Preface

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1.0 Acknowledgements

The Urban Storm Drainage Criteria Manual (USDCM), Volume 3, was first released in 1992 under the direction and leadership of Ben Urbonas, P.E., B.C.WRE. Although Mr. Urbonas retired from Mile High Flood District (MHFD) in 2008, he continued to serve as an advisor throughout the 2010 revision to Volume 3 and some of his ongoing work continued to inform updates in 2024, for which we are grateful. Each update builds upon the core philosophy, principles and practices developed by Mr. Urbonas and others. MHFD recognizes the significant contributions of those that continued to advance the state of the practice with ongoing updates to this manual. Notably, we recognize the work of Ken MacKenzie, P.E.

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2.0 Purpose

Volume 3 of the Urban Storm Drainage Criteria Manual (USDCM) is designed to provide guidance for engineers, planners, landscape architects, developers, and Municipal Separate Storm Sewer System (MS4) permit holders in selecting designing, maintaining, and carrying out best management practices (BMPs) to minimize water quality and quantity impacts from stormwater runoff. Whereas Volumes 1 and 2 of this manual focus primarily on stormwater quantity management for drainage and flood control purposes, Volume 3 focuses on smaller, more frequently occurring events that have the greatest overall

impact on the quality of receiving waters.

3.0 Overview

This manual is organized according to these topics:

- **Chapter 1: Stormwater Management and Planning.** In order to effectively design stormwater quality BMPs, it is important to understand the impacts of urbanization on receiving waters, as well as to understand the federal and state regulatory requirements under the Clean Water Act. Chapter 1 provides basic information on these topics and introduces UDFCD's approach to reducing the impacts of urban runoff through implementation of a holistic Four Step Process (see inset below). UDFCD continues to emphasize the importance of implementing all four steps in this process. Chapter 1 provides expanded guidance on Step 1 (Runoff Reduction), which has historically been implemented only minimally, but will be increasingly important to comply with new federal regulations and state stormwater discharge permits.

The Four-Step Process for Stormwater Quality Management

Step 1 Employ Runoff Reduction Practices: To reduce runoff peaks, volumes, and pollutant loads from urbanizing areas, implement Low Impact Development (LID) strategies, including measures to "minimize directly connected impervious areas" (MDCIA). These practices reduce unnecessary impervious areas and route runoff from impervious surfaces over permeable areas to slow runoff (increase time of concentration) and promote onsite storage and infiltration.

Step 2 Implement BMPs that Provide a Water Quality Capture Volume (WQCV) with Slow Release: After runoff has been reduced, the remaining runoff must be treated through capture and slow release of the WQCV. WQCV facilities may provide both water quality and runoff reduction benefits, depending on the BMP selected. This manual provides design guidance for BMPs providing treatment of the WQCV.

Step 3 Stabilize Drainageways: During and following urban development, natural drainageways are often subject to bed and bank erosion due to increases in the frequency, rate, duration, and volume of runoff. Although Steps 1 and 2 help to minimize these effects, some degree of drainageway stabilization is required. Many drainageways within UDFCD boundaries are included in major drainageway or outfall systems plans, identifying recommended channel stabilization measures. If this can be done early, it is far more likely that natural drainageway functions can be maintained with the addition of grade control to accommodate future development. It is also less costly to stabilize a relatively stable drainageway rather than to repair an unraveled channel.

Step 4 Implement Site Specific and Other Source Control BMPs: Frequently, site-specific needs or operations require source control BMPs. This refers to implementation of both structural and procedural BMPs.

- **Chapter 2: BMP Selection.** Long-term effectiveness of BMPs depends not only on proper engineering design, but also on selecting the right combination of BMPs for the site conditions. In addition to physical factors, other factors such as life cycle costs and long-term maintenance requirements are also important considerations for BMP selection. This chapter provides information to aid in BMP selection and provides the foundation for the *UD-BMP* and *BMP-REALCOST* design aid tools that accompany this manual.

- **Chapter 3: Calculation the WQCV and Volume Reduction.** Chapter 3 provides the computational procedures necessary to calculate the WQCV, forming the basis for design of many treatment BMPs. This chapter also covers the Excess Urban Runoff Volume (EURV) and full spectrum detention, developed to best replicate predevelopment peak flows. Additionally, procedures for quantifying runoff reduction due to the implementation of practices that reduce the effective imperviousness of the site are also provided. These procedures provide incentive to implement MDCIA practices and LID strategies.

- **Chapter 4: Treatment BMPs.** Chapter 4 provides design criteria for a variety of BMPs, generally categorized as conveyance practices and storage practices that provide treatment of the WQCV or EURV. A BMP Fact Sheet is provided for each BMP, providing step-by-step design criteria, design details, an accompanying design worksheet, and selection guidance related to factors such as performance expectations, site conditions and maintenance requirements.

- **Chapter 5: Source Control BMPs.** It is generally more effective to prevent pollutants from coming into contact with precipitation and/or from being transported in urban runoff than it is to remove these pollutants downstream. For this reason, guidance is provided on a variety of source control BMPs, which can be particularly beneficial for municipal operations and at industrial and commercial sites. Source controls and good housekeeping practices are also required under MS4 permits.

- **Chapter 6: BMP Maintenance.** Long-term effectiveness and safety of BMPs is dependent on both routine maintenance and periodic rehabilitation. Maintenance recommendations are provided for each post-construction treatment BMP in this manual.

