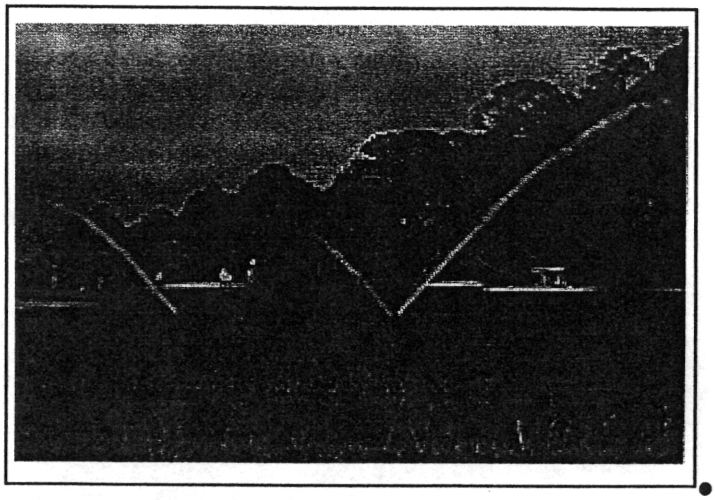
TREATMENT WETLANDS FACTS
University of Rhode Island • College of Resource Development • Department of Plant Sciences
Cooperative Extension

Growing Wetland Plants in Captured Irrigation Runoff for Treatment and Profit

WHY TREAT NURSERY RUNOFF?



Nursery runoff can pollute surface and ground water. Typical overhead irrigation results in as much as 78 percent of the water lost to runoff (1). This can mean a high volume of irrigation return flow, with quality that can vary vastly from day to day. Irrigation runoff can represent a serious "nonpoint" source of nutrients, pesticides, and sediment (see sidebar).

- **Growing plants takes a lot of water!** Nursery and greenhouse operations rely on water supplies which are both plentiful and of good quality. It only makes sense that nursery and greenhouse operators should care about--and for--these resourses.

POLLUTANTS CONTAINED IN RUNOFF:

Nutrients. It may seem strange that nutrients pollute. But the fact is, adding too much nitrogen or phosphorus to natural systems can disrupt nutrient balances. This causes some organisms to grow rapidly and others to decline, and can eventually ruin the entire system.

Pesticides. Insecticides and fungicides pose a more familiar threat to groundwater. Although only a tiny fraction of pesticides applied are typically lost in runoff, pesticides can attach to sediments and accumulate to concentrations high enough to threaten both wildlife and humans.

Sediments. Experts estimate that 50 percent of the sediment in the nation's waterways has originated from croplands (2). In addition to clogging waterways, sediments hold and carry an array of nutrients and pesticides.

- **Soon you may have to capture and treat your runoff.** Although the Clean Water Act exempts irrigation return flows from federal regulation, many states have independently instituted such regulations. Discharge permits in place typically require complete initial capture of irrigation runoff as well as disposal of treated runoff containing specified levels of nitrogen, pesticides, and sediments. Eventually, such requirements may be standard nationwide (4).

- **But every cloud has a silver lining!** If your state requires that you capture runoff, why not grow wetland plants in it and kill two birds with one stone? Not only will you keep more land in production this way, but your new wetlands will *treat the water.*

WHAT'S A WETLAND GOT TO DO WITH IT?

- **Increasingly, constructed, artificial wetlands are being used in wastewater treatment.** Treatment wetlands are an inexpensive and effective menas of purifying runoff before it is reused or discharged. What's more, these systems create the potential for sales expansion.

A wetland = wet land! A natural wetland is an area saturated with water for longer than a week to a month each year, but whose average depth does not exceed 2 to 5 feet. Wetlands are identified in part by the plants and wildlife that live there, as well as by the type of soil and organic matter present.

PURIFYING MECHANISMS IN WETLANDS:

Water capture. Wetlands prevent flooding that can cause erosion or sediment deposition.

Gravity. Brings about settling of sediments.

Plant roots (and stems). Serve as (1) filters for sediments, (2) homes for microbes that use up nitrogen and break down other contaminants, (3) sinks for nitrogen, phosphorus and other compounds.

Soil. Filters solids. Soil particles also absorb phosphorus, pesticides etc.

Chemical processes. Allow further breakdown of pollutants to occur.

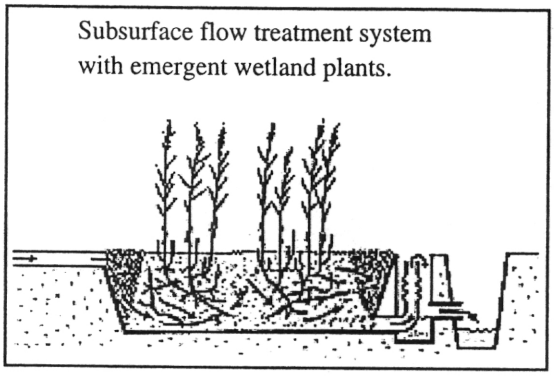
HOW DO WETLANDS TREAT WASTEWATER?

