems are regularly inspected by either the researchers or by local and central-office health department personnel.

The performance standard for fecal coliform at 12 inches below the drainfield trench/pad was not demonstrated because the conditions under which samples were obtained (saturated conditions) are excluded by the protocol.

Due to the design of the test wells, saturated conditions at 12 inches beneath the drainfield trench/pad were required to attain a sufficient sample volume from the test wells. Therefore, when drainfield well samples were available, the conditions under which the samples were collected did not meet the requirements established in the protocol, namely, that the samples be taken from unsaturated soil horizons. The drainfield samples obtained represent saturated conditions where the water table is at the seasonal high as determined by Chroma II mottling.

Most of the selected sites had a seasonal high water table condition at 12 inches (or less) below the drainfield installation depth. As a result, drainfield well samples were only attained during the wet season or after significant rainfall events. The large number of dry wells encountered during the summer months and during the severe drought of 1999 (February through the Fall) indicate that the systems were operating in an unsaturated state during those periods but no samples were available.

Based on published research, under such conditions and given the quality of the Puraflo® effluent, the required FC standard would have been achieved with a high degree of certainty had samples been available (by suction lysimeter for example) during unsaturated conditions. Down-gradient and background wells frequently exceeded the standard indicating the likelihood of external contamination. The integrity of a sample well penetrating the actual drainfield is difficult to assure against short-circuiting.

Almost all of the test wells sustained some physical damage, even to the point where they had to be replaced (see ODU notes, *Appendix C*). In some cases when the researcher went to a site, he/she found the well caps missing, surface water on the interior seal, or the well missing altogether after being run over by lawnmowers or other machinery. Damage to the wells might have allowed leakage and infiltration of contaminated water.

At three sites, most noticeably, the property owners may have added to the fecal contamination of the samples. One placed uncomposted chicken manure directly on the drainfield to improve grass growth (*Stanley*/ the drainfield was also installed in a former heavily used cattle pasture). Another keeps turkeys, ducks, and other poultry within 50 feet of the wells with a pond that overflowed at least once (*Long-Arthur*); and a third system was installed in a neighborhood with a large number of failing septic systems (*D. Smith*). This last site also has a leaking septic tank, which was reported to the local health department. Due to lack of funds, the tank still has not been repaired.

Although not required in the original experimental protocol, Bord na Móna undertook substantial additional testing of the Puraflo® effluent to demonstrate system performance. Through September 1999, the average influent BOD_5/TSS and fecal coliforms for all 23 single pass systems was 270/489 mg/l and 1,279,315 cfu/100ml respectively. The average Puraflo® effluent BOD_5/TSS and fecal coliforms for all systems was 6.6/26 mg/l and 611 cfu/100ml respectively. The performance of the re-circulation system (50% of the Puraflo® effluent was returned to the pump tank) was even better. The retired couple who owned the house with the re-circulating peat system occupied the dwelling on an intermittent/seasonal basis thus verifying Puraflo®'s ability to perform under intermittent/seasonal conditions.

The BOD readings from the tanks may also be related to the depth of the sample taken during any one sampling event: deeper layers may have greater BOD counts. In some cases, researchers found tanks that were only half-full, which may have led to higher figures.

As a result of all these factors, the demonstration project can not reliably make a direct comparison between the performance of the Puraflo® system followed by 6 to 12 inches of unsaturated soil versus a conventional drainfield followed by the required (unreduced) depth of unsaturated soil.

Puraflo® Performance and Soil Treatment of Effluent

Reliable research is available to show that additional treatment of septic tank effluent can be substituted for soil depth. Most significantly, Virginia Tech's C.S. Duncan, R.B. Reneau, Jr., and C. Hagedorn published a paper entitled "Impact of Effluent Quality and Soil Depth on Renovation of Domestic Wastewater" in the proceedings of the Seventh International Symposium in Individual and Small Community Sewage Systems.

