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Constructed Wetlands for Homeowners

by Danny Buck

Wetlands—in drylands? In 1992, Permaculture Drylands introduced the concept of constructed wetlands to homeowners—right here in the drylands. Hands-on workshops on constructing your own backyard wetlands were presented in both Santa Fe, New Mexico, and Prescott, Arizona. Michael Ogden, P.E. of Southwest Wetlands Group, designed the wetlands and presented a slide show and open discussion for each workshop. I contracted with the owners to install the systems, with workshop participants doing a large part of the labor. Besides providing a good physical workout, the workshops were informative, fun and well received.

So, just what is a constructed wetlands? It is an engineered system which imitates the process that nature has used for eons to cleanse water in marshes, swamps and bogs. All of these systems contain water plants which supply oxygen to microbial ecologies which break down organic material. In the food chain of life, *everything* is just below something else.

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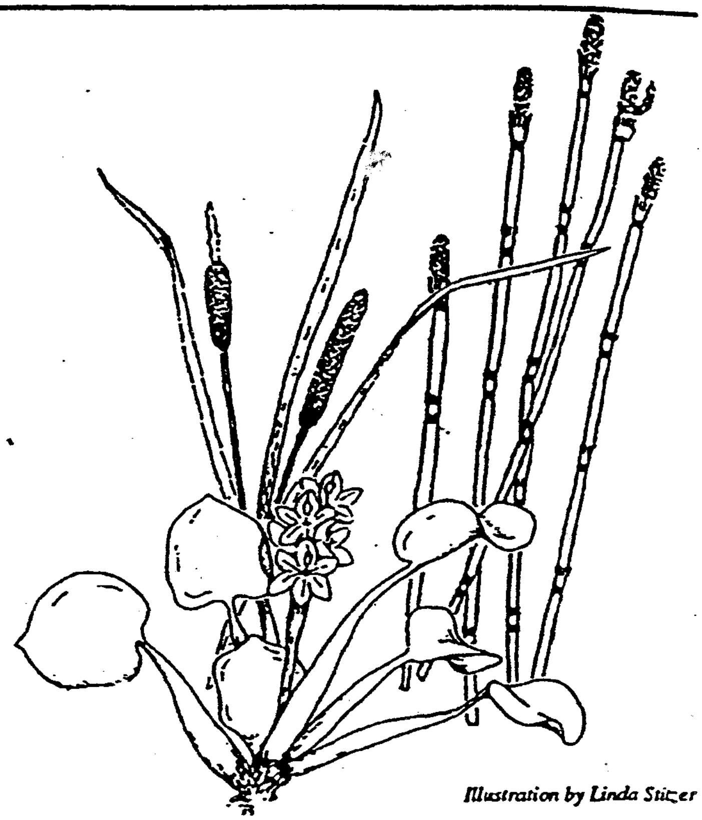

Illustration by Linda Stitzer

By matching organisms and material correctly, we can purify mine waste water, urban storm water, landfill leachate, agricultural run-off, paper mill effluent, septage, and the waste products of the petroleum, plastics and electronics industries. This process of bioremediation is now doing what conventional mechanical-chemical systems do but for less construction and operating cost, while creating habitat and green zones as a by-product.

Most constructed wetlands are marshes. Marshes are tolerant of wide variations of water quality and fluctuating water levels, and have adapted to almost every climate on earth. Although a slow level of metabolic function is maintained in the cold of winter, some constructed systems are placed in greenhouses to maximize their treatment capability all year. For outdoor wetlands, the mulch formed on the top by the plants and the heat of the influent wastewater combine to maintain working temperatures. (For a general article on natural water treatment with wetlands, see PDJ #17.)

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The two systems presented in our workshops were for sewage treatment on single family residences. The basic system starts with a traditional septic tank to remove the solids and perform a primary treatment with anaerobic organisms. The effluent then passes through the constructed wetland for secondary treatment, with both aerobic and anaerobic action (see illustration, page 13). The yield is an effluent meeting Arizona and New Mexico state regulations for irrigation water and/or subsurface discharge.

