Jacobsen, James

From: Dave Potts [dpotts@geomatrixllc.com]
Sent: Friday, July 18, 2008 12:13 PM
To: Jacobsen, James
Subject: GeoMat and SoilAir
Follow Up Flag: Follow up
Flag Status: Red

Jim,

Thank you for your review and approval of the GeoMat leaching system and SoilAir aeration system for use in the State of Maine. Based on our phone conversation of earlier today, we suggest the following:

GeoMat
Our controlled testing, presented in "Wastewater Renovation and Hydraulic Performance of a Low Profile Leaching System", published in the April 2008 NOWRA Proceedings and current field sizing is based on a hydraulic loading rate of 1.8 gallons per day / square foot of "typical" residential septic tank effluent. We request that this loading rate be applied to the GeoMat sizing for use in the State of Maine. Horizontal spacing of the products should be no less than the width of the respective product, i.e. with the 12" wide GeoMat 1200, a minimum of 12" edge to edge should be maintained.

SoilAir
Unlike other treatment systems, SoilAir aerates the leaching/disposal system. By aerating the soil, in a process similar to composting, treatment is not limited by the solubility of oxygen in water; this equates to a 21,000 times increase in oxygen. Through this process anaerobic biomat is eliminated, microbial populations are significantly increased and hydraulic capacity can match that of the soil that the system is installed in. Through studies conducted to date (included in our application information) and hundreds of field installations, it has been proven that wastewater loading rates can be increased 3 to 5 times without any negative effects; in fact, nitrogen remove is significantly improved. Based on this, we request that when SoilAir is utilized that a 50% size reduction be allowed on a leaching/disposal system; as is similarly provided for with other aerobic systems. We believe that this will still provide for a significant safety factor.

Thank you for your help with this matter, and let us know if you have any questions or suggestions.

Sincerely,
David Potts
Geomatrix Systems, LLC

Maine Center for Disease Control and Prevention
An Office of the Department of Health and Human Services
John E. Baldacci, Governor Brenda M. Harvey, Commissioner

Department of Health and Human Services
Maine Center for Disease Control and Prevention
286 Water Street
11 State House Station
Augusta, Maine 04333-0011
Tel: (207) 287-8016
Fax: (207) 287-9058; TTY: 1-800-606-0215

June 16, 2008

Geomatrix Systems, LLC
Attn.: David and Elizabeth Potts
385 Roast Meat Hill Road
Killingworth, CT 06419

Subject: Product Registration, GeoMat, Models 600, 1200, and 3900

Dear Mr. and Ms. Potts:

The Division of Environmental Health has completed a review of a registration application for your company's product. This information was submitted pursuant to Section 1802 of the Maine State Plumbing Code, Subsurface Wastewater Disposal Rules (Rules), for code registration, for use in Maine.

Product Description

The GeoMat consists of a one inch thick mat comprised of fused, entangled plastic filaments. Non-woven geotextile fabric is bonded to the bottom of the mat. A one inch diameter pressure distribution pipe is placed on the top of the mat, and both are then covered with one layer of non-woven geotextile fabric. Clean out ports are incorporated into the distal ends of the distribution pipes. The minimal storage capacity of the GeoMat is mitigated through use of flow equalization measures including, but not limited to, timed doses. Biomat formation is minimal after one year of operation according to the report titled "*Wastewater Renovation and Hydraulic Performance of a Low Profile Leaching System*".

GeoMat is available in six inch, 12 inch, and 39 inch widths. (Note: the product cross section drawing dated 07/02/07 shows 12 inch, 39 inch, and 78 inch widths.) GeoMat is designed for use with septic tank effluent treated to secondary levels, as well as untreated septic tank effluent. No sizing modification was proposed for use with treated effluent. A cover of six to 12 inches of fill is recommended. Horizontal spacing between rows of GeoMat are not specified.

Claim

According to the information you provided, and information available on your company web site, the GeoMat provides reductions in BOD_5, nitrogen (total, ammonia, and nitrate), and phosphorus. However, reduction in the strength of disposal area leachate is to be expected from any disposal area.[1] At the risk of stating the obvious, cleansing of the effluent is a broad function of ***any*** onsite sewage disposal system's disposal area.[2, 3]

Determination

On the basis of the information submitted and available on your company web site, the Division has determined that the GeoMat is acceptable for use as a disposal area for wastewater effluent pursuant to the Rules, in the State of Maine, provided that it is installed, operated, and maintained in conformance with the manufacturer's directions and the following conditions:

1. Sizing of GeoMat disposal areas shall be in accord with the following table:

GeoMat Model	Size Rating
600	0.5 sq. ft./linear foot
1200	1.0 sq. ft./linear foot
3900	3.25 sq. ft./linear foot

2. Backfill and construction fill used in GeoMat systems shall conform to the backfill specifications of Section 804.2.2 of the Rules, copy enclosed.

3. Vertical separation from the limiting factor shall be measured to the bottom of the GeoMat.

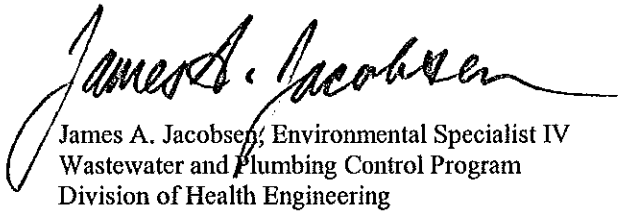
4. Horizontal separation between rows of GeoMat shall be 200 percent of the width of the model in use, measured center to center.

In the event that the product fails to perform as claimed by the applicant, use of the product in Maine, including all installations approved pursuant to Chapter 18 of the Rules, shall cease. Use of the product shall not resume until the applicant and the Division have reached a mutually acceptable agreement for resolving the failure to perform as claimed.

Because installation and owner maintenance has a significant effect on the working order of onsite sewage disposal systems, including their components, the Division makes no representation or guarantee as to the efficiency and/or operation of GeoMat. Further, registration of this product for use in the State of Maine does not represent Division preference or recommendation for this product over similar or competing products.

If you have any questions please feel free to contact me at (207) 287-5695.

Sincerely,



James A. Jacobsen, Environmental Specialist IV
Wastewater and Plumbing Control Program
Division of Health Engineering
e-mail: james.jacobsen@state.me.us

/jaj

Enc: Page 8-2, CMR 241

xc: Product File

1. Table 3-18, U.S.E.P.A. *"Onsite Wastewater Treatment Systems Manual"*, 02/2002.
2. Pages 5 & 6, *"Site Evaluation for Subsurface Wastewater Disposal in Maine"*, 04/2001
3. *"In Ground Dispersal of Wastewater Effluent: The Science of Getting Water into the Ground"*, Small Flows Quarterly, Spring 2003, Volume 4, Number 2

Maine Center for Disease Control and Prevention
An Office of the Department of Health and Human Services

John E. Baldacci, Governor Brenda M. Harvey, Commissioner

Department of Health and Human Services
Maine Center for Disease Control and Prevention
286 Water Street
11 State House Station
Augusta, Maine 04333-0011
Tel: (207) 287-8016
Fax: (207) 287-9058; TTY: 1-800-606-0215

APPLICATION FOR REGISTRATION OF EXPERIMENTAL SYSTEM/INNOVATIVE TECHNOLOGY OR ONSITE SEWAGE DISPOSAL SYSTEM PRODUCT

Please complete the following Sections. Please print or type.

Applicant

Company Name: Geomatrix Systems, LLC
Contact Person: David Potts
Address: P.O. Box
Town/City: Killingworth State/Province: CT Zip Code: 06419
Country: USA
Telephone: 860-663-3993 e-mail: dpotts@geomatrixllc.com

Product

Product Name: GeoMat™
Model: 600, 1200, 3900

Product Classification (choose one)

Primary or Secondary Treatment Unit

[ ] Septic Tank [ ] Extended Aerobic Treatment Unit [ ] Recirculating Aerobic Unit

[ ] Aerobic Fixed Film Unit [X] Other (specify): Soil Aeration System

Effluent Filter

[ ] Septic Tank Outlet Filter [ ] Post-Tank Filter [ ] Other (specify) _____

Disposal Device

[ ] Gravel-less Disposal Pipe [X] Gravel-less Disposal Bed [ ] Chamber, Plastic

[ ] Chamber, Other [ ] Other (specify) _____

Miscellaneous

[ ] Pipe [ ] Effluent Flow Distribution Device [X] Other (specify): Soil Aeration System

Claim

Describe the product's features (attach additional sheets if necessary).

- Low profile
- Enhance aeration
- Pressure distribution

Describe the product's performance (attach additional sheets if necessary).

- GeoMat has been proven to provide enhanced hydraulic performance
- GeoMat has been proven to provide high levels of dissolved oxygen, Total Nitrogen removal of 35%, ammonia removal of 99.9%, total phosphorus removal of 84%, BOD removal of 100% and fecal coliform removal of 100% - after 10" of sandy loam soil

Has the product received National Sanitation Foundation or Canadian Standards Authority approval?

