Summary of Alternative Onsite Wastewater Demonstration Systems Treatment Performance And Operation and Maintenance Needs Chepachet Village, Glocester, Rhode Island

November 10, 2004

Submitted to
Town of Glocester, Rhode Island
Wastewater Management Board
In partial fulfillment of RIDEM Grant
Chepachet Village: Onsite Wastewater and Stormwater Solutions

Submitted by
University of Rhode Island
Cooperative Extension
Onsite Wastewater Training Center

Prepared by
George Loomis
Research and Extension Soil Scientist
Director, OWT Center

Summary of Alternative Onsite Wastewater Demonstration Systems Treatment Performance And Operation and Maintenance Needs Chepachet Village, Glocester, Rhode Island

Background

During the Fall 2001 five alternative and innovative systems were installed in Chepachet Village (Town of Glocester), Rhode Island under the auspices of a Sec. 319 grant administered by Rhode Island Department of Environmental Management (DEM). The Town of Glocester was the recipient of the grant. Installations were conducted by members of the RI Independent Contractors and Associates and URI Onsite Wastewater Training Center staff. RIDEM staff witnessed installations and several Town of Glocester staff and volunteer board members visited installations periodically during construction.

These systems were sampled four times during 2002, twice in the winter (representing the cold season) and twice during the summer (warm season). The field sampling protocol for these systems followed the procedures outlined in Quality Assurance Project Plan (QAPP) approved by DEM and USEPA. Figures in this report will reference the actual figures in the QAPP so as to minimize confusion in case individuals wish to seek more information and cross reference both documents. Copies of this QAPP have been mail to a distribution list that included the Town of Glocester Planning Department. Please check with the Glocester Planning Department for the availability of that document.

Executive Summary

Locations of the five systems in Chepachet Village are shown in QAPP Figure 3.

The systems installed on the Chepachet Village project consist of the following treatment trains:

System (please see QAPP Figures 13 – 17 for system treatment train)
Number:

CH – 1 (HAT)

Wastewater flow from the building enters a 1,500 gallon processing tank (also serving as a septic tank and recirculation tank) containing a time dosed pump that pressure doses a 4 x 8 foot Orenco Systems, Inc. Recirculating Advantex (AX-20) Textile Filter. Wastewater recirculates between the processing tank and the textile filter several times a day. Final treated wastewater is dosed to 164 feet of pressure dosed shallow narrow drainfield. See Figure 3 location 1.

CH – 2 (BRA)

Wastewater from the building enters a 1,500 gallon processing tank (also serving as a septic and recirculation tank) containing a time dosed pump that pressure doses a 4 x 8 foot Orenco Systems, Inc. Recirculating Advantex (AX-

20) Textile Filter. Wastewater recirculates between the processing tank and the textile filter several times a day. Final treated wastewater is dosed to a 7 x 25 foot raised bottomless sand filter (serving as a drainfield). See Figure 3 location 2.

CH – 3 (CHR)

This system consists of a 1,500 gallon septic tank which gravity flows to a 1,000 gallon recirculation tank containing a time dosed pump that pressure doses a 4 x 8 foot Orenco Systems, Inc. Recirculating Advantex (AX- 20) Textile Filter. Wastewater recirculates between the recirculation tank and the textile filter several times a day. Final treated wastewater is dosed to 180 feet of pressure dosed shallow narrow drainfield. See Figure 3 location 3.

CH – 4 (ETH)

This small community system serves three buildings on Tanyard Lane (total design flow of 900 gallons per day). Each building unit has its own primary treatment tank (ranging in size from 1,000 to 2,000 gallon septic tank with effluent screen on outlet) gravity flowing to a 2000 gallon recirculation tank. Wastewater is time dosed from the recirculation tank to two 4 x 8 foot Orenco Systems, Inc. Recirculating Advantex (AX- 20) Textile Filters (in a recirculating mode). Wastewater recirculates between the recirculation tank and the textile filter several times a day. Final treated effluent is dosed to a two-zone 7 X 48 foot raised bottomless sand filter serving as the final treatment and effluent dispersal zone. See Figure 3 location 4.

CH – 5 (LAV)

This system consists of a 2,700 gallon per day commercial system servicing a restaurant, small doctor's office, one duplex apartment, and a five small business strip mall. The doctor's office and strip mall each have 1,000 gallon septic tanks and the duplex apartment has a 1,250 gallon septic tank. All three of these septic tanks have effluent screens on their outlets and gravity flow to a 2,500 gallon recirculation tank.

Wastewater flow in the restaurant is separated into black water (toilet wastes) and gray water (kitchen wastewater). Black water generated in the restaurant flows by gravity into a 2,500 gallon two compartment septic tank (with effluent screen on outlet) and then into the aforementioned 2,500 gallon recirculation tank. Gray water from the restaurant kitchen flows by gravity into a three compartment 2,000 gallon grease trap, then into the aforementioned 2,500 gallon black water septic tank and then into the 2,500 gallon recirculation tank.

Wastewater is time dosed to four 4 x 8 foot Orenco Systems, Inc. Recirculating Advantex (AX-20) Textile Filters. Wastewater recirculates between the recirculation tank and the textile filter several times a day. Final processed effluent is pressured dosed to eight 98 foot long shallow narrow drainfield lines (fed from the middle and set in four zones, consisting of two lines each). See Figure 3 location 5.

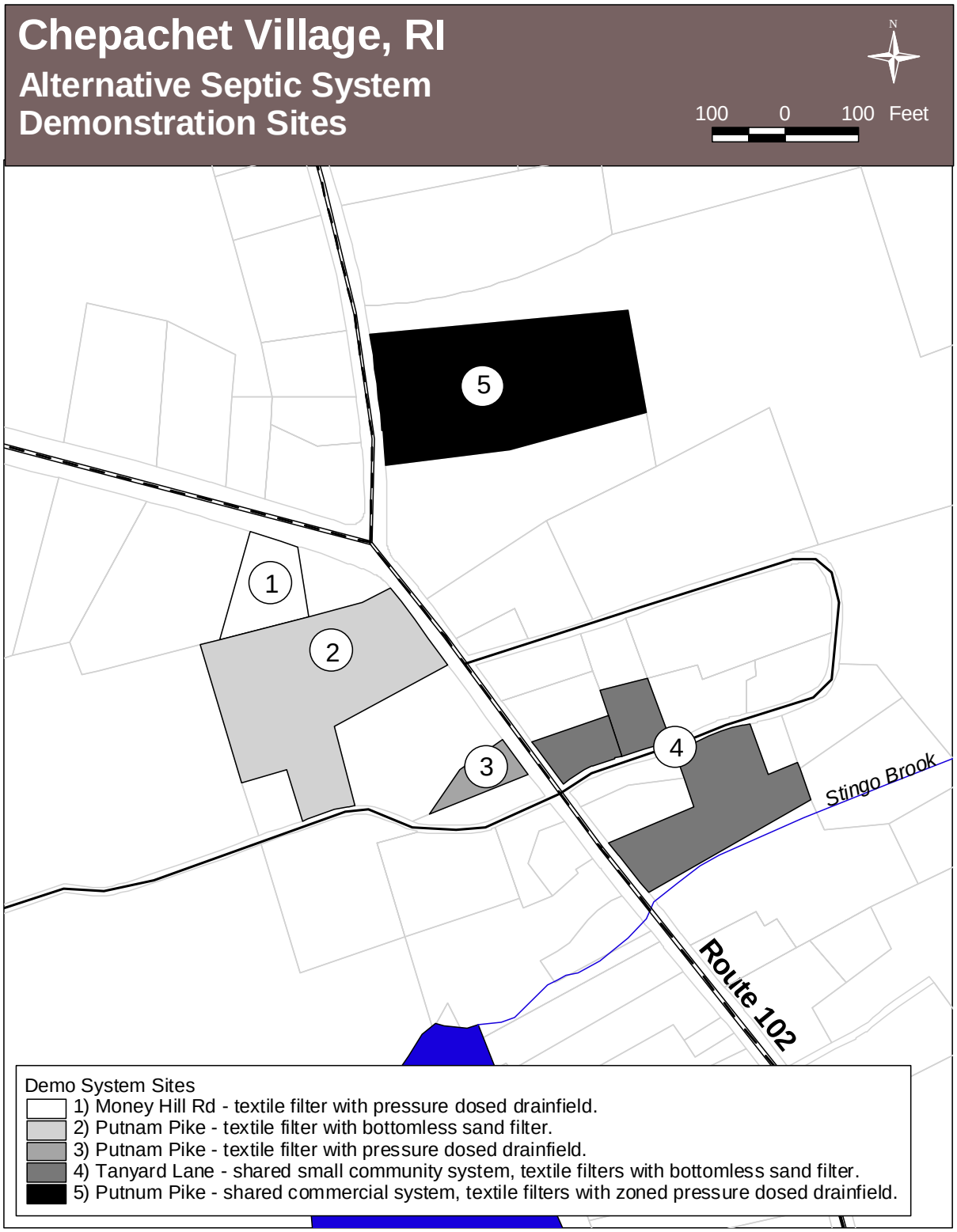


Figure 3 (from QAPP). Alternative septic system demonstration site locations in Chepachet Village, Glocester, RI.

