SECTION VI. IOWA CONSTRUCTED WETLAND SYSTEMS TREATMENT EFFICIENCY

Water Quality Data

Influent and effluent water quality data from Iowa treatment systems with constructed wetlands were collected, when available, from the some of the operators and from Iowa and U.S. EPA's National Pollutant Discharge Elimination System (NPDES) databases. Treatment system refers to the pretreatment system and wetlands. Samples are collected from the effluent after the wetlands and sometimes influent samples are collected. Thus, information is available only on the treatment system and not it's separate treatment components including the pretreatment system and the wetlands. Not all facilities have the same monitoring requirements due to differences in flows, receiving stream characteristics, months of operation, treatment system, and influent and effluent quality. The parameters that are most often monitored include: flow, pH, temperature, total suspended solids (TSS), carbonaceous biochemical oxygen demand (CBOD), and in some cases, ammonia nitrogen and fecal coliform.

Most treatment systems with surface flow wetlands have flows greater than systems with subsurface wetlands and usually are required to monitor effluent quality on a weekly basis. They are typically required to monitor flow, pH, TSS, and CBOD, and depending on the receiving stream, ammonia and fecal coliform. The systems with subsurface wetlands that receive smaller flows typically monitor for pH, CBOD, and TSS, often less frequently, on a monthly basis or before and after season basis compared to systems with surface flow wetlands.

