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Considerations in the Design of Treatment Best Management Practices (BMPs) to Improve Water Quality

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Notice

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Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threaten human health and the environment. The focus of the Laboratory's research program is on methods and their cost-effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and ground water; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

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Abstract

For the past three decades, municipalities in the United States have successfully addressed pollution in the watershed by collecting and treating their wastewater. Currently, all municipalities provide secondary level treatment, and in some cases tertiary treatment, and industries provide best available/best practicable treatment. This has had great benefits. More rivers are meeting water quality standards, and the public health is being protected from waterborne disease. The challenge now facing us is to address pollution associated with storm water runoff, since this is now the last major threat to water quality.

It is less costly to prevent the generation of polluted runoff than to treat it. Today, many municipalities are implementing low-cost best management practices (BMPs) that prevent runoff. The lowest cost BMPs, termed non-structural or source control BMPs, include practices such as limiting pesticide use in agricultural areas or retaining rainwater on residential lots (currently termed "low impact development"). There are a set of higher cost BMPs, which involve building a structure of some kind to store stormwater until it can be discharged into a nearby receiving water. These can be more costly, especially in areas where land costs are high. The three most commonly used structural treatment BMPs that will be discussed in the document are ponds (detention/retention), vegetated biofilters (swales and filter/buffer strips) and constructed wetlands. Two categories of treatment considered in this document are ponds and vegetated biofilters. Ponds are probably the most frequently used BMP in the United States. There are three types of pond BMPs: wet ponds (retention ponds); dry ponds (notably extended detention ponds); and infiltration basins. Three different types of vegetative biofilter BMP types are discussed: grass swales, vegetated filter strips, and bioretention cells. Grass swales include three variations: traditional grass swales, grass swales with media filters and wet swales.

This document presents factors that should be considered in the design of treatment BMPs to improve water quality. The state-of-the-practice is such that existing design guides vary and the performance of treatment BMPs shows a wide range of pollutant removal effectiveness.

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Acronyms and Abbreviations

ASCE	= American Society of Civil Engineers
BMP	= best management practice
BOD	= biochemical oxygen demand
CERCLA	= Comprehensive Environmental Response, Compensation and Liability Act
CZARA	= Coastal Zone Act Reauthorization Amendments
CZMA	= Coastal Zone Management Act
COD	= chemical oxygen demand
CWA	= Clean Water Act
EPA	= Environmental Protection Agency
EPT	= ephemeroptera (mayflies), plecoptera (stoneflies), and trichoptera (caddisflies)
ESA	= Endangered Species Act
EMC	= event mean concentration
FIFRA	= Federal Insecticide, Fungicide and Rodenticide Act
FWPCA	= Federal Water Pollution Control Act
IBI	= index of biotic integrity
MDE	= Maryland Department of the Environment
MTBE	= methyl tertiary butyl ether
NEPA	= National Environmental Policy Act
NGPE	= native growth protection easement
NMFS	= National Marine Fisheries Service
NOAA	= National Oceonographic and Atmospheric Administration
NPDES	= National Pollution Elimination Discharge Program
NRCS	= Natural Resources Conservation Service
NURP	= Nationwide Urban Runoff Program
OCZM	= Office of Coastal Zone Management
RCRA	= Resource Conservation and Recovery Act
RFS	= rainfall frequency spectrum
SCS	= Soil Conservation Service
SWMM	= StormWater Management Model
TMDL	= total maximum daily loads
TN	= total nitrogen
TP	= total phosphorus
TSS	= total suspended solids
UDFCD	= Urban Denver Flood Control District
USDA	= US Department of Agriculture
USFWS	= US Fish and Wildlife Service
USGS	= US Geological Survey

USTM = Unitied Stormwater model
WEF = Water Environment Federation
WEPP = Water Erosion Prediction Model
Wq_v = water quality volume
WWF = wet weather flow

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