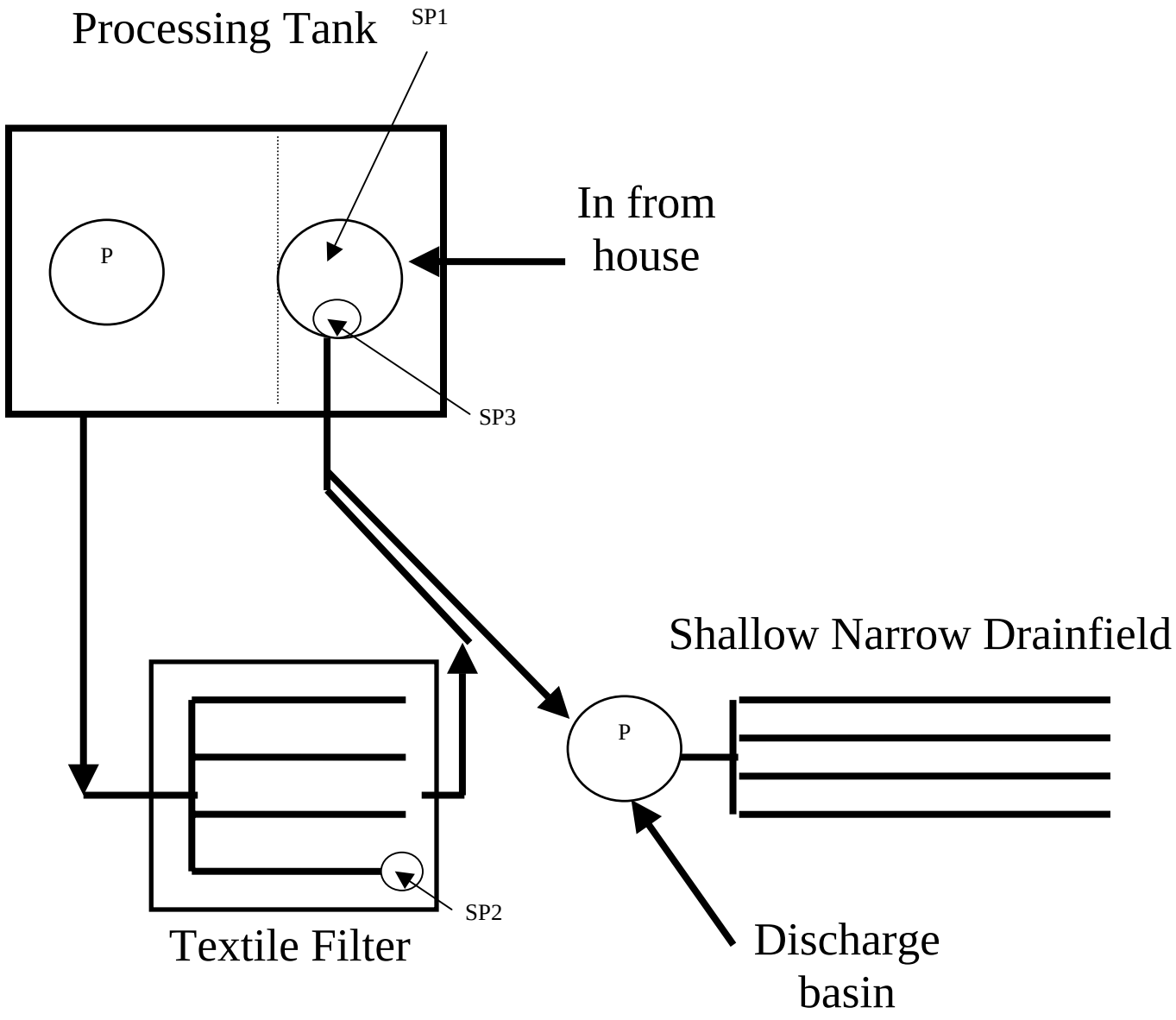


Figure 13 (from QAPP). Advantex Textile Filter Treatment Train for Chepachet System CH 1 (HAT).

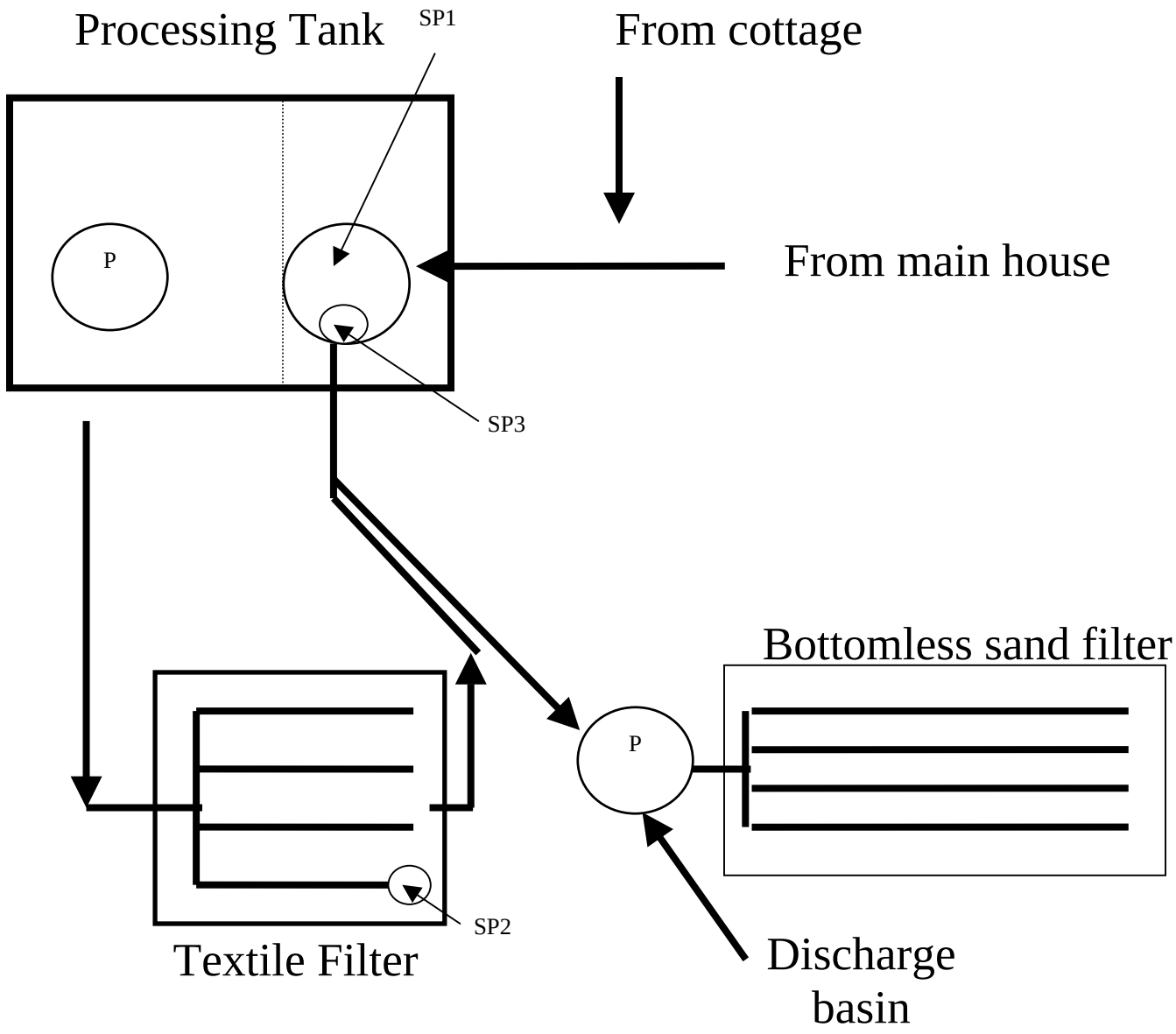


Figure 14 (from QAPP). Advantex Textile Filter Treatment Train for Chepachet System CH 2 (BRA).

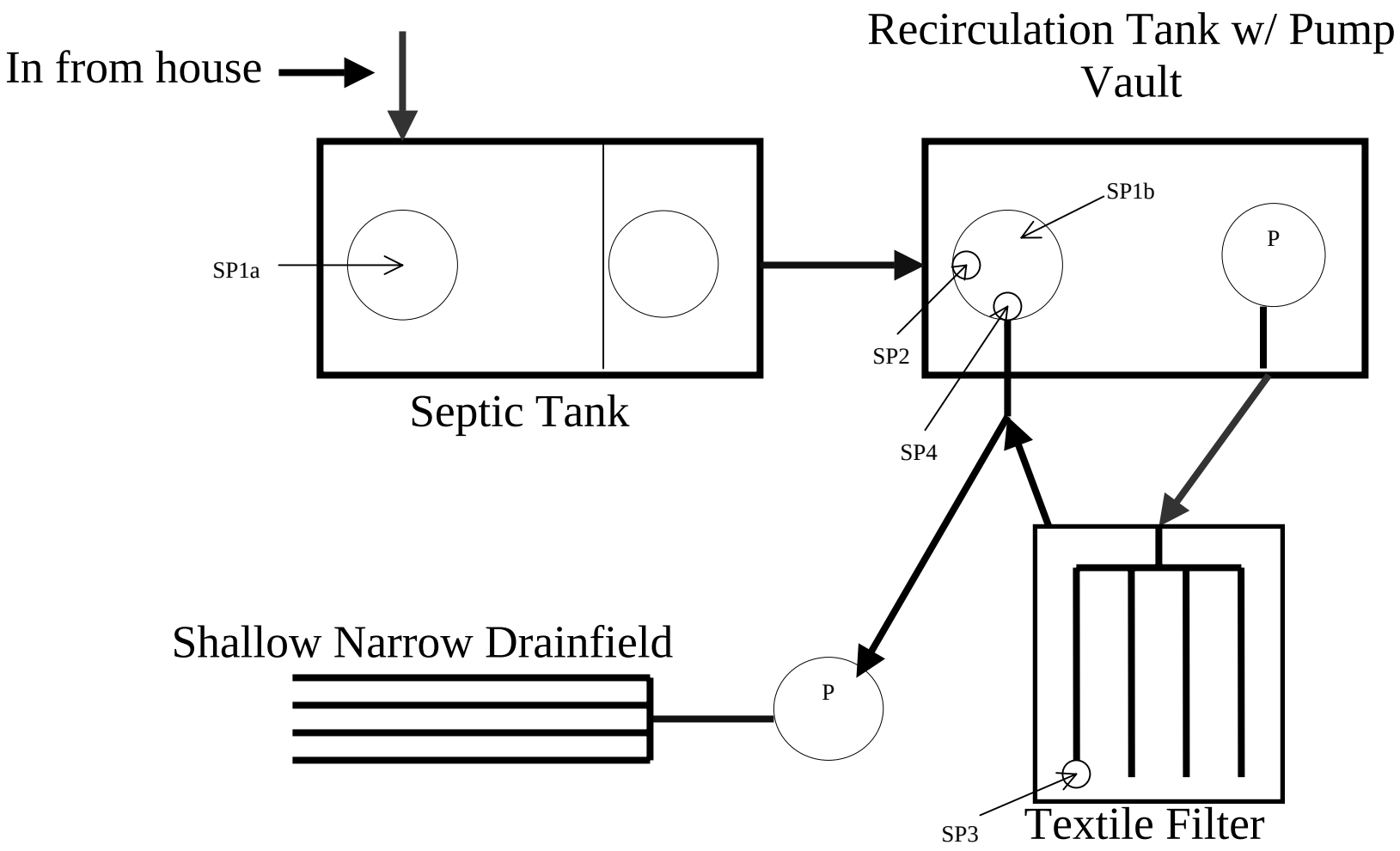


Figure 15 (from QAPP). Advantex Textile Filter Treatment Train for Chepachet System CH 3 (CHR).