The percentage reductions and effluent quality from the pre-treatment systems (re-circulating sand filter and constructed wetland) selected for this study is comparable with the effluent quality produced by the Puraflo® peat filter. Fecal coliform counts for the sand filter and constructed wetland ranged from 170 to 3,200 cfu/100 ml respectively. The fecal coliform mean for all Puraflo® systems combined was 611 cfu/100ml with only two of the 24 individual site means exceeding 3,200 cfu/100 ml. This is an impressive performance by the Puraflo® system considering the influent strength in the demonstration project (1,279,315 cfu/100ml) far exceeded the influent strength observed in the Virginia Tech study (35,800 cfu/100ml).

The method of dosing (time dosing) and hydraulic loading on the soil sample was comparable with the manner in which the experimental Puraflo® systems were designed and operated. In fact, this and other recognized studies support a drainfield area reduction (typically 50%) for pretreated effluent.

The pretreated sand filter and constructed wetland effluent was applied to columns of fine loamy soil (core samples). Leachate samples were extracted from the unsaturated column sample at specific depths using a suction lysimeter. No fecal coliforms were detected at 30 cm (11.81 inches) for either of the pretreated effluents. At 15 cm (5.90 inches) no fecal coliforms were detected from the sand filter effluent and 40 cfu/100ml were detected from the constructed wetland effluent.

All of the test Puraflo® systems were installed in difficult conditions with the bottom of the pad or trench between 6" and 12" from the seasonal high water table or rock. It is clear that under the correct sampling conditions the Puraflo® effluent would have met the required standard of 10 cfu/100ml on average with no single sample exceeding 200 cfu/100ml at 12 inches below the drainfield.

Recommendations for Future Studies

This was a demonstration project to verify the treatment performance of the Puraflo® system under real-life applications and, as such, the project was highly successful. Despite a good-faith effort of all involved, a conclusive demonstration of some of the objectives was not attainable via the proposed methodology. The sampling methodology was not sufficiently sophisticated and the testing environment was not sufficiently controlled to allow certain deductions to be made directly. In many respects, the target sampling at 12 inches below the drainfield crossed over into the realm of scientific research. It will be crucial to the conclusion of future projects to set realistic objectives and apply appropriate methodology.

The duration of the project extended far beyond what was expected because the lag time associated with attaining the required number of sites with the specified characteristics was underestimated. In hindsight, the two-phase testing approach that resulted from this delay could have been built into the study from the start.

Conclusions Regarding Puraflo®

Puraflo® has been shown to be a safe, effective and efficient treatment system capably of producing a highly treated effluent under a wide and varied range of domestic applications. The technology can be applied in difficult situations including, shallow depth to wetness conditions and reduced drainfield area. In addition, the product's performance was demonstrated in all four major soil group classifications.

Effluent from the Puraflo® modules almost meets standards for human contact. Final polishing of the effluent by the soil ensures that Virginia's ground and surface waters are protected from almost all contaminants. Puraflo® will serve and protect the environment and the health of Virginia's citizens.

Time Dosing

Although several of the test sites used dose on demand, time dosing has become a standard feature of the Puraflo® system. As well as the treatment and hydraulic disposal advantages of micro-dosing, time dosing can be an effective means of detecting leaks, infiltration and system abuse.

Stand-off Distances

The system has been proven to work in very difficult soils and site conditions without ponding or surfacing of effluent. Eleven of the 24 test sites were installed in soils with <u>less than 12"</u> to the seasonal high water table or rock.

Pad Design

The project has shown there are safe and useful applications for the pad disposal method. The performance of the pad disposal system can be enhanced by installing long, narrow pads on contour rather than the original 16' X 20' pad proposal. This facilitates lateral movement out of the pad and minimizes the potential for mounding under the system.

The original experimental protocol also limited the square footage of the pad and required trench extensions from the pad to make up additional square footage as required. This practice was found to be problematic in the field and in some cases it prevented more hydraulically appropriate configurations from being applied.

The infiltration rate used for all designs has been simplified from the original charts outlined in GMP #69 (and later versions in GMPs #79 and 93). The rates are the same, just the format has been changed. *(See Appendix D).*

Treatment Capacity

The protocol described each Puraflo® module as capable of treating approximately 125 gallons per day. In fact, after extensive testing by Bord na Móna, it was learned that each module can effectively treat up to 150 gallons per day when time dosing is implemented. This is the standard that is used in all other states besides Virginia, with similar test results.