- **Wetland treatment takes advantage of the natural "cleansing action" of ordinary wetlands.** All wetlands (natural and artificial) act as filters. Wetlands support a wide variety of biological activities, which allow wetlands to take up large quantities of nutrients and other contaminants. See the side bar for a description of the wetland components that help to purify water, at work in all wetlands.

- **Constructed treatment wetlands are designed to incorporate characteristics of natural wetlands.** Media, plant selection, area setup and establishment time are all factored into artificial wetland design.

HOW DO I SET UP A TREATMENT WETLAND?

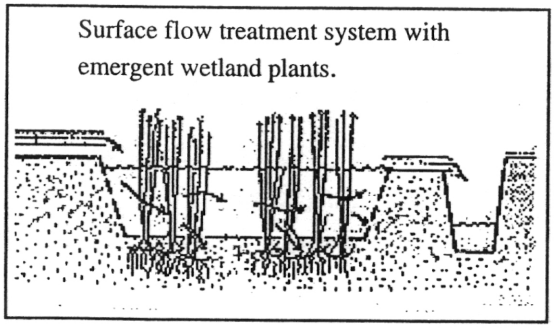
- **Two types of constructed wetland systems are typically recommended for wastewater treatment: subsurface flow and surface flow.** In both submergent flow and surface flow systems, wastewater is channeled through a (usually) rectangular, lined bed or detention pond in which water-loving plants grow. Beds are lined with various substrates, based on the preferences of the plants themselves, as well as the substrate's ability to take up nutrients such as phosphorus.



Subsurface flow treatment system with emergent wetland plants.

SUBSURFACE FLOW

Treatment occurs as wastewater flows through the root zone. Water moves just *below* the surface of the substrate. Microbes thrive on the surface of the media, often gravel, and in the roots of plants. Plants take up some nutrients. Because the water flow is "subsurface," mosquito and odor problems are minimized. Herbaceous emergent plants, such as pickerelweed (*Pontederia cordata)*, are suited to subsurface flow.



Surface flow treatment system with emergent wetland plants.

SURFACE FLOW

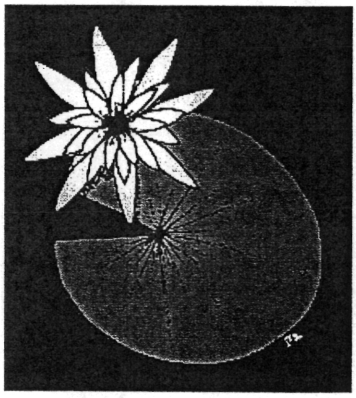
Treatment occurs as wastewater flows through plant litter and live vegetation *above* the substrate. Microbes attach to plant parts. Plants take up some nutrients. Shallow water is recommended for these systems as best for plant growth, best for treatment and easiest harvest. Good plants to use include floating aquatics such as water hyacinth *(Eichhornia)* or emergent vegetation, such as cattails (*Typha* sp.).

- **Simpler, but less effective, natural water capture and treatment methods include plant filter strips, wet ponds, and stormwater basins.** Best management practices (BMPs) for urban stormwater runoff often perform the same or similar function(s) as constructed treatment wetlands: water is pooled in or channeled into an area where wetland plants either volunteer or are deliberately established.

The major difference between these systems and those described above is the extent of treatment. The formal systems described above tend to be uniformly designed and lend themselves better to monitoring, whereas plant filter strips, for example, are designed with a lesser expectation of treatment. Nurserymen may feel a less complex design suits their purposes just as well.

WHAT DO I NEED TO KNOW ABOUT WETLAND PLANTS?

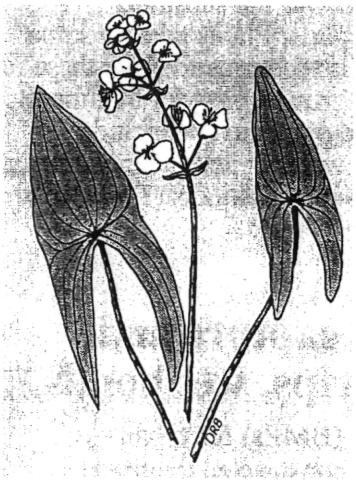
- **Two classes of plants are used in treatment wetlands: herbaceous emergent vegetation and floating aquatic vegetation.** While cattails, bulrushes, reeds, and water hyacinth are most commonly used in water treatment, other species have been shown to perform as well.



Waterlily, *Nymphea odorata*

FLOATING AQUATIC VEGETATION
such as water lettuce (*Pistia stratioides*), water hyacinth (*Eichhornia crassipes*), and water lily (*Nymphea odorata*).

These plants are among the most productive in the world, possessing extremely high growth rates. Their uptake of nutrients is rapid in the early growth stage. Because the roots of some floating aquatics (such as water hyacinth) dangle in water, these plants can strip nutrients directly from the water column, making them especially suitable for free surface flow treatment systems. Large standing crops are possible.



