NebGuide

University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

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G1474

Residential On-site Wastewater Treatment: Constructed Wetlands

Jan Hygnstrom Extension Project Manager
Sharon Skipton, Extension Educator
Wayne Woldt, Extension Specialist

This NebGuide is the result of a cooperative effort by the Nebraska On-site Wastewater Treatment Task Force, whose members are listed on the last page, and discusses recommended practices for the design and installation of a constructed wetland as part of a residential on-site wastewater treatment system.

Many Nebraskans live in homes that do not have access to a public wastewater treatment system. Instead, they must rely on their own on-site systems for wastewater treatment and recycling. The septic tank/drainfield and wastewater lagoon are two commonly used systems in Nebraska. In some situations, neither of these systems may be appropriate. Soils may not be suitable for a traditional drainfield. Some owners object to the appearance of a fenced wastewater lagoon system. In these cases, a constructed wetland system may be a good alternative. A properly designed, installed and maintained on-site wastewater treatment system, whether it has a traditional drainfield, gravelless system, mound system, constructed wetland or other system, reduces risk to human health and the environment.

This publication explains the basics of a constructed wetland system, including how it works, design considerations and maintenance. In Nebraska, the Nebraska Department of Environmental Quality (NDEQ) requires the landowner to have a permit prior to construction of a constructed wetland. For additional information regarding on-site wastewater treatment systems, see the NebGuide *Residential On-site Wastewater Treatment: Traditional and Gravelless Drainfield Systems for Septic Tank Effluent Treatment* and Extension Circular *Residential On-site Wastewater Treatment: An Overview.*

How A Constructed Wetland System Works

Constructed wetlands are designed to mimic natural wetlands to treat wastewater, using plants and microorganisms. A constructed wetland system consists of a septic tank, the wetland cell(s) and a method for returning the treated wastewater back to the environment, such as a drainfield if the soil is adequate, or a polishing lagoon or wildlife habitat pond (*Figure 1*).

In the septic tank, wastewater receives initial treatment. Anaerobic bacteria begin to break down wastes, and solids settle to form a sludge layer, while greases and oils float to form a scum layer. The clarified middle layer travels to the constructed wetland cell. For additional information on septic tanks see the NebGuide *Residential On-site Wastewater Treatment: Septic Tank Design and Construction.*

There are two main types of wetlands — surface and subsurface flow. Surface-flow wetlands look like natural wetlands, because wastewater flows on top of existing soil. They are more economical for treating large volumes of wastewater such as those generated by communities. Surface-flow constructed wetlands are not discussed in this publication.

The subsurface constructed wetland is a cell of gravel (*Figure 2*), designed so that wastewater remains about 1 to 3 inches beneath the surface. This controls mosquitoes and offers little chance of human contact with the wastewater. Cattails, bulrushes, reeds and other aquatic plants are planted in the cell. Microorganisms living on the face of the gravel stones and plant roots break down organic materials in the wastewater. The plants in turn provide oxygen to the cell, and remove some of the nutrients from the wastewater. Some of the wastes settle out and attach to particle surfaces.

From the wetland, wastewater goes through a water-level control sump that allows the wetland water level to be adjusted. This is important, because the wetland water level must remain below the gravel surface in order to prevent odors, yet be high enough to prevent plant roots in the cell from drying or freezing. Occasionally, water levels may drop to more than 3 inches below the surface of the wetland cell. This is acceptable periodically, because it allows for plant root development.