System Design

Of the 24 test sites, 22 were designed by Bord na Móna or its representative, 2 were designed by Virginia-certified engineers. Of the remaining 236 systems installed as of 12/1/99, 231 were designed by Bord na Móna or its representative and 3 were designed by Virginia-certified engineers.

The fact that Puraflo® is a proprietary, "pre-engineered" system allows the manufacturer and its authorized representatives to provide accurate and appropriate siting and technical information to the VDH for the permitting process.

Applications

In addition to single family homes, Puraflo® is in use for a number of larger domestic and commercial applications in Virginia. Applications other than single family residences include the following, a golf course, two fire stations, a marina, two churches, a yacht business, a trucking company; multi-family homes; and visitor's center for an archaeological site.

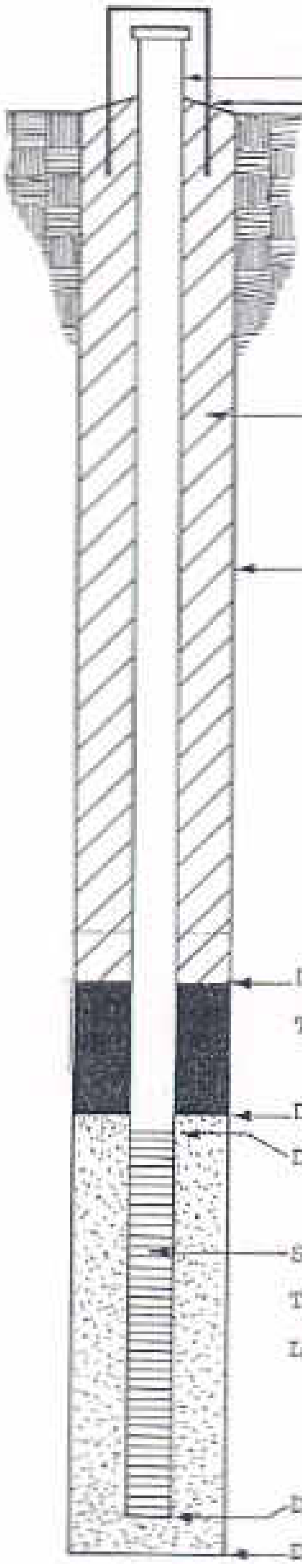
In the test sites and in the other Virginia installations, safe and successful disposal of the Puraflo® system effluent has been proven by many different methods; shallow gravel pads; shallow trenches; discharge with disinfection by ultra-violet light and chlorination. This demonstrates Puraflo®'s ability to work with gravity, pressure or any other approved disposal method.

All of these issues need to be addressed in the final approval document.

Appendix A

Sample Well Design

MONITORING WELL CONSTRUCTION DETAILS



Stick-Up Riser Pipe: (WELL ID)

Type of Surface Seal: BENTONITE / GROUT MIX

Riser Pipe I.D.: (WELL ID)

Type of Riser Pipe: SCHEDULE 40 PVC

Borehole Diameter: 4"

Type of Backfill: BENTONITE 3/8" PELLETS

Depth to Top of Seal: (VARIES)

Type of Seal: BENTONITE HIGH YIELD GEL & PELLETS

Depth to Top of Sand Pack: (VARIES)

Depth to Top of Screen: (VARIES)

Screen I.D.: BRADY MACHINE SLOTTED

Type of Screen: PVC 0.010

Length of Screen: 12"

Depth to Bottom of Screen: (VARIES)

Depth to Bottom of Hole: (VARIES)

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Appendix B

FC Tests, ODU/HRSD Protocol and Standard Field Operating Protocol

FECAL COLIFORM REPORTING PROCEDURE

Calculation of Reported Values for Non-Split Volumes :