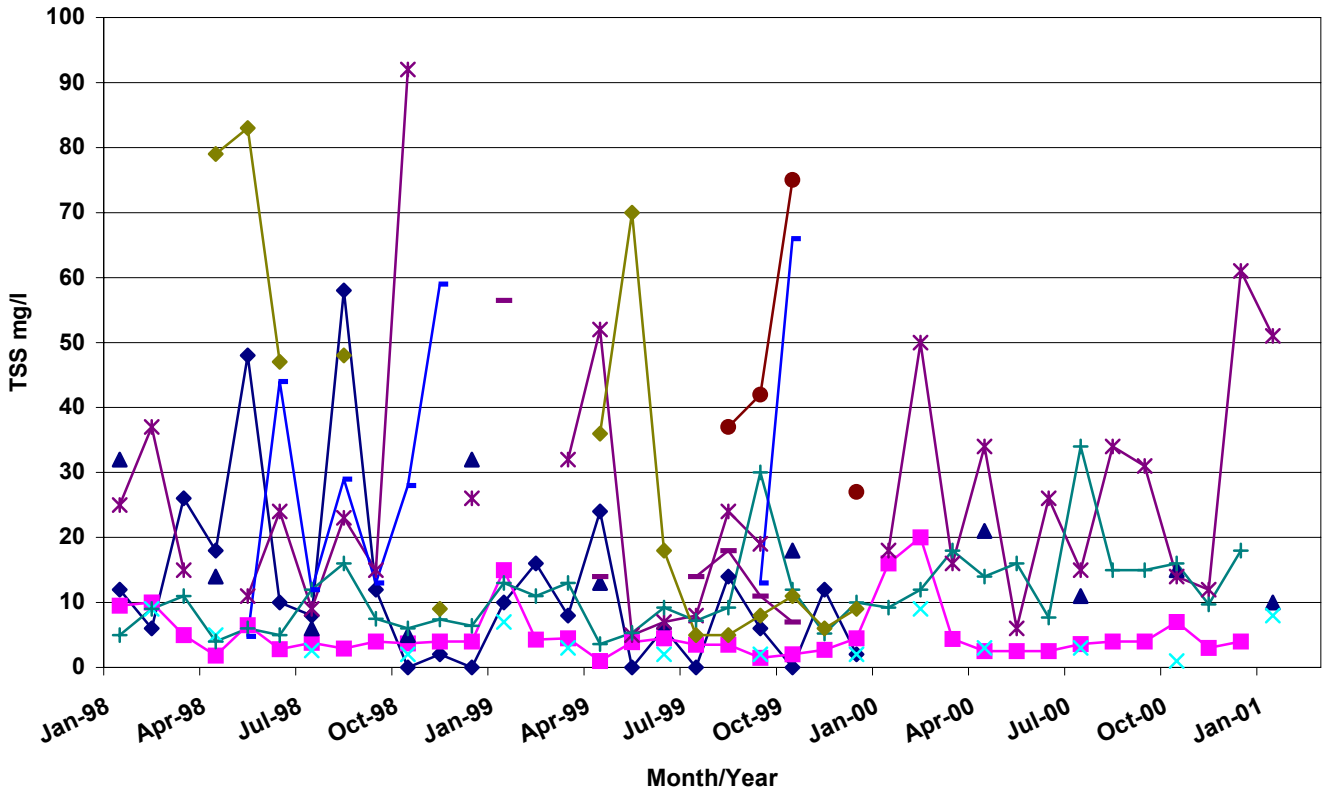
Total Suspended Solids

Data is available for 10 treatment systems with constructed wetlands and of these, two have subsurface flow wetlands and the others have surface flow wetlands. As shown in Figure 10 (pg. 42), most TSS concentrations in effluent for monthly averages were typically less than the permit average monthly limit of 80 mg/l imposed by the Iowa DNR. Permit limits were exceeded at only a few sites on a few occasions. Most concentrations remained less than 50 mg/l throughout the year. General seasonal fluctuations in effluent quality are observed, higher concentrations occur in the spring and summer months, May, July and September. Seasonal variations in TSS may occur in pretreatment quality and in influent concentrations and mass loadings due to inflow and infiltration. There are also changes in TSS that occur in the wetlands alone as observed in study results reported by Kadlec and Knight (1996). Solids are generated internally within wetlands especially during plant growth, which occurs during the spring and summer. Resuspension of solids can occur due to wildlife activity within the wetland. Solids concentrations decrease during periods of plant dormancy in the winter.

Some systems seem to experience more extreme changes in effluent quality, with high concentrations occurring one month followed by dramatic decreases in TSS

concentrations the next month. Other systems experience less dramatic changes in concentration with time.

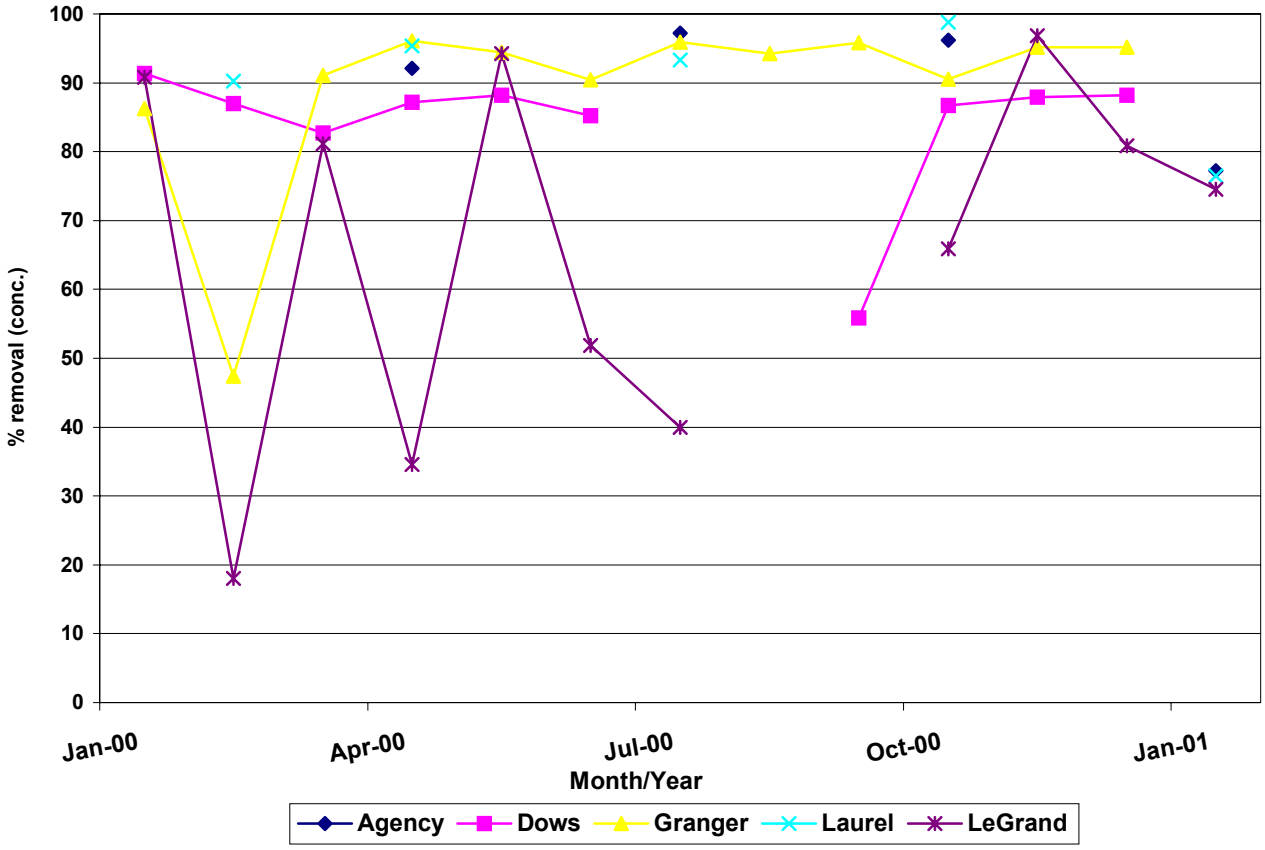
Figure 10. Average monthly TSS in Iowa wetland system effluent.