[X] No [ ] Yes (If "yes", enclose a copy of the certification.) NSF does not approve soil based systems

IMPORTANT NOTE!

Don't forget to enclose relevant product literature, engineering specifications, studies, and third party certifications with this application.

I, _____, am the [ ] applicant [ ] agent for the applicant of the subject product.
(print name)
I state that the information submitted is correct to the best of my knowledge and understand that any falsification is reason for the Department to deny registration for use of the product in Maine.

_____ _____
[X] Signature of Applicant Date
[ ] Signature of Agent for Applicant See cover letter - JAP

GEOMATRIX

May 27, 2008

James A. Jacobsen, Environmental Specialist IV
Department of Health and Human Services
Division of Environmental Health
Subsurface Wastewater Program
286 Water Street, Augusta, ME 04333

RE: GeoMat Leaching System Approval Submittal

Dear Mr. Jacobsen,

I am finally getting around to sending you the documentation for the approval of the GeoMat Leaching System. I am sorry for the delay.

Please let me know if there is anything else that would help you or if you have any questions on the documents. I can be reached at 860-663-3993 and would be happy to talk with you.

Thank you.

GEOMATRIX SYSTEMS, LLC

Elizabeth Potts

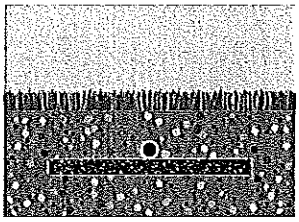
(860) 663-3993 Fax: (860) 663-0324

GeoMat™ has a thin profile that maximizes contact with the soil – which enhances oxygen transfer, and increases plant uptake and retention of nutrients.

- Easy and fast to install
- Minimizes the height of mounds
- Helps polish pretreated wastewater
- Laterals and orifices are adjustable and serviceable

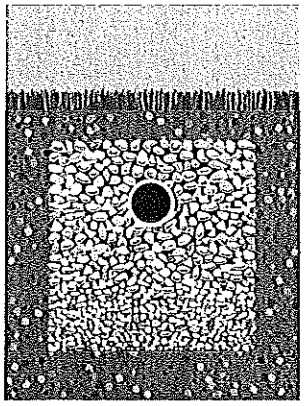
GeoMat Flat

When depth is limited by ledge, water table or impermeable soils.



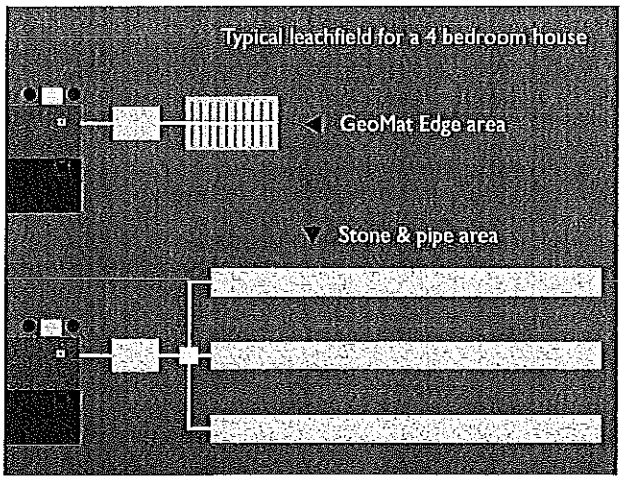
GeoMat Edge profile: approximately 8" to base ▲

Stone and pipe profile: approximately 18" to base ▶



GeoMat Edge

When area is limited by setbacks and other obstacles.

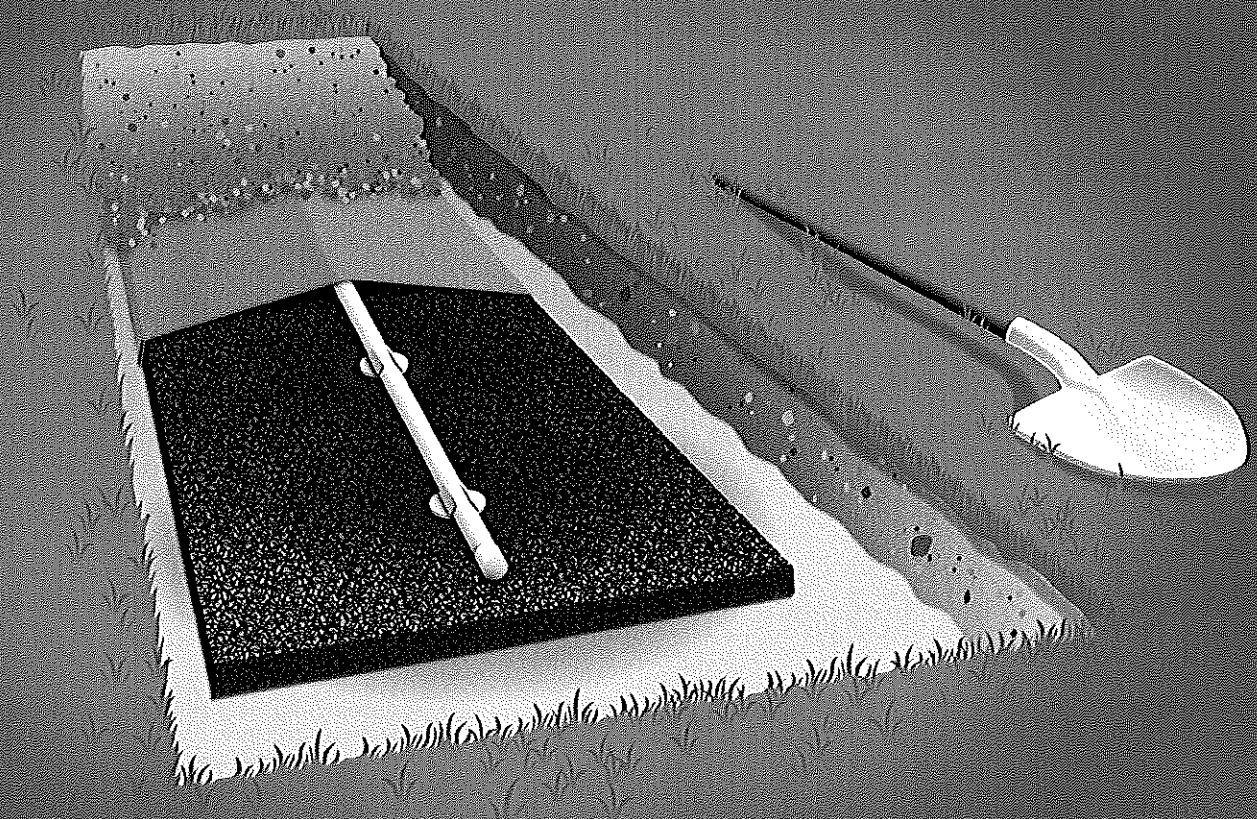


GEOMATRIX

www.geomatrixsystems.com info@geomatrixsystems.com 860-663-3993 Fax: 860-663-0324

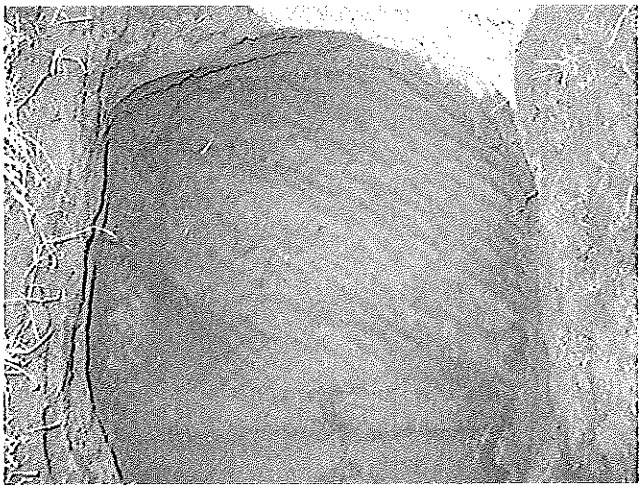
GeoMat™

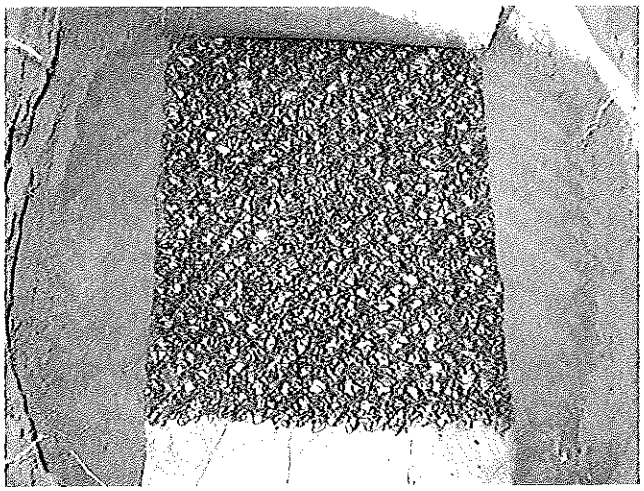
High performance, low profile, wastewater infiltration and reuse systems