What would have been wastewater now has a variety of uses: it can go back into the ground via a drain field to recharge the aquifer; it can feed into a fishpond or fountain; or it can be used for irrigation. Although theoretically clean at this point, it is conservatively recommended that it be used on non-vegetable crops. These crops can include forage, windbreaks and fruit and nut trees. A disinfecting treatment using ultraviolet light will remove any remaining pathogens and almost all of the viruses, bringing it to drinking water quality. These systems make wonderful sense in that they allow the reuse or recycling of "wastewater," they prevent contamination of ground and surface water, and they provide increased percolation through soils of low permeability. This last benefit is due to the fact that the cleaner water will not clog up the soil or other medium as the effluent straight from a septic tank will.

The variables involved in the design of a wetland sewage treatment system are: organic loading, daily water usage, average winter temperatures, and average humidity. The system also must be sized for extreme conditions (maximal influent, minimal ambient temperature, and minimal plant and microbe activity). Although some rules of thumb are evolving (each of our designs were approximately 600 square feet of treatment area), *at this stage in the evolution of the science, it is highly recommended that professional engineering be done on each individual system.* This service is available at a reasonable cost and is a necessity in dealing state and local regulators, who usually require design calculations and the stamp of a registered civil engineer. An engineer's presence in discussions regarding permitting can facilitate the process, as he or she can help the regulators learn about wetlands in the context of systems with which the regulators have more experience.

Once in place, a wetlands is dependent upon a definite level of awareness on the homeowner's part as to what goes down their drain. *Solvents, chlorine and some herbicides and insecticides may kill off some organisms which are vital to efficient treatment. The real maintenance required for these systems is avoiding highly toxic chemicals.* As all but the very fine solids are captured by the septic tank, and all of the large molecules are organically broken down and reconstructed (see Water Quality Data below), a well constructed and maintained system will last for decades. Some wetlands authorities have predicted they could last over a century. Also, as there is no surface water in these systems, some edge effects such as mosquito breeding do not occur—nor are there any odors.

The simplest system is all gravity fed and is comprised of a home (or homes), a septic tank(s), the wetlands and a drainfield or pond. The influent to the wetland is free of so[lids] and is dispersed across the width of the treatment area with header (perforated PVC) pipe. The treatment area is a submerged porous media, such as gravel, which provides t[he] surface area for the micro-organisms to grow onto. A minimal

Bioremediation vs. Conventional Treatment Systems

Advantages

- Low construction costs
- Low operating costs
- Energy efficient (solar)
- Consistent, reliable
- Simple operation
- Advanced treatment level
- Eliminates sludge and chemical handling
- Accepts load variations
- Attractive to wildlife
- Aesthetically pleasing
- More applicable to point source treatment

Disadvantages

- Larger land area required
- Optimal design factors still evolving
- Engineers and regulators not familiar with technology

Typical Water Quality Data
Constructed Wetland Treating Septic Tank Effluent
(All numbers are parts per million)

	In	Out
BOD*	140	10
Total suspended solids	140	5
Total Nitrogen	30	10

** Biological Oxygen Demand (BOD) is a measurement of organic material in suspension and solution. It is the total amount of oxygen the material can absorb as it breaks do[wn].*

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Wetlands Species

Common Name	Scientific Name
Horsetails	*Equisetum* spp.
Cattails	*Typha* spp.
Rushes	*Juncus* spp.
Bulrushes	*Scirpus* spp.
Sedges	*Carex* spp.
Common Reed	*Phragmites communis*
Water Hyacinth	*Eichhornia crassipes*
Duckweed	*Wolfia* spp., *Lemna* spp., *Spirodela* spp.

Although wetlands species can be obtained commercially through nurseries, many can be found in boggy, marshy areas near the wetlands site. Look in drainage ditches, irrigation ditches, stock ponds, marshes and cienegas in your area. Plant material obtained regionally is better adapted and more likely to survive both the stress of transplanting and the unique characteristics of your climate.

period of five days of meandering through the gravel will allow full treatment, delivering the effluent to a header collection pipe identical to the influent's. From here it flows into a level adjusting basin, which controls the wetland water level (about 2" below the surface of the gravel), then out to the drainfield or pond. The surface of the treatment area is planted with marsh plants, typically bulrush, cattail and reed. These are plants with varying root depth which pump oxygen via tubular stems and roots down into the treatment medium, allowing the necessary aerobic oxidation of contaminants. Other water plants may be added, including ornamentals.