Removal efficiencies were also determined for treatment systems with wetlands when influent and effluent data were available. Figure 11 (pg. 43) shows the removals for five systems with surface flow wetlands. Influent water quality data is not collected from all systems. Most removals during 2000 were greater than 80%. There is variability in removals between sites. Some sites experience fluctuations in removal efficiencies, with steep decreases in removals followed by steep increases in removal efficiencies. It is difficult to comment further on why these fluctuations occur without knowing the details of wetland performance, water quality changes, wildlife habitat changes, precipitation

events and system management. This information could be obtained through further studies of these wetland systems.

Figure 11. % TSS removal in Iowa constructed surface flow wetland systems.

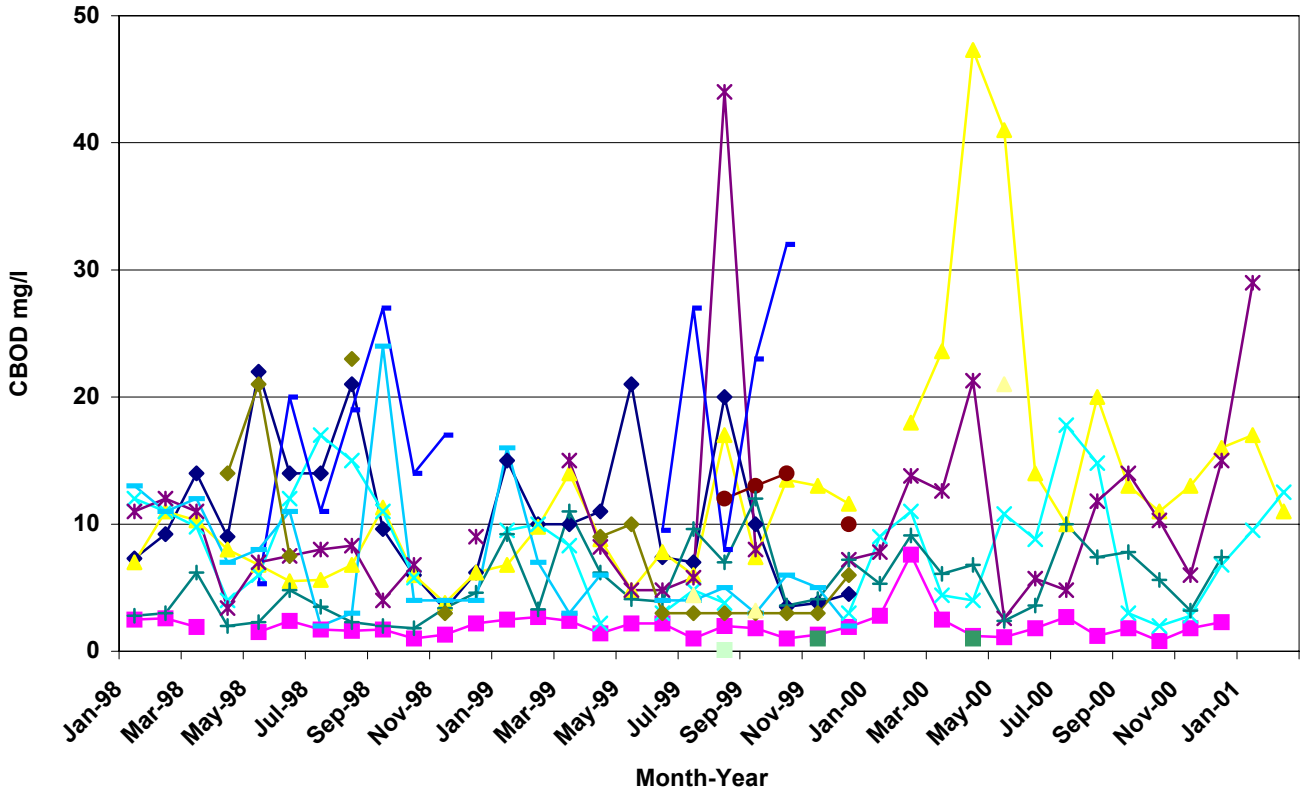


Carbonaceous Biochemical Oxygen Demand

Data is available for 12 of the treatment systems with wetlands, two of these systems have subsurface flow wetlands and the rest have surface flow wetlands. Figure 12 (pg. 44) shows a plot of monthly CBOD averages for treatment system effluent. Most concentrations on an annual basis are less than the 25 mg/l average monthly limits imposed by the Iowa DNR. Some