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TECHNICAL REPORT STANDARD PAGE

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16. Abstract

The Louisiana Department of Transportation and Development has long been interested in low maintenance waste treatment systems that can be used to treat small flows in situations where skilled operators are not available. The purpose of this project was to develop design and operating data for a rock filter (formerly rock-plant or rock-reed, filter) to treat high strength wastewater at an interstate rest area. Data have been collected over an eight-year period regarding removal of biochemical oxygen demand (BOD), total suspended solids (TSS), and ammonia. Granite rock media as well as a synthetic media have been evaluated for removal efficiency and ease of construction. The system described herein has been shown to be highly robust with respect to flowrate and waste strength. The synthetic media functions as well or better than granite media and is far easier to place and move when necessary.

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Optimization of Subsurface Flow and Associated Treatment Processes

by

D.M. Griffin, Jr., Ph.D., P.E.
Professor of Civil Engineering
Louisiana Tech University

State Project No. 736-99-0917
LTRC Study No. 01-1ENV

conducted for

Louisiana Department of Transportation and Development
Louisiana Transportation Research Center

February 2006

ABSTRACT

The Louisiana Department of Transportation and Development has long been interested in low maintenance waste treatment systems that can be used to treat small flows in situations where skilled operators are not available. The purpose of this project was to develop design and operating data for a rock filter (formerly rock-plant or rock-reed, filter) to treat high strength wastewater at an interstate rest area. Data have been collected over an eight-year period regarding removal of biochemical oxygen demand (BOD), total suspended solids (TSS), and ammonia. Granite rock media as well as a synthetic media have been evaluated for removal efficiency and ease of construction. The system described herein has been shown to be highly robust with respect to flowrate and waste strength. The synthetic media functions as well or better than granite media and is far easier to place and move when necessary.

ACKNOWLEDGEMENTS

The principal investigator would like to acknowledge Curtis Fletcher of the Louisiana Department of Transportation and Development (LADOTD) and Art Rogers of the Louisiana Transportation Research Center (LTRC) for their assistance and patience during this project. He also wishes to thank the members of the project review committee and LADOTD and LTRC for the opportunity to perform this study.

IMPLEMENTATION STATEMENT

The Louisiana Department of Transportation and Development Rest Area Management Program calls for using the waste treatment technology described herein at all interstate rest areas that cannot be tied into municipal systems. Such a system is presently being designed for the Mound rest area/visitor center on I-20 in Louisiana.

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INTRODUCTION

The waste treatment system at the Grand Prairie Rest Area has operated continuously since November 1, 1996. The system operates under a general permit limiting the maximum daily flow to 25,000 gal./day, and the maximum daily BOD and TSS to 30 mg/liter each. Two previous reports are available documenting earlier research at this rest area and others in the state *[1],[2]*. This study was initiated by Task Order 736-99-0937 with an effective date of July 1, 2001. A major impetus for these studies was LADOTD's desire to develop a robust, low cost, low maintenance waste treatment system suitable for small flows in situations where knowledgeable treatment plant operators are not available. Samples have been collected and field tests conducted on a biweekly basis over the life of the system. Numerous modifications to the original system have been made. This report will focus on modifications made and operational results obtained during the period from 2001 to 2004. These modifications involved replacing granite rock media in cell 3 with synthetic media in 2002. The modified system was then examined for pollutant removal efficiency, including ammonia-N removal. Earlier data will be used where it is considered useful for comparison, clarity of intent, or providing the reader perspective.

OBJECTIVE

The objective of this study was to examine the use and performance of synthetic media (growth substrate) in a rock filter waste treatment system located at the Grand Prairie rest area on I-49 approximately 40 miles south of Alexandria, Louisiana. Specifically, this study examined performance of the synthetic media in removing BOD and TSS as compared to the granite rock media used previously. In addition, the performance of the synthetic media in the removal of ammonia-N from the waste was evaluated. Observations and data specifically related to the ease of installation and amount of maintenance required for the synthetic media will be accumulated, evaluated, and compared to similar information and experience for the granite media used previously.

SCOPE

This project investigated several methods for improving the pollutant removal capabilities of the existing Grand Prairie treatment system, one of which involved removing the granite rock media from cell 3 and placing it on top of the rock media in cell 4. A synthetic media (brand name: Kompact) manufactured in 2' x 2' x 4' blocks was then placed in cell 3 and covered with commercially available shade cloth. The cloth was held in placed by treated 2' x 6' x 12' pieces of lumber. The standard sampling frequency (bi-weekly) was followed. Samples were collected and analyzed for BOD, TSS, TKN, NH_3, NO_3. In addition, field tests for pH, dissolved oxygen, and conductivity were performed when samples were collected. After allowing system performance to stabilize, 3 recycle pumps were installed at the effluent end of cell 3. Treated effluent was recycled (41:1 recycle ratio) and sprayed into the air to strip out unionized ammonia.

METHODOLOGY

All laboratory test results described herein were produced in the Folk Memorial Laboratory at Louisiana Tech University. Samples were collected on-site, stabilized as required with acid, and placed on ice. Samples were then transported to the Folk Lab and testing began within the prescribed time limit for each individual test. The Folk Lab is accredited by the Louisiana Department of Environmental Quality's Environmental Lab Accreditation Program (certificate number 04021, expiration date June 30, 2005, agency interest number 87808). All quality control measures were adhered to during testing and quality control data is maintained by the lab. Field tests, pH, conductivity and dissolved oxygen were conducted on site; the instruments used were calibrated before each use.

Water use data contained in this report was obtained from daily readings of a totalizing water meter placed in the discharge line of the well supplying water to the facility. Sequential readings were subtracted to obtain water use during the previous 24-hour period.

DISCUSSION OF RESULTS

Water Usage

Daily water usage at the site has been monitored and recorded since July 1, 1997. This was accomplished by reading a totalizing water meter located in the discharge line of the well serving the site at the same time each day. Sequential readings were then subtracted to obtain water used during the intervening 24-hour period. These were plotted over time as shown in figure 1 below. The mean flow rate is 5,238 gal./day with a standard deviation of 4,119 gal./day (N = 2439). This translates to a wastewater loading rate of approximately 0.16 ft./day based on a nominal cell area of 150'x 30'.

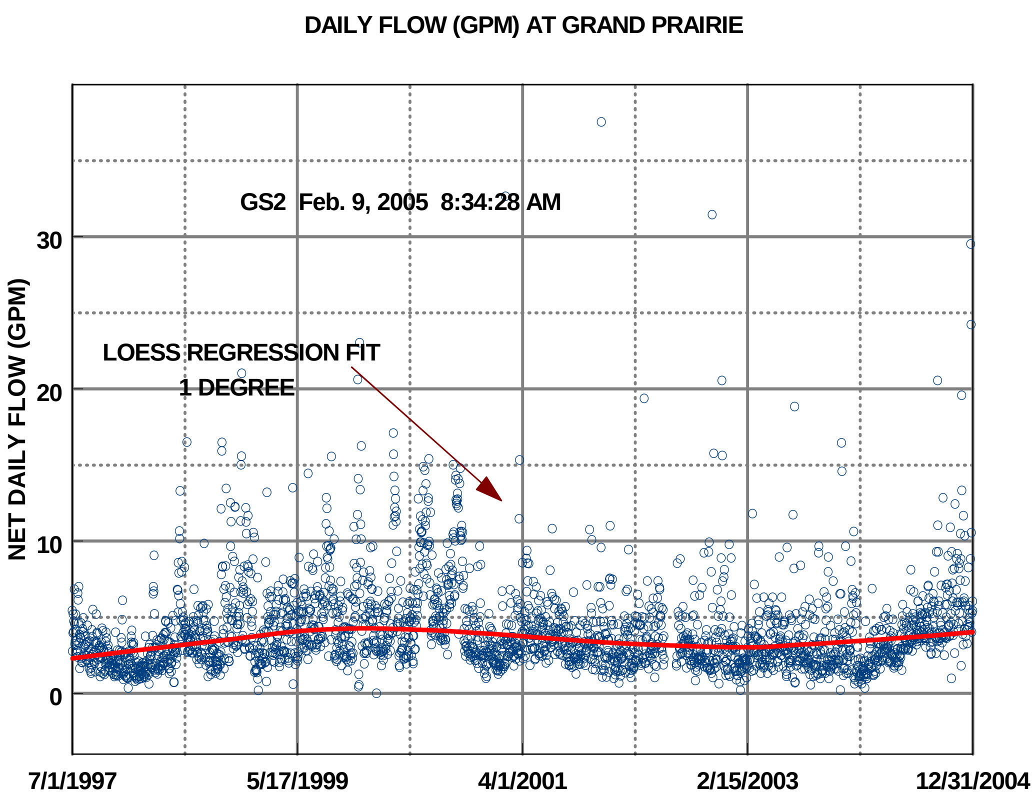

Figure 1
Daily water use at the Grand Prairie rest area

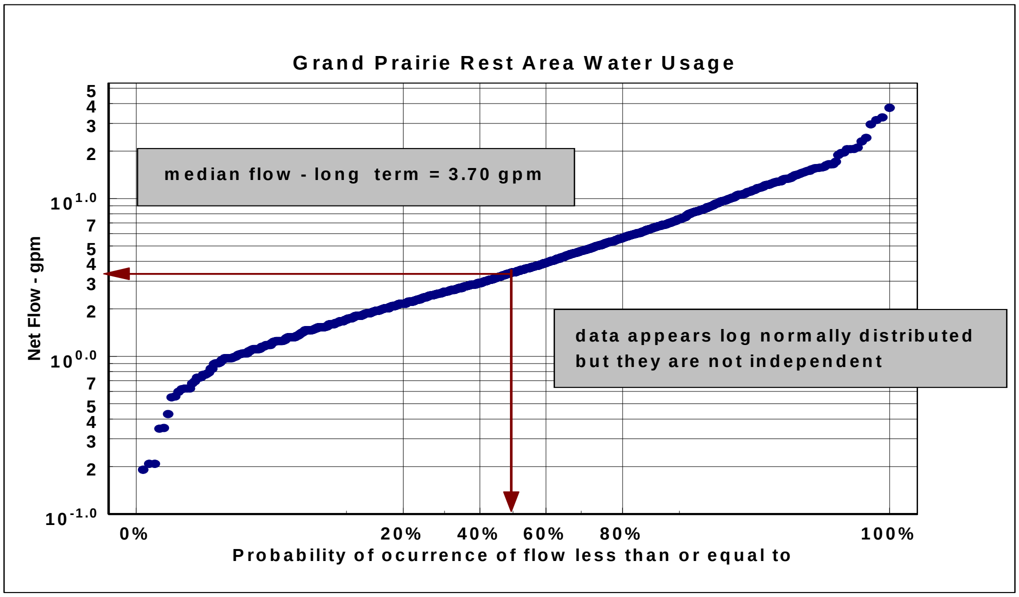

Figure 2
Log Probability Plot – daily water flow at Grand Prairie

As shown, daily water usage at this facility has remained a relatively constant 3.5 gal./min. The spikes in usage occurring during 1999 and 2000 resulted from hydraulic conductivity and dye tests being conducted at the facility. Previous studies have shown that the ratio of water use to waste generation at this facility is very close to 1.0, indicating that water use data is an excellent surrogate measurement for waste generation. Figure 2 shows the water usage data plotted as a reference distribution. The procedures used to construct this distribution are the same as those used to construct probability plots for annual maximum flows on a river and can be found in any hydrology textbook *[3]*. Using this curve, the probability of occurrence of a specified daily flow at the facility can be determined. As an example, one would expect a flow equal to or less than 5.5 gal./min to occur approximately 80 percent of the time. Stated another way, a daily flow of 5.5 gal./min or greater should occur, on the average, about once every 5 days. This distribution was updated regularly and used to monitor daily flows for unusually high or low values that might indicate leaks in the system.

