SECTION IV. IOWA INVENTORY OF CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT

Iowa Wetlands

Iowa has 20 Iowa Department of Natural Resources permitted constructed wetlands for wastewater treatment. Figure 3 (below) shows the location of the constructed wetlands in Iowa. In addition to these, the City of Des Moines in 2000 installed a constructed wetland system for treatment of leachate from its municipal landfill. The Iowa Department of Health estimates that there are close to 800 individual wetland systems in Appaloosa, Davis, Lucas, and Monroe counties. Wetlands are installed in lieu of standard individual drain fields in areas with restrictive soils. Wetlands have also been constructed in Iowa for treatment of animal and agricultural wastes and drainage, landfill leachate, and storm water drainage.

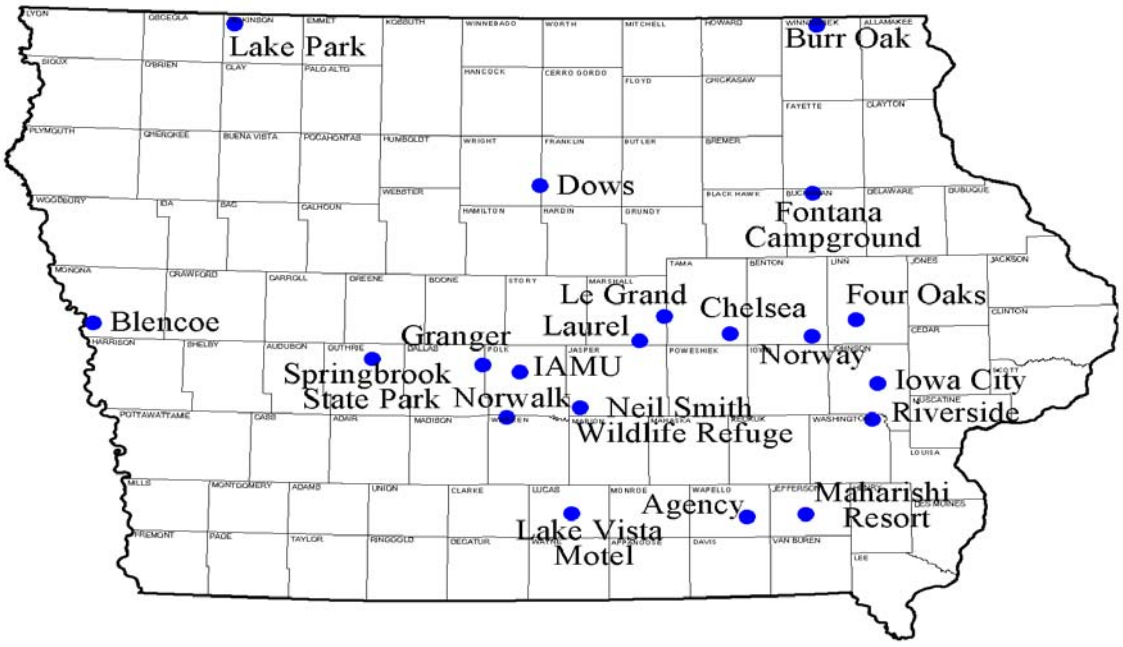

Figure 3. Location of constructed wetlands for wastewater treatment in Iowa.

History of Constructed Wetlands for Wastewater Treatment in Iowa

Constructed wetland treatment in Iowa was first used about the same time that U.S. EPA was encouraging the use of treatment alternatives such as wetlands. For a short time grants were also available for communities considering this type of treatment that included an extra 10% grant as innovative technology grants. The first wetland system in

Iowa was constructed at Riverside in 1980. The other 19 systems were constructed throughout the 1980's, 1990's, 2000's. Table 1 (pgs. 28-29), lists the wetland construction and start-up years.

System designs have undergone an evolution. The first wetland system was created, with minimal engineering design, at Riverside where lagoon effluent is discharged to a natural wetland that was diked. Earlier designed wetland systems are surface flow (1981-early 90's) and are located near receiving streams and were constructed in on-site soil materials. These systems were also designed as fully vegetated with little open water area. Wetland design changed in the late 90's. Surface flow systems were constructed in areas where soils had higher clay content, or bentonite was used as a liner to minimize impacts on subsurface soil and groundwater quality. Shapes of wetland cells also changed from rectangles and L-shapes to more tortuous s-shaped cells that had depressional areas of open water and vegetated areas. The shape would assist in solids settling and BOD removal. Depressional areas are a design feature used to equalize flow and prevent channeling. They are also a benefit to wildlife and may provide the added benefit of promoting more ammonia removal because in these areas more oxygenated or aerobic conditions might exist and nitrification would occur. The vegetated areas are typically anaerobic and are where dentrification would occur.