systems have increases in CBOD during spring and summer, May, August and September, and decreases in the fall and winter, October, November, and December. Peaks in concentration occur during both warm and cold weather months. There is variation in concentrations between some sites, and some systems experience greater increases in CBOD during certain months. Several of these systems experience seasonal variations in pretreatment quality and seasonal variations in influent concentration and mass loadings due to infiltration and inflow. Changes in CBOD can occur within the wetlands themselves. According to Kadlec and Knight (1996), the dynamic nature of wetlands may mask seasonal trends, such as changes in

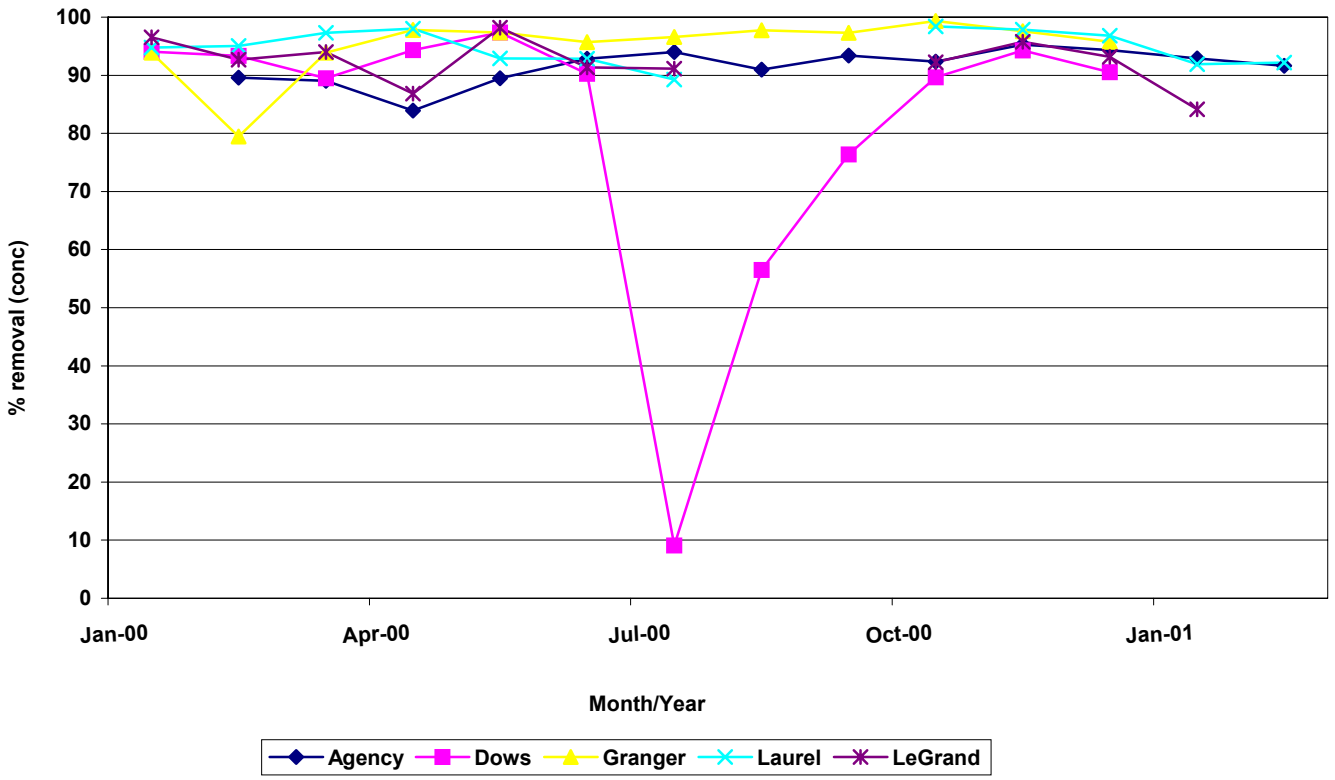
temperature. Wetland treatment is affected by more variables than typical microbial film treatment systems due to such factors as plant growth, seasonal changes in plant litter generation, and decomposition. For some systems the quality of the pretreatment through the lagoon system has a direct bearing on the wetlands removal of CBOD. It is difficult to determine where CBOD removal is occurring in the system because there is no sampling of the pretreatment system and the wetlands. Therefore, comments cannot be made on the effectiveness of Iowa wetlands alone for removing CBOD.