1. Calculation:

$$FC/100\ mL = \frac{\text{Number of colonies counted}}{\text{Volume of sample filtered(mL)}} \times 100$$

2. Selecting Correct Plate Counts for Calculation of Reported Values:

   a. Select the sample quantity that produces a plate count within the desired range of 20-60 colonies and calculate the FC/100 mL. See Example 1, Section A,3.

   b. If all of the plates have no colonies, select the largest volume filtered: calculate the FC/100 as if there was one colony on the plate. Report as a A<@ value. See Example 2, Section A,3.

   c. If all the sample volumes have plate counts less than 20, total the number of colonies in all volumes and calculate the FC/100 mL. Remember to include the total volume in the calculation. See Example 3, Section A,3.

   d. If none of the sample volumes have plate counts in the desired range, but some counts are <20, and some >60 (or TNTC), select the plate with counts closest to the desired range and calculate FC/100 mL. See Example 4, Section A,3. If more than one sample volume have plate counts equally distant from the desired range, calculate the FC/100 mL for both and **AVERAGE** the results for a final reported value. See Example 5, Section A,3.

   e. If more than one volume per sample have plate counts in the 20-60 range, calculate the counts per 100 mL. For **EACH** volume and average the results. Report the **AVERAGE** as the final result. See Example 6, Section A,3.

   f. If all sample volumes have greater than 60 but less than 200 total colonies per plate, or if all plates counts are TNTC (>200 colonies/plate), select the smallest volume filtered and calculate as if there were 60 colonies on the plate. Report result as a A>@ value. See Example 7, Section A,3. On the following day, add a dilution volume (100, 10, 1, and 0.1mL). Do not delete the other volumes.

   g. If a plate(s) exhibits atypical colony morphology which is too indistinct for an accurate count, make a note on the sheet. Use plate counts from the other volumes to calculate the FC/100mL. See Example 8, Section A,3.

   h. If a plate count for a particular volume cannot be used, use plate counts form the other sample volumes to calculate the FC/100mL.

TABLES

A. Examples Unsplit Volumes with calculations.

Example	# Colonies/Plate Volume filtered 1 mL	# Colonies/Plate Volume Filtered 10 mL	# Colonies/Plate Volume Filtered 100 mL	Plate Count/Vol.	FC/100 mL
1	3	32	TNTC	32/10 mL	320
2	0	0	0	1/100 mL	<1
3	5	12	18	35/111 mL	32
4	12	18	65	18/10 mL	180
5	3	18	62	18/10 mL 62/100 mL	180 62 AVG =121
6	3	20	59	20/ 10 mL 59/100 mL	200 59 AVG =130
7	61	100	199	60/1 mL	>6,000
8	TNTC	TNTC	TNTC	60/1 mL	>6,000
9	1	12	*	13/11 mL	118

* ÂColony morphology too indistinct for an accurate countê

Standard Field Operating Protocol:

Arrive on site:
- Time and weather conditions logged

Visual Inspection of monitoring wells
- Conditions logged
- Depth readings taken
- Wells purged
  - Any characteristics of water logged
  - Standard bailers

Visual Inspections of Puraflo system and Sample Chamber
- Conditions logged
- Sample obtained
  - From bucket – necessary implement added when inability to constantly obtain fresh sample
  - Fresh sample – occasionally system is operating
  - Force-fed – last resort, only used if previous visit resulted in no sample or verbal instruction to do so
    - System is manually fed for 30sec-2 min
    - Five minutes of effluent is allowed to waste
    - Sample collected
  - Samples are collected in a 500 ml plastic container

Obtainment of samples from monitoring wells
- Conditions logged
- Samples are collected in a 500 ml plastic container

Visual Inspection of Pump Tank
- Obtainment of samples from pump tank
  - Samples are collected in a 500 ml plastic container
- Hours from usage logged – if available
- Condition of tank logged

On Site Analysis conducted
- DO, pH, and Temp using standard equipment
  - Equipment is tested monthly for accuracy
- Testing done from alleged cleanest to dirtiest sample
  - BG, DG, PW, SC, PT

Time for departure logged
- Additional comments noted

Appendix C

ODU Notes on Well Damage and Site Conditions

Greg,

Here are the additional field conditions that you need for your report.