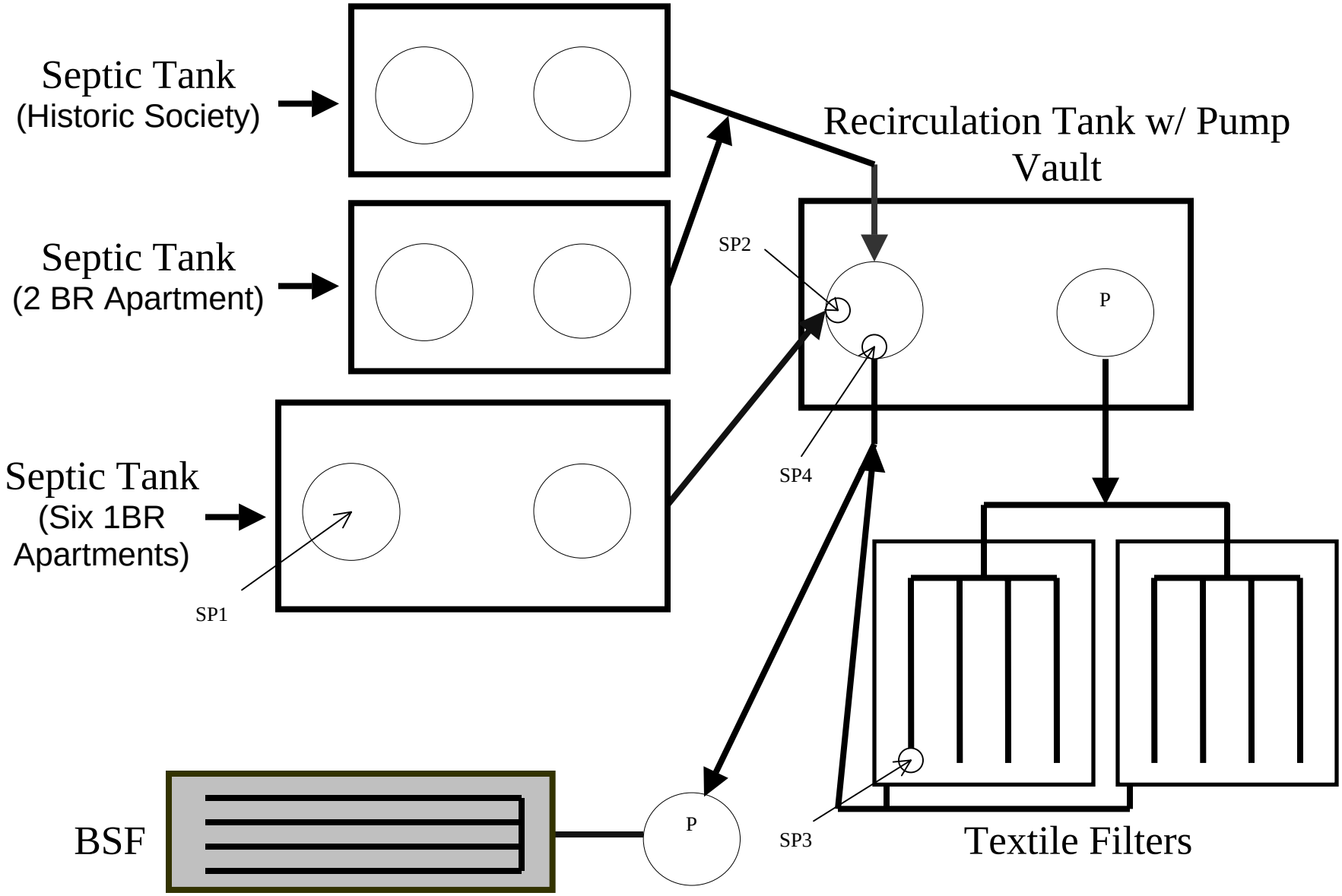


Figure 16 (from QAPP). Advantex Textile Filter Treatment Train for Chepachet System CH 4 (ETH).

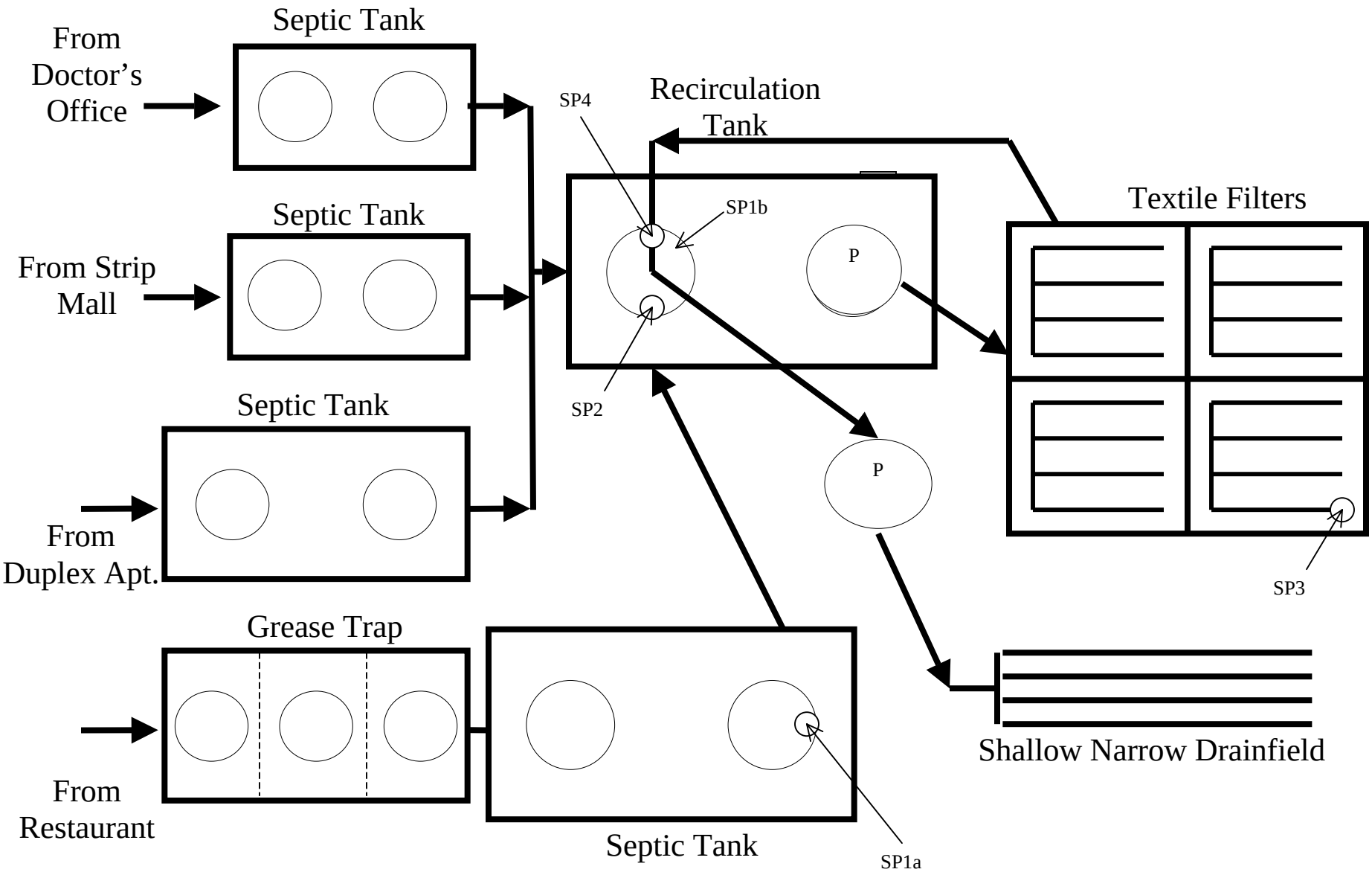


Figure 17 (from QAPP). Advantex Textile Filter Treatment Train for Chepachet System CH 5 (LAV).

Sampling and Laboratory Methods

Details about sample station locations, sample types, and sampling protocol are included in the QAPP. All sampling was conducted by URI Onsite Wastewater Training Center staff following QAPP procedures. Sampling dates in 2002 were February 13 and March 28, representing cold season dates; and June 20 and July 24, representing warm season dates. Treatment component dissolved oxygen and temperature measurements were collected in the field during each sampling visit. Laboratory analyses included five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), total nitrogen (TN), total phosphorus (TP), and fecal coliform. All laboratory analyses were conducted by the URI Watershed Watch Laboratory following standard methods and procedures (APHA, 1995). We report component treatment performance in three ways: textile filter effluent concentration; percent reduction within a textile filter based upon observed influent and effluent levels; and in the case of fecal coliform bacteria, we report reductions in log 10 values.

For Systems CH – 1 HAT and CH – 2 BRA, which are one-tank systems where effluent from the textile filers is recirculated back to the inlet of the septic tank, we are not able to calculate percent reduction. The reason for this is that the recirculation process creates a blended wastewater in the septic tank consisting of raw wastewater from the home and treated effluent from the textile filter, so we can not determine beginning wastewater strength. The three other systems have separate septic tanks, which facilitates calculating percent reductions.

Treatment Results and Operation and Maintenance Summaries

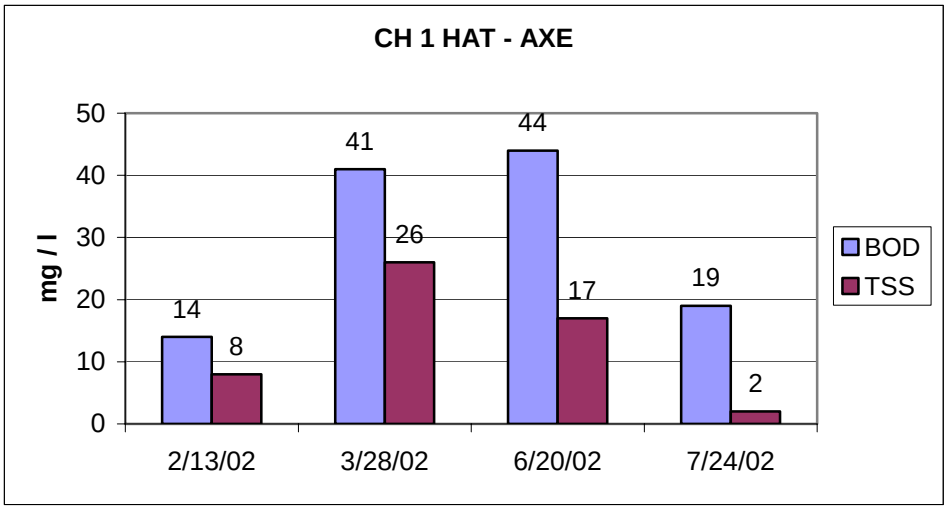
All raw data for the five demonstration systems is included as Appendix material. Summarized information for BOD5, TSS, fecal coliform, TN, TP, pH, and alkalinity for individual systems is included in this section.

