SECTION III. WETLAND USE INTERNATIONALLY, WITHIN THE UNITED STATES, AND IOWA NEIGHBORING STATES

International Use

Internationally, constructed wetlands for municipal/domestic wastewater treatment have been used in the United Kingdom, Norway, Uganda, Australia, Iran, Morocco, Thailand, Slovenia, the Czech Republic, and Canada, to name a few countries. Wetland performance has been monitored under temperate climatic conditions and climatic extremes ranging from the tropics and arid conditions to the cold conditions that exist in northern hemisphere countries. Wetland studies have been conducted in Asian countries ((Koottatep and Polprasert, 1997), Iran (Badkoubi, et. al., 1998), and Australia (Mann and Bavor, 1993) addressing issues ranging from phosphorus removal to plant uptake of nitrogen. Other studies have focused on wetland performance under cold climatic conditions in such countries as Norway and Canada (Jenssen et. al., 1993; Herskowitz, 1986).

There is no way of determining the number of wetland systems used internationally, except to note through the literature the plethora of research studies addressing constructed wetland issues and the number of international conferences that are held throughout the world. This is an indicator that this type of treatment technology is widely accepted and used throughout the world.

Wetland Use in the United States

Wetland systems were installed in the 1970's in the U.S. with an increasing number in the 1980's. The increase in the 1980's was due in part by the grant program developed by U.S. EPA for installation of alternative land treatment technologies, wetlands being one of the alternatives. The 1990's saw a major increase in the number of these systems as the application expanded for use not only to treat municipal wastewater, but also storm water, industrial and mining wastes, and agricultural wastes. Research efforts in the U.S. follow the same trend and were developing in the 1970's and 1980's. Major research efforts occurred during the 1990's and are continuing on into the early 2000's.

There is no inventory of constructed wetlands for wastewater treatment in the U.S. It is difficult to determine the exact number of these systems. The North American Wetlands for Water Quality Treatment Database (NADB) provides information on natural and constructed wetlands for wastewater treatment in North America (U.S.EPA, 2000). The second version of this database is currently being reviewed by U.S. EPA and lists 245 locations in the U.S. and Canada with more than 800 wetland cells. These numbers probably underestimate the true number of systems, especially for Iowa, which is listed as having 2 wetland systems when in fact there are 20 systems. This underestimation is an indication that there is a lack of communication somewhere on a state and/or federal level in knowing how many constructed wetland systems exist in Iowa. The IDNR currently does not have a detailed database for constructed wetlands in Iowa.

Considerable research on constructed wetlands has been conducted in the U.S. over the past twenty years. Robert Kadlec, Donald Hammer, and Sherwood Reed led early research in the 1970's and 1980's. These individuals along with many others continue to document the performance, operation, and maintenance of these systems in the United States (IWA, 2000; Kadlec and Knight, 1996; Hammer, 1993; Reed and Brown, 1992). Most research efforts have been concentrated in the southern states with milder climates, than the northern states that experience more climatic extremes. However, due to the concerns over performance during the winter months, more recent studies have been conducted in Midwestern states such as Minnesota that experience more winter temperature extremes (McCarthy et. al., 1996; McCarthy et.al., 1999; Schrader et. a., 1998; and Vanier and Dahab, 1997).

Status of Constructed Wetland Use by Iowa Neighboring States

Illinois

Illinois has one permitted wetland wastewater treatment system at a state park that has been in operation since 1998. A single-cell aerated lagoon precedes the surface flow wetland. Wetland vegetation consists of *Typha* (cattail) and *Phragmites* (giant reed). Minimal maintenance is required by the wetland system. The state park has had no discharge from the wetland in summer due to high evaporation losses. Plans are under way for the installation of 2 additional wetland systems at another state park.

There currently are draft regulations used for the design and approval of these systems in Illinois.

Minnesota

There are currently 10 constructed wetlands for wastewater treatment in Minnesota that are approved by the Minnesota Pollution Control and Ecology Agency (MPCE). This agency approves the design and permits for these systems. Currently there is no formal code for the design and construction of wetlands for wastewater systems with flows greater than 10,000 gpd. The agency reviews and approves systems on an individual basis using Ten States Standards, Wetland Treatment (Kadlec and Knight, 1996), USEPA manuals and other accepted references. Minnesota Rule 7080 is the individual sewage system treatment rule that does not specifically address wetlands, but the technology would be covered under "performance systems".

Flows of municipal or other MPCE-permitted systems range from 10,000- 20,000 gpd. Systems with flows less than 10,000 gpd are under the jurisdiction of local government and must follow their permit requirements. According to MPCE there are approximately 30 wetlands that receive flows less than 10,000 gpd that have been constructed in Minnesota. These systems typically receive septic tank effluent and are used in place of a drain field.

There are several configurations for systems with flows greater than 10,000 gpd. One type of system receives septic tank effluent that, via a dosing tank, discharges subsurface to a recirculating sand or gravel filter planted with wetland vegetation and has a synthetic liner (30 mil polyvinyl chloride: 1 mil = 1/1000 inch). The vegetation consists of some *Schoenoplectus lacustris* (bulrush) and more than 20 different native flowers.

Another system that receives septic tank effluent discharges subsurface to a lined wetland with 18 inches of rock covered with 18 inches of mulch. The mulch is finished compost. Wastewater flows from the lined to an unlined wetland with final discharge to groundwater. These systems are required to have groundwater monitoring wells. Groundwater is monitored for chlorides, nitrate-N, temperature and conductivity. According to MPCE, nitrate has never been detected in groundwater. Nitrate coming out of the lined wetland is greater than 10 mg/L and from the unlined wetland nitrates have not been detected.