The Treatment Facility

The original Grand Prairie waste treatment system layout is shown in figure 3.

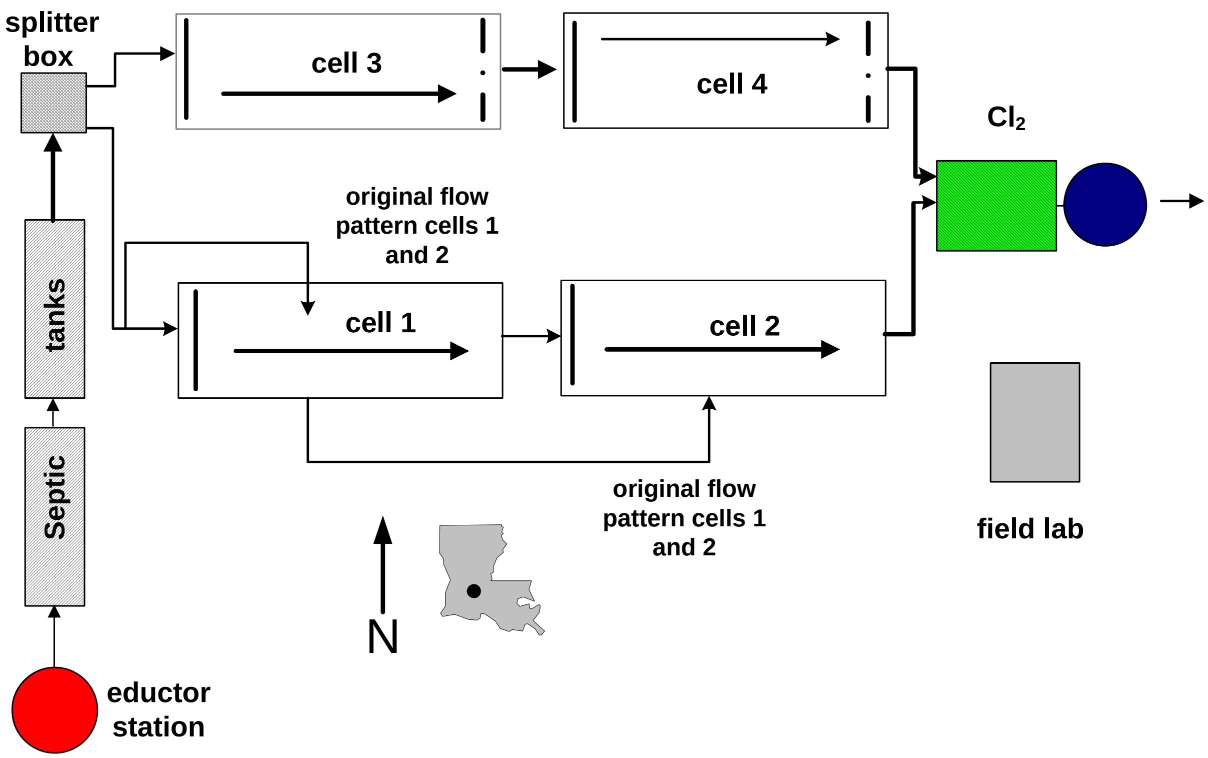

Figure 3
Layout Grand Prairie treatment system

When the system began operating in 1996, the anticipated daily flow rate was 10 gal./min. Waste drains by gravity from the rest area building and an RV dump station to the eductor (pump) station. The pump station lifts the waste into 2 - 10,000 gallon septic tanks connected in series. Effluent from the septic tanks can then flow through either cells 1 and 2 or 3 and 4. Each cell can be characterized hydraulically as plug flow, and biologically as a fixed film process. Unlike other fixed film processes such as trickling filters and rotating biological contactors, the contact time between the wastewater and the organisms growing on the media is measured in days rather than minutes or seconds. As indicated previously, the flow has remained around 3.5 gal./min. As a result, only cells 1 and 2 were originally used.

This continued until 2000 when flow was switched to cells 3 and 4. Cells 1 and 2 have remained inoperative since that time.

In 2002 the Project Review Committee (PRC) decided to move the rock media in cell 3 to cell 4, thereby increasing the depth of media in cell 4 to approximately 3 ft., and replace it with synthetic media. The rationale was to examine the effectiveness of synthetic media in removing BOD, TSS, and ammonia as compared to the rock media, to examine the effect of media depth on removal efficiency, and to determine how easy synthetic media was to install and work with. Past experience with moving rock media manually had been extremely difficult, time consuming, and labor intensive. In addition, considerable time and energy was required to remove fines from the media, prior to placement, to prevent clogging. Figure 4 shows prisoners from the St. Martinville prison unloading and placing media sections into cell 3. The media is manufactured in 2' x 4' x 2' blocks that could be easily handled by a single individual (note prisoner carrying block in upper right of picture below). The media has an advertised void ratio of 98 percent, resulting in a high surface-to-volume ratio.

Figure 4
Placement of synthetic media – cell 3

Figure 5 shows a close-up of a single block of media. The blocks were sturdy enough to be walked on, once in place. In addition, they could be cut as needed to fill odd spaces in the cell.

Figure 5
A block of synthetic media

The configuration of the completed cell 3 is shown schematically in figure 6. Once the media had been placed, it was covered with commercially available shade cloth to protect it from UV radiation and prevent algae growth in the wastewater being treated. Three 1 Hp sump pumps were placed on the bottom of the cell. These recycle treated wastewater, spraying it into the air to strip out ammonia. Sample collection in the modified cells 3 and 4 began in September of 2002. A schematic of cell 3, as modified, is shown in figure 6. The treatment system has never had a plant "operator" in the conventional sense. Maintenance personnel perform routine cleanup around the plant and replenish the tablet chlorinator to insure disinfection of the effluent. In the event one of the three recycle pumps fails, they are relatively inexpensive and easy to replace.

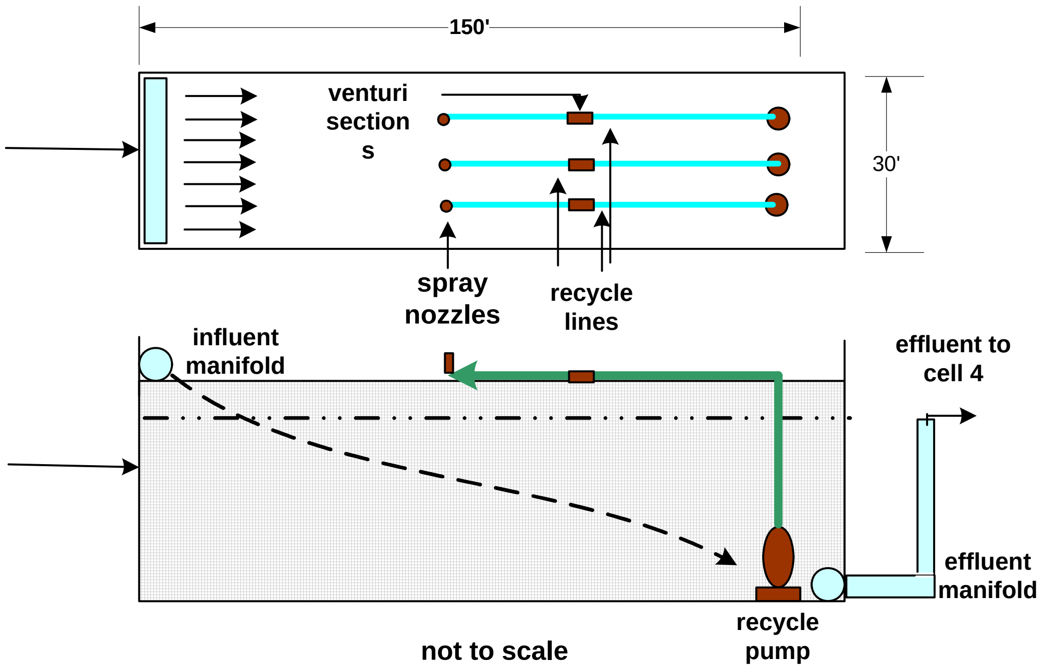

Figure 6
Schematic of modified cell 3

Waste Flow Patterns

The actual waste flow pattern during a typical period is illustrated in figure 7. As shown, the flow to the treatment was highly variable, ranging from near zero upwards to 50 gal./min. Such flow rate variation is extremely difficult to treat effectively in conventional mechanical systems because of the large variation in hydraulic loading to the secondary clarifiers.

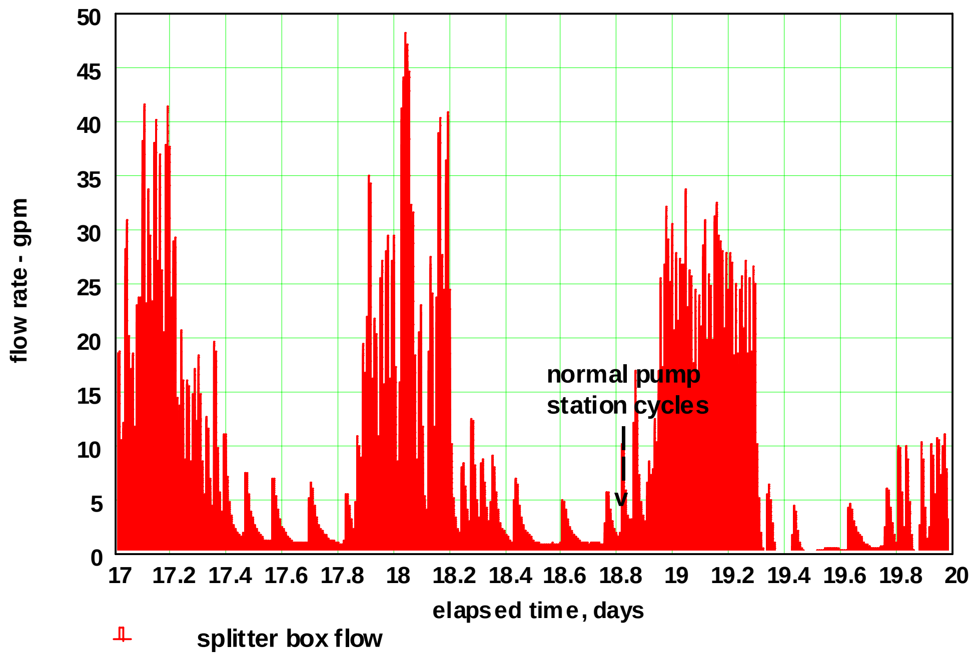

Figure 7
Pump station flow at Grand Prairie

Waste Temperature

The variation in waste temperature at the splitter box, cell 3, cell 4, and the chlorination chamber is shown in figure 8. Data for the splitter box and chlorination chamber are provided for the life of the plant. Data for cells 3 and 4 are provided for the period of time they have been in operation. Temperature data for cells 1 and 2 is available, but is not provided here. Annual yearly temperature variations have been relatively constant during the operation of the plant, ranging from a low of 10^{o}C in January/February to a high of near 30^{o}C in July/August. Observations during that period indicated that as long as the temperature was relatively constant (either high or low), treatment efficiency remained high; however, during periods of rapid temperature change treatment efficiency tended to become somewhat erratic. A close-up of the temperature variation during the period of operation of cells 3 and 4 is provided in figure 9. The curves are splines intended only to make trend visualization easier.