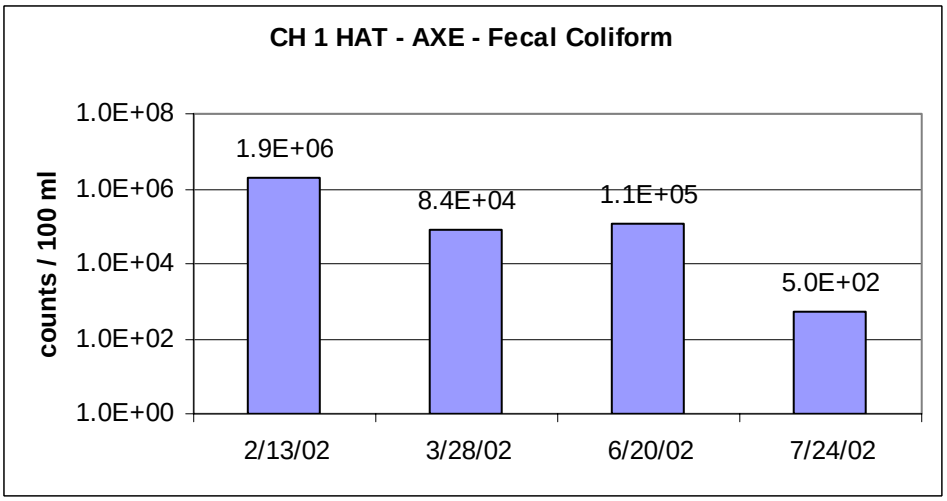
System CH 1 HAT

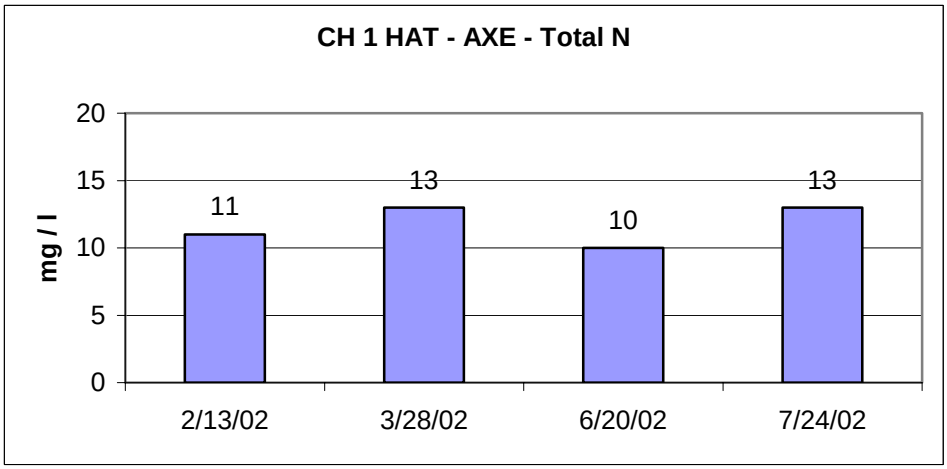
Actual wastewater generation at this site averaged 510 gallons per day (gpd) for the study period. This volume was below the design loading rate of 600 gpd. BOD5 concentrations in final textile effluent ranged between 14 and 44 mg/l (ppm) and averaged 30 mg/l for the four sample events. Final effluent TSS concentrations ranged between 2 and 26 mg/l, and averaged 13 mg/l. Fecal coliform concentrations in final effluent ranged between 500 and 1,900,000 counts/100 ml, with a geometric mean of 55,000 counts/100 ml. TN concentrations in final effluent ranged between 10 and 13 mg/l, and averaged 12 mg/l. These TN concentrations were below the Rhode Island TN standard of 19 mg/l. TP concentrations averaged 4.5 mg/l and ranged between 3.6 and 5.7 mg/l. No seasonal effects on treatment performance were observed. Because this is a one-tank system, we were not able to calculate percent reductions.

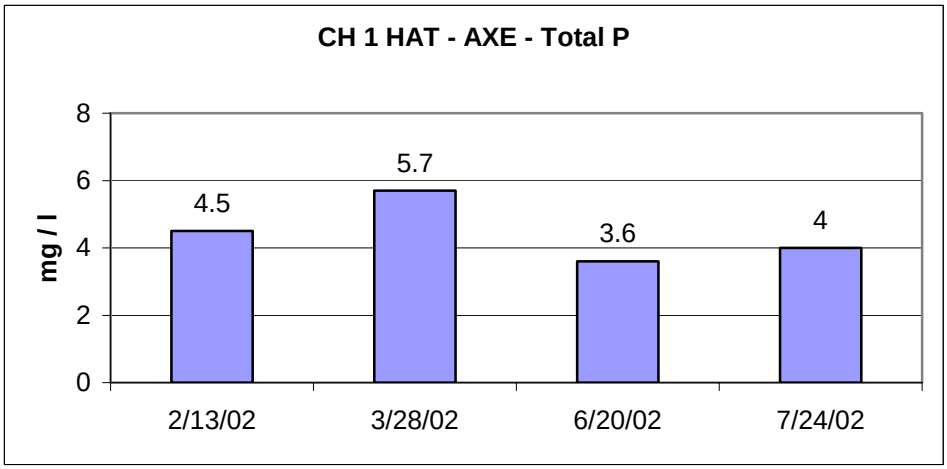
Routine wastewater operation and maintenance procedures were conducted on this system by URI OWT Center personnel twice per year. These procedures are required

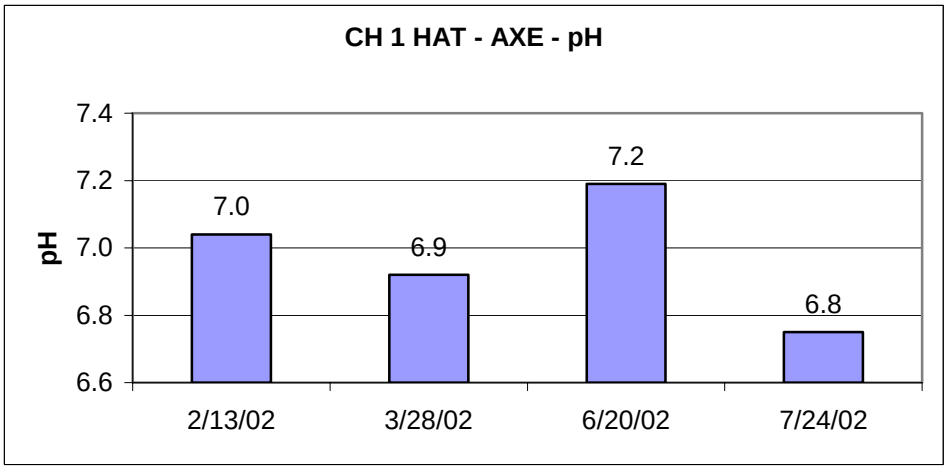
under the RIDEM permit approval for this particular technology (actually required for all approved alternative technologies in Rhode Island). No abnormalities, or system or component failures were observed for this system during the study period.

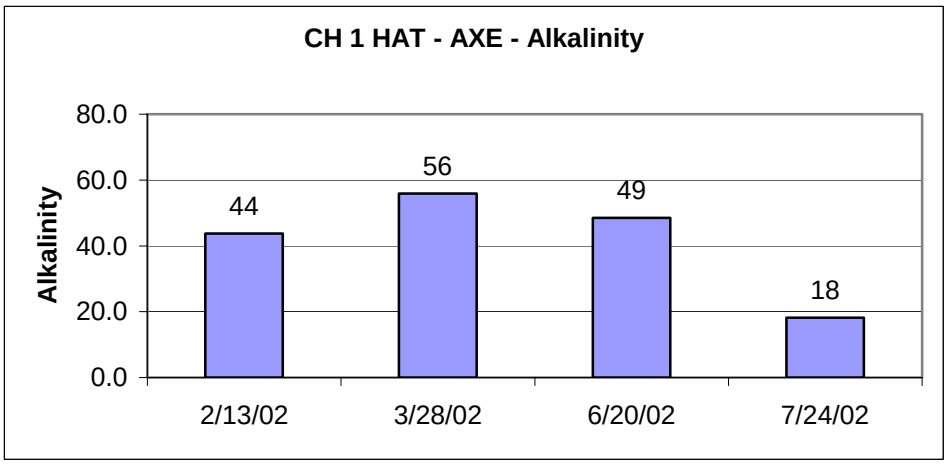







CH 1 HAT - AXE - Total P
mg / l
8
6
4
2
0
4.5
5.7
3.6
4
2/13/02
3/28/02
6/20/02
7/24/02

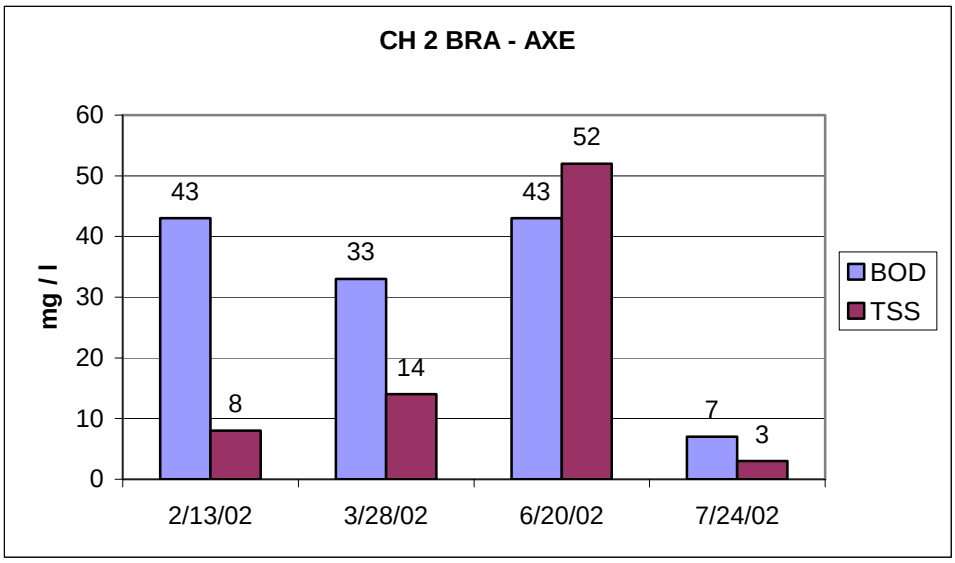

CH 1 HAT - AXE - pH
pH
7.4
7.2
7.0
6.8
6.6
7.0
6.9
7.2
6.8
2/13/02
3/28/02
6/20/02
7/24/02

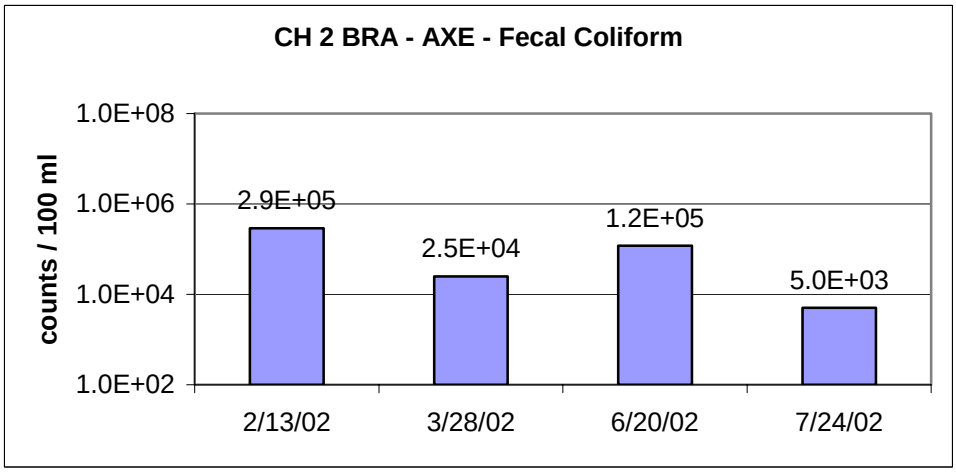

CH 1 HAT - AXE - Alkalinity
Alkalinity
80.0
60.0
40.0
20.0
0.0
44
56
49
18
2/13/02
3/28/02
6/20/02
7/24/02

