Reducing the Land Area Requirements of Natural Treatment Systems in Urban Areas

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Abstract

Natural treatment systems (such as wetlands, ponds, rain gardens and green roofs) offer multiple benefits (recreational, environmental, and economic) to urban cities. It is well recognized that the potential for multiple-benefit projects exist, however finding available land area in urban environments to implement "green" solutions remains a major challenge.

Various strategies for reducing the land area of natural treatment systems have been developed. These include combinations of mechanical treatment systems to elements such as green roofs, rain gardens, and constructed treatment wetlands. Another strategy is to intensify the wetland treatment process to minimize the land area required (Fonder and Headley, 2009). Wetland intensification methods currently in use include (Kadlec and Wallace, 2009):

- Varying the hydraulics of the constructed treatment wetland to convert the system from single-pass treatment to a system where water is passed through the wetland multiple times. These systems typically use flow recirculation or fill-and-drain hydraulics, with the addition of pumps to control the wetland water levels.
- Using reactive media to improve the efficiency of certain chemical reactions. For instance, phosphorus removal can be enhanced by the use of medias with a high phosphorus adsorption capacity (expanded clay aggregates, blast furnace slag, or apatite).
- Aerating the wetland to increase oxygen transfer, which improves removal of chemical oxygen demand and ammonia nitrogen.
- Using variable-volume floating treatment wetlands for applications (such as stormwater treatment) that experience wide swings in flow and loading conditions.

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- Adding nutrients (when appropriate) to ensure that balanced nutrient ratios are present for biological treatment of industrial effluents.

Case Study

The Mayfield Farm treatment wetland at London Heathrow airport is an example of how intensification of existing treatment works can dramatically improve the performance of “green” infrastructure. The Mayfield Farm system is designed to treat runoff from aircraft deicing during winter conditions. Deicing requires the use of glycol-based compounds that are very high in BOD concentrations.

The Mayfield Farm system consists of a 45,000 m^3 main reservoir, two floating treatment wetlands with a nominal volume of 4,000 m^3, a secondary balancing ponds, and twelve horizontal subsurface flow treatment wetlands with a total area of 20,800 m^2 (Worrall *et al.*, 2002; Richter *et al.*, 2003). The system was designed to treat flows at up to 40 Lps and a BOD mass loading of 380 kg/d.

The system was started up in 2002 and performance did not meet expectations, mainly because the BOD loadings were in excess of the original design parameters (Adeola *et al.*, 2009). A study was undertaken over the 2009-2010 deicing season to study the effects of wetland intensification, including mechanical aeration of the treatment wetlands (both the floating units and the horizontal subsurface flow beds), nutrient addition, and improved hydraulic controls.

Data collected over the course of the deicing season indicated that the combined effect of these intensification strategies could improve the BOD removal capacity from 380 kg/d to over 3,500 kg/d, and the flow rate could be increased from 40 Lps to 80 Lps. Based on the outcome of the 2009-2010 study, a major construction project is currently underway to upgrade and optimize the existing works.

To put this in the context of domestic wastewater treatment, a BOD removal capacity of 3,500 kg/d is a population equivalent of over 58,000 people, indicating that large-capacity “green” treatment systems can be implemented even in an urban, built environment. Intensification of the wetland increased the overall treatment capacity from approximately 6,300 PE to over 58,000 PE with no additional land. The intensified wetland system has a land area requirement of approximately 0.36 m^2/PE.

References

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