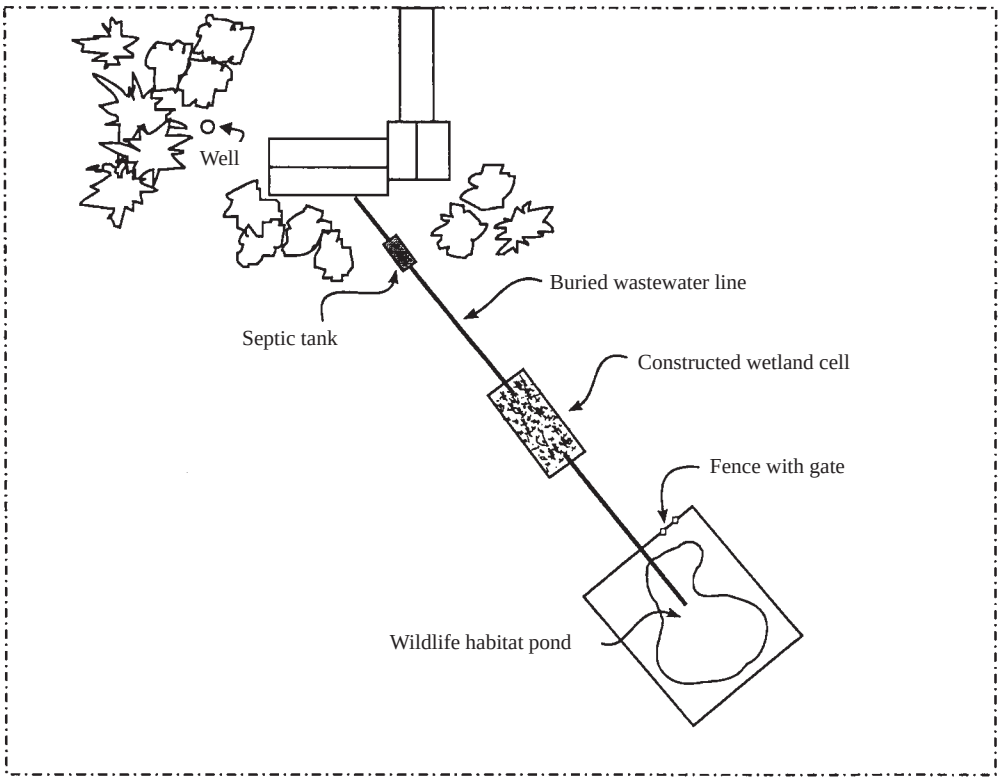

Figure 1. Constructed wetland system on residential site.

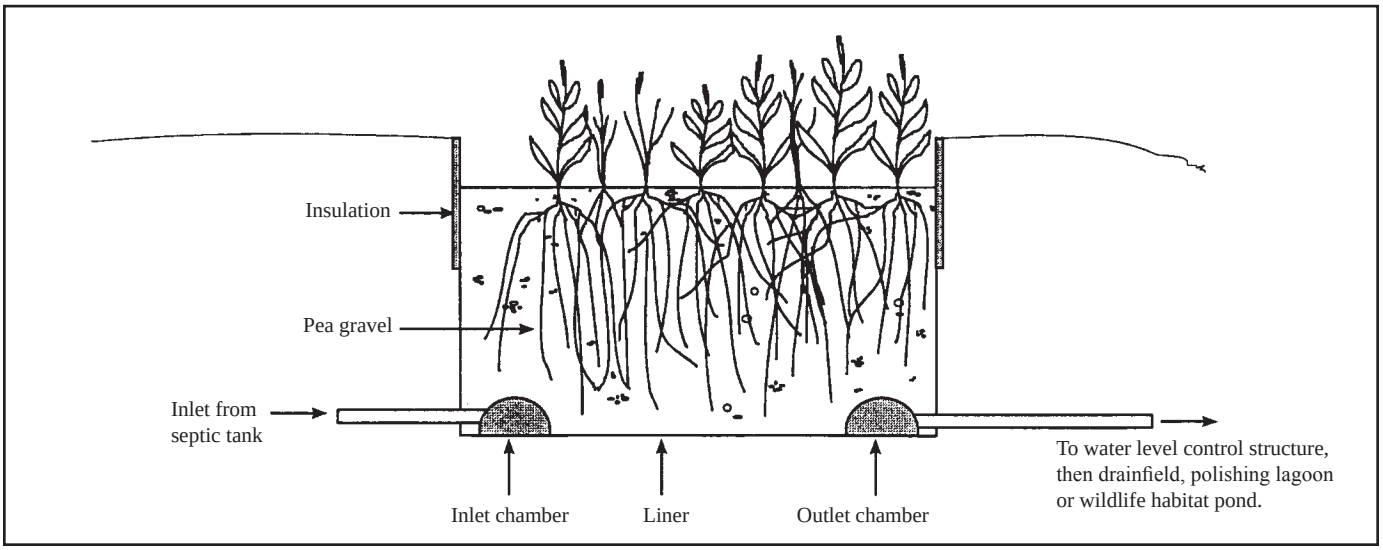

Figure 2. Constructed wetland cell.

If the soil and site characteristics are suitable, wastewater flows from the constructed wetland to a subsurface drainfield where microorganisms and soil continue treatment as it is released back into the environment. If the soil is not suitable for a drainfield, the wastewater may go to a polishing lagoon or wildlife habitat pond, where more treatment may occur. Discharge to land or natural bodies of surface water is illegal in Nebraska. From the polishing lagoon or habitat pond, wastewater evaporates into the air and some will seep into the soil. Seepage rates must not exceed 1/8 inch per day.