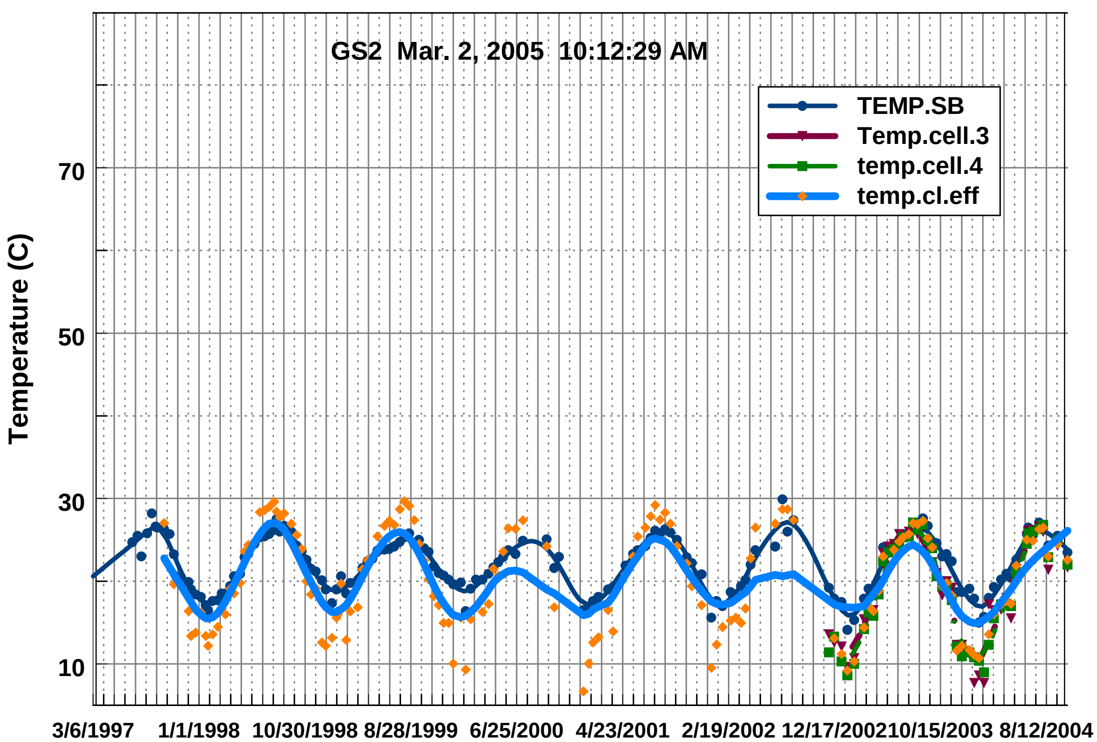

Figure 8
Temperature variation across the Grand Prairie treatment system

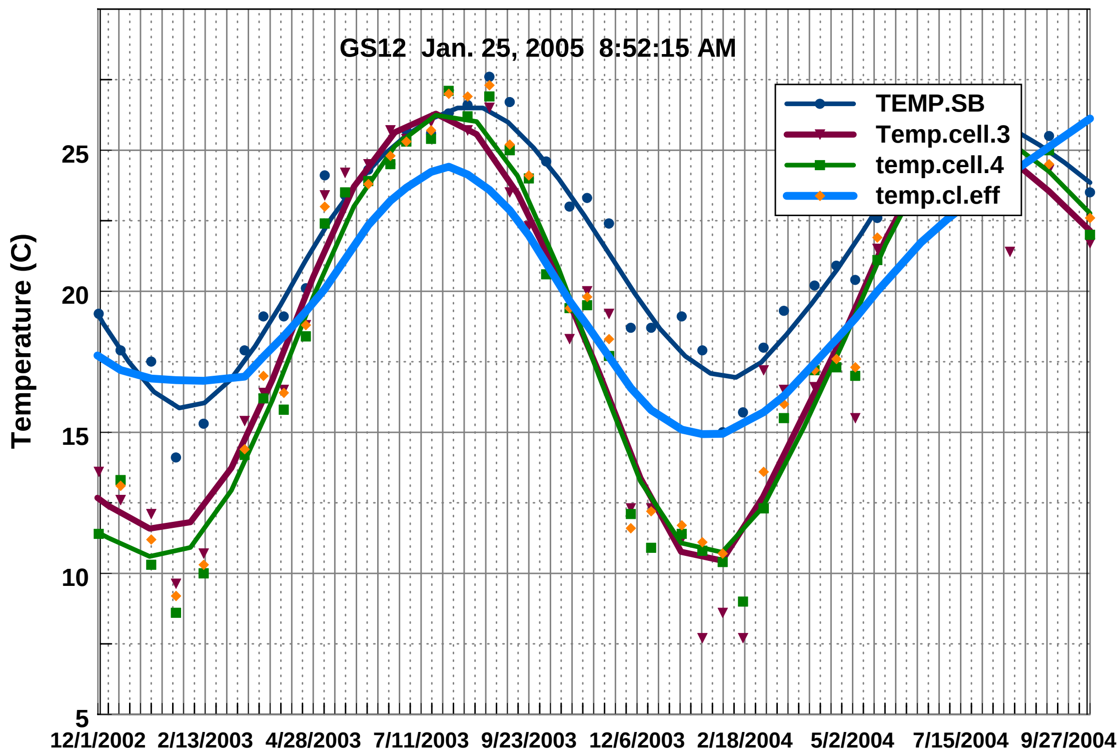

Figure 9
Temperature variation in cells 3 and 4

Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is a rather crude measure of the organic content of wastewater. Over the life of the system, samples for BOD analysis have been collected every other week from the pump station, the splitter box, and cells 1 and 2 or cells 3 and 4, depending on which were in operation. Figure 10 is a semi-log plot of BOD at four points in the system during the period cells 1 and 2 were in operation. BOD levels measured at the pump station were highly variable with a mean of 525 mg/liter and a standard deviation of

349 mg/liter (N=156). However, the septic tanks served as primary clarifiers, substantially decreasing the degree of variation in BOD going to the cells. The mean BOD measured at the splitter box was 176 mg/liter with a standard deviation of 54 mg/liter (N =164). The effluent from cell 1 had a mean concentration of 35 mg/liter with a standard deviation of 27 mg/liter (N = 124) while cell 2 produced a mean effluent concentration of 19 mg/liter with a standard deviation of 15 mg/liter (N = 114). These values include start-up data. Effluent concentrations from both cells dropped continuously for about three years after they were first placed in operation, as shown in figure 10.

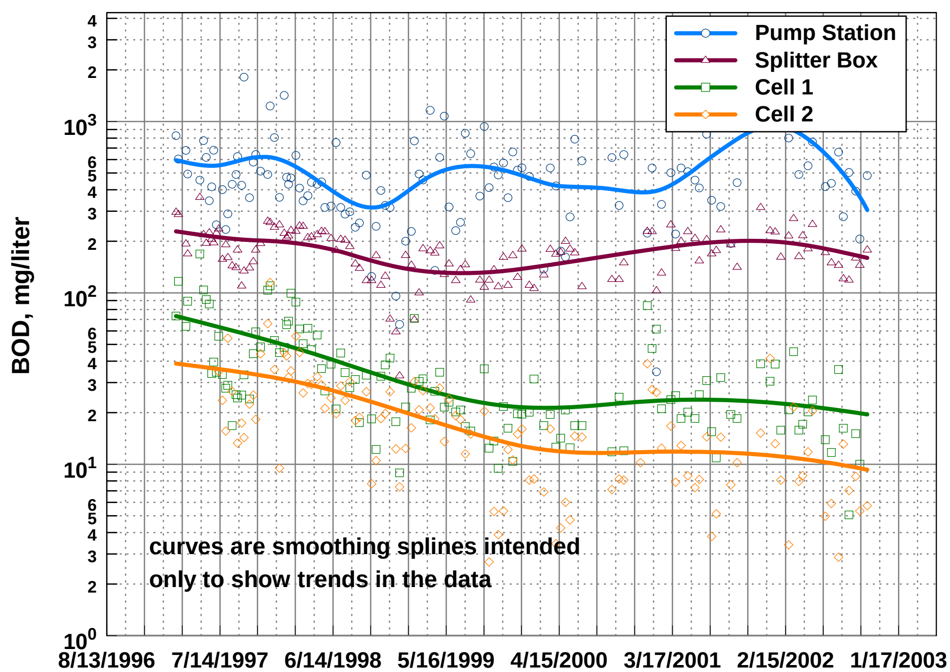

Figure 10
BOD concentrations across treatment plant – cells 1 and 2

BOD levels from 2002 to 2004, the period cells 3 and 4 were in operation, are shown in figure 11. The mean effluent concentration from cell 3 was 24 mg/liter with a standard deviation of 18 (N = 24) while that from cell 4 was 17 mg/liter with a standard deviation of 12 mg/liter (N = 37). The mean BOD loading to cell 3 was 70.1 lbs./day. The North American average is 25 lbs./day *[4]* .

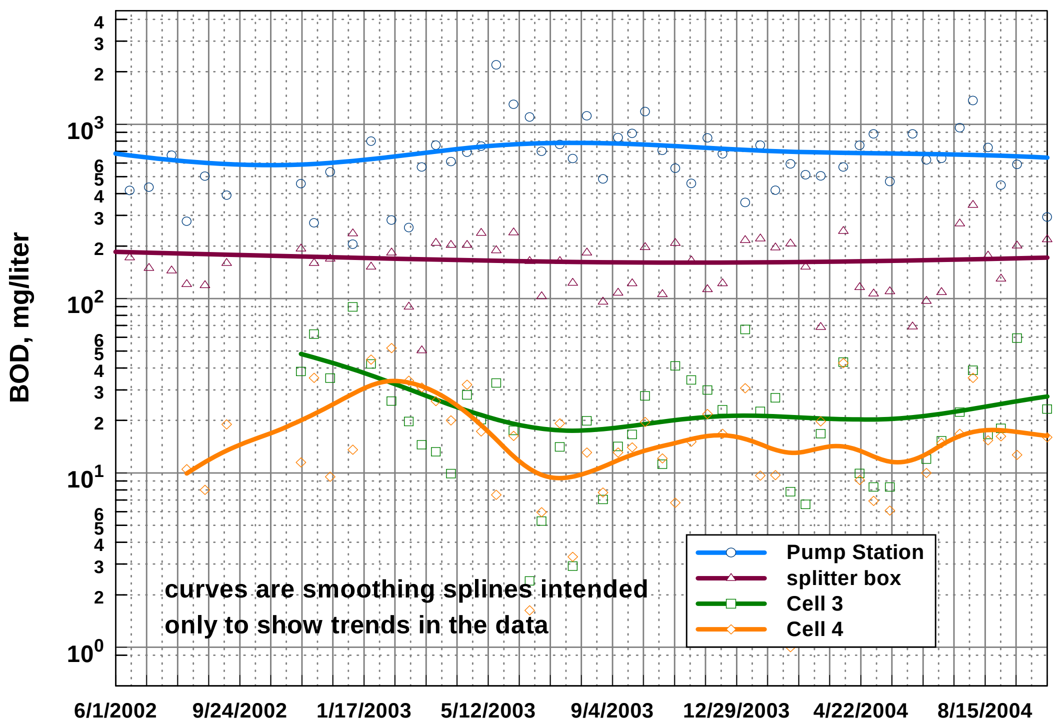

Figure 11
BOD Concentrations across cells 3 and 4

Probability plots for each year from 1997 to 2004 are shown in figure 12. Based on these plots, the mean median effluent BOD from the system was less than 20 mg/liter for every year except 1997 and 1998. The median value in 1997 was increased by the inclusion of start-up data prior to the system reaching steady state. Plots for the years 2003 and 2004 represent removals using cells 3 and 4 in series, synthetic media in cell 3 and increased rock depth in cell 4.

