Constructed Wetlands

For Feedlot Runoff Treatment

Constructed wetland technology has been well established over the last decade as an effective means of treating livestock wastewater. Uptake of the technology in Manitoba has been minimal due to limited awareness of wetland potential. Two full scale demonstration projects were developed to showcase and evaluate constructed wetlands as a runoff treatment option for cattle producers in Manitoba.

Constructed Wetlands

- Are man-made treatment systems designed to emulate and enhance natural wetland processes.
- Use algae, fungi, microbes and wetland plants likecattail to reduce or transform pollutants in wastewater.
- Create optimal conditions for natural organisms “to do their work”.
- Provide sufficient residence time to treat and remove contaminants.
- Effectively treat wastewater high in nitrogen, phosphorus, bacteria, organic material, and suspended sediment.

Rainfall and snowmelt draining off cattle feedlots picks up manure, bacteria, and nutrients, that can affect water quality in receiving lakes and streams. Because prairie waters are already nutrient rich, additional loading of phosphorus and nitrogen greatly accelerates the process of eutrophication that leads to excessive growth of aquatic plants and algae. This can impair recreational and biological values, as well as degrade water quality for domestic or livestock consumption. Some potential effects of releasing untreated feedlot runoff to surface waters include:

- Excessive organic material in runoff can use up valuable oxygen supplies that fish and other aquatic life depend on.
- Ammonia contained in livestock wastewater can be toxic to fish and other forms of aquatic life.
- Bacteria and other disease causing organisms can be flushed into receiving streams and affect downstream users.

Cattail is the predominant wetland plant species used in the constructed wetlands.

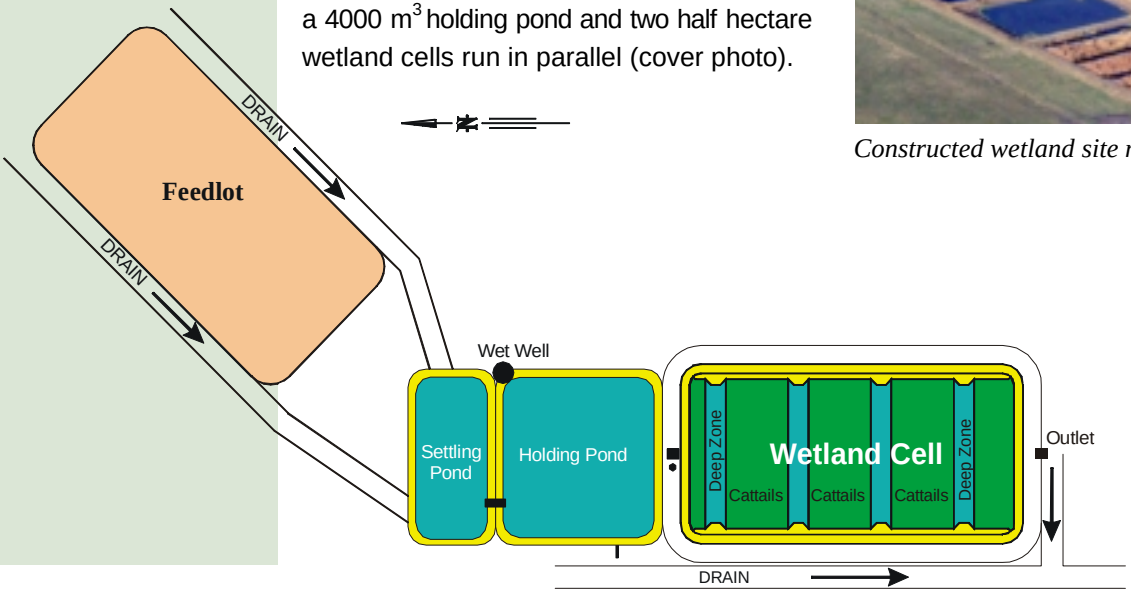
An interesting feature of wetland plants like cattail, is their ability to transport oxygen from the leaves and stems to their roots providing an oxygen-ated "rhizosphere" where aerobic bacteria can thrive.

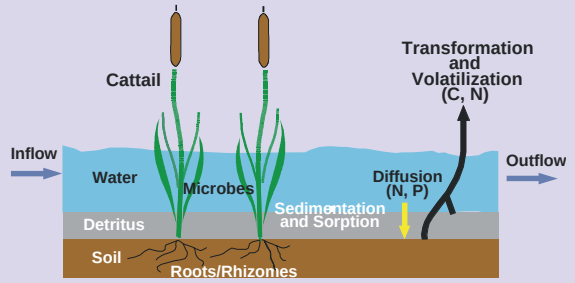
The Demonstration Projects

Two Green Plan projects were initiated in 1996 to demonstrate the effectiveness of constructed wetlands and evaluate their potential for use on Manitoba livestock farms. Wetland projects were constructed at two cattle feedlot operations in the Interlake Region of Manitoba. Both projects were designed to capture the feedlot runoff, store it in a holding pond and then treat the wastewater in constructed wetland cells.

An 800 head feedlot operation located a mile from Lake Winnipeg was the first treatment wetland developed. Drains were constructed around the feedlot each empty-ing into a settling pond where solids and other debris settle out. The water from the settling pond overflows into a larger holding pond for further preliminary treatment. The water is then pumped into the head end of the half-hectare wetland cell. The holding pond can store seven months of accum-ulated precipitation from the three hectare drainage area. The water retention time in the wetland is approximately 30 days.

The second constructed wetland site was constructed at an 1800 head feedlot bordering Lake Manitoba. The project, which began operation in 1999, consists of a 4000 m^3 holding pond and two half hectare wetland cells run in parallel (cover photo).