Sawmill – System is not being maintained. Wells cannot be located due to overgrowth. Small trees are growing up through the puraflo system. Wells have always had high level of moisture inside, which is an indicator that the well has been compromised. Additionally rust color has been noted since the beginning of the project in the BG pipe.

Harmon – System is located between a used car dealership and an auto junkyard. Both have been seen practicing unsafe disposal of hazardous materials.

Merritt – Downgradient and Padwell sample sites were compromised by flooding during February and March of 1999. Well depth is no longer the same as initial parameters. This would indicate that the well integrity has been compromised.

Kemp – During flood period of 1999 ground was percolating at time of sample. System has been tampered with (rocks in sample chamber, missing screws). Site has been unoccupied for most of testing period. It is currently chained off and inaccessible for sampling.

Farrell – During flood period BG was under water. Additionally DG and PW typically have water between 2 and 4 inch piping which indicates a compromised well. DC lid is cracked which could cause invalid results for analysis. Oily sheen has been noted in well samples on several occasions.

Nesbitt – Property is located next to farm with several horses.

AOA – Water has been found inside the BG well. Oily sheen seen in PW sample. Caps have had to be replaced due to owner damage.

C. Brown – System is located in middle of field, which is used for rotational crop planting. DG has been plowed under and cannot be located. PW has been struck by farm equipment.

Long – Arthur – House has small pond, which is occupied by a variety of geese, ducks, peacocks, and assorted wildfowl. During drought period no drop was noticed in water level of pond. During raining season soil is extremely swamp-like.

E. Brown – VICIOUS dog is chained where samples cannot be taken from SC, BG, PW, and DG.

Easter – Site has been replumbed (by owner) and connected to house located at rear of original property.

Munford – Site has geese and ducks roaming freely.

Link – Site now has commercial nursery operating within 10ft of system and BG. All of the wells are missing caps and SC has been found with lid off.

Sharf – System has been disconnected. Owner on city sewage.

L. Smith – PW and DG wells are rising and cannot be used for sampling.

Henderson- House has never been occupied.

Stanley – Owners use raw chicken litter for fertilizer. Front yard, where wells are located, is used to grow hay. Wells have been mowed over by equipment once and had to be relocated.

Jacobson – no unusual conditions

T. Smith – Commercial horse farm is located uphill of property. Owner has expressed concern over liquid flowing from neighbor's property that has septic odor.

Samson – Excessive moisture has been found on wells. Currently lids cannot be removed for sampling.

Carter – Land had to be regraded and filled in. During raining season trenches were formed. Sinkholes have been filled in around the PT.

Moore – no unusual conditions

The following owners would probably be agreeable to Don's desire to conduct additional studies:

C. Brown
L. Smith
Moore
Samson

Let me know if you need any additional information.

Regards,
Roxanne

Appendix D

Infiltration Rate Table

TABLE 1

INFILTRATION RATES

Perc Rate	Soil Group	Trench	Pad/Bed
min./inch	Classification/Texture	gpd/sq.ft.	gpd/sq.ft.
5		3.60	3.31
10	Group I - Sand, Loamy Sand	3.10	2.76
15		2.60	2.21
20		2.22	1.66
25		1.77	1.33
30	Group II - Sandy Loam, Loam,	1.48	1.11
35	(Sandy Clay Loam)	1.40	0.95
40		1.30	0.83
45		1.20	0.74
50		1.10	0.67
55		0.95	0.61
60		0.90	0.55
65	Group III - Sandy Clay Loam,	0.85	0.51
70	Silt Loam, Clay Loam,	0.80	0.48
75	Silty Clay Loam, Silt	0.75	0.44
80		0.70	0.42
85		0.65	0.39
90		0.60	0.37
95		0.47	0.35
100		0.44	0.33
105	Group IV - Sandy Clay,	0.42	0.22
110	Silty Clay, Clay	0.40	0.30
115		0.39	0.29
120		0.37	0.28