If the site does not allow for gravity-flow, then pumps can be installed to help out at various points as needed. Pumps can assist water flow at the house (to the septic tank), at the septic tank (to the wetland), and at the adjustment basin (to either the drainfield or irrigation).

For Additional Information

Design and Engineering Services:

Southwest Wetlands Group, 1590 San Mateo Lane, Santa Fe, NM 87501, 505-988-7453

Installation Services:

Living Structures, PO Box 6447, Santa Fe, NM 87502-6447, 505-986-8225

Information Sources:

Wastewater Treatment Information Exchange Bulletin Board Service, National Small Flows Clearinghouse, West Virginia University, Morgantown, WV 26506, 1-800-624-8301

Center for Environmental Research Information, 26 West Martin Luther King Dr., Cincinnati, OH 45268, 513- 569-7562

The Regional Waste Department, Valley Resource Center, Tennessee Valley Authority, 2B Old City Hall Bldg., Knoxville, TN 37902, 615-632-6433

BRS, Inc., 8405 165th Avenue NE Suite #15, Redmond, WA 98052, 206-833-8474

Suggested Reading:

Crites, Ronald W. et al. Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment. ISOPIA, Cincinnati, OH. 1988

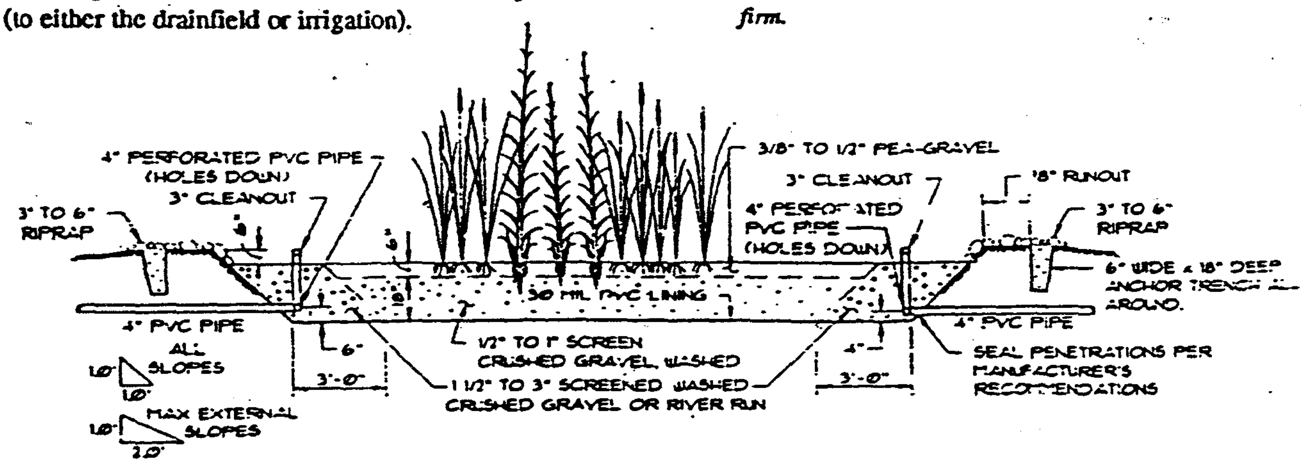
Dinges, R. Natural Systems for Water Pollution Control. Van Nostrand Reinbold Co., NY. 1982

Hammer, D.A., ed. Constructed Wetlands for Wastewater Treatment. Lewis Publishers, Chelsea, MI. 1990.

Reed, Sherwood C., Chairman. Natural Systems for Wastewater Treatment Manual of Practice FD-16. Water Pollution Control Federation, Alexandria VA. 1990.

Reed, Sherwood C., Middlebrooks, E. Joe, Crites, Ronald W. Natural Systems for Waste Management and Treatment. McGraw-Hill, NY. 1988

Danny Buck is a contractor with many years of experience in traditional rock and earth construction, and, more recently, permaculture and constructed wetlands installation. He operates Living Structures, a general contracting and permaculture design firm.



SECTION A-A THRU CONSTRUCTED WETLAND

SCALE : NONE

Illustration courtesy of Southwest Wetlands Grou

CONSTRUCTED WETLANDS GREYWATER SYSTEM

Designed by Penny Livingston-Stark