Subsurface flow system designs in Iowa were also introduced in the late 90's. These systems are typically used by very small communities, parks, or for individual on-site systems. Wetlands are lined with bentonite or a synthetic liner and are typically rectangular-shaped.

Current Iowa Regulations for Constructed Wetlands for Wastewater Treatment

The Iowa Department of Natural Resources (IDNR) currently has no specific design guidelines for wetlands for municipal wastewater treatment. Wetland systems are considered innovative technology and would not be classified as conventional treatment until further studies are conducted on existing and experimental systems and design criteria and permit guidelines are available. Delays in the design review process and permit review process for wetlands may be caused by the lack of design criteria, permit guidelines, and permit forms. IDNR reviews proposed wetland systems on a case-by-case basis and relies on technical information such as scientific publications for design guidance.

Iowa Rule 567 in the Iowa Administrative Code 69.11 provides code design and construction requirements for subsurface constructed wetland systems designed for 1,500 gallons per day or less that serve four or fewer dwellings for 15 population equivalents. This includes systems for residential and nonresidential use and does not include industrial facilities. See Appendix A for guidelines.

The overall impression given by most IDNR wastewater bureau engineers is that wetlands are effective in removing TSS and BOD. However, their biggest concern is with seasonal changes in ammonia concentrations in effluent, especially during some

winter and summer months. Ammonia removal does decrease during the winter months as shown in several studies. The ammonia data in Section VI(pgs. 45-47) of this report indicate that at some sites, considering current limits, this is not a concern. There are a few sites where there may be periodic seasonal concerns over ammonia concentrations and permit limits. The wetlands that have been constructed in Iowa have not been designed for ammonia removal but for BOD and TSS removal and final polishing.

Department staffs are not as familiar with the latest developments in subsurface wetland systems that include aeration. So they might be more hesitant to approve these types of systems. Iowa Department of Natural Resources staff needs to be exposed to updates in this technology and be involved in the development of design criteria and permit guidelines.

The Iowa Inventory of Constructed Wetlands for Wastewater Treatment

Methods

Wetland systems were identified from a printout of National Pollutant Discharge Elimination System (NPDES) permitted wetlands in Iowa. From August 2000 to June 2001 wetland managers were contacted, interviewed, and site visits were made. In many cases the manager of the facility was the certified operator of the system. The following information was obtained during site visits: type of treatment system, year that system was constructed and used for treatment, design and dimensions of wetlands, design flow, type and condition of wetland vegetation, firms that designed and constructed wetlands, estimated construction costs and cost comparisons with treatment alternatives, summer and winter maintenance, energy and management requirements, operator impressions of system, types of wildlife attracted to wetlands, and problems and concerns with wetlands. Copies of engineering reports and monthly operating reports that may provide influent and effluent data were obtained when possible and pictures were taken of each system.

Wetland Locations

Wetland systems are located throughout Iowa, as shown in Figure 3 (pg. 21), and seem to be concentrated in the central part of the state for no apparent reason. Table 1 (pgs. 28-29) can be used as a reference for the following discussion on constructed wetlands in Iowa.

Wetland System Update

Three wetland systems have changed operational status. The wetlands at Norwalk are currently receiving effluent from their newly constructed Biolac system. They discontinued the use of lagoons and may discontinue using the wetlands. The Iowa DNR may require that the effluent from the Biolac system be discharged directly to the receiving stream rather than to the wetlands and then receiving stream. There is concern that the quality of effluent from the Biolac system alone is much better than the effluent from the wetlands that receive the Biolac effluent. The quality of water discharged from

the wetlands varies seasonally due to the natural processes that occur within the wetlands. It is believed that the effluent quality from the Biolac system is less subject to seasonal variations. Lake Vista Motel is no longer in business. The wetland system may currently be receiving wastewater from one home. The entire treatment system at Springbrook State Park was over designed and as a result the wetlands have never received effluent. The Iowa DNR is currently deciding the fate of this system. The wetland system at Four Oaks Group is in the start-up phase.