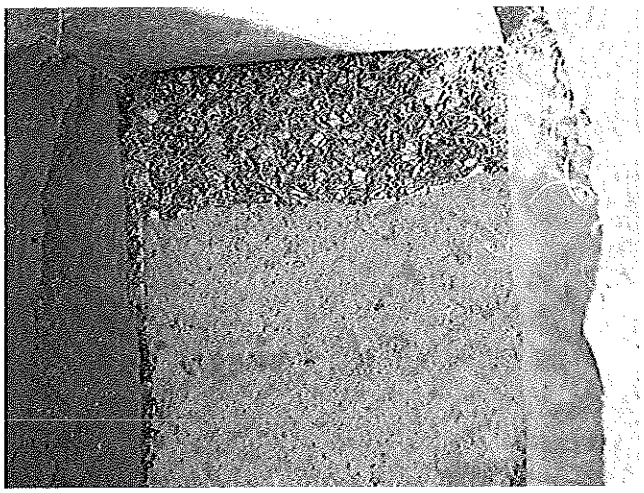


GEOMATRIX

GEOMATRIX

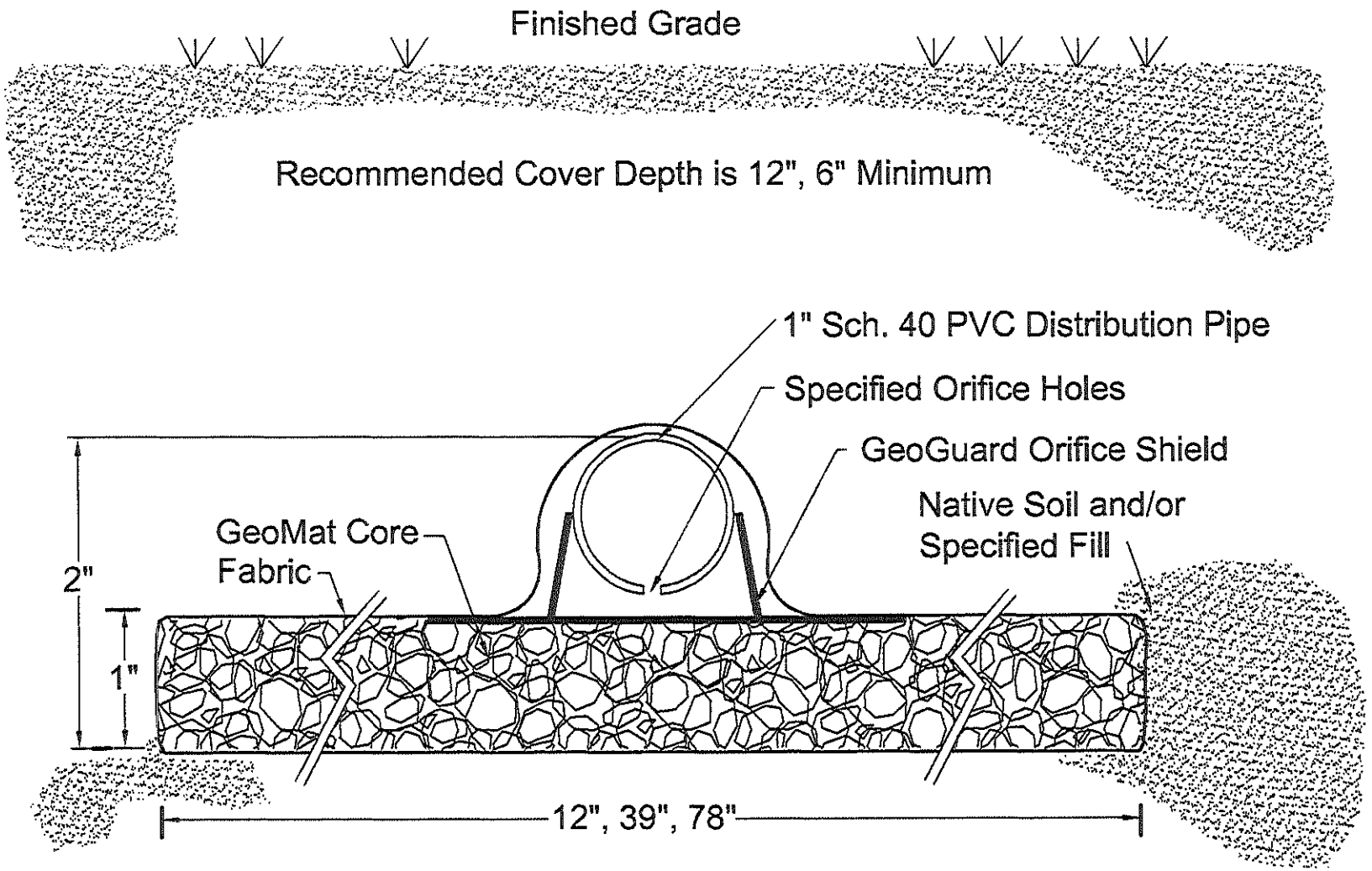






Geomat System serving 3 bedroom house
after 3 years in operation

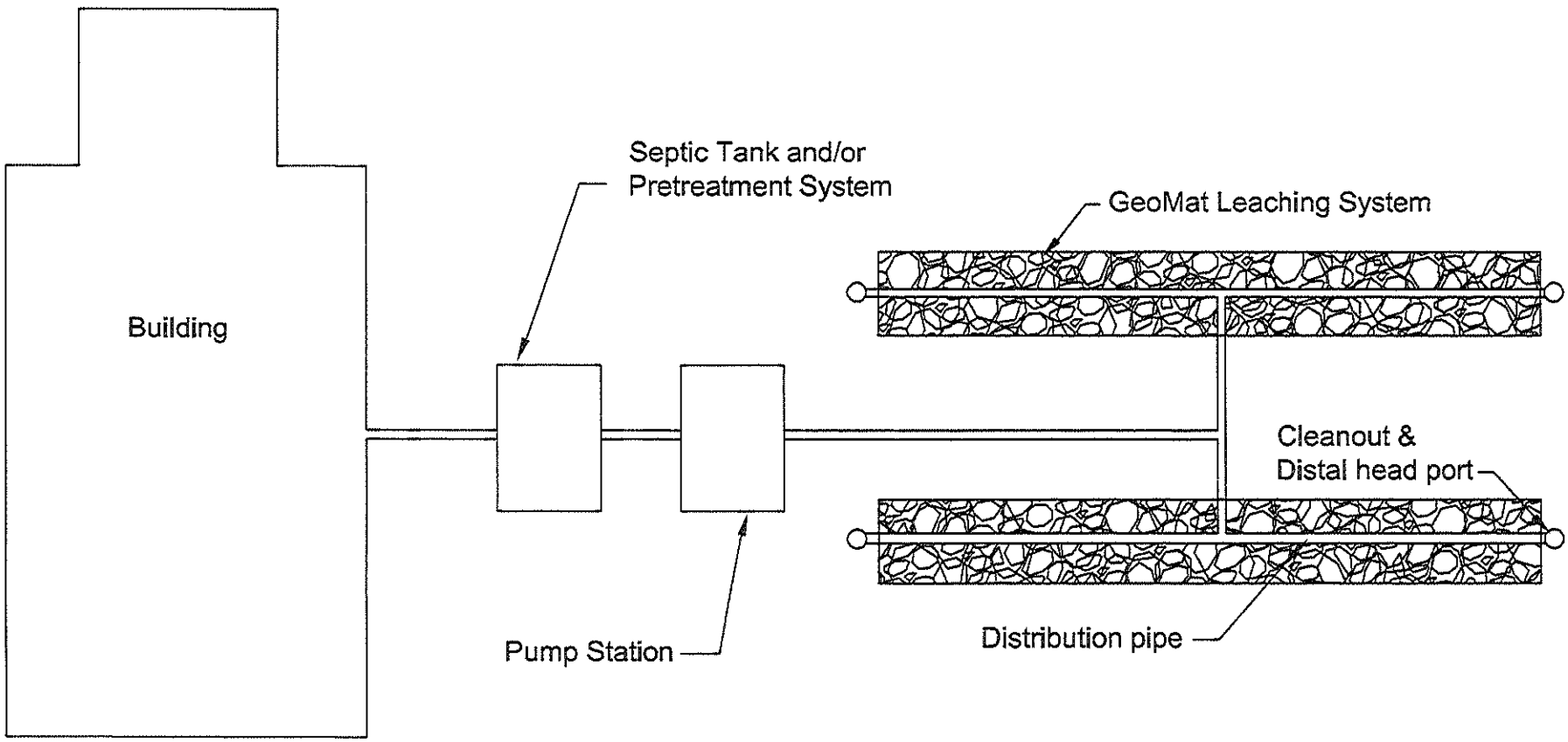
(860) 663-3993 Fax: (860) 663-0324



GEOMAT LEACHING SYSTEM
Cross Section
- Not to Scale -

NOTE: Lateral spacing as required

GEOMAT LEACHING SYSTEM Cross Section Geomatrix Systems, LLC., Killingworth, CT 860-663-3993	
SCALE NONE	REV. A
DATE 7/2/2007	ACAD NO. GEOMAT XSECT.DWG
DRAWN BY: ERP	SHEET 1 OF 1