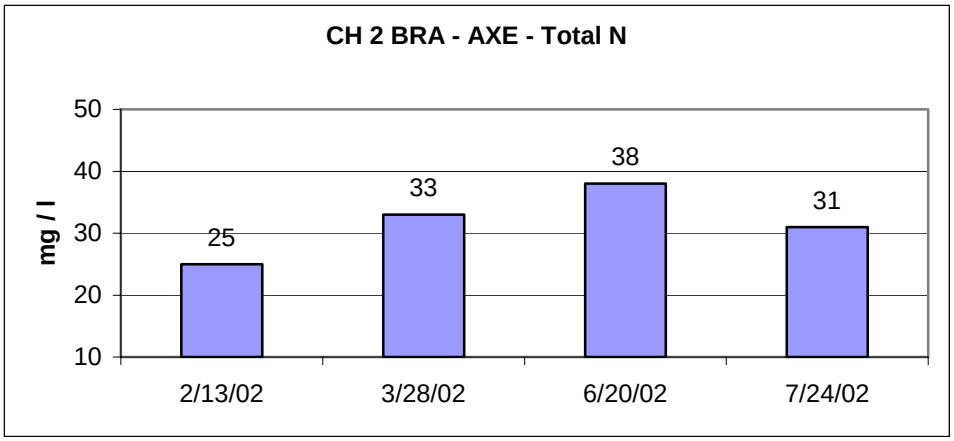
System CH 2 BRA

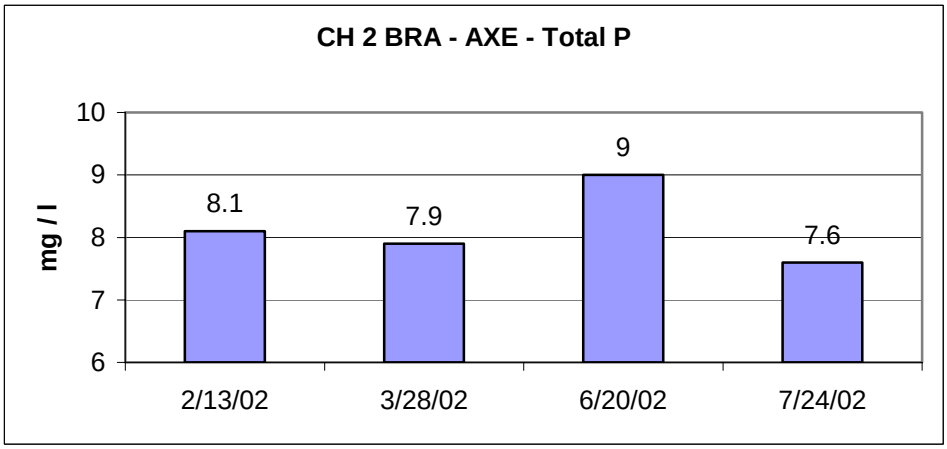
The design loading rate for this textile filter was 600 gpd, whereas the actual loading rate for the study period averaged 283 gpd. Final effluent BOD concentration averaged 32 mg/l and ranged from 7 and 43 mg/l during the study. TSS concentrations in system CH 2 BRA final effluent ranged between 7 and 52 mg/l, and averaged 19 mg/l. Geometric mean fecal coliform concentrations were 46,000 counts / 100 ml, and ranged between 5,000 and 290,000 counts / 100 ml in final effluent. TN concentrations in final effluent ranged from 25 to 38 mg/l, and averaged 32 mg/l, which exceeded the Rhode Island standard of 19 mg/l. TP concentrations averaged 8.2 mg/l and ranged between 7.6 and 9.0 mg/l. No seasonal effects on treatment performance were observed. Because this is a one-tank system, we were not able to calculate percent reductions.

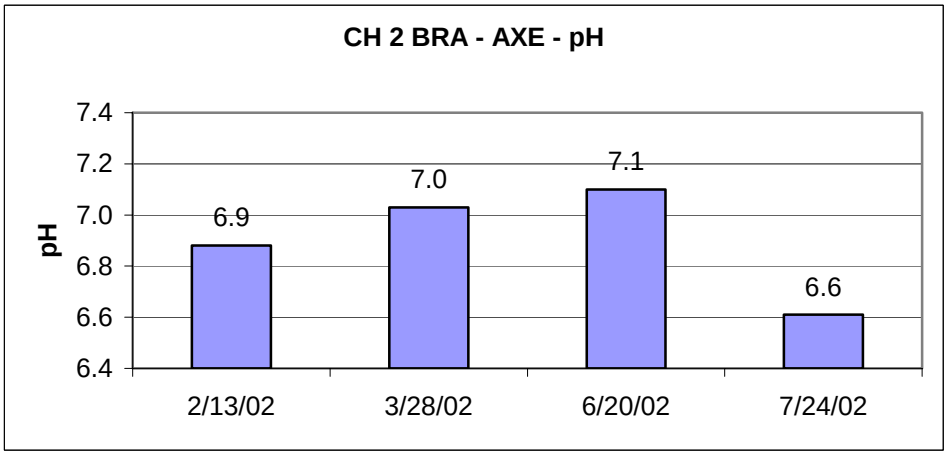
Required wastewater operation and maintenance procedures were conducted on this system by URI OWT Center personnel twice per year. No abnormalities, or system or component failures were observed for this system during the study period. An unusually thick scum layer was observed in this system's septic tank. However, combined solids levels in the tank did not necessitate a septage pump out.

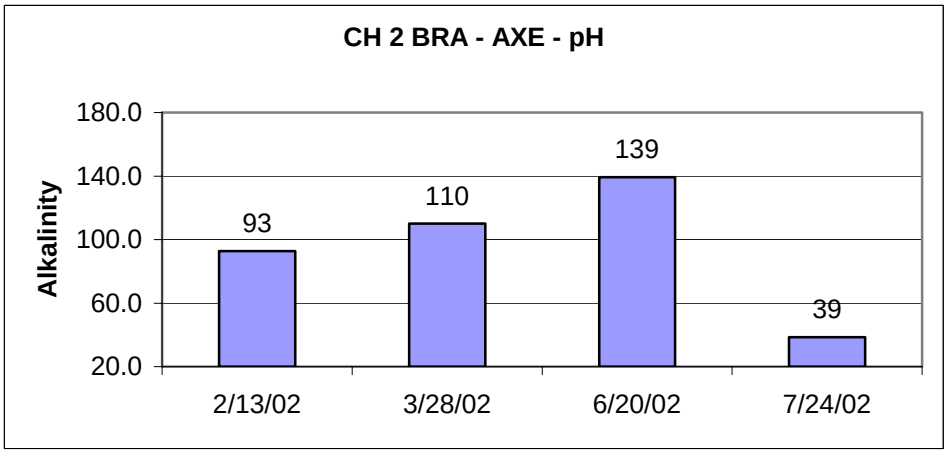





CH 2 BRA - AXE - Total N
mg / l
50
40
30
20
10
25
33
38
31
2/13/02
3/28/02
6/20/02
7/24/02


CH 2 BRA - AXE - Total P
mg / l
10
9
8
7
6
8.1
7.9
9
7.6
2/13/02
3/28/02
6/20/02
7/24/02

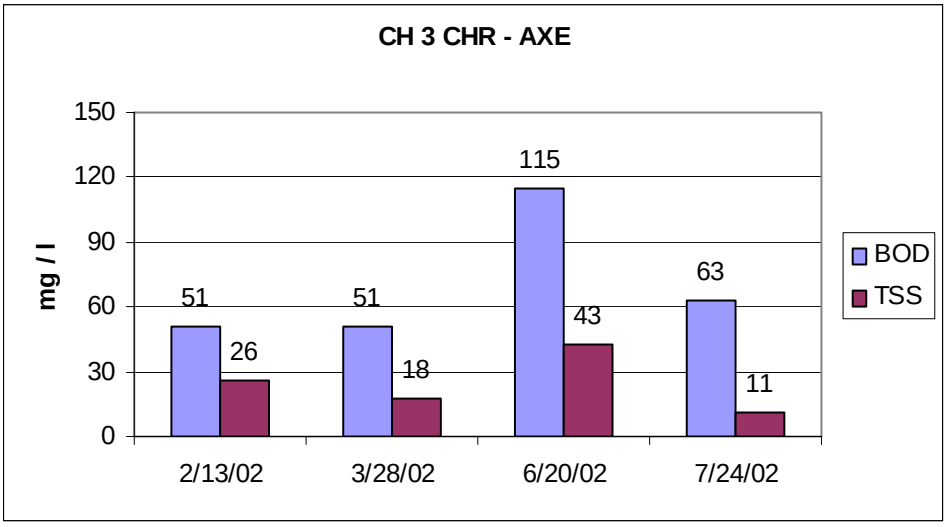

CH 2 BRA - AXE - pH
pH
7.4
7.2
7.0
6.8
6.6
6.4
6.9
7.0
7.1
6.6
2/13/02
3/28/02
6/20/02
7/24/02

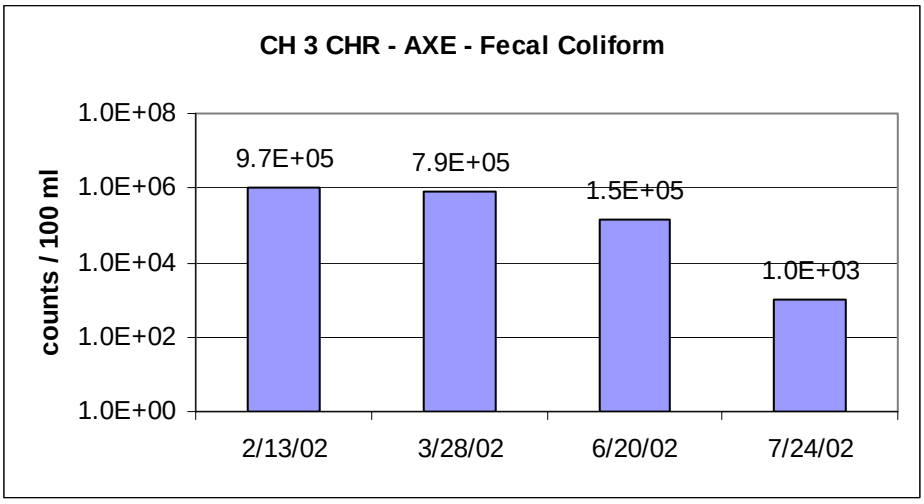

CH 2 BRA - AXE - pH
Alkalinity
180.0
140.0
100.0
60.0
20.0
93
110
139
39
2/13/02
3/28/02
6/20/02
7/24/02