- **Chapter 7: Construction BMPs.** Many different types of BMPs are available for use during construction. This chapter provides design details and guidance for appropriate use of these temporary BMPs.

Volume 3 BMPs

Treatment BMPs

Grass Swale
Grass Buffer
Bioretention/Rain Garden*
Green Roof
Extended Detention Basin
Retention Pond
Sand Filter
Constructed Wetland Pond
Constructed Wetland Channel
Permeable Pavement Systems
Underground BMPs

Source Control BMPs

Covering Outdoor Storage & Handling Areas
Spill Prevention, Containment and Control
Disposal of Household Waste
Illicit Discharge Controls
Good Housekeeping
Preventative Maintenance
Vehicle Maintenance, Fueling & Storage
Use of Pesticides, Herbicides and Fertilizers
Landscape Maintenance
Snow and Ice Management
Street Sweeping and Cleaning
Storm Sewer System Cleaning

**Referred to as Porous Landscape Detention in Previous Releases of Volume 3*

- **Glossary:** A glossary is included to provide users of Volume 3 with a basic understanding of terms used in this manual.

- **Bibliography:** Many references have been used to develop this Manual. The Bibliography provides a listing of these references for more detailed information on key topics.

4.0 Revisions to USDCM Volume 3

Volume 3 of the USDCM has been updated and expanded several times since it was first published in 1992 as our understanding of urban hydrology and BMP performance expanded, and as the design of various BMPs has been refined. Updates will continue as the needs of communities and regulatory requirements change, and as UDFCD continues to build, use, and monitor BMPs. In 2010, this major revision to Volume 3 was completed, including the following:

- Increased emphasis on runoff reduction, which is Step 1 of the Four Step Process. Although UDFCD has previously included runoff reduction as the first step in stormwater management, this step has not been routinely implemented. A significant change to the manual includes quantifying stormwater management facility sizing credits using quantitative methods when MDCIA and LID practices are implemented.

- Substantial revision to design criteria for several BMPs already in this manual and inclusion of BMPs not previously in this manual. Green roofs and Underground BMPs were added. Although UDFCD continues to strongly recommend treatment of runoff above ground, we also recognize the need to provide guidance related to underground BMPs when surface treatment is not practicable.

- Revision and expansion of the Construction BMPs chapter.

- Addition of supplemental guidance to promote more effective implementation of BMPs. This information is typically provided in the form of "call-out" boxes. While this manual remains focused on engineering design criteria, UDFCD also recognizes that it is helpful for designers to be aware of why certain criteria have been developed, how various practices can best be implemented on a site, opportunities to consider, and common problems to avoid.

- New Excel® worksheets to assist in BMP selection based on site-specific conditions, BMP design including integration of the EURV for use with full spectrum detention, and BMP performance expectations and life cycle costs.

5.0 Acronyms and Abbreviations

>	Greater Than
<	Less Than
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BOD	Biochemical Oxygen Demand
BMPs	Best Management Practices
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
cfs	Cubic Feet Per Second
COD	Chemical Oxygen Demand
CRS	Colorado Revised Statutes
CSO	Combined Sewer Overflow
CUHP	Colorado Urban Hydrograph Procedure
CWC	Constructed Wetland Channel
CWCB	Colorado Water Conservation Board
CWQCC	Colorado Water Quality Control Commission
CWQCD	Colorado Water Quality Control Division
DCIA	Directly Connected Impervious Areas
DO	Dissolved Oxygen
DRCOG	Denver Regional Council of Governments
DRURP	Denver Regional Urban Runoff Program
EDB	Extended Detention Basin
EMC	Event Mean Concentration
EPA	U.S. Environmental Protection Agency
ET	Evapotranspiration
EURV	Excess Urban Runoff Volume

fps	Feet per second
ft	Feet
FHWA	Federal Highway Administration
GB	Grass Buffer
GS	Grass Swale
H:V	Horizontal to Vertical Ratio of a Slope
HSG	Hydrologic Soil Group
i	Impervious Ratio of a Catchment (I_a/100)
I_a	Percent Imperviousness of Catchment
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
MCM	Minimum Control Measure
mg/L	Milligrams per Liter
µg/L	Micrograms per Liter
MDCIA	Minimize Directly Connected Impervious Areas
MS4	Municipal Separate Storm Sewer System
MSDS	Material Safety Data Sheets
MWCOG	Metropolitan Washington Council of Governments
N/A	Not applicable
NPDES	National Pollution Discharge Elimination System
NPV	Net Present Value
NRCS	Natural Resources Conservation Services
NTIS	National Technical Information Service
NTU	Nephelometric turbidity units
NURP	Nationwide Urban Runoff Program
NVDPC	Northern Virginia District Planning Commission
PA	Porous Asphalt

PC	Pervious Concrete
PICP	Permeable Interlocking Concrete Pavers
PLD	Porous Landscape Detention *(term replaced by Bioretention in 2010 update)*
PPS	Pervious Pavement System
ppm	Parts Per Million
RP	Retention Pond
RPA	Receiving Pervious Area
SCS	Soil Conservation Service (now the NRCS)
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SF	Sand Filter Extended Detention
SPA	Separate Pervious Area
SWMM	Stormwater Management Model (EPA)
TOC	Total Organic Carbon
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
UDFCD	Urban Drainage and Flood Control District
UIA	Unconnected Impervious Area
USCC	United States Composting Council
USDCM	Urban Storm Drainage Criteria Manual
USGS	United States Geological Survey
WERF	Water Environment Research Foundation
WQCV	Water Quality Capture Volume