GEOMAT™ LEACHING SYSTEM
Plan View

GEOMAT LEACHING SYSTEM
Plan View
Geomatrix Systems, LLC., Killingworth, CT
860-663-3993

SCALE NONE	REV. A
DATE 7/22/2007	ACAD NO. GEOMAT 1 S PLAN.DWG
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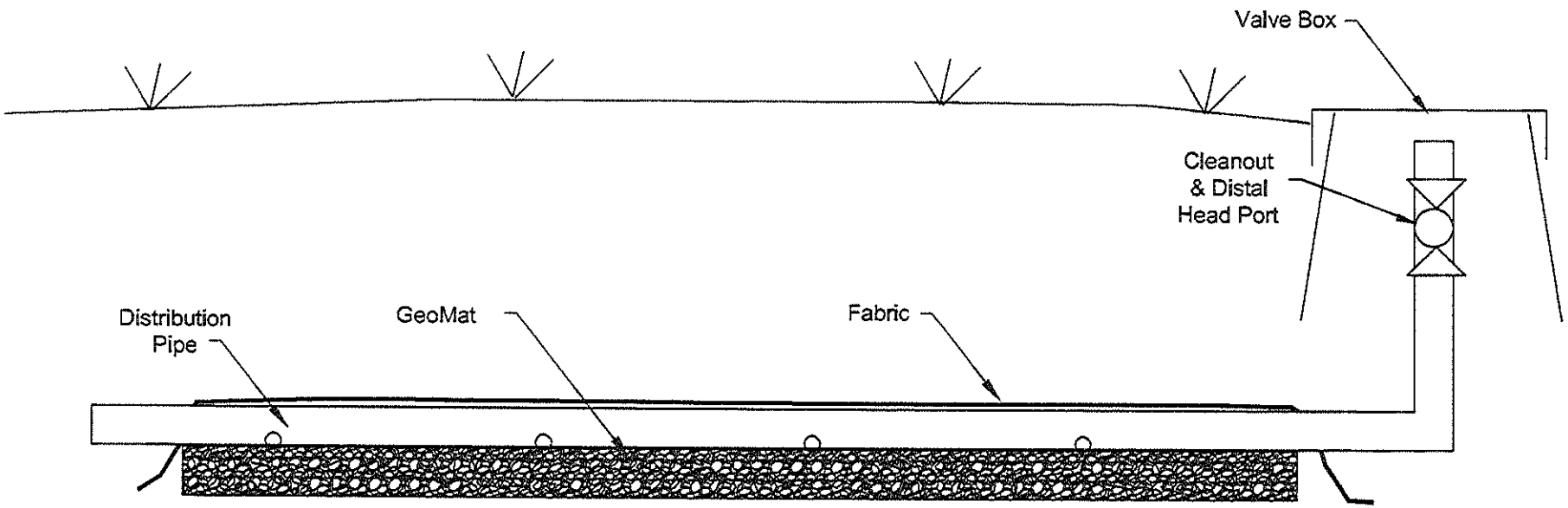


GEOMAT™ LEACHING SYSTEM
Longitudinal Cross Section

GEOMAT LEACHING SYSTEM Longitudinal Cross Section Geomatrix, LLC., Killingworth, CT 860-663-3993	
SCALE NONE	REV. A
DATE 3/25/2006	ACAD No. GEOMAT PLAN VIEW.DWG
DRAWN BY: ERP	SHEET 1 OF 1

Geomatrix

GeoMat™ Leaching System Description

The GeoMat Leaching System (GLS) is comprised of a core of fused, entangled plastic filaments with a geotextile fabric bonded to one side. A pressure distribution line is installed on top of the core and covered with another layer of geotextile fabric. GLS is designed for maximum treatment and infiltration of wastewater into soil, in certain instances it is used for subsurface irrigation. GLS can be utilized with pretreated wastewater or septic tank effluent, if B.O.D. is accounted for.

Although typically installed in a horizontal orientation, GLS is modular and can also be installed in vertical and multi-planer applications. It is available in 1x 6, 1 x 12 and 1 x 39 inch widths. A pressurized distribution pipe typically runs the entire length of the GLS and provides for uniform application of wastewater down the entire length. Additionally, GLS can be configured with a time dose pump station for greater flow equalization. The combination of pressure dosing and flow equalization serves to reduce the peak hydraulic loading. In certain instances, GLS can also be configured for gravity applications.

GLS is designed for maximum oxygen transfer. The relatively narrow profile of GLS, the shallow burial depth and the uniform loading serves to maximize the oxygen transfer efficiency to the wastewater and the associated microbial community. This results in increased removal of pathogens, B.O.D. and nutrients such as nitrogen and phosphorus. The high level of oxygen in and adjacent to the GLS also serves to inhibit excess accumulations of biomat from developing and prematurely clogging the GLS. This further improves the long term acceptance rate of the leaching system.

GLS has many similar benefits to drip irrigation, but it is significantly less mechanically complex and provides for massive surface area when compared to drip emitters. GLS also shares some similarities to low pressure pipe systems; however, it is significantly easier to install and has a much lower profile. The distal head pressure of the GLS is fully adjustable through valving on the distribution manifold, which is often located in the pump station. A cleanout/distal pressure monitoring port is installed on the terminal end of each of the lateral lines. The lateral lines can be readily cleaned, flushed and jetted.

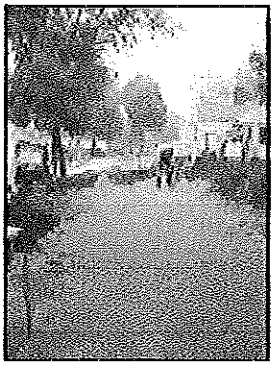
When soil conditions permit, GLS can be installed directly in the "A" horizon. The low profile provides for a lower landscape profile. This can be especially helpful when depth to ledge or groundwater is present. When fill is required, it should meet regulatory requirements. Fill specifications can be adjusted for site specific conditions, when necessary and approved by the design engineer. The narrow profile of GLS requires less fill depth than many other systems, often resulting in a cost savings.

When GLS is utilized for high strength wastewater such as restaurants, etc., it is recommended that a pretreatment system or a SoilAir™ system be utilized to prevent excess biomat from forming.

(860) 663-3993 Fax: (860) 663-0324

GeoMat™ Leaching Systems Installation Guidelines

1.

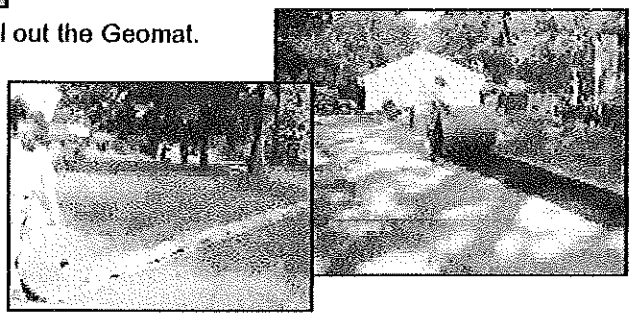


Locate and mark out location of trenches, equipment and piping. Set stakes for location and elevation reference points. Ensure that trees are removed to prevent root intrusion.

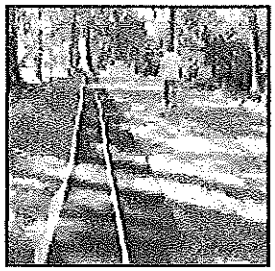
Ensure that trench bottoms are level. Rake bottom and sides if smearing has occurred. Remove any large stones and other debris - bed Geomat with approved fill if necessary to ensure level grade and/or protection during backfill.

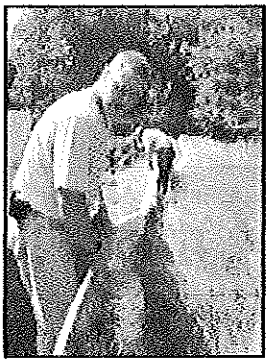
2.

Roll out the Geomat.



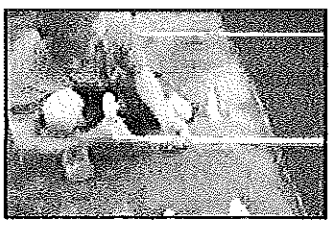
3.





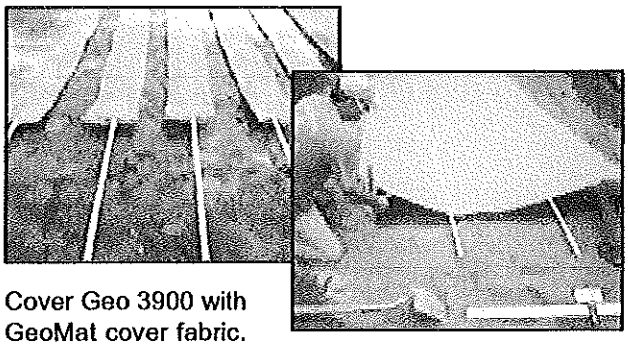
Install the Geomat lateral lines by installing the distribution piping in the Geo1200 and Geo600 or on the Geo3900.