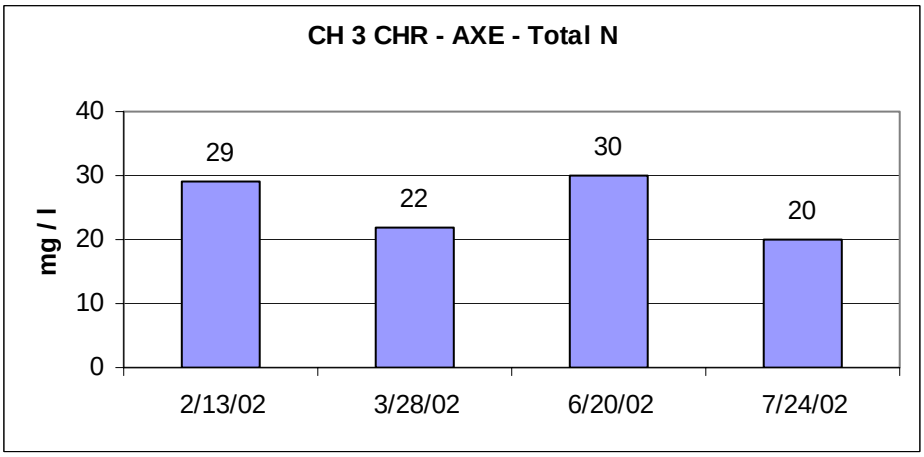
System CH 3 CHR

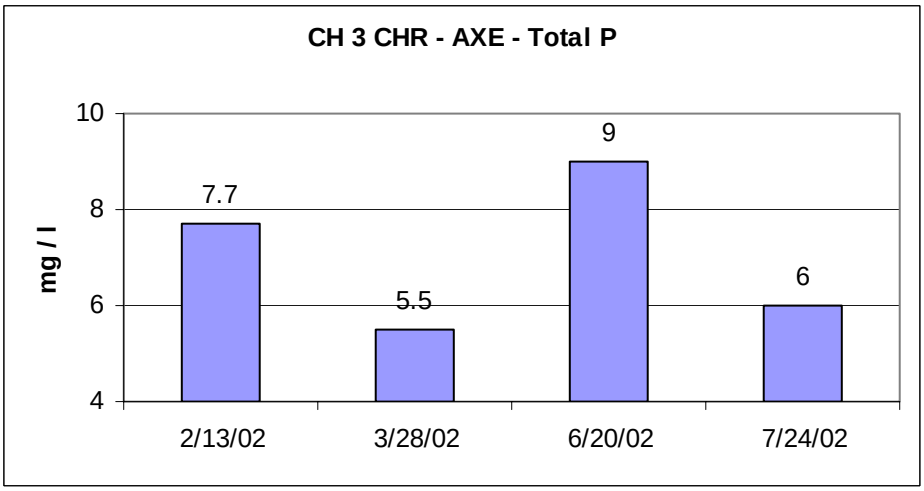
Actual wastewater generation at this site during the study period averaged 485. This volume was below the design loading rate of 660 gpd. BOD concentrations in final effluent from system CH 3 CHR averaged 70 mg/l, and ranged from 51 to 115 mg/l. Percent BOD reduction in this system averaged 84%. Mean TSS concentration in final effluent was 25 mg/l, and ranged between 11 and 43 mg/l. TSS reduction in this system averaged 59% (and ranged from 19 to 98%). Fecal coliform concentrations in final effluent ranged from 1,000 to 970,000 counts / 100 ml, with a geometric mean concentration of 100,000 counts / 100 ml. Mean fecal coliform reduction was 0.8 logs (note 1 log = 1 order of magnitude). TN concentrations in final effluent from this system ranged from 20 to 30 mg/l, and averaged 25 mg/l. Average percent TN reduction was 54%, and ranged from 39 to 66%. TP concentrations ranged from 5.5 to 9 mg/l, and averaged 7.1. No TP reduction was observed in this system.

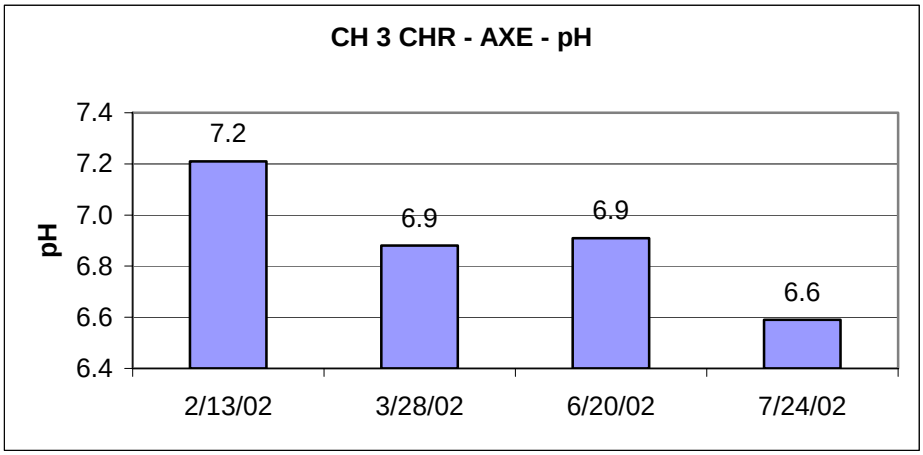
RIDEM prescribed and required wastewater operation and maintenance procedures were conducted on this system by URI OWT Center personnel. No abnormalities or system or component failures were observed for this system during the study period. However, as a result of landowner activities on the site, a heavy vehicle was driven over the shallow narrow drainfield resulting in damage to the drainfield. URI OWT Center staff worked with the landowner to arrange repair of the drainfield, we coordinated the repair with a private sector system installer, provided construction oversight of the replacement drainfield, and actual assistance with the construction. The actual construction for this repair occurred October 21 – 22, 2002. The private sector labor costs for this work were covered by the landowner. URI staff time reimbursement was not requested of the landowner nor charged to the grant.

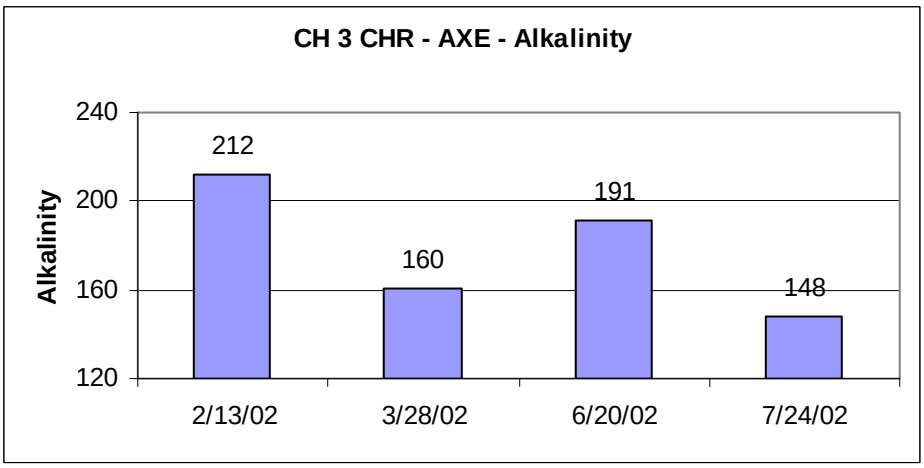



CH 3 CHR - AXE - Fecal Coliform
counts / 100 ml
1.0E+08
1.0E+06
1.0E+04
1.0E+02
1.0E+00
9.7E+05
7.9E+05
1.5E+05
1.0E+03
2/13/02
3/28/02
6/20/02
7/24/02


CH 3 CHR - AXE - Total N
mg / l
40
30
20
10
0
29
22
30
20
2/13/02
3/28/02
6/20/02
7/24/02


CH 3 CHR - AXE - Total P
mg / l
10
8
6
4
7.7
5.5
9
6
2/13/02
3/28/02
6/20/02
7/24/02