Figure 12. Average monthly CBOD in Iowa wetland system effluent.



Removal efficiencies were also determined for CBOD in five treatment systems that had surface flow constructed wetlands when influent and effluent data were available. As shown in Figure 13 (pg. 45), most systems' efficiencies remain fairly constant throughout the year and are typically greater than 90%. The high removals are an indication that the wetland systems are efficient year round at removing CBOD. One wetland system appears to have had an event in July of 2000 when the removal was 10% and several months later the removals increased to 90%.

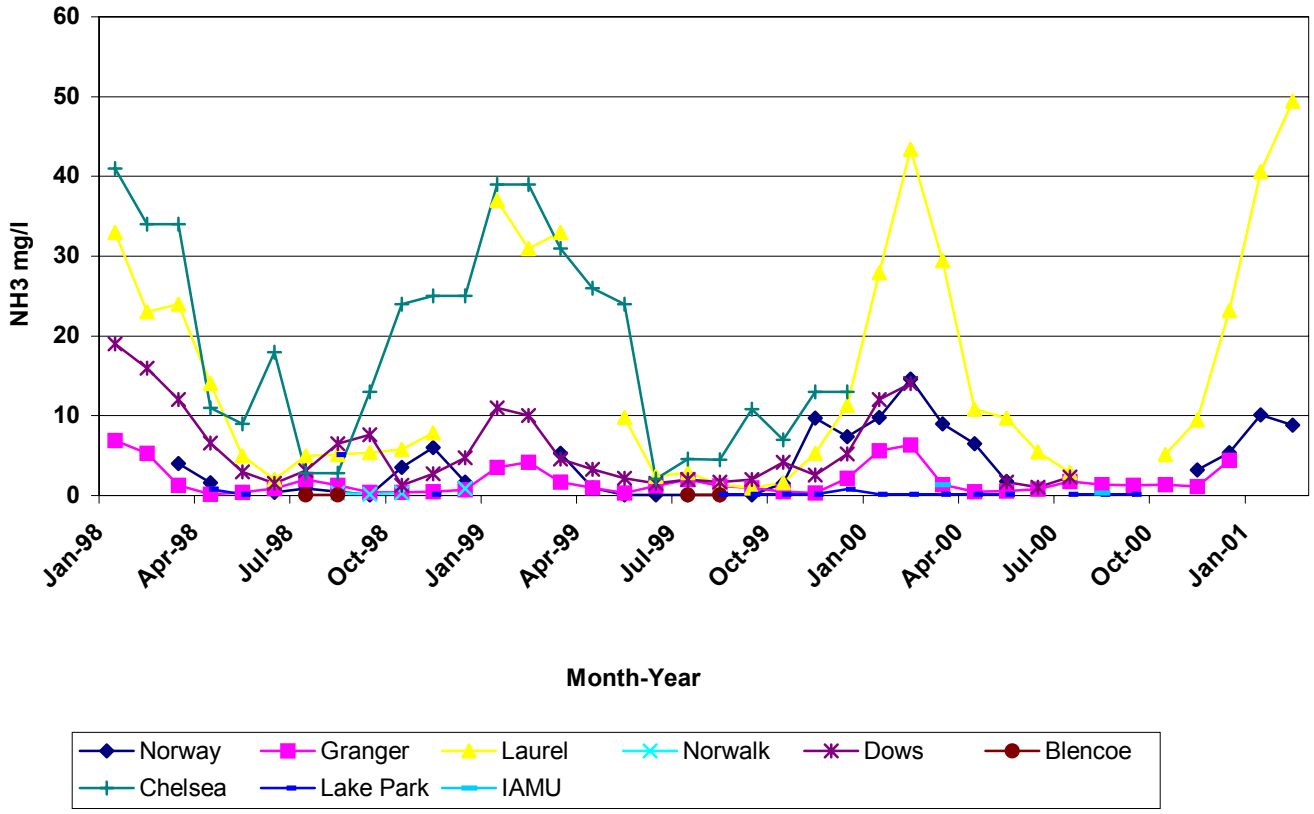
Figure 13. % CBOD removal in Iowa constructed surface flow wetland systems.