4.



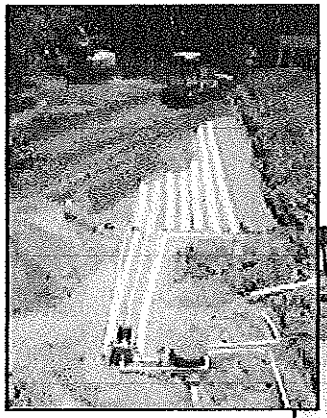
Install distal pressure ports on the distal of the lateral piping. Install valve box over distal end port and protect with stake.

5.

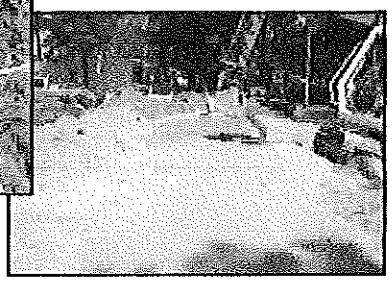


Cover Geo 3900 with GeoMat cover fabric. Wrap ends of Geo1200 and Geo600 with GeoMat fabric. Stake in place with staples as necessary.

6.



Backfill system components. Ensure that cover material and thickness are relatively uniform over Geomat lateral lines.



7.

Seed disturbed area immediately after installation to stabilize soil.

8.

Connect to time dosing system.

GEOMATRIX
860-663-3993
www.geomatrixsystems.com

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

June 16, 2006

David Potts
Geomatrix, LLC
385 Roast Meat Hill Road
Killingworth, CT 06419

Re: Geomatrix GeoMat Series & LowPro Series Leaching System Approvals

Dear Mr. Potts:

The Department of Public Health, Environmental Engineering Program (Department) has reviewed the revised documentation you submitted on Geomatrix's GeoMat Series and LowPro Series leaching systems. This Department previously issued an April 13, 2006 approval for these leaching system products. The backfill and bedding material for the LowPro Series systems has been modified. This approval replaces the earlier approval.

Geomatrix's GeoMat Series and LowPro Series leaching systems utilize GeoMats, which are comprised of fused, entangled filaments surrounded with geotextile filter fabric. The GeoMat products are 1 inch thick, and the have widths of 12 inches, 39 inches and 78 inches for GeoMat 1200, 3900 and 7800 products respectively. The GeoMat Series leaching systems utilize a single GeoMat placed in a row. The GeoMat Series systems can be installed in undisturbed natural soil, or in select fill or ASTM C-33 sand.

The LowPro Series systems utilize six foot lengths of either the GeoMat 1200 or 3900 products placed perpendicular to the row, and side-by-side 3.5 inches apart on a sand bed that is a minimum of 1-inch thick. Sand is placed in the 3.5-inch space between the GeoMats. The sand bedding and backfill material must meet ASTM C-33 specifications. The LowPro Series utilizes a "distribution mat" which consists of either the GeoMat 1200 or 3900 products that is installed along the center of the row on top of the lower GeoMats.

The calculated effective leaching area (ELA) credits for the GeoMat Series and LowPro Series leaching system products are as follows:

Product	ELA Credit	Spacing
GeoMat 1200	1.0 sq. ft. per lf.	9 ft.
GeoMat 3900	3.0 sq. ft. per lf.	9 ft.
GeoMat 7800	5.9 sq. ft. per lf.	15 ft.
LowPro WB 1200	5.2 sq. ft. per lf.	12 ft.
LowPro WB 3900	5.6 sq. ft. per lf.	15 ft.

Phone: (860) 509-7296
Telephone Device for the Deaf (860) 509-7191
410 Capitol Avenue - MS # 31SEW
P.O. Box 340308 Hartford, CT 06134

The Department hereby **APPROVES** the Geomatrix GeoMat Series and LowPro Series proprietary leaching system products with the above noted ELA credits and center-to-center spacing. No test information was submitted on the products relative to vehicle loads, therefore they should not be utilized in vehicular travel areas. The leaching systems can be utilized with low-pressure distribution systems or gravity flow applications. The latter method requires that the distribution pipe on top of the distribution mat be approved distribution pipe (Technical Standards for Subsurface Sewage Disposal Systems-Table 2-C).

Your correspondence and the product specification sheets stated that documentation contains trade secret information and it is not releasable under FOI request pursuant to Connecticut General Statute Section 1-210 (b) (1). As you know the Department has requested guidance from the Office of the Attorney General on issues related to trade secret disclosure restrictions. Please be aware that all proprietary manufacturers are required to provide product information (dimensions, cross sections, cover requirements, etc) to sewage system plan designers, and provide detailed installation instructions to systems installers and local health department inspectors. Leaching system products could not be approved and permitted by local health departments without such documentation.

This letter may be reproduced in its entirety as a means of notifying local health departments, engineers and installers of the product approval. This approval should not be construed to be an endorsement of this product.

Sincerely,

Robert W. Scully, P.E.
Supervising Sanitary Engineer
Environmental Engineering Program

C: Ellen Blaschinski, Chief, Regulatory Services Branch, DPH
Suzanne Blancaflor, Chief, Environmental Health Section, DPH

N\sewage\Bob\GeomatrixGeoMat&LowProSeriesAmd

NOWRA Conference 2008

Wastewater Renovation and Hydraulic Performance of a Low Profile Leaching System

David A. Potts[1], Erika L. Patenaude[2], Josef H. Görres[2], and José A. Amador[2]

[1]Geomatrix, LLC, Killingworth, CT

[2]Laboratory of Soil Ecology and Microbiology, University of Rhode Island, Kingston, RI

INTRODUCTION

Significant efforts have been made towards improving the performance of traditional septic systems, to protect water quality. Technologies such as low-pressure pipe (LPP) and drip irrigation are designed to uniformly apply the wastewater across the entire soil infiltration surface area to enhance treatment and extend the useful lifespan of the system. These technologies introduce the wastewater into the upper parts of the soil profile where oxygen is most readily available and nutrient uptake by plants is possible. These systems, referred to as low profile infiltration systems because of their minimal thickness, are particularly useful on sites where shallow depth to groundwater or ledge are present and where increased treatment efficiencies are desirable.

GeoMat™ (GLS) is a low profile subsurface irrigation and leaching system designed for the shallow application of wastewater to soil (patent pending). GLS are similar to LPP systems, but are lower in profile and simpler to install. GLS are also similar in certain respects to drip irrigation systems, but have significantly more contact area with the soil and are easier to maintain. GLS is comprised of a fused entangled filament core surrounded by a geotextile fabric well suited for wastewater infiltration. The GLS mat is typically 0.1 – 2.6 cm thick and is available in rolls that are 10 cm – 2 m wide and approximately 30 m long. Water is typically applied to the GLS with a pressure distribution system, similar to that used with LPP, or with a drip irrigation tube. Since GLS have such a low profile, the associated storage volume is limited; consequently, they are typically utilized in conjunction with flow equalization devices, such as time dose pump stations.

The objective of this study was to determine the wastewater renovation and hydraulic functions of the GLS receiving septic tank effluent (STE), under controlled conditions. This test methodology was selected to minimize the effects of potentially confounding variables, such as dilution by storm water and plant nutrient uptake, on interpretation of the data.

MATERIALS AND METHODS

Facility. The study was conducted at a domestic wastewater research facility in southeastern Connecticut, USA described previously in Potts et al. (2004). Briefly, it

consists of a laboratory adjacent to a two-story, two-family home built in 1983. The home was fitted with a conventional septic system. The septic tank had a capacity of 4,733 L and was not pumped during the course of the study. The home was inhabited continuously by 3 to 6 people.

A schematic diagram of the experimental setup can be found in Potts et al. (2004). All of the effluent from the septic tank was diverted to a pump station and stored in a high-density polyethylene (HDPE) tank (1,325 L max. capacity) housed in a climate-controlled (17 to 19°C) room above the laboratory. The contents of the tank were mixed at regular intervals using a pump. Wastewater from the tank was pumped through a PVC manifold to a series of dosing tanks in the laboratory. Cylindrical, high-density polyethylene (HDPE) dosing tanks (30.5 cm i.d., 45.7 cm height) had a maximum capacity of 38 L and were dosed every 6 h. Dosing was regulated using electronically actuated valves. Dosing tank overflow was allowed to drain completely until only the desired dose volume was retained. Wastewater from the dosing tank flowed by gravity into a series of lysimeters (described below). Sampling ports were located on the raw wastewater supply line and on the bottom of each lysimeter.