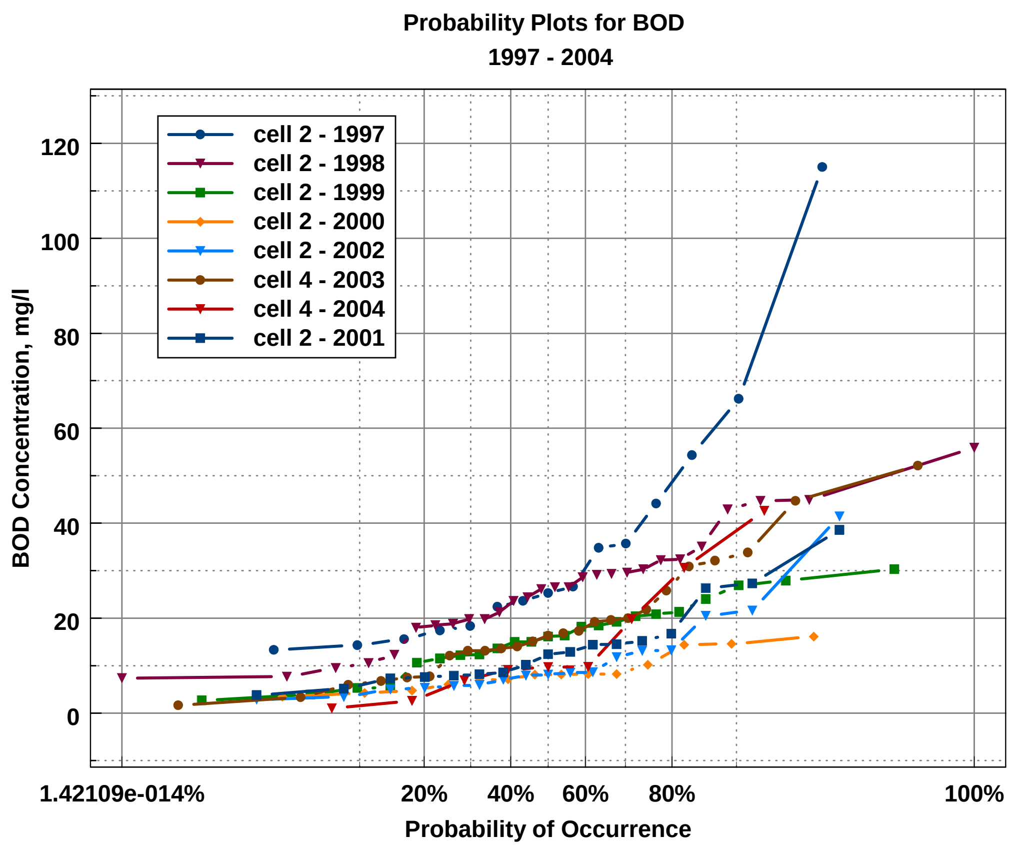

Figure 12
Probability plots for BOD 1997 to 2004

These results are in contrast to those obtained from “rock-reed filters” common in Louisiana in the 1980s. Most of these systems were plagued with clogging problems, ultimately resulting in partial or total system failure. This system has never exhibited problems due to clogging. The closest present analogy might be a horizontal trickling filter.

Total Suspended Solids

Total suspended solids were measured with the same frequency and at the same locations as BOD. Figure 13 shows the TSS concentrations at the pump station and splitter box since the system was placed in operation. TSS concentrations at the pump station exhibited much greater variation that those at the splitter box, demonstrating the value of the septic tanks as clarification units. The mean TSS concentration at the pump station was 825 mg/liter with a standard deviation of 863 (N = 157) while that at the splitter box was 71 mg/liter with a standard deviation of 29 mg/liter. Figure 13 is a plot of TSS in the effluent from cells 3 and 4.

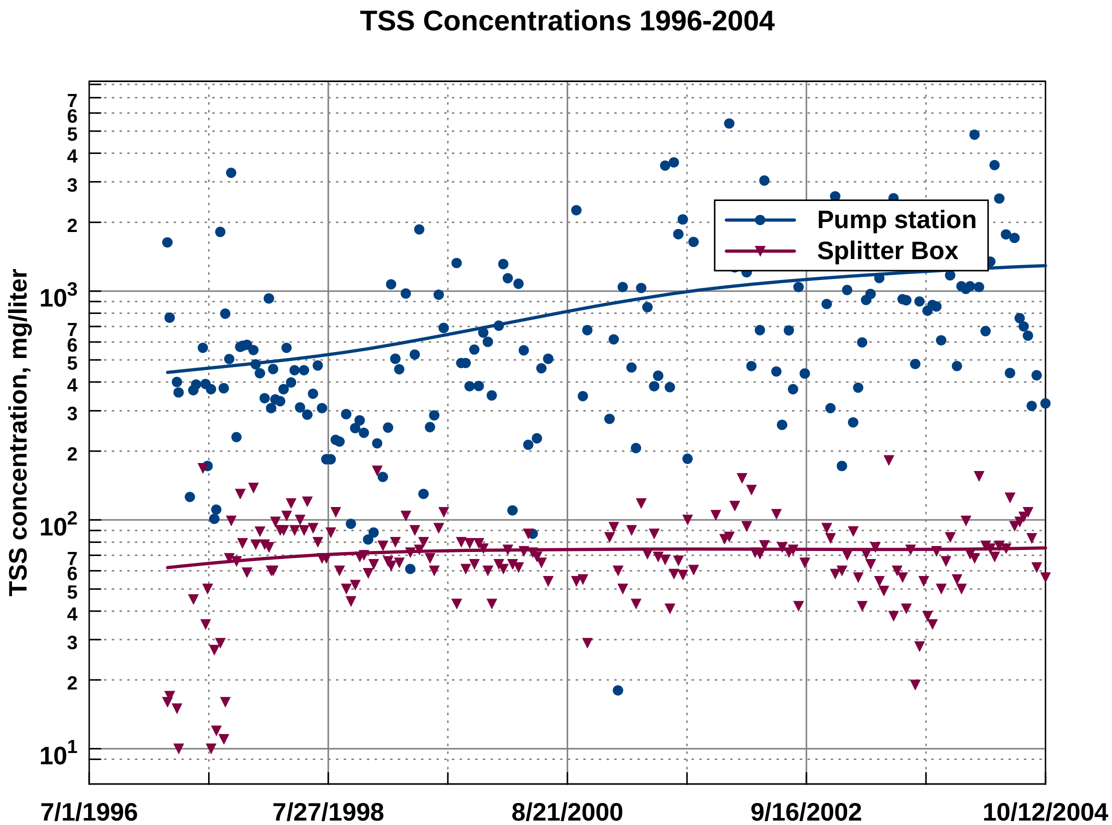

Figure 13
TSS concentrations at the pump station and splitter box 1996-2004

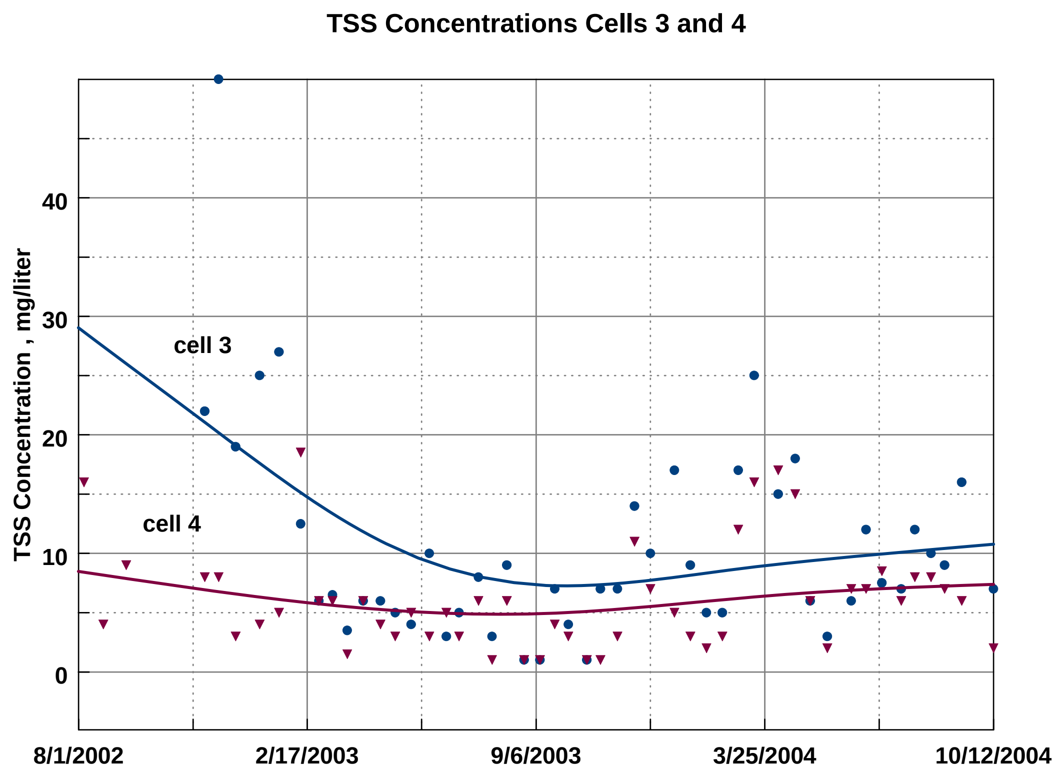

Figure 14
TSS concentrations cells 3 and 4 2002-2004

The mean TSS concentration from cell 3 is 10 mg/liter with a standard deviation of 9 mg/liter (N = 37) while that from cell 4 is 6 mg/liter with a standard deviation of 4 mg/liter (N = 40). The high values in August and September occurred before the system reached equilibrium. The mean TSS loading to cell 3 was 28.9 lbs/acre*day. It should be noted that the influent TSS loading to cell 3 was substantially higher than loadings to most rock-plant filters in Louisiana, but even so, clogging has never been a problem at this facility. Figure 15 shows TSS probability plots for each year of operation of this facility.