Ammonia Nitrogen

Data is available for nine of the treatment systems with wetlands. One of the systems has a subsurface flow wetland and the others have surface flow wetlands. It is difficult to determine where ammonia removal is occurring in the system, pretreatment or wetlands. It is believed that it is dependent on influent quality, the pretreatment system and type of wetland. As shown in Figure 14 (pg. 46), most ammonia concentrations in treatment systems with wetlands effluent followed the same seasonal pattern, with a few more pronounced increases in concentration that occurred at two sites. Increases in ammonia in effluent occurred in January, February and March. Regardless of other peaks that occur during the year, almost every treatment system with wetlands experiences an increase in the effluent ammonia nitrogen during the winter months of January through March. When focusing on the wetlands alone, according to U.S.EPA (2000) and Mitch and Gosselind (2000), nitrogen removal within wetlands is achieved through plant uptake/harvesting, and nitrification/denitrification. These processes are temperature dependent and will decrease during colder winter months when microbial activity slows down.

Figure 14. Ave. monthly NH3 in Iowa wetland system effluents.



Figures 15-20 (pg 48) provide ammonia plots for the 6-treatment systems with wetlands that are required to monitor for ammonia in effluent. There is a significant amount of variation in ammonia concentrations between systems. The ammonia limits set for these systems also vary with receiving stream. Average and maximum monthly limits are shown for each system, with the exception of Dows, which does not have ammonia effluent limits. Lake Park appears to have stored wastewater in their lagoons, and possibly in their wetlands, during 1998 and 1999 winter months. They appear to have discharged continuously in 2000. The other systems are continuous discharge.

All systems, with the exception of Chelsea and Lake Park, experience seasonal fluctuations in ammonia concentrations in effluent. Lake Park ammonia concentrations always remain low. Peaks in concentrations at Granger and Laurel occur in January and February, and some may approach or exceed the average monthly limit. Norway and Dows peaks occur in September and October and December through February. Norway peaks have exceeded the average monthly limit. Chelsea ammonia concentrations vary between years and seasons with no real trend. The Chelsea system periodically exceeds their permit limits. Their system receives wastewater from individual septic systems. This wastewater is very high in ammonia that is very difficult to treat with an aerated lagoon/wetland system. The wetland has never been maintained properly so there has

never been a healthy stand of vegetation. The system is currently under review by IDNR that is requiring that consultants evaluate possible modifications to Chelsea's permit following studies or require expansion of their treatment system.

Ammonia removal does occur in Iowa treatment systems that include wetlands and varies among systems. Limited studies that have been conducted at Granger in the 1980's by the consultant firm Veentra and Kimm would suggest there is very little removal of ammonia through the wetland itself during the winter months. These studies suggest all of the ammonia removal during the winter occurs in the lagoon treatment system with nominal or no removal in the wetlands itself. In order to confirm this a more thorough study needs to be conducted to look at removal in the pretreatment system and wetlands of the different system configurations. Some wetland systems experience seasonal fluctuations, with peaks during the winter months. Other systems follow their own unique trends. Removal efficiencies cannot be determined because these systems are not required to monitor for ammonia in influent.

References

Kadlec, R.H. and R.L. Knight. 1996. Treatment Wetlands. CRC Press LLC, Boca Raton, FL.

Mitch, W.J. and J.G. Gosselink. 2000. Wetlands. 3rd edition, John Wiley and Sons, New York, New York.

U.S. EPA. 2000. Constructed Wetlands Treatment of Municipal Wastewaters. EPA/, 2000. National Risk Management Research Laboratory, Office of Research and Development, U.S. EPA, Cincinnati, OH.