Treatment. The test was conducted in a lysimeter built of stainless steel (34 cm i.d., 61 cm height) and outfitted with ports for gas (1.9 and 2.5-cm i.d.) and water inputs 1.9-cm i.d.), drainage (1.9-cm i.d.), and inspection (15-cm i.d.). A 2.5-cm thick by 26.6-cm diameter disk of GLS was placed directly on 30.5 cm of sandy loam soil (Figure 1). A 1.9-cm i.d. PVC wastewater delivery pipe with six, 6-mm holes was placed on top of the GLS core and connected to the dosing tank. The delivery pipe and core were covered with the GLS Geotextile fabric and 20 cm of a blend of composted leaf matter and fine sand (1:1, vol/vol). The GLS test fixture was loaded with wastewater four times per day, equivalent to a hydraulic loading rate of 5 cm/day.

A small blower connected to a 1.9-cm i.d. port was used to promote air exchange in the headspace of the lysimeter, which was vented to the atmosphere through a 2.5-cm i.d. vent port. The blower was set at a flow rate of approximately 0.01 L/min for the first 13 days of operation, with the rate set to 0.5 L/min thereafter to maintain an O_2 level of 0.20 – 0.21 mol/mol.

Water quality analyses were conducted as described in Potts et al. (2004).

RESULTS

Hydraulic performance. Throughout the one year study, when STE was applied at 5cm/day, the GLS infiltrated 100% of the wastewater dose volume within one hour of application. Upon completion of the study, the test fixture was disassembled and visual observations and photo documentation of the various components were made (Figure 2). There was no evidence of clogging on the geotextile fabric where the wastewater infiltrated. The soil directly under the GLS had a thin surficial accumulation of biomat, but it did not penetrate the soil.

Water quality. Values for water quality parameters in wastewater and in drainage water from the lysimeter are shown in Figures. 5, 6 and 7. The rate of removal of constituents was calculated from the difference in concentration between the wastewater and the treated water for the last 10 months of the study. Data from the first two months of operation were not included in removal calculations, to account for development of a stable microbial community/biomat in the GLS and surrounding soil. The results can be summarized as follows:

- Average dissolved oxygen concentration in water from the GLS was 6.7 ppm.
- Average removal for Total Nitrogen was 35%.
- Average removal for ammonium was 99.9%.
- Average nitrate concentration in drainage water from the GLS was 14.5 ppm.
- Average removal for Total Phosphorus was 84%.
- Average removal for Five-Day Biological Oxygen Demand (BOD_5) was 100%.
- Average removal for fecal coliforms was 100%.
- Average removal for *E. coli* was 100%.

Head space gases. Six months into the testing, gases were extracted from the headspace of the GLS, two hours after applying a dose of wastewater. Oxygen was 20.2 % by volume, carbon dioxide was 0.9 % by volume and methane was 40 ppmv.

DISCUSSION

Hydraulic function In a separate test in the same facility using an open surface lysimeters filled with fine silica sand and a slightly lower loading rate (4 cm/day), a significant biomat mat developed within a few months (Potts et al., 2004). This restrictive layer (Figure 3) resulted in the continual ponding of wastewater above the infiltrative surface.

The soil infiltrative surface of the GLS at the one-year test period is shown in Figure 4. No evidence of an anaerobic biomat was observed. Throughout the test period, the wastewater dose infiltrated into the soil within one hour of application and ponding was completely absent.

The open infiltrative surface developed a significantly thicker and more restrictive biomat than the GLS, despite being loaded with 20% less wastewater per day. When disassembling the GLS lysimeter at the end of the test period, there was no indication of anaerobic odors. This contrasted sharply with the previous tests involving the open infiltrative surface, where the soil beneath the infiltrative surface was strongly anaerobic in nature as evidenced by the odor and color.

Wastewater renovation. Comparison of treatment data from the GLS tests with results from the open infiltrative surface study (Potts et al., 2004) allow us to gauge the relative performance. Average total nitrogen removal in the open infiltrative surface was 0.8%, as compared to 35% from the GLS. No total phosphorus removal was observed for the open infiltrative surface in silica sand, whereas the GLS removed 84%. However, the

presence of iron and aluminum oxides in the soil used for the GLS test – absent in the silica sand tests lysimeters - likely accounts for part of the difference. Average BOD_5 removal was 60.9% for the open infiltrative surface and 100% for the GLS. On average, 98.9 % of the fecal coliforms were removed with the open infiltrative surface, while the GLS consistently removed 100%.

These data suggest that performance of the GLS is at least equivalent to – and in many cases better – than observed for the traditional infiltrative surface from a water quality perspective. The shallow burial depth and high surface area/void ratio in the GLS likely create aerobic conditions that are conducive to enhanced treatment. In addition, the combination of aerobic conditions, which can support nitrification, and the dosing of the wastewater may help explain the relatively high level of total nitrogen removal, with the wastewater dosing providing both a carbon source and the anaerobic conditions that are necessary for denitrification.

Headspace gases. Analysis of headspace gases indicated that predominantly aerobic conditions existed within the void space of the GLS. The shallow burial depth and high surface area/void ratio appear to be beneficial from a gas transfer perspective. Furthermore, when the dose of wastewater was applied, a significant percentage of the void space in the GLS was filled. This resulted in the displacement of the gases that had accumulated in the void space between doses. When the wastewater infiltrated into the underlying soil, air was likely drawn down from above. This dosing method may have further helped maintain aerobic conditions in the GLS. The presence of high levels of dissolved oxygen in drainage water from the lysimeter suggest that there is a considerable oxygen transfer in these systems.

CONCLUSIONS

We found that the GLS was capable of handling the STE at the applied hydraulic load and also capable of providing a high level of treatment. The shallow burial depth and significant surface area both inside and around the perimeter of the GLS likely results in aerobic conditions in and adjacent to the GLS. The GLS is another option for wastewater treatment on sites in environmentally sensitive areas where shallow infiltration of wastewater is desirable.

REFERENCES

Potts, D., J.H. Görres, E.L. Nicosia, and J.A. Amador. 2004. Effects of aeration on water quality from septic system leachfields J. Environ. Qual. 33:1828–1838.