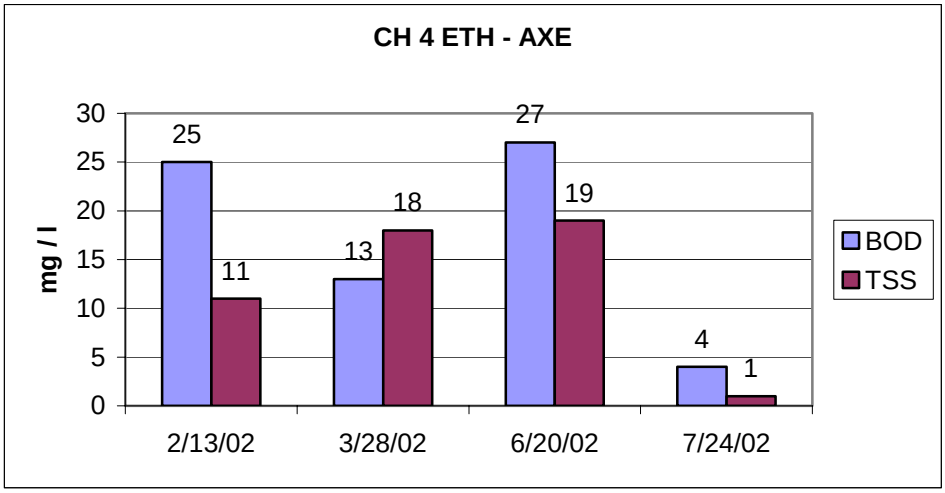


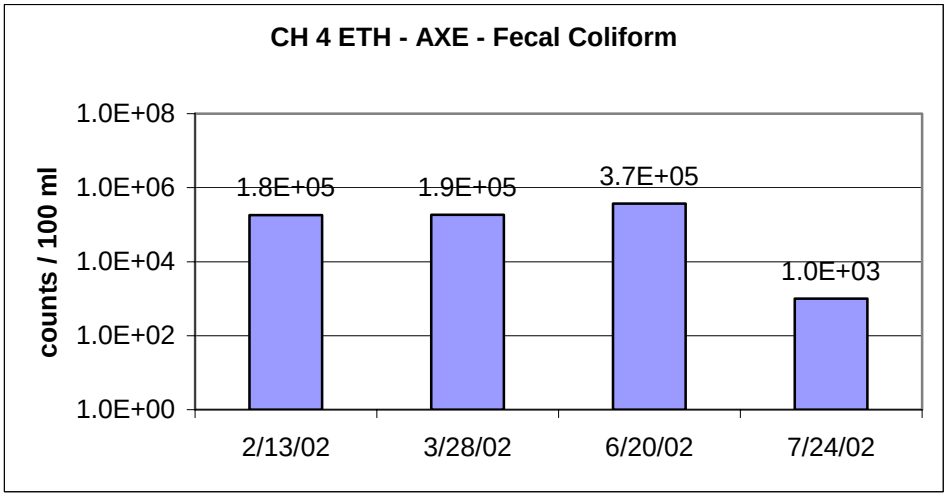


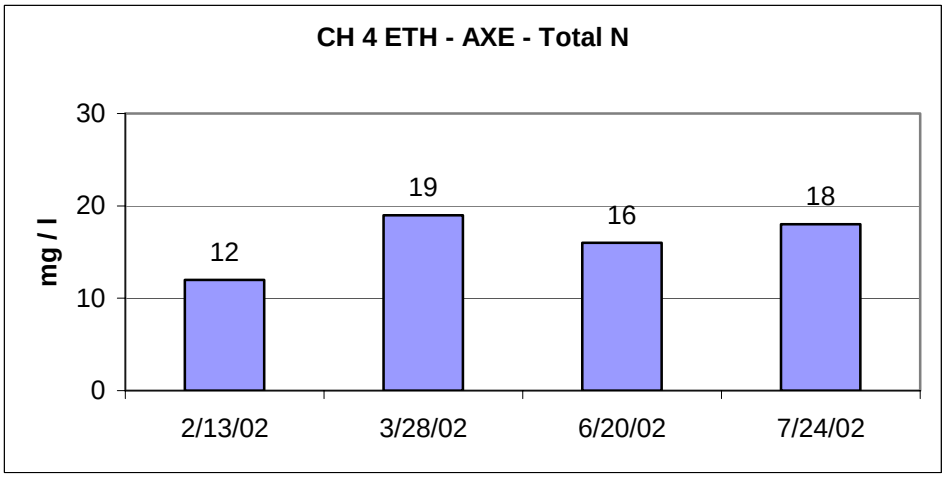
System CH 4 ETH

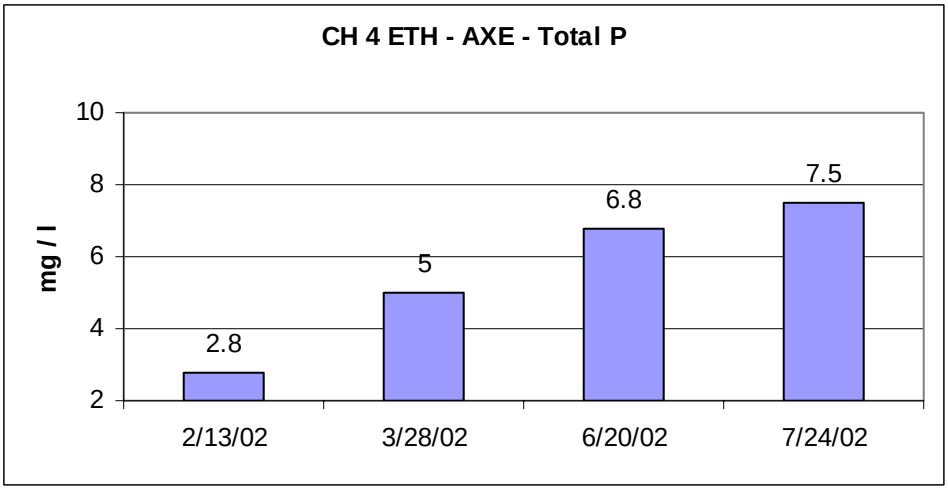
Design loading rate for this system was 1200 gpd, however actual hydraulic loading rate averaged 590 gpd during the study period. BOD concentrations in final effluent from system CH 4 ETH averaged 17 mg/l, and ranged from 4 to 27 mg/l. Percent BOD reduction in this system averaged 91%. Mean TSS concentration in final effluent was 12 mg/l, and ranged between 1 and 19 mg/l. TSS reduction in this system averaged 59% (and ranged from 17 to 99%). Fecal coliform concentrations in final effluent ranged from 1,000 to 370,000 counts / 100 ml, with a geometric mean concentration of 59,000 counts / 100 ml. Mean fecal coliform reduction was 1.6 logs (1.6 orders of magnitude reduction). TN concentrations in final effluent from this system ranged from 12 to 19 mg/l, and averaged 16 mg/l. Average percent TN reduction was 66%, and ranged from 46 to 80%. Both TN concentration and reduction fell within the RI nitrogen treatment standards. TP concentrations in final effluent ranged from 2.8 to 7.5 mg/l, and averaged 5.5. Mean percent TP reduction for System CH 4 ETH was 11%.

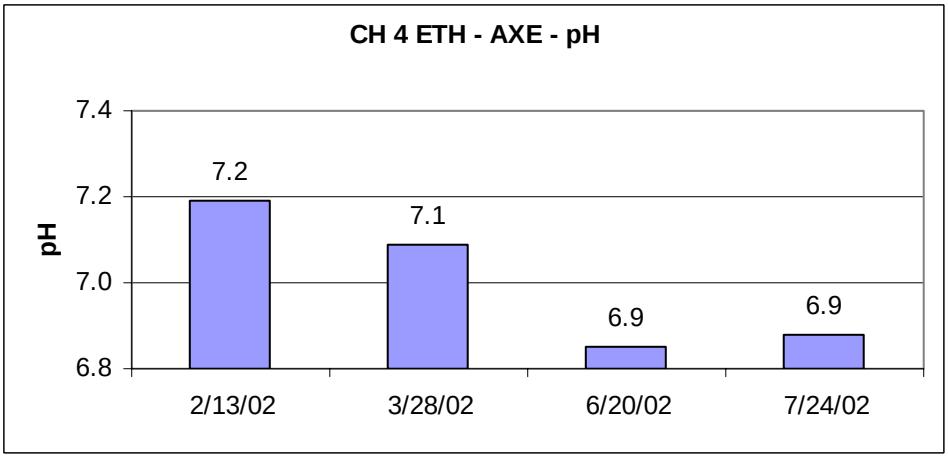
RIDEM prescribed and required wastewater operation and maintenance procedures were conducted on this system by URI OWT Center personnel. No abnormalities or system or component failures were observed for this system during the study period.

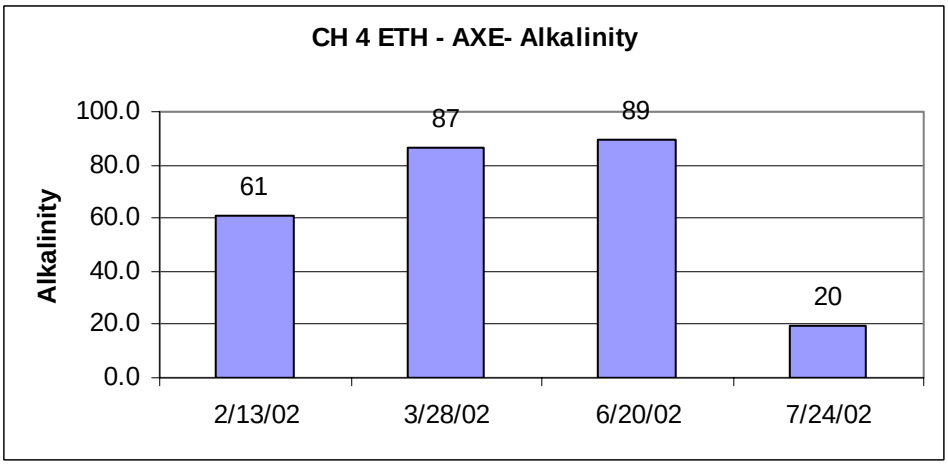






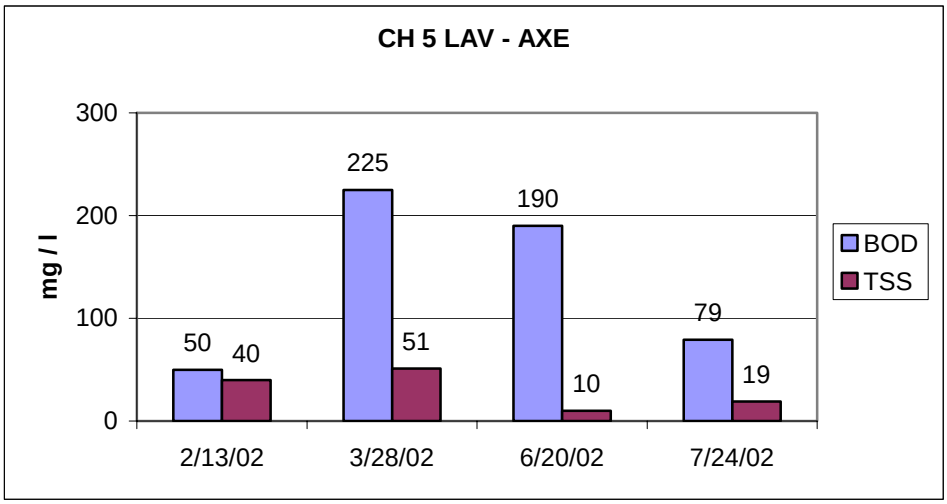

CH 4 ETH - AXE - Total P
mg / l
10
8
6
4
2
2.8
5
6.8
7.5
2/13/02
3/28/02
6/20/02
7/24/02

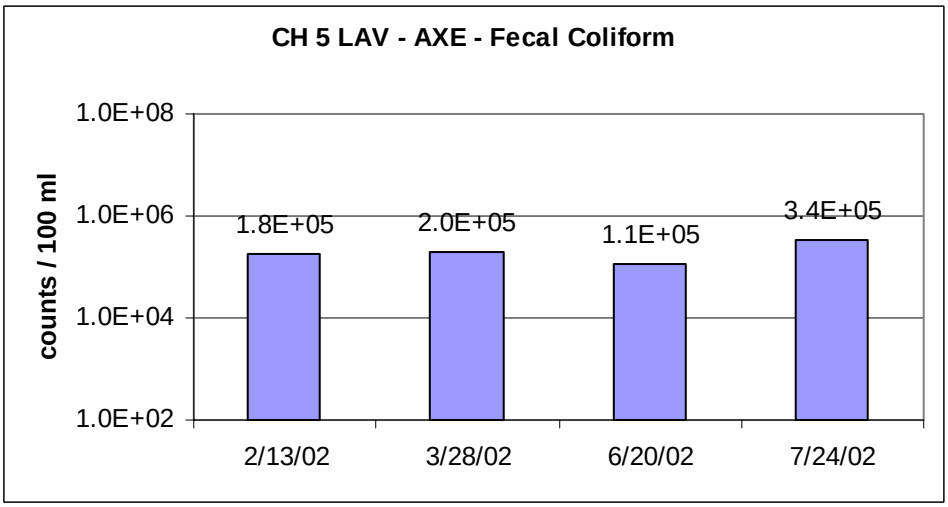

CH 4 ETH - AXE - pH
pH
7.4
7.2
7.0
6.8
7.2
7.1
6.9
6.9
2/13/02
3/28/02
6/20/02
7/24/02

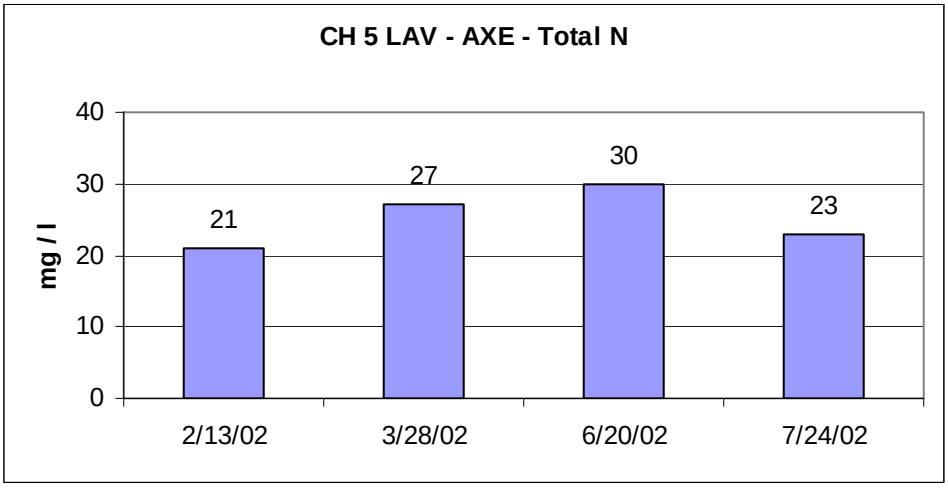

CH 4 ETH - AXE- Alkalinity
Alkalinity
100.0
80.0
60.0
40.0
20.0
0.0
61
87
89
20
2/13/02
3/28/02
6/20/02
7/24/02