Community and Facility Populations

According to several Iowa consultants, lagoon systems with wetlands would typically be used in communities with populations less than 1000. Land prices usually restrict the treatment options to a mechanical system in communities with populations greater than 1000. Wetland systems are used in Iowa in communities with populations that range from 250 to 996. Table 1 (pgs. 28-29) lists the populations of the communities that use wetlands. The largest community that used a wetland system up until the fall of 2000 was Norwalk that has a population of 6302. Lake Park with a population of 996 is now the largest community in Iowa that uses a wetland. Burr Oak that has an estimated population less than 100 is the smallest community that uses a wetland. The facilities where populations are not listed have major variations in populations, because they serve parks that operate only during the summer months or they are educational and training facilities that serve large and small groups. The Four Oaks system is used at a group home that serves 40 people.

Wetland System Pretreatment

Figure 4 (pg. 34) shows that the most commonly used pretreatment systems are aerated lagoons, lagoons, and septic tanks. Communities with constructed wetlands use aerated or facultative lagoons, or activated sludge for pretreatment, followed by discharge to treatment wetlands prior to discharge to receiving streams. Burr Oak uses a septic tank and sand filter for pretreatment. Four Oaks uses a septic tank and multi-flow system. The wetland systems at Buchanan County Fontana Campground, IAMU, Lake Vista Motel, and Neil Smith Wildlife Refuge use septic tanks for pretreatment followed by discharge to treatment wetlands prior to discharge to receiving streams.

Wetland Construction and Startup

The first wetland system used in Iowa is at Riverside. A dike was created around a natural wetland in 1980 and Riverside's lagoon effluent was discharged to this wetland. The first completely engineered constructed wetland system was used at Norwalk in 1981. Four Oaks Group home received approval to construct a wetland system May of 2001. Figure 5 (pg. 34) shows that most wetlands were constructed and began use in 1990-94 and 1995-99.

Wetland Design

There are two types of wetland designs used in Iowa, surface flow and subsurface flow. These systems are defined in Section II (pgs. 4-13) of this report. The majority of wetlands are surface flow, as shown in Figure 6 (pg. 34). Aerated or facultative lagoons precede all surface flow systems in Iowa. Whereas, all subsurface systems are horizontal flow and are preceded by a septic tank, with the exception of Burr Oak and Four Oaks. Burr Oak has a sand filter between the septic tank and wetland. The Iowa DNR required the additional treatment offered by the filter because the receiving stream is a Class B trout stream. Four Oaks has a multi-flow system after the septic tank.

The predominant plant species in wetlands are cattail (*Typha*), bulrush (*Scirpus*), sedges (*Carex*), and iris (*Iris*). Some systems have combinations of wetland and prairie vegetation. Wetlands were designed as fully vegetated, open, or vegetated and open, with the majority of systems designed as vegetated and open as shown in Figure 7 (pg. 34). Some of the earlier wetlands designs, such as Granger that are not lined with clay experience little difficulty in maintaining a healthy stand of vegetation. Whereas, many of the wetlands that were designed with sealed bottoms have experienced more difficulty in establishing appropriate levels of vegetative growth. This difficulty in maintaining vegetation growth in sealed wetlands may be a primary concern in weighing against additional surface systems.

Most wetlands as shown in Figure 8 (pg. 34) consist of one or two cells. Buchanan County Fontana Campground has the smallest wetland area that is 0.07 acres and LeGrand has the largest wetland area that is 10 acres. The average wetland area is 3.03 acres. Cell shapes also vary and include L-shapes, rectangles, S-shapes, and kidney shapes.

Most surface flow systems where information was available used on-site soil material during construction, for wetland media; depths range from 6 to 18 inches. Surface flow wetlands that were constructed in the late 1980's and early 1990's are unlined and those constructed in the late 1990's are lined with native clay or bentonite. Subsurface systems were constructed beginning in the late 1990's and use gravel for a medium. Bed depths range from 11 to 24 inches and are lined with bentonite or a synthetic liner.

Design flows for surface flow systems range from 0.002 to 1.09 mgd; average design flow is 0.18 mgd. Design flows for subsurface flow wetlands range from 0.001 to 0.018 mgd; average design flow is 0.007 mgd. Most design flows for all types of wetlands, range from 0.01 to 0.09 mgd, as shown in Figure 9 (pg. 34). All wetlands eventually discharge to streams. The constructed wetlands at IAMU and Buchanan County Fontana Campground discharge to natural wetlands that eventually discharge to streams.