Constructed Wetland Design

Although a constructed wetland system is more expensive than either a traditional septic tank/drainfield system or a lagoon, some people prefer it because a wetland can be very attractive and benefit wildlife. The wetland must be designed by an engineer and permitted by NDEQ.

For new home construction, determine where to build the wastewater treatment system while deciding on the location

of the home. See the NebGuide *Residential On-site Wastewater Treatment: Site Evaluation* for more information. If the constructed wetland system site will be lower than the home site, wastewater can travel by means of gravity through the system. Otherwise, a pump will be needed to force water through the system. Pumps require an energy source and maintenance, which will increase the cost of installing and using the system.

The wetland cell should have a length-to-width ratio ranging from 2:1 to 3:1 to ensure proper water flow. For example, a 300-square-foot wetland could be 30 feet long by 10 feet wide (30 feet /10 feet = 3:1). If the wetland cell must be enlarged, keep the length-to-width ratio constant by increasing both the length and width. The engineer will determine the size of the system based on temperature, which affects how fast the wetland can remove nutrients and other pollutants, and the amount of wastewater that needs treatment, typically determined by the number of bedrooms in the home. This information is used to determine hydraulic retention time, the amount of time wastewater needs to stay in the wetland for proper treatment. The longer the wastewater stays in the wetland, the more time microorganisms and plants have to treat the water. Generally, wastewater needs to stay in the wetland system for 2 to 3 days before being recycled into the environment.

The wetland cell is a bed of graded stone where aquatic plants are grown. The cell is generally an earthen basin lined with compacted native clay, bentonite, concrete or a synthetic liner. The bed itself is usually gravel, but can be any porous material that resists corrosion or being dissolved by wastewater. Limestone is not satisfactory because it breaks down in the acidic conditions of the cell. The gravel or other material should be free of silt and clay (fines) that could clog the pores. The wetland cell has pipes or chambers (*Figure 2*) to distribute wastewater entering it, and again to collect it after it has traveled horizontally through the cell. Slight slope of the wetland bottom helps gravity move wastewater through the cell. Common slopes in residential systems range from 0 to 1 percent, or a 0 to 1 foot drop per 100 feet of length. To reduce the risk of freezing, consider having the top 18 to 24 inches of the cell's perimeter insulated.

After treatment in the wetland cell, wastewater travels to a drainfield system or wildlife habitat pond for further treatment and dispersal into the environment. For additional information on drainfields, see the NebGuide *Residential On-site Wastewater Treatment: Traditional and Gravelless Drainfield Systems for Effluent Treatment.*

Wildlife Habitat Pond

Instead of a traditional drainfield, a wildlife habitat pond may be used for final recycling of wastewater. Unlike a wastewater treatment lagoon, a pond can be designed to look more natural, such as kidney-shaped. If possible, locate the pond so that wastewater from the constructed wetland can flow by gravity to the wildlife habitat pond. The constructed wetland cell is connected to the pond using a four-inch diameter Schedule 40 Thermoplastic PVC pipe or equivalent with a slope of at least 0.5% or 1/2 foot per 100 feet.

Since the wastewater has been partially treated in both the septic tank and the constructed wetland, NDEQ requirements for a wildlife habitat pond are not as stringent as those for a residential wastewater treatment lagoon. For example, a fence and sign may not be required if a disinfection method such as chlorine tablets are used. However, this adds to the regular maintenance requirements and the chlorine may have an effect on the wildlife habitat. For safety reasons, consider installing a fence or some other barrier to prevent children and pets from wandering into the water. The fence may be more decorative than those required for lagoons by NDEQ *Title 124.*

An engineer will design the pond and size it based on wastewater generation rates, and evaporation and precipitation rates for the geographic area. Try to maintain at least two feet of water in the pond for aesthetics and to encourage wildlife use. Unless a synthetic liner has been installed, the bottom may form cracks if the pond is allowed to dry up. Cracks will increase seepage to more than the allowed maximum of 1/8 inch per day.

Operation and Maintenance

Each part of the constructed wetland — the septic tank; constructed wetland cell; and drainfield, wildlife habitat pond or polishing pond — requires maintenance. Routine inspection and pumping of the tank is necessary for proper wastewater treatment. If the tank has an effluent filter (which is a highly recommended feature) to prevent solids from entering the wetland cell, the filter should be inspected and cleaned periodically. See the NebGuide *Residential On-site Wastewater Treatment: Septic System and Drainfield Maintenance* (*G1424*) for more information.