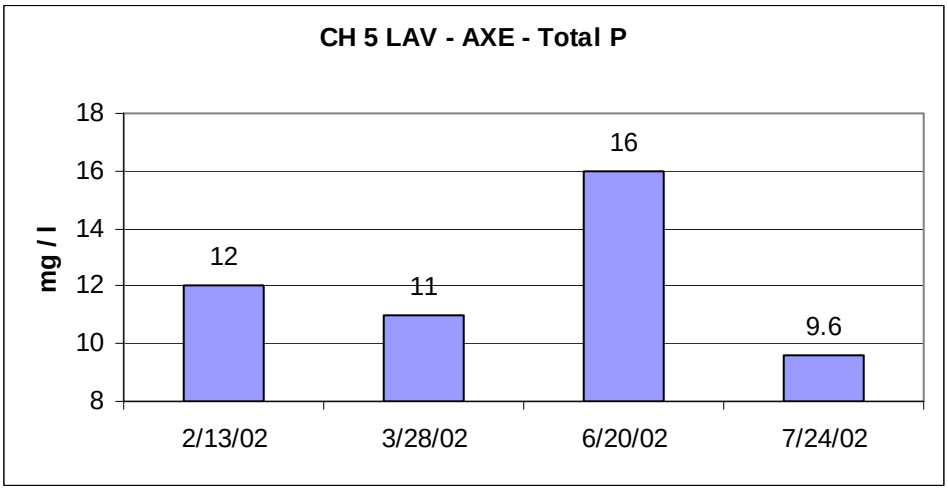
System CH 5 LAV

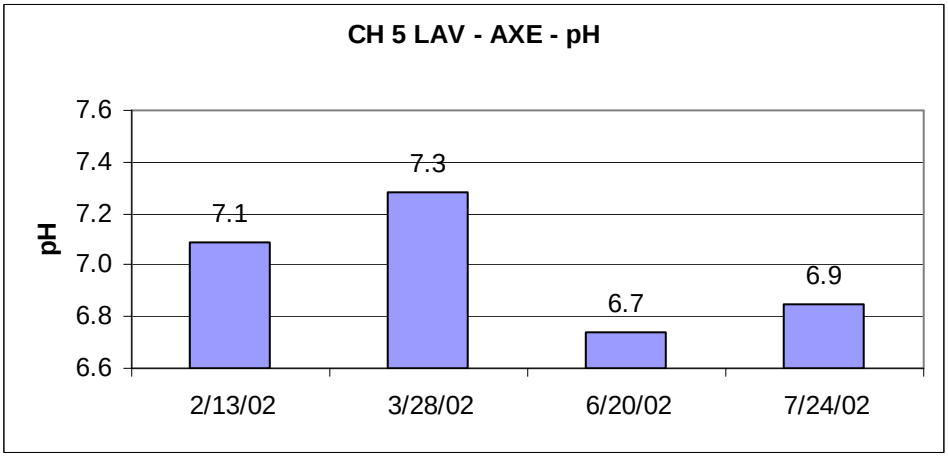
The actual loading rate for this system averaged 1,300 gpd, whereas design loading rate was 2,700 gpd. Mean BOD concentration in System CH 5 LAV was 136 mg/l and ranged between 50 and 225 mg/l. TSS concentrations in final effluent ranged from 10 to 51 mg/l, with a mean concentration over the study of 30 mg/l. Geometric mean concentration of fecal coliform bacteria in final effluent from this system was 290,000 counts / 100 ml and ranged from 28,000 to 9,500,000 counts per 100 ml. Mean TN concentration in final effluent was 25 mg/l and ranged from 21 to 30 mg/l. Final effluent TP concentrations ranged from 9.6 to 16 mg/l, with a mean of 12.2 mg/l. With multiple septic tanks serving several buildings connected to this system it is not possible to accurately define beginning wastewater strengths, so calculating percent reduction in this system is not feasible.

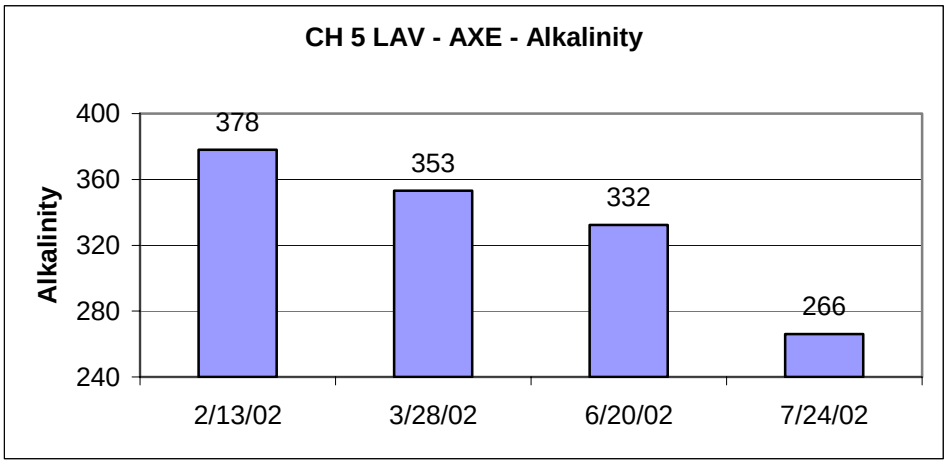





CH 5 LAV - AXE - Total N
mg / l
40
30
20
10
0
21
27
30
23
2/13/02
3/28/02
6/20/02
7/24/02


CH 5 LAV - AXE - Total P
mg / l
18
16
14
12
10
8
12
11
16
9.6
2/13/02
3/28/02
6/20/02
7/24/02


CH 5 LAV - AXE - pH
pH
7.6
7.4
7.2
7.0
6.8
6.6
7.1
7.3
6.7
6.9
2/13/02
3/28/02
6/20/02
7/24/02



Operation and Maintenance Issues for System CH 5 LAV

RIDEM prescribed and required wastewater operation and maintenance procedures were conducted on this system by URI OWT Center personnel. Fats, oils, and grease (FOG) generation is a constant challenge for most sit-down restaurants. In this particular system, high levels of FOG were generated in the restaurant and, although somewhat mitigated by the grease trap installed on this system, excess FOG was transferred to the textile filters. URI OWT Center staff worked with the landowner to encouraged better FOG management within the restaurant itself, more frequent grease trap maintenance and pump outs (this activity the responsibility of the landowner), and more proactive system management (also a landowner responsibility).

As a result of poorer than desired FOG management, the textile filters required more frequent cleaning, and more frequent URI OWT Center personnel site visits than initially anticipated. In February 2002, URI installed an aeration pump (the pump vendor was Orenco Systems, Inc., the same vendor for the textile filter) to the recirculation tank in an effort to introduce more oxygen and encourage more growth of bacteria to lower FOG levels. (This procedure was only marginally effective and this aerator was removed in September 2002). Significant FOG carryover to the shallow narrow drainfield component of this system had occurred, which resulted in reduction in soil permeability. This necessitated a repair to half of the shallow narrow drainfield. URI contracted with the RI Independent Contractors and Associates (RIICA) to do the drainfield repair. RIICA was our partner organization that performed the initial Glocester demonstration system installations. This work was performed during the period April 1 – 4, 2002. URI OWT Center staff worked with the landowner to arrange repair of the drainfield, we coordinated the repair with RIICA, provided construction oversight of that portion of the drainfield being replaced, and provided physical assistance during construction. David Dow, from URI OWT Center devoted four days to this effort. The charge from RIICA for these

repairs was $4,052.50. The Onsite Wastewater Training Center paid this bill (no Glocester Project funds were expended for this activity nor did the property owner have to pay any of these costs).

Recognizing that the Purple Cat Restaurant was still likely to produce wastewater with high FOG, URI investigated a long-term solution to protect the CH 5 LAV system. To help remedy this problem, URI researched the use of bacteria bioengineered to specifically tolerate FOG levels that are typically toxic to lower order (less robust) bacteria. URI contracted with Environmental Operating Solutions, Inc. (EOS), a Falmouth, MA firm specializing in the use of microbiological supplements. In September 2002 an EOS, Inc. aeration pump was added, then later moved to the drainfield pump basin to provide more efficient aeration. David Dow from the URI OWT Center devoted three full days working with EOS staff on these activities at the Purple Cat. This bacterial supplement process was able to help bring FOG concentrations in final wastewater down to acceptable levels that appear to be protective of the drainfield. Throughout this period of time, considerable URI staff time was expended trying to remediate problems on this system. Reimbursement for this time was not requested of the landowner nor charged to the Glocester Project.

In addition to the above-mentioned work to remediate the FOG problems, sixteen hours were required for general operation and maintenance of the Purple cat system. These activities represent typical procedures that would be required by RIDEM for any innovative and alternative system as part of that technology's state approval. A higher level of operation and maintenance would be expected from a larger high-strength system such as this.

Summary and Conclusion

Actual flow to all of the study systems was below RIDEM design loading rates. Systems CH 1 HAT and CH3 CHR, where actual loading rates represented 85% and 73% of the design flow, respectively, certainly experienced an "active workout" during the observation period. Actual loading rate to the other three systems was about 48% of the design loading rate, a number that falls within the typical rule of thumb range.

Chepachet systems performance for TN, TP, fell within the range observed for similar Rhode Island textile filter systems (unpublished data - TN means 23 – 31 mg/l; range 6 – 51 mg/l; and TP means 7 – 14 mg/l; range 5 – 28 mg/l). Systems CH 1 HAT and CH4 ETH consistently met the Rhode Island TN standard of 19 mg/l. Chepachet systems BOD results were higher than other similar RI textile filters (unpublished data; means 7 – 18 mg/l; range 3 – 26 mg/l). In addition, Chepachet project systems TSS results were higher than other unpublished data for similar RI textile filter systems (means of 7 – 10 mg/l and ranges 3 – 20 mg/l). Fecal coliform bacteria results for Chepachet systems were consistently higher than other similar RI textile filters (geometric means of 18,170 – 39,560 counts / 100 ml; ranges of 830 – 130,000 counts / 100 ml).

System Ch5 LAV, although experiencing some startup perturbations, performed well considering the inputs of FOG from the Purple Cat Restaurant. Although this system did not meet Rhode Island TN standards (mean TN concentration of 25 mg/l), it performed adequately for a mixed use system receiving high strength wastewater.

Standard and routine operation and maintenance (O&M) procedures are absolutely essential in order for these technologies, and any advanced treatment system, to function properly, maximize longevity, and protect owner investments. All of the systems installed on the Chepachet Village Project have operation and maintenance plans required by RIDEM. These plans were entered into the land evidence records at the Town Hall. However, unless careful attention is given to making certain that O&M measures are actually done, then system performance and lifespan will be questionable. It is important that the Town of Glocester insure that required O&M occurs for all advanced treatment systems in the town, by trained and qualified service providers. Training is available at the URI Onsite Wastewater Training Center for practitioners wishing to do this service.

Appendix A

Total phosphorus, total nitrogen, fecal coliform, total suspended solids,

and biochemical oxygen demand data for the Chepachet Village Demonstration Sites