The University of Minnesota, Natural Resources Research Institute, Duluth, Minnesota is conducting studies of alternative wastewater treatment systems including wetlands. They have focused some of their studies on cold weather performance of these systems (Kadlec, et. al., In: Press, McCarthy et. al., 1999; McCarthy et. al. 1996).

Missouri

The Missouri Department of Natural Resources, Division of Environmental Quality and Water Pollution Control Program has approved 8 wetland systems in Missouri. Missouri Code Chapter 8 contains design rules for wetlands. All of the wetlands are used for final polishing after some sort of pretreatment and are required be to lined with clay or a synthetic material. Two of the largest free water surface wetland systems in the state are at Columbia and Whitman Air Force Base. The 90 acres of wetland at Columbia may be the largest wetland system in the Midwest. Columbia experienced extensive population growth during the 1980's and decided that instead of expanding their existing activated sludge system to a design flow to 16 mgd, they would construct a more natural system of wetlands after the mechanical treatment plant. These wetlands discharge to restored riverine wetlands in a major wildlife area near the Missouri River and Perche Creek.

The wetland system is relatively low maintenance except for muskrat removal and vegetation management. Ducks have also been a concern during migration periods when thousands of them descend upon the wetland and stir up the solids. There have only been a few instances when the solids content in the effluent was near permit limits. Ammonia-nitrogen concentrations in the final effluent do increase during the winter months. However, the receiving stream limits for ammonia are higher during the winter.

Nebraska

The Nebraska Department of Environmental Quality has drafted suggested guidance for constructed wetlands for wastewater treatment. There presently is no established code for these types of systems in Nebraska. Wetland systems must be preceded by an approved pretreatment system. There presently are two constructed wetlands in Nebraska that are part of a research project conducted by the University of Nebraska-Lincoln. One subsurface-discharge system was installed in 1995 for a small community. Clay-lined wetlands cells with gravel were planted with *Typha* (cattail), *Scirpus* (bulrush), and *Phragmites* (giant reed). This system has been the focus of several research studies including the performance of wetlands in cold climates (Vanier and Dahab, 1997; Schrader et. al., 1998). The other research study site consists of a surface-flow wetland following a lagoon that was constructed in a small community.

A third wetland system has just been constructed for wastewater treatment and has no primary treatment. This system consists of a wetland followed by discharge to a sand filter with final discharge to a drainage area.

Wisconsin

The Wisconsin Department of Natural Resources (WIDNR) currently has no Wisconsin code for constructed wetlands for wastewater treatment for permitted wastewater discharges. Systems are approved on an individual basis and scientific literature is used for guidelines in approving system designs. There currently are two approved systems and both are located in northern Wisconsin. The community of Nagen has two, 200-day treatment lagoons that discharge to a 3-4 acre, 4-cell wetland. This system has been in operation since 1999. The surface flow wetland has a synthetic liner and discharges to a seepage bed that discharges to groundwater. The concern with this wetland is that the muskrats will chew through the synthetic liner. Iron River has two 200-day lagoons that discharge to a 2-acre surface flow wetland system with 3 cells. The system has been in operation since 1997. This wetland is lined with "lake clay" and also discharges to a seepage bed that discharges to groundwater. Both wetlands are predominantly vegetated with *Typha* (cattail).

Both systems retain winter flows from October through May-June. The summer depth in the wetlands is usually 4-6 inches and the winter depth 2-3 feet. Groundwater discharge is used in both cases because the communities are located in areas where the surface water supplies are listed as exceptional or outstanding trout streams. According to the WIDNR these systems have been operating well with no reported winter management or water quality concerns especially ammonia-N and nitrate-N.

In addition to these wetland system, the Department has approved two "greenhouse wastewater treatment systems". These wastewater systems consist of a series of wetland vegetated basins with medias consisting of sand, gravel, soil or peat that are contained in a greenhouse. The basins are designed to perform different contaminant transformations.

Some may operate under aerobic conditions and others anaerobic conditions. One system is located at a rural school and the other at a cheese factory.

South Dakota

Constructed wetlands for wastewater treatment have been used extensively for the past 15 years in South Dakota according to the South Dakota Department of Environment and Natural Resources. It is estimated that there are currently 30-40 of these systems in operation in the state and most are municipal systems. The first systems were installed in the 1980's when construction grants were available. Design criteria for these systems are available at (http://www.state.sd.us/denr/des/P&s/designcriteria/design-16.html). Wetlands are not required to be lined so there is groundwater interaction. Consideration is presently being given to require groundwater monitoring at wetland sites. One of the mining companies in the state is also using wetlands for treatment of acid mine drainage.

Almost all systems are surface flow; subsurface flow system technology is treated with more apprehension by South Dakota Department of Environment and Natural Resources staff. Lagoons precede wetlands. Both open water and vegetated surface flow systems are used.

The Department staff has observed that wetlands require a little more management with regard to water levels and vegetation than lagoons. Those wetlands that are not managed properly have turned into ponds. Some lagoons are used for winter storage of wastewater and batch discharge, while other systems discharge continuously. The Department believes that if lagoon and wetland systems are designed and operated properly there should be no concerns with ammonia in effluent. Wetlands have created habitat for wildlife. Most systems have to manage muskrats.

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