How They Work

Wetland vegetation obstructs water flow and causes suspended sediments and attached pollutants to settle. Micro-organisms including algae, protozoa, fungi, and bacteria, carry out the bulk of the water treatment. The wetland optimizes the habitat for these organisms by providing a detrital layer on the wetland bottom to which millions of microbes can attach and then treat the wastewater. A major pathway for nitrogen removal is volatilization of ammonia to the atmosphere. Phosphorus is bound up or accreted in wetland sedi-ments, while bacteria are destroyed by exposure to UV radiation from sunlight in the shallow wetland cells.

Constructed wetland site near Lake Winnipeg.

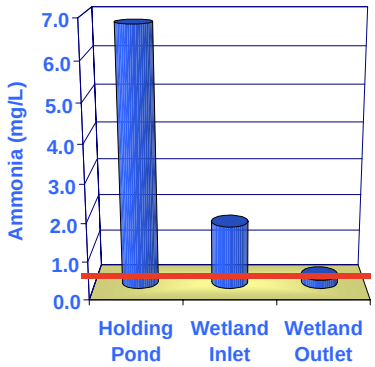
Performance Monitoring

To determine the effectiveness of treating feedlot runoff with wetland cells, water quality has been monitored at the two sites for several operating seasons. The results show that the wetlands are performing well, with excellent reductions in organic strength (BOD_5), ammonia, and fecal coliform bacteria. Almost fifty percent of phosphorus (TP) is also being removed and over 70% of total suspended solids (TSS).

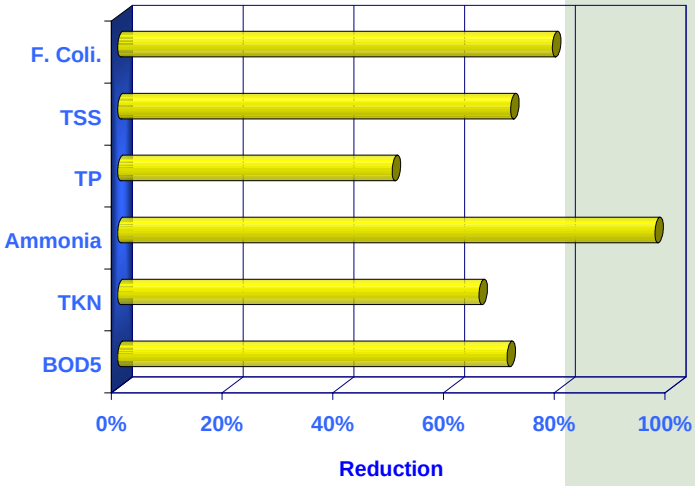
As runoff water flows through the system the pollutant concentrations drop dramatically, as illustrated for ammonia at right. By the time the runoff water reaches the wetland outlet most of the ammonia has been removed making it safe for fish and aquatic life and also meeting Canadian Water Quality Guidelines (red line).

Actual discharge concentrations of the various parameters have been close to wetland background levels and below environmental guidelines for treated waste-water release. To date, the monitoring confirms the effectiveness of constructed wetlands in treating feedlot runoff.

Average Ammonia Concentrations
Site 2 Wetland July 1999 - Oct. 2000



Wetland Treatment Performance
Site 2 Wetland July 1999 - Oct. 2000



Water samples before and after wetland treatment.

Wetland Operation

The constructed wetland systems operate during the growing season for approxi-mately 150 days each year and are set at a water depth of approximately 30 cm. The system normally operates on a continuous flow basis from May through September. In dry years, evaporation removes the water and wetland releases are not required.

Pump control panel and wetwell containing submersible pump.

Operating a wetland cell is quite simple. Landowners set an automatic pump timer and flow control valves, and adjust the height of weir plates at the outlet. A submersible pump is installed in the wetwell each spring and removed in the fall. Periodic monitoring is recommended to ensure pump operation and to check wetland water levels and controls.

The maintenance requirement for the system is minimal, as annual harvest of cattail is not required. Wetland cells may require clean-out of collected sediment and organic debris after ten or more years. The need for clean-out will be based on reduction in wetland volume over time.

Construction of "deep zones" in the wetland cells is a design feature to help distribute wastewater and prevent short circuiting across the surface of the cell.

New cattail growth in a wetland cell.

Wetlands for Livestock Operations

Agriculture specialists often advocate applying livestock waste to land to make use of its moisture and fertilizer value. This may not always be possible due to limitations on nearby land, or proximity to residences, communities, lakes, and streams. Constructed wetlands offer an effective low maintenance option for livestock waste treatment where it is needed.

With increasing scrutiny and regulation in the livestock industry, waste treatment may soon become necessary, especially in areas with high densities of livestock and sensitive zones of ground or surface water. While the current study only examined one application, constructed wetland technology has been used for treatment of livestock wastewater from hog and dairy operations. Wetlands can be incorporated into overall waste treatment systems for many types of livestock facilities.

Operating costs are quite low as there are few work requirements. Monitoring pumping equipment, setting flow controls, and occasional dike mowing, are the main activities. Debris and solids will likely accumulate in the wetland over the project life and require removal in later years.

Some important factors that can affect the design and cost of a wetland project include: local soil and groundwater conditions, requirements for cell lining, muskrat exclusion fences, land costs, and availability of electrical service.

The constructed wetland treatment technology is only one of many options for control and treatment of agricultural wastewater. Uptake of the technology by the livestock industry will depend on environmental regulation and cost comparisons with other options. This study has shown that treatment wetlands can be built and operated successfully in Manitoba.

Acknowledgements

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For More Information

Contact PFRA in Beausejour at (204) 268-3233 or Winnipeg at (204) 983-2243 for information on wetland development.

Constructed wetland site near Lake Manitoba. Wetland cells at left.