Wetland Energy Requirements, Maintenance and Special Management

Two of the most significant features of wetlands acknowledged by managers and operators of these systems are the lack of electrical energy and low maintenance requirements. There are no mechanical parts so electrical energy is not used and maintenance is related to vegetation, water levels, and wildlife. The maintenance is also

periodic compared to mechanical systems that require constant attention. Table 2 (pgs. 30-31) lists the maintenance requirements provided by each wetland manager. Spring and summer maintenance for surface flow systems typically consists of mowing around the berms or edges around the wetlands; tree and weed removal; berm repair; turtle and muskrat removal; and water level management. Lake Park and Granger use a flock of sheep to graze the grassy areas surrounding the wetlands. Water level management during the summer is ensuring that there is enough water in the wetlands to maintain vegetation during high evapotranspiration periods. Some wetland systems such as the system at Granger that is unsealed and constructed in sandy soils have experienced zero discharge during dry summer months. During these times they may not be able to wet the entire wetland area even with water level management practices.

Winter and fall maintenance for some surface flow wetlands consists of muskrat removal, water level management, and vegetation management. Some wetlands are used for winter storage of wastewater others raise the water level to create an insulating ice layer for the winter and then lower the water level. Granger burns their wetland vegetation in February.

Special management of wetlands reported by managers of surface flow systems include some of the following: reseeding cattails and other vegetation to keep a thick healthy stand; replanting vegetation if flooded or allowed to dry out too long; muskrat removal; berm management; deer browsing of wetland vegetation especially bulrush; and turtle removal.

Spring and summer maintenance for subsurface flow systems consists of tree and weed removal, and at Neil Smith Wildlife Refuge biomass management on the gravel surface. This same facility has reported that because they load and rest their wetland cells, they have more difficulty maintaining a healthy stand of wetland vegetation in their cells. Fall and winter maintenance at all sites is minimal. Buchanan County Fontana Campground was the only system that reported maintenance during this season and that consists of trimming back all vegetation after a hard frost.

Very few subsurface system managers reported any special management requirements for this type of wetland. Buchanan County Fontana Campground, during wetland startup, used compost as mulch on the wetland cell surface. Neil Smith Wildlife Refuge has periodic biofilm buildup on the surface of the gravel on some of their wetland cells. They remove the film by washing off the gravel surface with water.

Manager/Operator Comments and Concerns

Table 2 (pgs. 30-31) lists some of the comments provided by managers/operators of the wetland systems during site visits. Almost all managers/operators were happy with their wetland treatment systems. Some systems are considering expansion of their wetlands. They note the non-energy and low maintenance requirements and all enjoy the added benefit of wildlife that is attracted to the wetlands. The Buchanan County Fontana

Campground wetland has been used for outdoor educational purposes by the Buchanan County Nature Center.

The wetland systems at Chelsea, Norwalk, and LeGrand have difficulties in keeping wetland vegetation established in certain areas of their wetland cells. One of the underlying hydraulic conductivity (tightness or clay content) may be a significant contributing factor. Soils with high clay content may decrease the sustained growth of vegetation normally found in wetland cells. Other systems such as at Blencoe have had difficulties during the dry summer months. In some cases they may need different control structures to allow them to split the flow between cells. Another comment was provided by the manager of the Iowa City wastewater treatment system that includes a wetland. He mentioned the additional labor requirements for hand weeding of the wetland research site, and the damage to bulrush caused by deer grazing in the cells.

Concerns with wetlands have included periodic pipe jetting, odors, windblown cattail seeds, lack of flow control at some sites, berm washouts, and weed control. Some suggestions have included requiring rip rap around the edges of wetland cells to prevent washouts, having flow controls (some sites have flow control) especially during dry periods so that wetland vegetation in resting cells could be maintained during dry periods (not all wetlands are loaded and rested, most continuously discharge), and developing a network of individuals involved with wetlands to consult with when experiencing operation and maintenance difficulties or to just share ideas.

Construction Information

Table 3 (pgs. 32-33) lists the engineering firms that designed the wetland systems in Iowa and the contractors that constructed the wetlands. Construction costs and costs for alternative and annual wetland system operating costs are also provided in this table. Section V (pgs. 35-40) provides a more detailed discussion on construction and operating costs.