

# Greenhouse and Nursery Water Treatment Information System

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## Vegetated buffers

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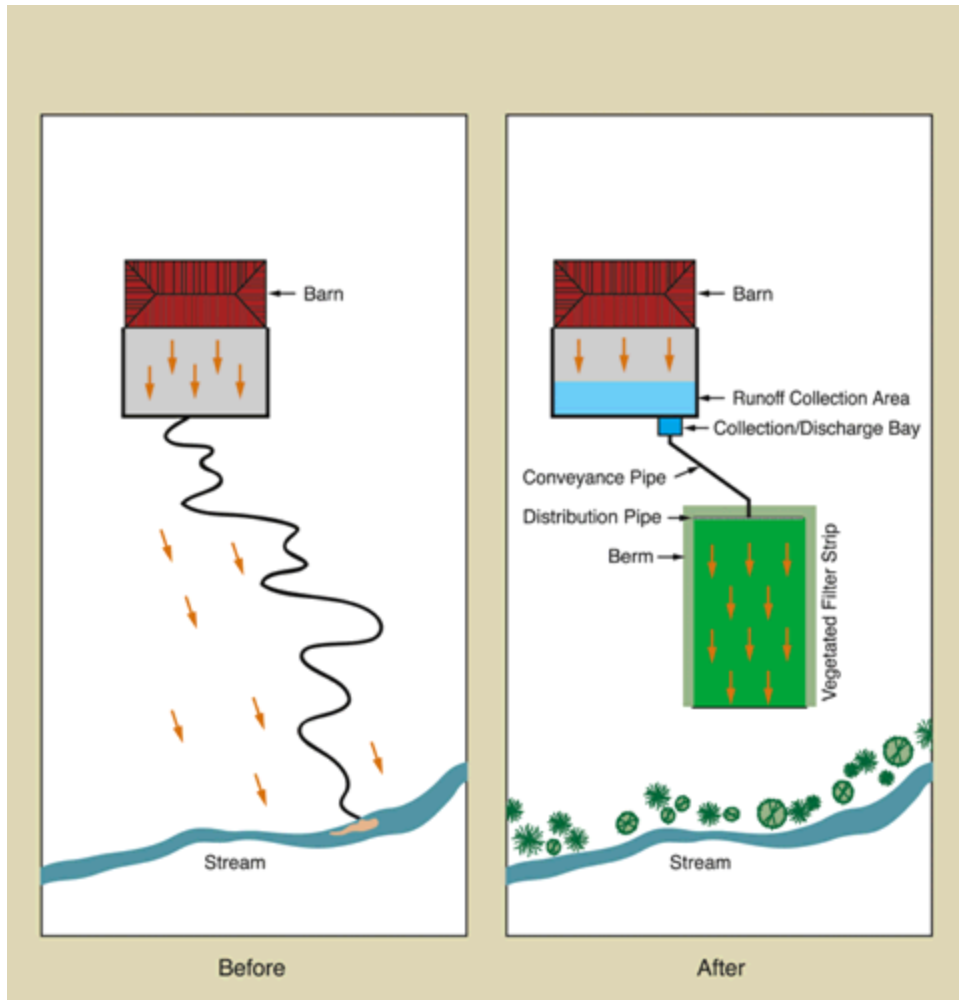
Allowing effluent water to flow through vegetated strips before entering surface water is one means of treating effluent. These structures are commonly encouraged and incorporated in agricultural systems. Vegetated buffers work to remove sediment, organic matter, nutrients, and pesticides from runoff water by slowing runoff velocity, allowing material to settle out and promoting infiltration into underlying soil (EPA, 2012). A number of designs of vegetated buffers exist. These systems all operate on the same principle, and are as such fairly similar. Systems include:

Vegetated swales: A strip of land that is densely vegetated and constructed for the purpose of taking in and slowing down runoff, so that particulate matter may settle out and infiltration may occur (Stone, 2010).

Vegetated filter strips: A strip of vegetated land through which runoff may flow (Fig 1). Can be oriented perpendicular to the bank of a body of water or run parallel along the bank.

Permanently vegetated areas: A forested area, permanent pasture, or permanent hayfield through which runoff may flow (Stone, 2010)

Grassed waterways: These buffers, planted with grass, are wide and often shaped like a shallow saucer (Fig 2; Stone and McKague, 2009). They are typically established in pre-existing drainage ways that are part of the natural topography of a field. By vegetating these drain ways and forming them into a saucer-shape, runoff can be spread out and slowed down, increasing infiltration into the ground and decreasing the amount of runoff that will reach surface water.