Arrowhead, *Sagittaria latifolia*

HERBACEOUS EMERGENT VEGETATION
such as big-leaved arrowhead (*Sagittaria latifolia*), common reed (*Phragmites australis*), and blue flag (*Iris versicolor*).

Many of these plants maintain their structure through winter, and thus store nutrients during their dormancy. Like floating aquatics, emergents are highly productive plants and therefore capable of high nutrient uptake and exceptional biomass production. Emergents are appropriate for both surface flow and subsurface flow systems. Roots and stems of these plants provide sites for microbial activity. Tolerant of a wide range of conditions, many of these plants, popularly and successfully used in water treatment, are native to our area.

- **The market is BOOMING! Expand your sales!** At one time, wetland plants were obtained through wild harvest. This practice is no longer legal. Today the market for aquatic and wetland plants is booming. Ornamental aquatics are popular for backyard water gardens; native wetland plants are in demand for wetland restoration and creation.

Winterberry, *Ilex verticillata*

- **Wetland and aquatic plants lend themselves to bareroot harvest and sales.** Herbaceous wetland plants propagate easily by seed, division or cuttings. Saleable plants (usually divisions) may be produced in weeks to months. Excellent propagation notes have been developed by W. E. Brumback (1991) and G. Thunhorst (1993).

- **Woody wetland plants thrive at the edges of wet areas.** Woody wetland plants are thought to store nutrients well, although their rate of nutrient uptake lags behind that of herbaceous species.

WHAT LAWS GOVERN CONSTRUCTED WETLAND ESTABLISHMENT OR NATURAL WETLAND DISRUPTION?

- **The Clean Water Act.** This is the most important federal law addressing water quality issues. This law protects all "waters of the U.S.," which means all bodies of water, large and small, some permantly wet (e.g. a lake) and others wet for extended periods of time each year (e.g. a wetland). On occasion, artificial wetlands which have been abandoned or upon which valued wildlife has become dependent have been deemed "waters of the U.S" as well. This law requires that all wastewater receive at least secondary treatment (the law specifies what this entails) before being released to any waters of the U.S. The Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (COE), and the U.S. Fish and Wildlife Service together oversee the implementation and enforcement of this act (3). See the side bar for descriptions of Sections 402 and 404.

- **The National Environmental Policy Act.** This act requires that the environmental impacts of various projects be assessed prior to their commencement. Usually the review process for small projects only involves an investigation of immediate effects on a small area. This law is enforced by the COE and the EPA (3).

WATER DISCHARGE. *Section 402 of the Clean Water Act, regarding National Pollutant Discharge Elimination Systems (NPDES)*, details the volume and chemical composition allowable for discharges of water or wastewater into "waters of the U.S." Permits are required for municiple and industrial discharges, primarily, but sometimes agricultural discharges as well. Stringency of these guidelines depends on the uses and value of the water into which wastewater is discharged. In Rhode Island, the NPDES permits are issued and enforced by the EPA (3).

DREDGE DISCHARGE. *Section 404 addresses regulation over the discharge of dredged and fill material into waters of the United States* Natural wetland disruption is a no-no; in fact, disruption of any of the waters of the U.S. is a no-no. Under certain circumstances, a natural wetland may be newly altered in order to establish a treatment wetland, such as in places where no appropriate dryland is available. Sometimes, law requires that compensation be made via mitigation in another location. In any case, permission must be obtained before wetland alteration ensues (3).

- **Upland treatment wetland facilities = no conflicts!**

LITERATURE CITED

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2. Pratt, James R. and Thomas Pluto. 1989. "Use of Wetlands for the Treatment of Industrial and Nonpoint Source Pollutants." *In:* Majumbar, S.K., *et al*, eds. *Wetlands Ecology and Conservation: Emphasis in Pennsylvania.* The Pennsylvania Academy of Science. Easton, PA. pp. 315-332.

3. Kadlec, Robert H. and Robert L. Knight. 1996. "Wetland Alternative Analysis." *Treatment Wetlands.* Lewis Publishers. Boca Raton, FL. pp. 561-602.

4. Wilkerson, D. C. 1990. "Know Your Options for Treating Greenhouse Runoff." *GrowerTalks.* Vol. 54(5): 34, 36, 38, 41-42, 44.

RECOMMENDED READING

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FOR ADDITIONAL TREATMENT WETLANDS INFORMATION

Contact Brian Maynard, Assistant Professor of Plant Sciences at the University of Rhode Island, (401)784-5372, or the RI Natural Resource Conservation Service.

ACKNOWLEDGEMENTS

The photograph of irrigation on p. 1 was taken from Kadlec & Knight, 1996, p 38. Diagrams of surface and subsurface flow treatment systems were provided by H. Brix's 1993 article, "Wastewater treatment in constructed wetlands..." in Moshiri's *Constructed Wetlands for Water Quality Improvement* . Drawings of all wetland plants can be found in G. Thunhorst's book, *Wetland Planting Guide for the Northeastern United States.* Additional information on these sources is provided under citations or recommended reading. These fact sheets were compiled by Deborah Zawadzki.