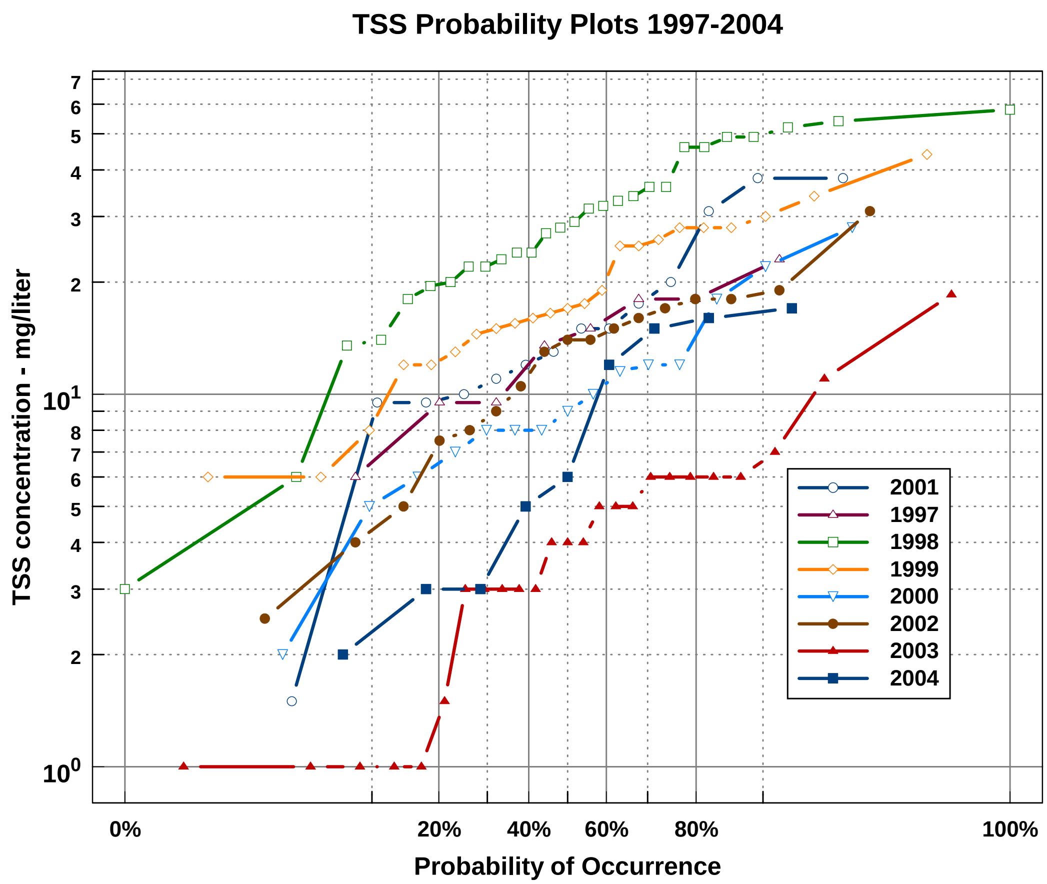

Figure 15
Probability plots for TSS, 1997 - 2004

The highest median concentration occurred in 1998 (cells 1 and 2, rock media), which was approximately 30 mg/liter, and the lowest occurred in 2003 (cells 3 and 4, synthetic media). The median concentration for all years falls at or below the permit limit (30 mg/liter) for this constituent.

BOD – TSS Correlations

Figure 16 shows the relationship between measured values of BOD and TSS for cell 1 during the period it was in operation. Figure 17 shows the same plot for cell 2. They show

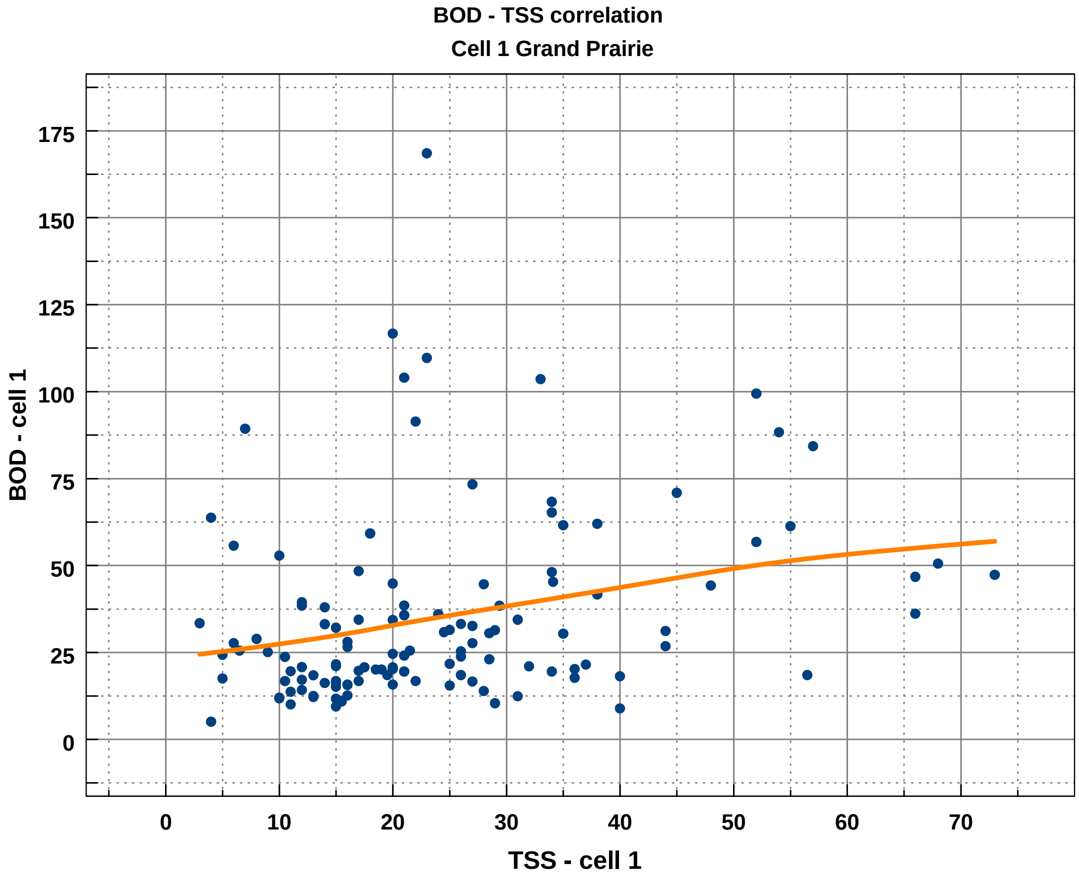

Figure 16
BOD TSS relationship cell 1

that BOD and TSS do not correlate well for either cell. The same was found when examining the relationship between TSS levels and turbidity. Thus, it does not appear that

TSS could be used as a surrogate measurement for BOD or that turbidity could be used as surrogate for TSS.

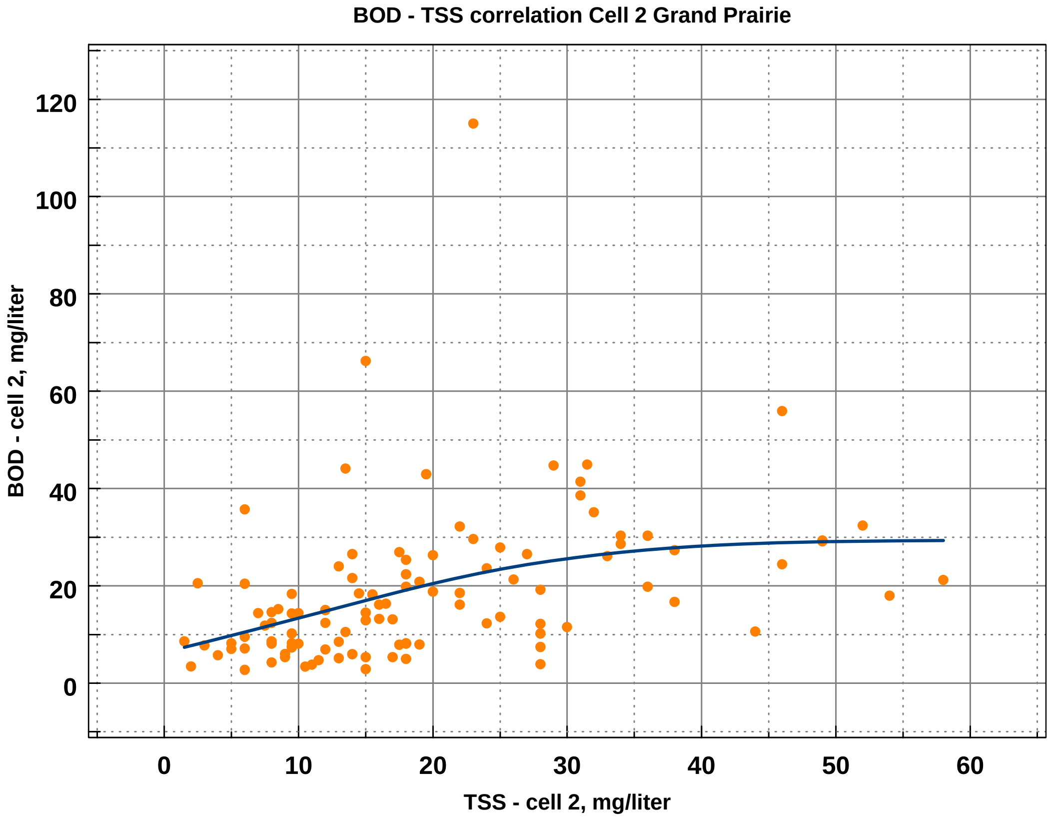

Figure 17
TSS – BOD relationship cell 2

Ammonia

Figure 18 shows the ammonia nitrogen concentrations at the pump station and splitter box.

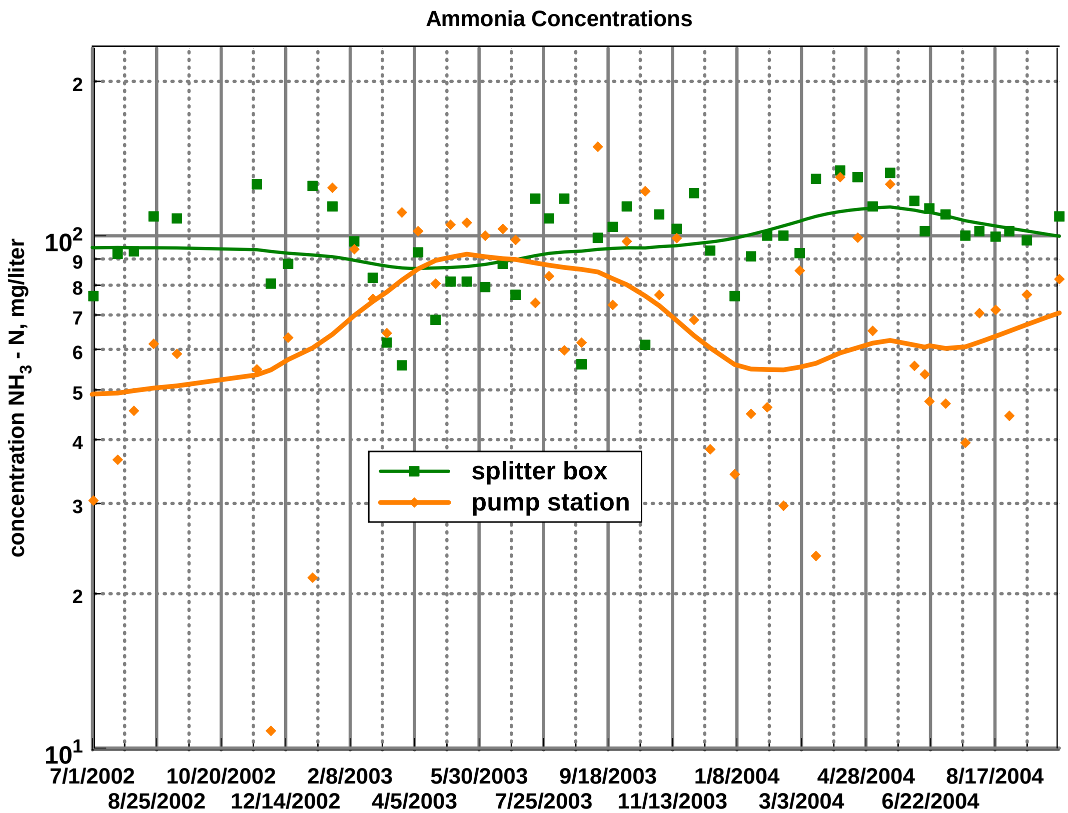

Figure 18
Ammonia concentrations at the pump station and splitter box

As with other constituents, ammonia nitrogen levels measured at the pump station vary widely. At the splitter box, ammonia nitrogen levels are much less variable but substantially higher due to the hydrolysis of organic nitrogen as the waste passes through the septic tank.