**Fig 1.** Diagram depicting vegetated filter strip for treating livestock effluent. Retrieved from OMAFRA (2011).



**Fig 2.** Photograph of a grassed waterway (including indication of the shallow saucer shape). Retrieved from Stone and McKague (2009).

However, one aspect of greenhouse and nursery effluent that sets it apart from other wastewater types more frequently treated by vegetated buffers is the high dissolved nutrient content, most importantly that of nitrate and phosphate (Prystay and Lo, 2001). Nitrate concentrations in nursery runoff can range from 0.2ppm to 300ppm, and phosphate from 0.6 to 144ppm, depending on the facility and time of year (Sharma et al., 2008). For greenhouses, phosphate concentrations have been reported to range from 40 to 284ppm, and nitrate from 30 to 362 ppm (Prystay and Lo, 2001). Research on the use of vegetated buffers for treatment of nursery or greenhouse runoff specifically is limited. The information below summarizes relevant information discussing the viability of vegetated buffers for adequate treatment of greenhouse/nursery effluent. For detailed guidelines on constructing vegetative buffers, several guide books are available. OMAFRA, for example, has a guide available < <http://www.omafra.gov.on.ca/english/environment/bmp/buffer.htm>>.

### **Nitrate removal**

Mayer et al. (2007) performed a meta-analysis of 45 studies to determine nitrate removal capabilities of various vegetated buffers (although constructed wetlands were included in this analysis). The studies included in the analysis all looked at treatment of wastewater with nitrate levels lower than those found in greenhouse/nursery runoff. They found buffers removed nitrate at an average rate of 0.394ppm per metre of buffer. This suggests that a very wide vegetated buffer would be needed to effectively remove nitrate from greenhouse/nursery effluent. The performance of the various systems tended to vary significantly, not just based on width. Soil type and soil hydrological characteristics likely also significantly affect nitrate removal capabilities (Mayer et al., 2007). This is further supported by Vidon and Hill (2004), who found that buffer strips on sandy loam soils removed nitrate more efficiently than

those on more sandy soils. More research specifically looking at greenhouse/nursery runoff needs to be done to determine if vegetated buffers can efficiently remove nitrate, particularly at times of high fertilizer application.

### **Phosphate removal**

Phosphorus in greenhouse/nursery effluent is primarily in the form of dissolved phosphate in solution. Vegetated buffer removal of dissolved phosphate (ie. phosphorus not in organic, mineral, or adsorbed form) is generally considered to be low (Dorioz et al., 2006; Gilliam, 1994). This is likely because, while vegetated buffers effectively retain particulate matter and any nutrient ions attached to this particulate matter, water flowing through these strips is moving too quickly for dissolved nutrients to be effectively taken up by plants or adsorbed to soil.

### **Pesticide removal**

Vegetated buffers are generally considered to be effective for removing pesticides from farm runoff, although this varies between pesticides and depends on the tendency of the pesticide to adsorb to sediment (Tang, 2012). Syversen and Bechmann (2004) found vegetated buffers (area of 5x5m to 5x7.5m) decreased concentrations of glyphosate, fenpropimorph, and propiconazole by 39%, 71%, and 63% respectively. Vianello et al. (2005) found concentrations of the herbicides metolachlor, terbuthylazine, and isoproturon in runoff were significantly decreased with the use of vegetated buffers, compared to without. In a study investigating retention of herbicides in nursery runoff, Briggs et al. (1999) found grassed waterways reduced isoxaben residues in runoff by 22% and trifluralin residues by 66%, compared to non-grassed waterways.

### **Pros and Cons**

Pros:

- Fairly low maintenance after establishment (EPA, 2012)
- Simple, low cost (Kabashima et al., 2003)

Cons:

- Tend to require a large amount of space
- Not very effective at removing dissolved phosphorus. Effectiveness at removing the levels of nitrate found in greenhouse/nursery runoff is unknown
- Would not be effective in the winter in temperate climates
- Fate of pesticides retained in the buffer (ie. risk of eventual release) have not been sufficiently evaluated (Tang, 2012)

### **Summary**

For removal of nutrients from runoff, vegetated buffers tend to be less effective than other treatment methods available (ie. constructed wetlands), largely due to the longer retention times and greater rate

of denitrification in constructed wetlands. If nutrient concentrations in runoff are to be minimized, it is likely vegetative buffers cannot be used as the sole method of effluent treatment. However, they may be useful for additional treatment after the effluent water has already gone through a primary treatment step. Kabashima et al. (2003) suggest a vegetative buffer was a useful addition to a system treating pesticide runoff from a commercial nursery, which also included sedimentation traps and irrigation practices to minimize runoff. A cost-benefit analysis is necessary before considering this technology, due varying effectiveness.

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