Figure 1a

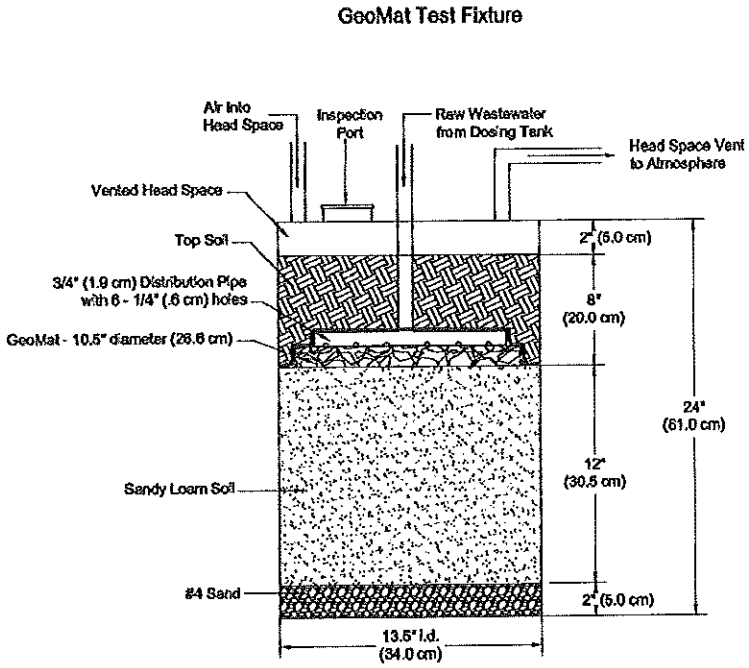


Figure 1b

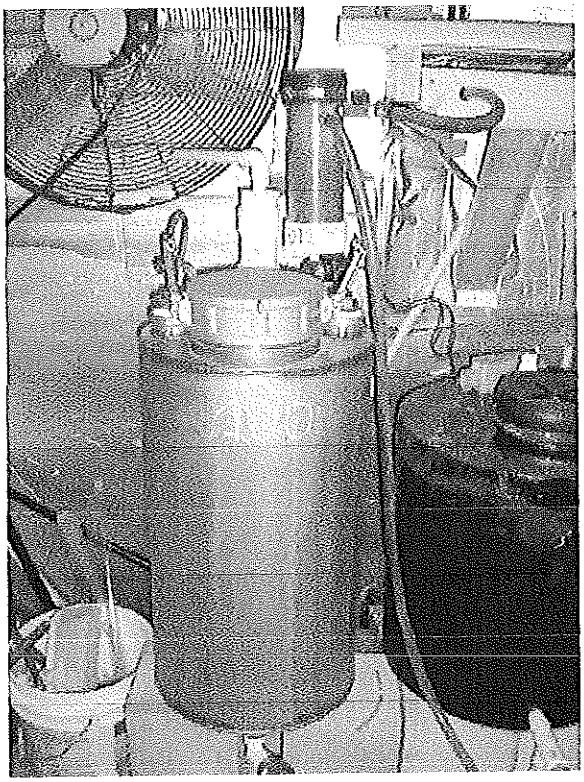


Figure 2

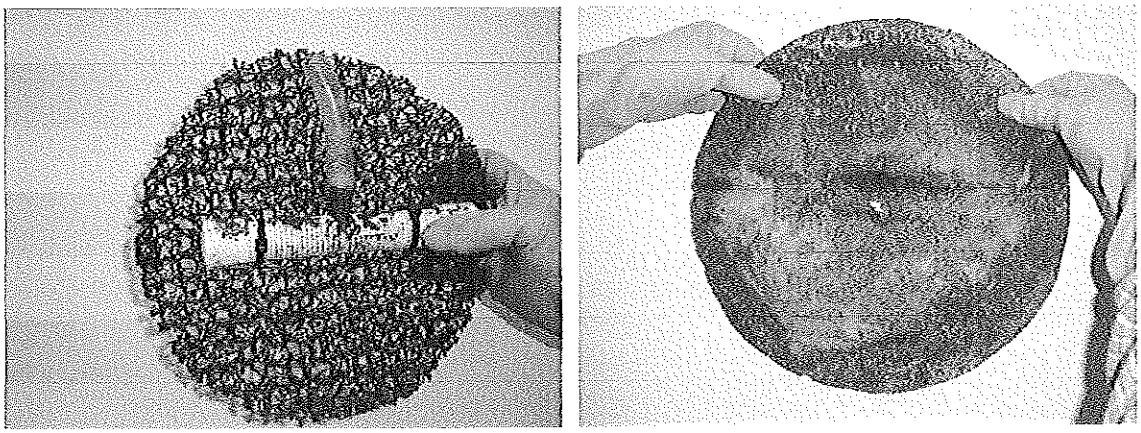


Figure 3

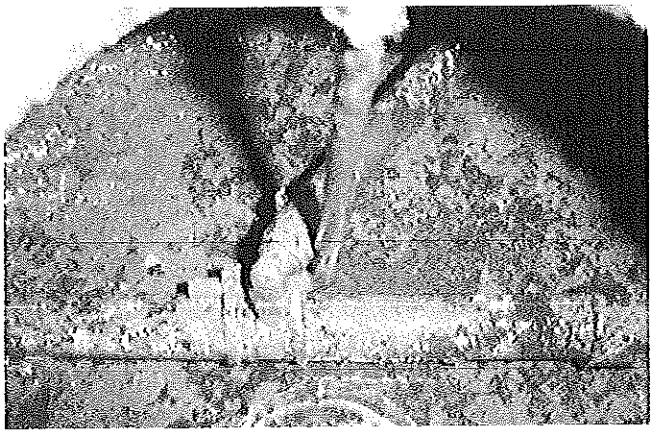


Figure 4

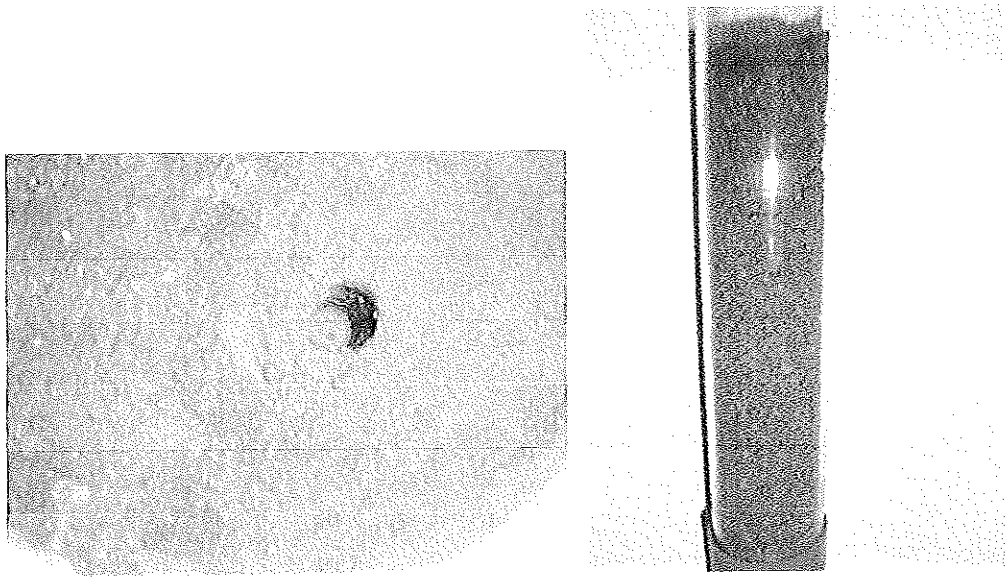


Figure 5

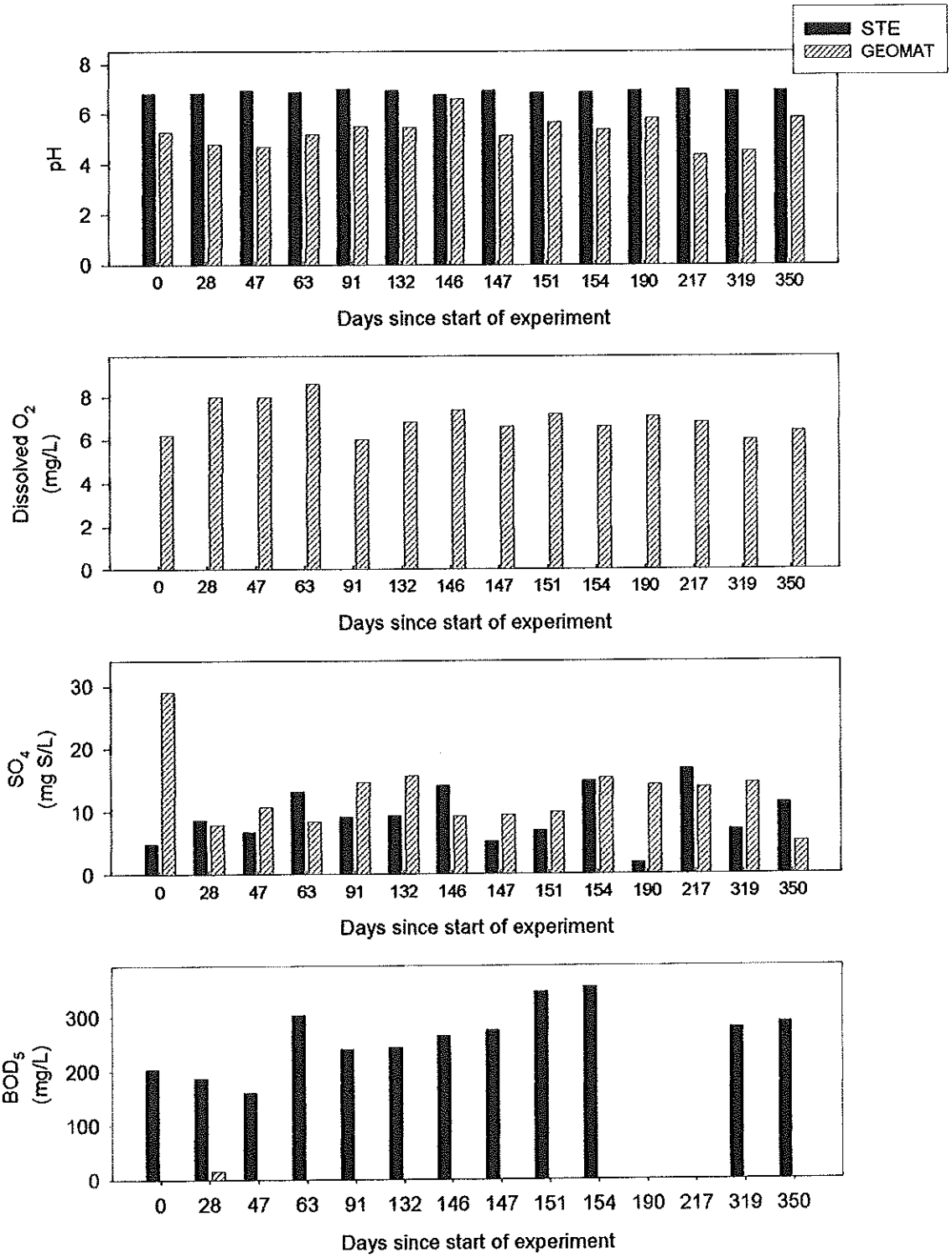

STE
GEOMAT
pH
0
2
4
6
8
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment
Dissolved O_2 (mg/L)
0
2
4
6
8
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment
SO_4 (mg S/L)
0
10
20
30
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment
BOD_5 (mg/L)
0
100
200
300
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment

Figure 6

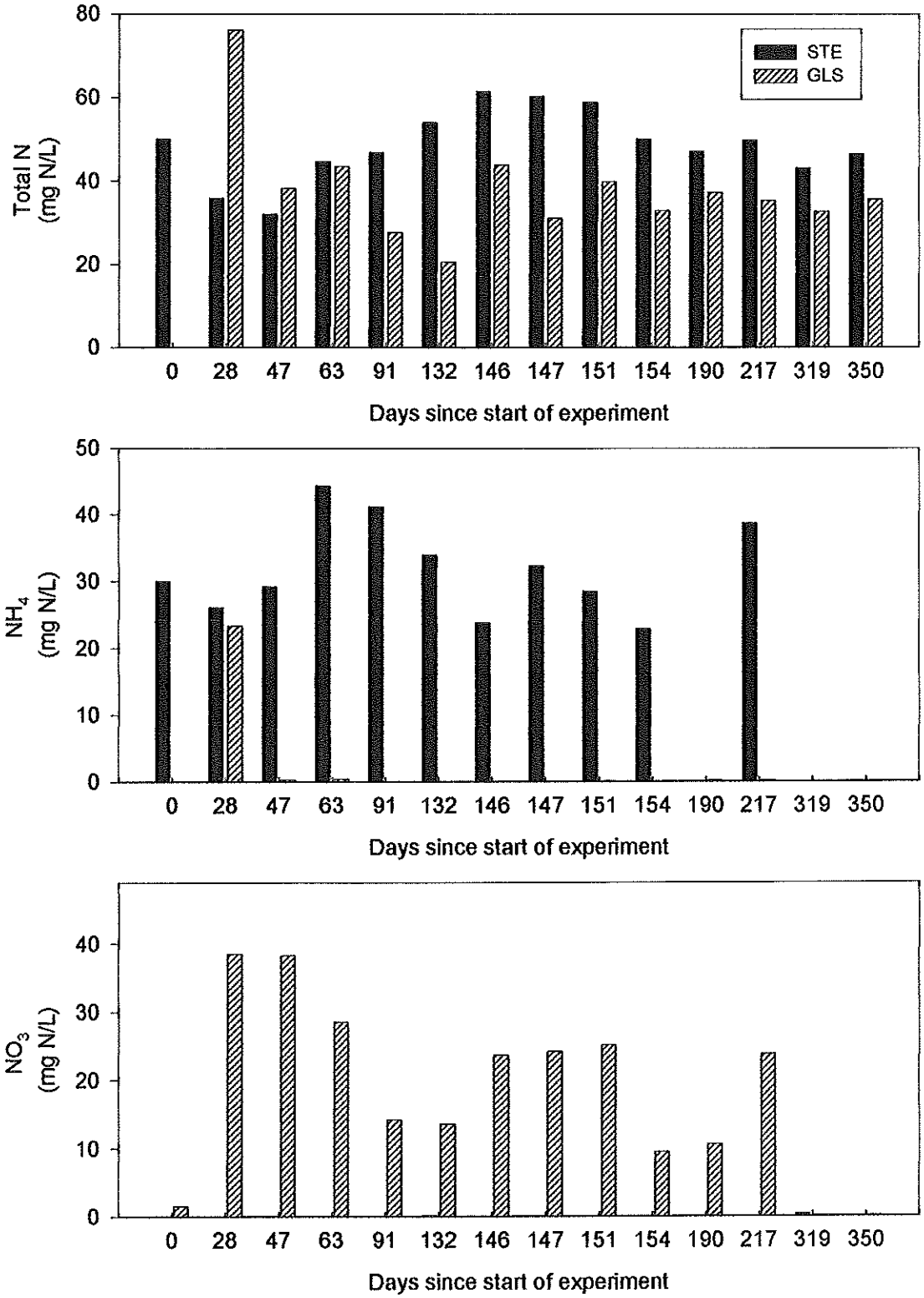
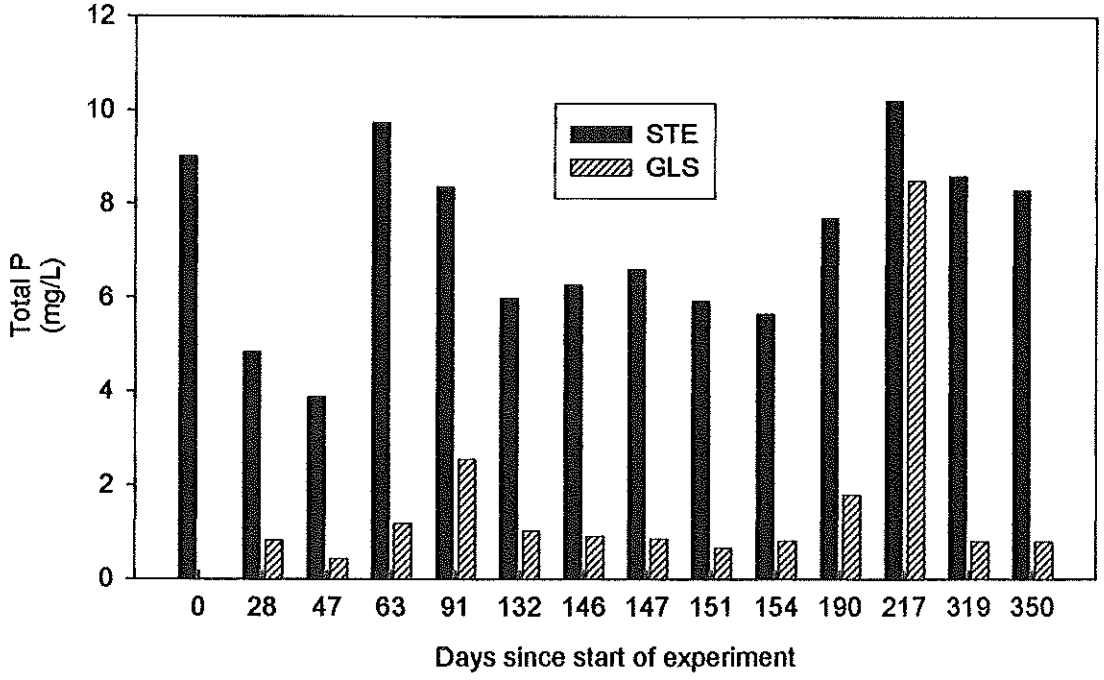
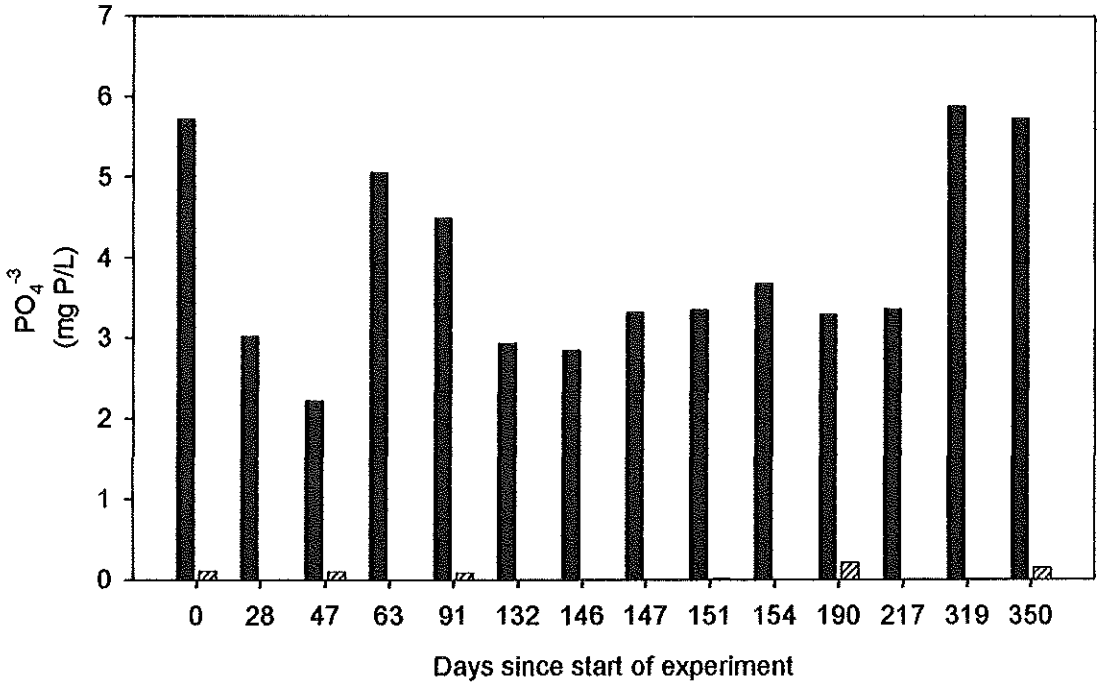

Total N (mg N/L)
80
60
40
20
0
STE
GLS
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment
NH4 (mg N/L)
50
40
30
20
10
0
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment
NO3 (mg N/L)
40
30
20
10
0
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment

Figure 7


12
10
8
6
4
2
0
Total P (mg/L)
STE
GLS
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment


7
6
5
4
3
2
1
0
PO_4^{-3} (mg P/L)
0 28 47 63 91 132 146 147 151 154 190 217 319 350
Days since start of experiment