The mean ammonia nitrogen concentration at the splitter box is 92 mg/liter. This is substantially higher than that in domestic wastewater. Figure 19 shows the ammonia – N concentrations in the effluent from cells 1 and 2 are approximately the same as at the splitter box. Initially, ammonia removal was not to be considered at Grand Prairie since it is not currently a permitted constituent. However, it is anticipated to be regulated in the future, so experiments were first begun in cell 1 in an attempt to develop simple ways to convert ammonia to nitrate. Early experiments were reasonably successful, finding that substantial ammonia-to-nitrate conversion could be achieved by simply spraying the partially treated wastewater into the air as it passed through cell 2. This was accomplished by placing 2 sump pumps in the bottom of cell 2 and connecting their discharges with a perforated PVC manifold. Waste was then continually sprayed into the air. When the flow pattern was changed so that waste flowed through cells 3 and 4 and the rock in cell 3 was replaced with synthetic media, several methods were tried to attempt to remove as much ammonia as possible from the wastewater.

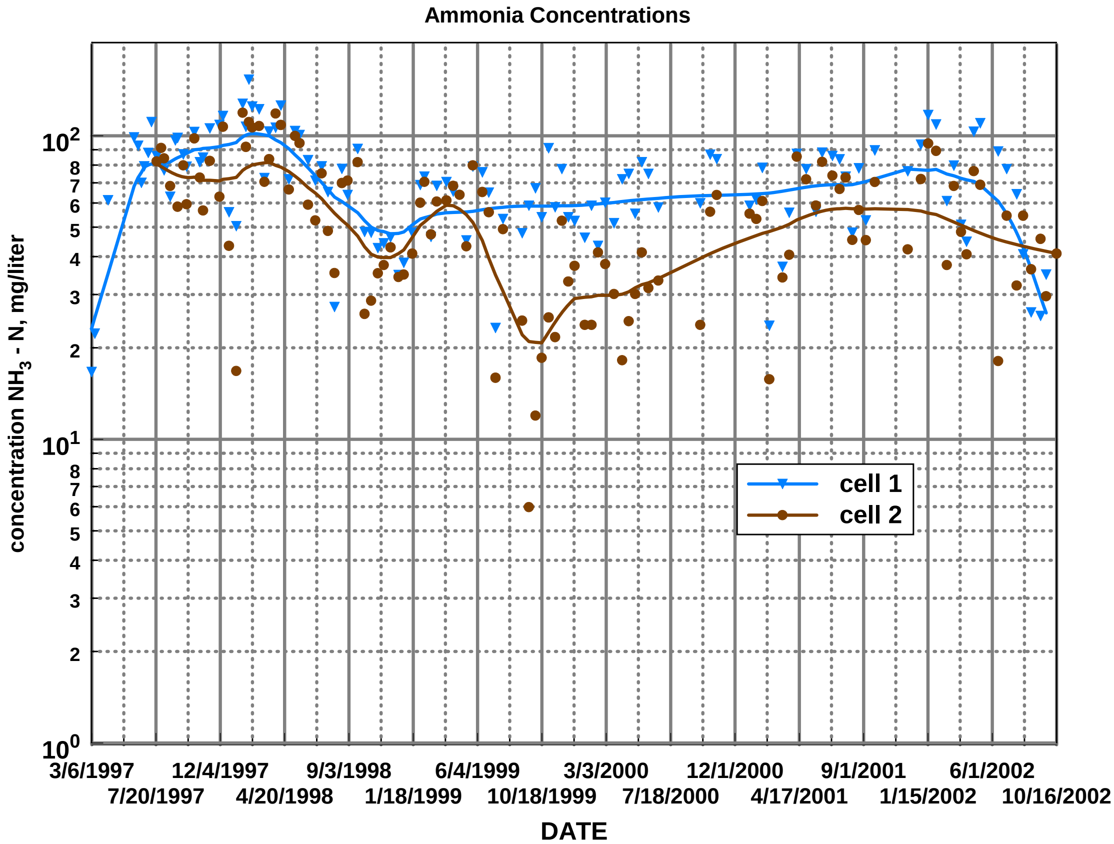

Figure 19 Ammonia
N Concentrations in the effluent from cells 1 and 2

Figure 20 shows cell 3 after modification. Synthetic media has been placed and covered with commercial shade cloth. Three sump pumps have been placed on the bottom of the cell at

Figure 20
Cell 3 with synthetic media and recycle

the effluent end, each delivering approximately 48 gal./min. The discharge is recycled through the spray nozzles in the center of the picture. Assuming an average flow of 3.5 gal./min through the system, the recycle ratio for the system is approximately 41:1. Using such high recycle ratios, ammonia could be stripped from the wastewater at near neutral pH levels.

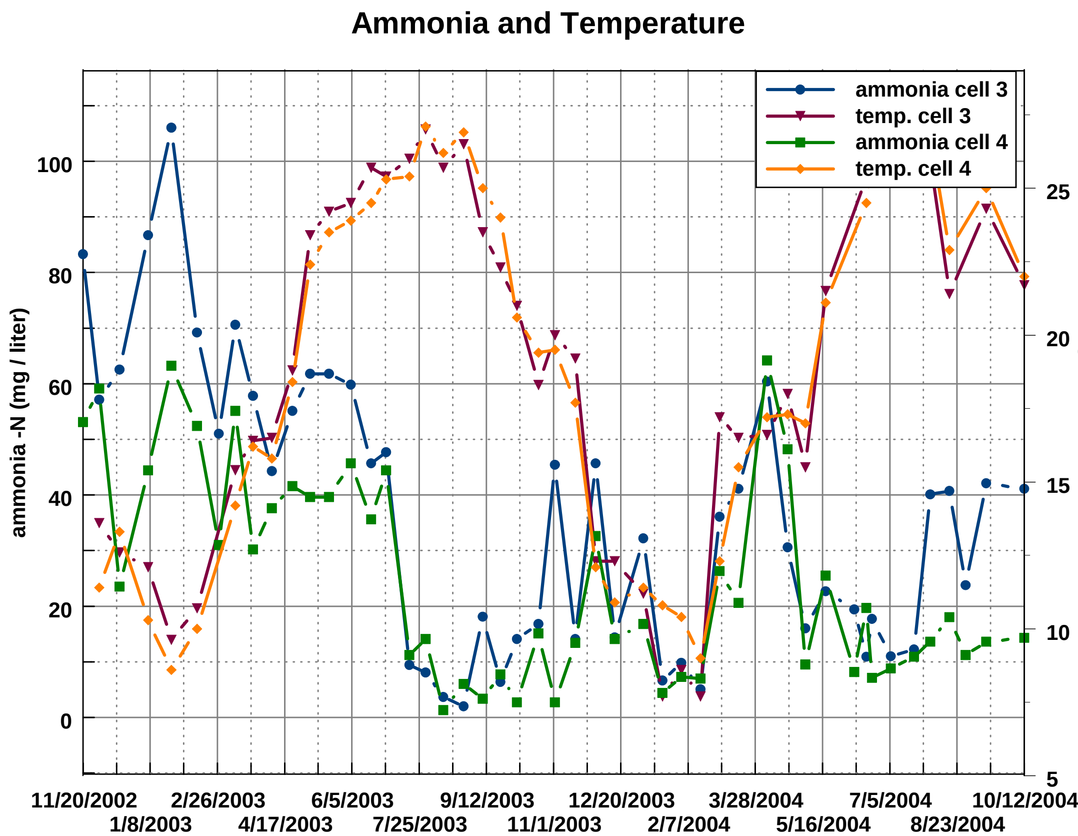

Figure 21
Ammonia levels and temperature cell 3 and cell 4

Figure 21 shows the effluent ammonia concentrations and temperature in cells 3 and 4. Ammonia nitrogen levels were reduced from near 100 mg/liter to less than 4 mg/liter in some instances, while routinely dropping to levels less than 20 mg/liter. Figure 22 shows probability plots of ammonia-N for cells 3 and 4. The median concentration in the effluent from cell 3 was 30 mg/liter while that from cell 4 was 20 mg/liter. The influent ammonia-N to cell 3 was 99 mg/liter. Thus median ammonia removal was near 80 percent across cells 3 and 4.

Figure 23 shows total nitrogen, ammonia, and temperature at the splitter box and cell 3 from November 2002 to September 2004. During that period, the total nitrogen at the splitter box increased to nearly 160 mg/liter while that at the effluent from cell 3 (synthetic media) dropped to approximately 40 mg/liter. Ammonia levels in cell 3 dropped from 85 mg/liter to around 30 mg/liter. Figure 24 shows a substantial ammonia reduction across cell 3 with concurrent nitrate production, suggesting that either nitrification/denitrification or ammonia stripping was occurring in cell 3. Because substantial amounts of nitrate were never measured anywhere in cell 3, ammonia stripping was likely the primary means of removal. Ammonia stripping normally does not occur unless the pH of the waste is raised to around 11, resulting in substantial amounts of NH_3, which is strippable. At lower pH levels, most ammonia exists as NH_4^+, which, because it is charged, is not strippable. This was overcome by recycling effluent at a rate of approximately 41 times that of the incoming flow.

