

Watershed Restoration Notes #1

Vertical Flow Wetlands

Vertical flow wetlands (VFW) are a relatively new tool for treating waters acidified by mining or acid deposition. VFWs add alkalinity and increase the pH of treated water by directing water through a bed of limestone (Figure 1). In order to prevent the limestone from becoming coated with aluminum and other metals, the environment inside the limestone bed is maintained in an oxygen-free (anaerobic) condition by first passing the inflowing water through a layer of mushroom compost. Decomposition of the compost by bacteria removes oxygen from the system and promotes the formation of hydrogen sulfide (H₂S), a soluble gas that can be toxic to trout. Treated water exiting the VFW has little or no dissolved oxygen and high H₂S concentrations; consequently, it is not suitable for fish and other aquatic life until it becomes aerated by natural or artificial means. The treated water may also contain small amounts of aluminum, which may in part be chelated (combined) with organics from the mushroom compost and, as a result, is less toxic to fish and other aquatic organisms.

The Mosquito Creek Watershed Restoration Project in Elk and Clearfield counties employed vertical flow wetlands to treat small, acidified

tributaries. The VFWs at Mosquito Creek were designed by Water's Edge Hydrology (Clearfield, PA) and incorporated two treated discharge configurations. One design discharges treated water in a closed pipe directly into the receiving stream (Figure 2) while the other first passes the treated water through a short, open channel prior to discharge (Figure 3). The open channels are approximately 250 feet long and 15 feet wide. We evaluated selected water quality effects of the two discharge designs.

The open-channel VFW design allows for dissipation of H₂S and some re-aeration of VFW effluents prior to stream discharge. Where discharges are to small streams, VFW effluent quality may be important to the water quality of the receiving stream and the open-channel design may be beneficial compared to a direct discharge.

A recent study of the VFWs in the Mosquito Creek Watershed evaluated receiving stream impacts of both the direct discharge and open channel discharge VFW designs. Results indicated that high H₂S concentrations occurred in the receiving stream up to 100 meters downstream of the direct discharge system. On the other hand, no H₂S

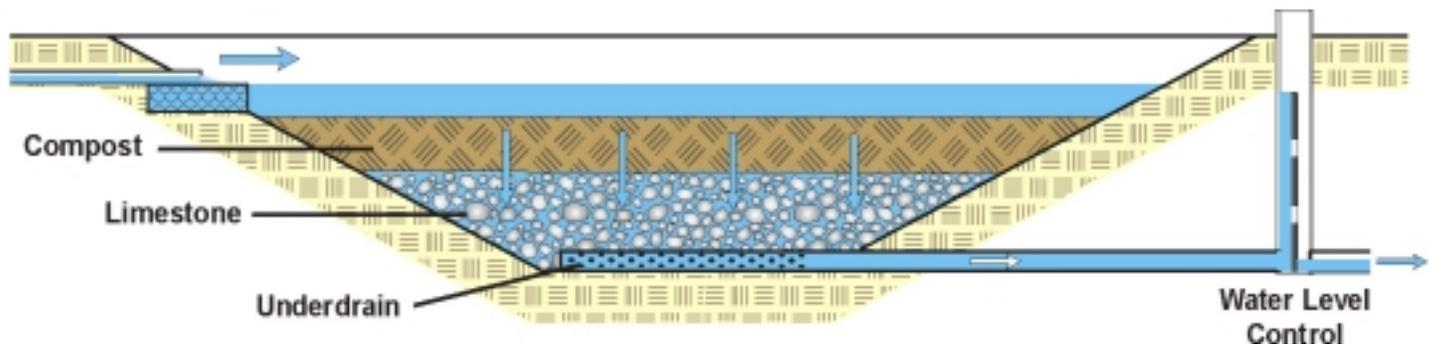


Figure 1. Schematic diagram of a typical vertical flow wetland system (image courtesy of Terry Rightnour, Water's Edge Hydrology, Clearfield, PA).



Figure 2. The Ardell Road Vertical Flow Wetland System installed to treat acidic water in a headwater stream of the Mosquito Creek Watershed in Clearfield County. Water in this pond percolates through compost and limestone before discharging directly to the stream.

could be detected downstream of two VFWs designed with the open channel to remove H_2S prior to stream discharge (Figure 3). Receiving water-dissolved oxygen (DO) concentrations were lower downstream of the VFWs, but not significantly different between the two VFW discharge designs. Receiving-water temperatures were also not significantly different. Mean maximum daily temperatures of VFW effluents were always cooler than influent temperatures, possibly due to the VFW's subsurface discharge system. However, when effluent from the outflow channels was measured, mean maximum daily temperatures were increased slightly.

VFW designs should take into account the potential for H_2S and DO problems in receiving waters. If the receiving water immediately downstream of the VFW discharge is to remain unaffected, these findings suggest that VFW discharges should be aerated using open-channel designs or other means. Designs should also provide for as much shading of the VFW and outflow channel as possible.

Site clearing for VFWs should be done so as to retain large shade-producing trees, or designs

should call for site landscaping with large trees after construction to shade the VFW and outflow channel. This will help to minimize negative temperature effects.

Summary

VFWs are an essential tool in the restoration of watersheds affected by acidification. They perform reliably and are an excellent low-cost alternative, particularly at remote sites. VFW designs that allow for shading of the outflow channel and aeration of the effluent will provide the maximum water quality benefits possible.

Additional Resources

For further information about watershed restoration and water resources management, consult the Penn State Water Resources Extension Web site at:

www.sfr.cas.psu.edu/water

or contact your local county cooperative extension office.



Figure 3. An open channel utilized to aerate effluent from the Pebble Run Vertical Flow Wetland in the Mosquito Creek Watershed.

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