The constructed wetland requires minimal but necessary maintenance to ensure proper wastewater treatment. **When performing maintenance tasks, always minimize exposure to wastewater by always wearing protective and waterproof gloves. Avoid any exposure if you have open skin wounds or sores. After completing tasks, thoroughly wash hands or shower, and disinfect any breaks in the skin.**

Water level

Adjust the water level in the wetland so that it usually is within 1 to 3 inches of the media surface. In the hot summer or cold winter months, lower water levels could cause plant roots and tubers to dry out or freeze. However, occasional lower water levels during seasons not subject to freezing temperatures may not harm the plants. The wetland will have an odor if the wastewater level is too close to the gravel surface. Moving the pipe in the water level control sump will adjust the water level in the wetland.

During times with low wastewater flow, low rainfall and/or high evapotranspiration (water loss through plants and soil), the constructed wetland may need to have water added. Run water from an indoor faucet, or water the wetland directly with a garden hose until water level is at least a foot below the wetland cell surface. Check water level at least weekly

during hot and windy weather and add water as needed. Ask a neighbor to check and add water as needed during prolonged absences.

Vegetation

Inspect vegetation for signs of stress, including yellowing, excessive dead material, insect infestations or disease. At the first signs of stress, make sure water is at the proper level. If the water level is correct, 1 to 3 inches from the media surface, have a horticulturist or other plant specialist look at the system.

Remove volunteer trees, shrubs and grasses such as fescue and brome from the wetland cell. These will compete with aquatic plants and could crowd them out. Remove manually if possible. Spot treat with an approved herbicide on a calm day to reduce the chance of drift to desirable aquatic vegetation.

Replace dead aquatic vegetation with new plants as soon as possible.

Sunlight is necessary for good plant growth. Control the growth of trees and tall shrubs near the wetland to prevent excessive shading of the wetland.

Remove dormant (not actively growing) and brown plant material during the winter months. For cattails, rushes and other plants that have a stalk, leave at least 12 inches of plant above the wetland cell surface to support new spring plant growth. Standing plant material collects snow, which will insulate the cells during winter months.

Additional concerns

Research is still being conducted on the effectiveness of wastewater treatment during cold winter months. Also, since the constructed wetland system is an alternative system, a professional engineer must design it and a NDEQ permit is required.

A fence around the wetland cell is usually not necessary as wastewater is below the surface of the media. While establishing vegetation, however, a woven wire fence may prevent deer and rabbits from chewing tender young plants. Wildlife such as muskrats may dig into the sides of constructed wetland cells and cause leaks. If you observe holes or "runways," trap and relocate or eliminate the animal, and repair damage to the wetland.

Control surface drainage so that surface water does not flow into the cell. Make sure that the sides of the cell are 6 inches or more above the surrounding soil surface. Maintaining minimum water levels in summer during periods of non-use may require planning and effort.

Level any low or high spots on the surface of the wetland with a rake or by filling in with additional gravel or filter material. Low spots can cause wastewater to pond, which could lead to odors.

Summary

A properly designed, installed and maintained constructed wetland can treat wastewater to reduce risk to groundwater, surface water and human health. The constructed wetland system consists of a septic tank, the wetland cell and a drainfield, wildlife habitat pond or polishing lagoon (depending upon soil characteristics) for reintroducing wastewater into the environment. The system must be designed by an engineer and approved by NDEQ prior to construction. Proper maintenance includes inspecting and pumping the septic tank on a regular basis, cleaning the septic tank effluent filter if present, managing vegetation in and around the wetland cell, managing the water level, and checking and repairing the wildlife habitat pond or polishing lagoon structure if present.

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Nebraska On-site Wastewater Task Force members included: Tom Baker, Douglas County Health Department; Francis Belohlavy, University of Nebraska Conservation and Survey; John Chess, Lincoln-Lancaster County Health Department; Doug Clark, Douglas County Health Department; Duane Eversoll, University of Nebraska Conservation and Survey; Steven Goans, Nebraska Department of Environmental Quality; DeLynn Hay, University of Nebraska Cooperative Extension; Rick Hoopes, Nebraska Department of Environmental Quality; Troy Huffman, Nebraska Health and Human Services System; Jan Hygnstrom, University of Nebraska Cooperative Extension; Mark Kuzila, University of Nebraska Conservation and Survey; Randy Nickeson, Douglas County Health Department; Terry Philippi, Nebraska Health and Human Services System; Randy Pryor, University of Nebraska Cooperative Extension; George Reese, Sarpy County Planning and Building Department; Sharon Skipton, University of Nebraska Cooperative Extension; Wayne Woldt, University of Nebraska Cooperative Extension; and Gary Zoubek, University of Nebraska Cooperative Extension.

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Index: Waste Management
Home Waste Systems
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