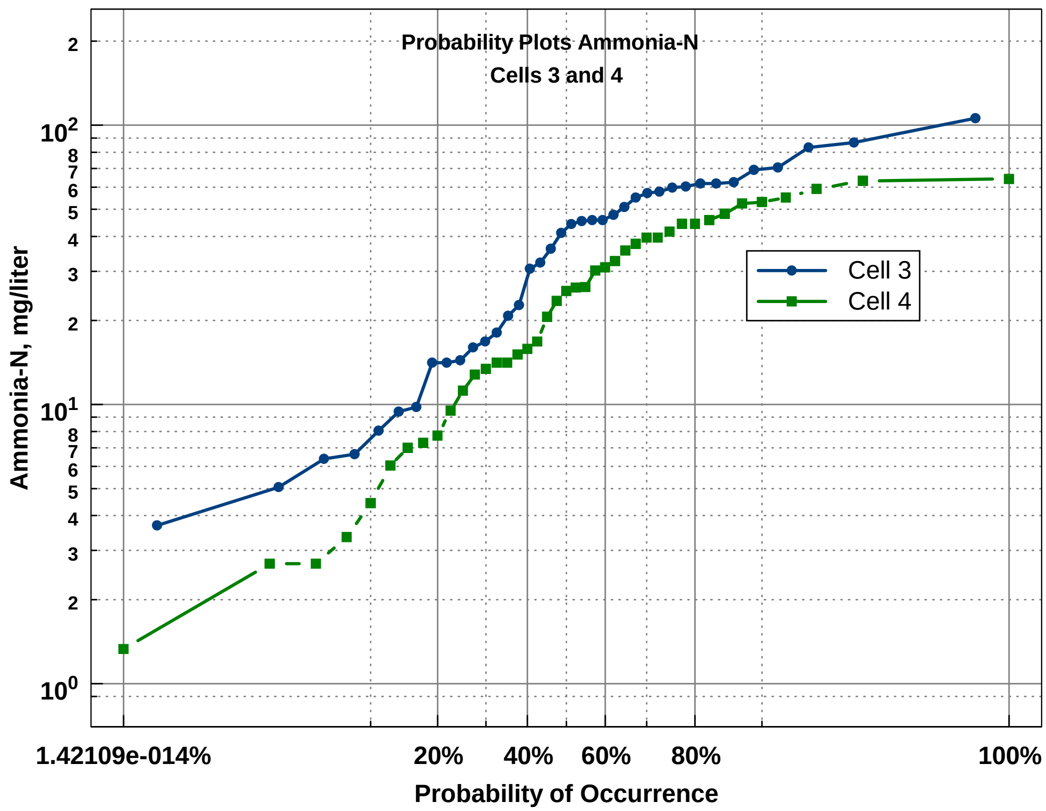

Figure 22
Probability plots for ammonia in cells 3 and 4

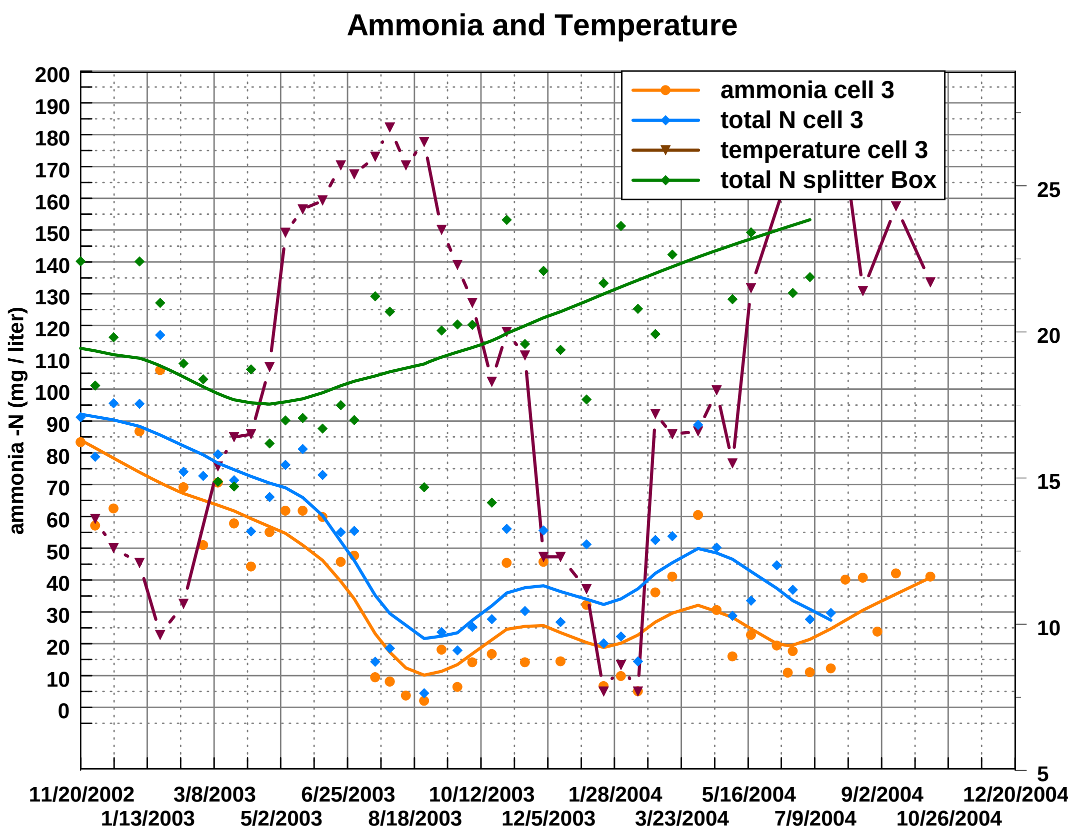

Figure 23
Total nitrogen, ammonia and temperature at the splitter box and effluent from cell 3

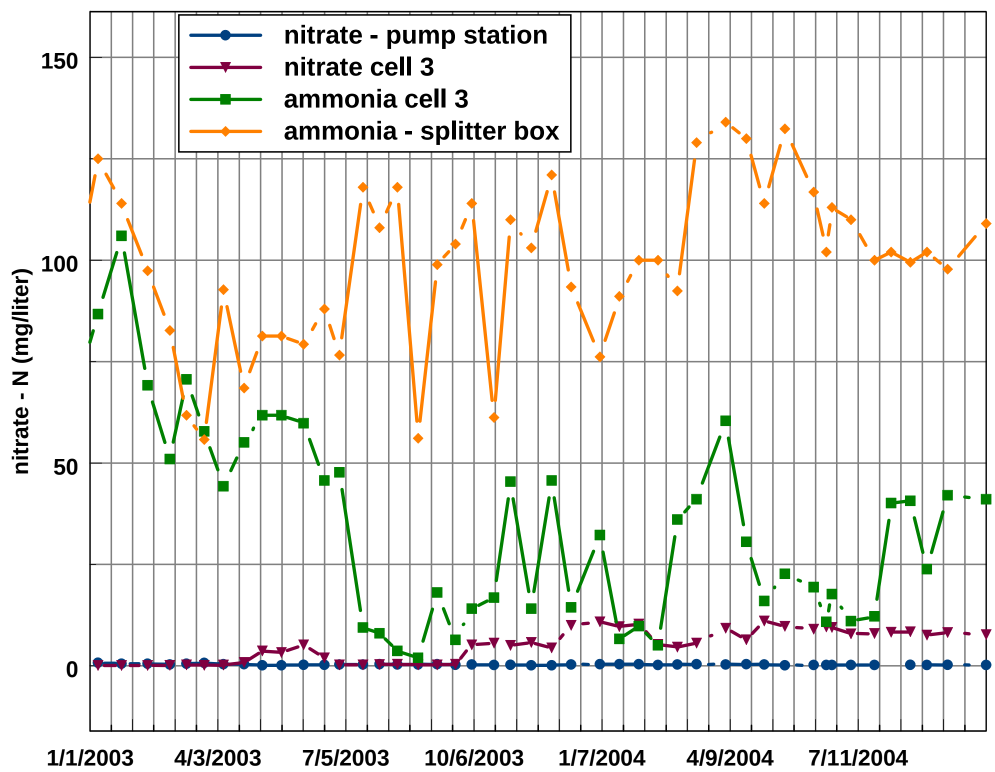

Figure 24
Ammonia and nitrate at pump station and cell 3

Operating Costs

Operating costs for this facility (excluding the pump station) are essentially the cost of the electricity to run the recycle pumps. Using a power cost of $0.065 per 100 kw-hr and an average daily flow of 5,000 gal./day, the treatment cost at this facility (not including pump station costs) is approximately 6.5 cents per 1,000 gallons treated.

CONCLUSIONS

1. The rock filter treatment process at the Grand Prairie rest area has proven to be highly robust with respect to rapid and substantial changes in flow rate and waste quality.
2. The treatment system at Grand Prairie can successfully and reliably meet all current discharge permit limitations.
3. The process is capable of substantial total nitrogen removal (>80 percent), but work remains to be done on improving nitrogen removal reliability.
4. A skilled operator is not required for this treatment process to function reliably and efficiently.
5. Operational costs of the process are negligible. Energy costs are approximately $0.065 per 1,000 gallons.

RECOMMENDATIONS

1. The researcher recommends that this process be seriously considered for small flows (less than 50,000 gal.) in situations where skilled operators are not available.
2. The researcher recommends that additional work be carried out on nitrogen removal in order to meet expected permit limitations on this constituent in the future.

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Appendix 1
Design Parameters and Operating Instructions
for the
Grand Prairie Waste Treatment System

D.M. Griffin, Jr.

Cell 3
Grand Prairie

Introduction

The purpose of this document is to provide the current design parameters for the Grand Prairie Waster Treatment plant and to describe the maintenance procedures necessary to keep the plant operating properly.

The waste treatment system at the Grand Prairie Rest Area was placed in operation in November of 1996. It has operated continuously since that time. A schematic of the system is shown in figure 1, below. Only cells 3 and 4 are in operation. Cells 1 and 2 are not being used.

Wastewater from the rest area buildings as well as an RV dump station drains by gravity to the eductor (pump) station. Water usage has been monitored daily since July 1, 1997, and is approximately equal to waste flow for all practical purposes. Based on this, the median daily waste flow has remained essentially constant at 3.6 gal./min (5,040 gal./day) while 95 percent of the daily flows are less than 10 gal./min (14,400 gal./day)

The NPDES permit limits for BOD and total suspended solids (TSS) at this facility are 30 mg/liter. Since being placed in operation, the system has violated these limits twice. The system has no dedicated operator and requires no "operation" in the sense of a mechanical treatment

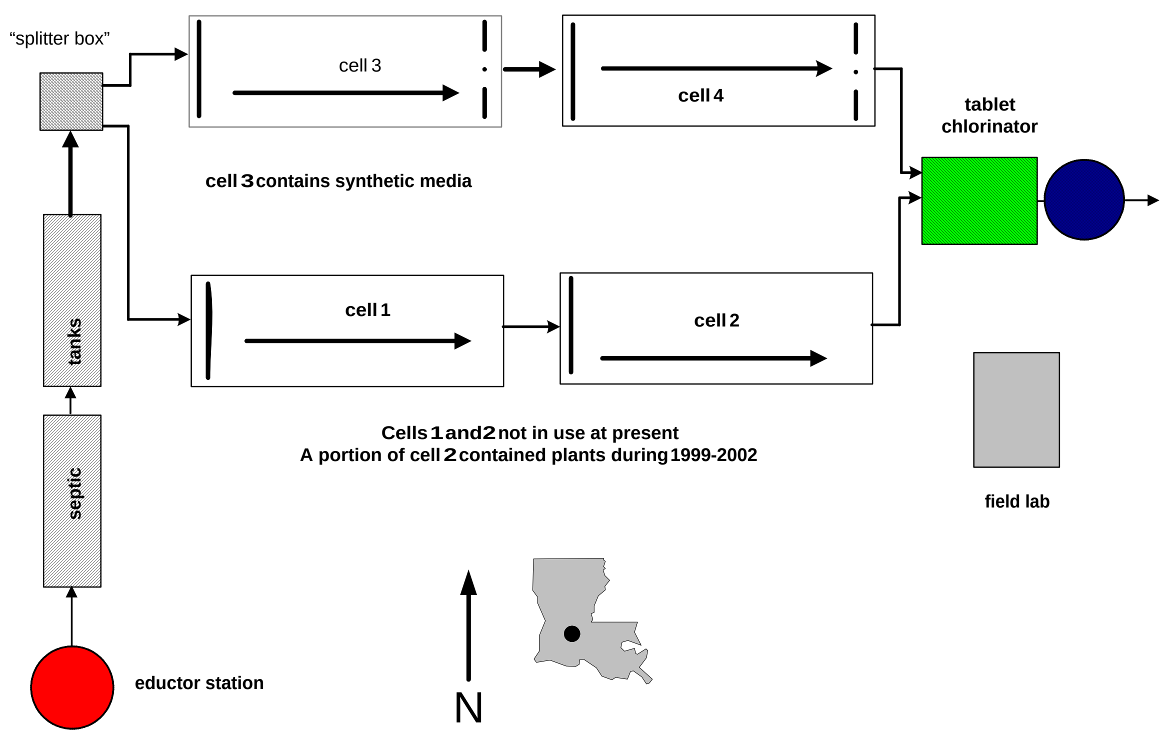

Figure 1
Schematic of the Grand Prairie treatment system

plant. Rest area maintenance personnel handle routine maintenance at the plant. This system has been found to be extremely robust in meeting permit limitations over a wide range of operating conditions.

Eductor (pump) Station

The eductor station contains two air lift pumps that lift raw waste from the wet well up to a channel containing a bar rack for the removal of large objects. The bar rack must be manually cleaned (raked) as needed. Failure to clean the rack will cause wastewater to accumulate in the channel and drain back into the pump station wet well. Material accumulated on the bar rack will rapidly develop a substantial odor. Problems with the eductor station appear to be mainly related to problems with the float switches that control the pumps. When pumps fail to operate properly wastewater will reach a high level in the wet well that will cause a red alarm light to flash. Maintenance personnel should continually be on the lookout for this flashing light. If necessary, the eductors can be operated manually by means of switches located at the pump station. Waste strength measured at the eductor station averages approximately 750-1,000 mg/liter BOD and TSS and 30 mg/liter ammonia. Waste strength at this point in the system is highly variable, however, ranging from 500 to over 2,000 mg/liter BOD and TSS.

Septic Tanks

Number - 2 -in series
Average hydraulic detention time - 48 hours, each tank
Average overflow rate - 19 gpd / ft^2, each tank

Following the bar rack, wastewater flows into the first of 2 - 10,000 gal. septic tanks. Interior dimensions of the tanks are 33'-6" by 8'-0" with a liquid depth of 5'-0". The tanks have an interior baffle located at the "2/3 volume" point in the tank. Assuming an average daily flow of 5,000 gpd, this results in a single tank detention time of 48 hours and an overflow rate of 19 gal./day*ft^2. These tanks serve as primary clarifiers, removing settleable and suspended solids. This is a very important step in the overall treatment scheme since the raw waste contains a very high total suspended solids concentration, most of which are removed here. Waste strength leaving the septic tanks is approximately 175 mg/liter BOD and TSS and approximately 100 mg/liter ammonia. Based on visual observation, the vast majority of solids accumulate on the liquid surface in the first 2/3 of the first septic tank. The rate of accumulation is approximately 1 foot per year. It is imperative that both septic tanks be pumped to remove accumulated solids on a regular interval, preferably every 1-2 years. This is usually done by a commercial pumper. Longer periods between pump-outs allow the accumulated material to dry out and solidify, making it extremely difficult to remove. In any case, a high volume hose with a nozzle to produce a high velocity stream is normally required to break up solids accumulation on the surface before they can be removed. In the past this was accomplished by connecting a 2" diameter hose to the bib located just outside the fence near the eductor station. A nozzle was fabricated from commercially available plumbing components.

It is important when having septic tanks pumped that the accumulated SOLIDS, rather than only the liquid in the tanks, be removed. In some instances septic tank pumpers simply pump out the liquid, leaving the accumulated solids on the tank bottom. Inspections should be carried out during pumping activities should make sure this does not happen and to make sure that all solids have been removed.

Splitter Box

Effluent from the septic tanks flows to a sump commonly referred to a "splitter box." Here waste can be sent to either cells 1 and 2 or cells 3 and 4 by removing plugs from the appropriate pipes. This sump should be inspected on a daily basis, during periods of flow, to be sure that waste is flowing as it should. Because of hydrogen sulfide deterioration plugs in the line to cells 1 and 2 should be replaced periodically; every six months is suggested. If the flow to cells 3 and 4 must be stopped temporarily, this can be done by blocking the line to them in this sump.

Cell 3

Dimensions - 30' by 150'
Media depth -2.0', media type - synthetic media (Kompact)
Total media volume - 9000 ft^3 (67,500 gal.), usable media volume - 4500 ft^3 (33,750 gal.)
Average hydraulic loading - .8 gal/day*ft^3 of media, 1.25 gal / ft^2 / day
Average BOD loading - 1.4 lbs BOD / day / 1000 ft^3 media
Average hydraulic detention time - 6.8 days

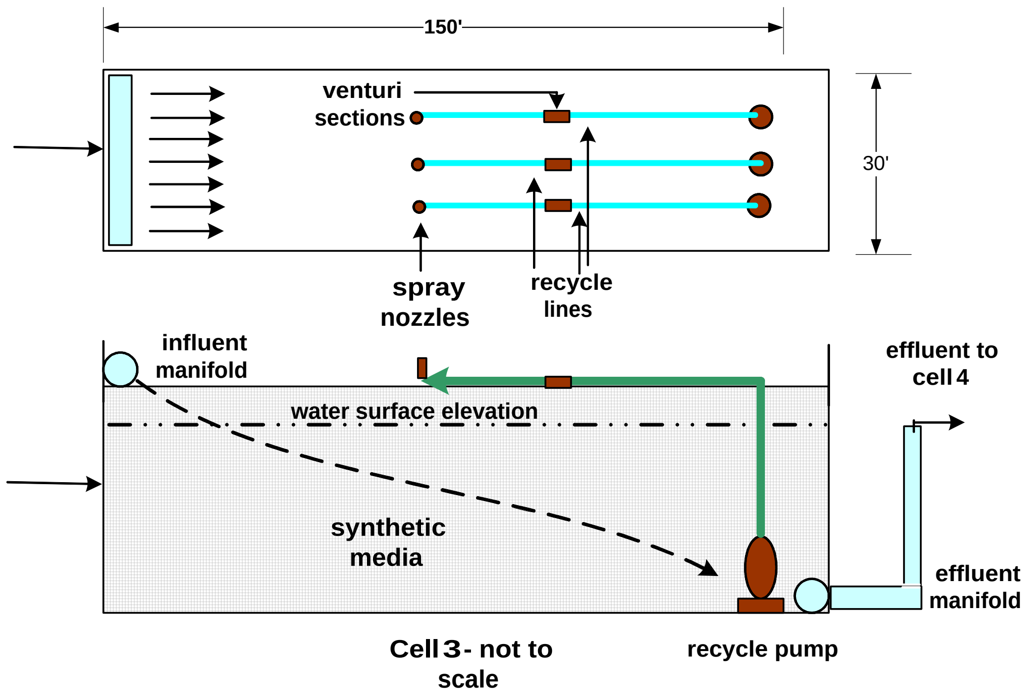

Figure 2
Schematic of cell 3

The dimensions of cell 3 are 30' by 150' with a media depth of 2' resulting in a nominal volume of 67,500 gal. (9000 ft^3). However, because the cell was constructed with a 1 percent bottom slope only about half of the volume is actually usable. This results in a nominal hydraulic detention time at average flow of 6.7 days. The cell is filled with 4' by 4' by 2' blocks of synthetic substrate (Kompact Media) which serves as a growth surface for microorganisms. According to the manufacturer the media has a 98 percent porosity. The media is structurally stable enough to be walked on by maintenance personnel as needed although care should be exercised to avoid falling. The blocks are covered with a commercially available shade cloth (95 percent effective at blocking sunlight) held in place with lengths of 2" by 6" lumber. The purpose of the cloth is to minimize sunlight contact with the media to prevent UV deterioration of the media as well as minimize sunlight contact with the wastewater to prevent the growth of algae. It is important to recognize that algae are autotrophic organisms and PLAY NO ROLE in the removal of organics from wastewater; they will however be measured as BOD and TSS in the plant effluent if allowed to proliferate. Wastewater is introduced into cell 3 at the upper end using a manifold with adjustable nozzles. This manifold should be inspected and the nozzles cleaned on a monthly basis. Maintenance personnel should continually remove all plant growth from inside the cell as well as the area around the influent manifold and the surrounding area. This should be done by pulling the plants out, including roots, NOT spraying them and leaving them in-place. The shade cloth covering should be inspected at regular intervals to be sure it completely covers the media. Lumber holding the shade cloth in place should be replaced as needed. If large tears occur, they should be repaired or the cloth replaced . “Walking inspections” should be conducted on a daily basis by maintenance personnel in order to look for obvious problems as well as items needing replacement. The water surface elevation in the cell is controlled by a piping structure that can be rotated, located in a sump at the effluent end of the cell. The wastewater surface should be maintained as high as possible to maximize detention time but SHOULD NEVER be allowed to rise above the level of the media in the cell or be allowed to come into contact with sunlight. Should this happen the wastewater surface can be lowered by rotating the effluent pipe.

At the downstream end of cell 3 are 3 sump pumps that recirculate effluent that is sprayed into the air to remove ammonia removal by stripping. Pumps should be observed to be sure they are operational on a daily basis. The spray nozzles should be cleaned once per week to maintain maximal flow rates. This can be accomplished by unplugging the pumps and scraping away accumulated growth from the slits. During this process, the electrical cords should be checked to make sure they are water tight. If necessary, replace the tape that seals the electrical plugs. Make sure the plastic covers on the electrical boxes, containing the plugs are not cracked or broken.

The BOD and TSS in the effluent from cell 3 have averaged 29 and 30 mg/liter during the life of the facility.

Cell 4

Dimensions - 30' by 150'
Media depth - 3.5', media type - granite rock, nominal diameter 4"
Media porosity - 40%
Nominal volume - 15,750 ft^3 (118,125 gal), usable media volume - 7875 $ft.^3$ (59,062 gal.)
Average hydraulic detention time, corrected for media porosity - 4.7 days
Hydraulic loading - .65 gal./day/ft^3 media, 1.25 gal. / $ft.^2$ /day
Organic loading - .1 lb BOD / 1000 $ft.^3$ usable media

Cell 4 also has nominal dimensions of 30' by 150'. The media in cell 4 is granite rock with a nominal diameter of 4". Media depth is approximately 3.5'. As with cell 3, a 1 percent bottom slope renders only about half of the media volume useable in treating the wastewater. Partially treated waste from cell 3 flows into cell 4 through a PVC manifold with adjustable nozzles, similar to that in cell 3. The water surface elevation must be maintained at least 6" below the top of the rock to avoid contact with sunlight and resulting algae growth. Maintenance personnel should remove all plant growth occurring in cell 4, including root systems. Daily “walk through” inspections should be carried out to look for irregularities in the system. The water surface elevation can be controlled using a rotating pipe in the effluent sump, similar to that in cell 3. BOD and TSS levels from cell 4 have averaged 19 and 20 mg/liter respectively during the life of the facility.

Tablet Chlorination System

Treated wastewater is disinfected using hypochlorite tablets. The tablets are stacked in PVC tubes that extend into the wastewater. They dissolve as the waste flows by, releasing chlorine. Maintenance personnel are required to maintain tablets in the system and to measure the residual chlorine on a daily basis. Treated effluent is pumped to Lake Dubuison.