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The use of Urban Stormwater Management Manual for Malaysia (MSMA 2nd Edition) requires professional interpretation and judgment. Appropriate design procedures and assessment must be applied to suit the particular circumstances under consideration.

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Second Printing
August 2012

Urban Stormwater Management Manual

Kuala Lumpur, Malaysia

ISBN 978-983-9304-24-4

Foreword

MSMA (Manual Saliran Mesra Alam), an abbreviation from Malay Language translation of Urban Stormwater Management Manual, has been widely accepted term and since become trade mark in the stormwater industry in Malaysia. The first edition of the Manual, published in 2000, has served as invaluable references for both authority and private professionals. The version included the latest standards and practices, technologies, best engineering practices that were generally based from foreign countries. The first edition was also quite voluminous and relatively difficult for engineers and professionals to use. Recognising all these and after ten (10) years time lapse, the Department decided that it is timely for the first edition be improved. This improved version is called MSMA 2nd Edition.

The MSMA 2nd Edition is developed through contributions from the Government as well as private sectors and foreign experts. The Manual has been simplified and updated to serve as a source of information and to provide guidance pertaining to the latest stormwater best management practices (BMPs). This is one of the many initiatives undertaken by the DID to further enhance its services parallel with ongoing transformations taking place in Government Department and private sectors.

There are just too many to name and congratulate individually, all those involved in preparing this Manual. Most of them are my fellow professionals who are well-respected within their fields. I wish to record my sincere thanks and appreciation to all of them and I am confident that their contributions will be truly appreciated by the users for many years to come.

Dato' Ir. Hj. Ahmad Husaini bin Sulaiman
Director General
Department of Irrigation and Drainage Malaysia

Acknowledgements

The Urban Stormwater Management Manual for Malaysia (MSMA 2nd Edition) has been prepared through the co-operative and collaborative efforts between governmental organizations, private agencies as well as individuals. The efforts of those involved in preparing this Manual are gratefully acknowledged.

Special thank goes to the Director General of Department of Irrigation and Drainage (DID) Malaysia, Yg. Bhg. Dato' Ir. Hj. Ahmad Husaini bin Sulaiman and Deputy Director General (Business Sector), Yg. Bhg. Dato' Ir. Nordin bin Hamdan.

This edition could not have been completed without the guidance and assistance of key staff members from DID's Stormwater Management Division recognized herein:
Ir. Leong Tak Meng, Ir. Hj. Abdul Hamid Md. Kassim, Dr. Hj. Md. Nasir Md. Noh, Anita Ainan, Dzulkifli Abu Bakar, Atikah Shafie and all the engineers and staff members who have contributed directly and indirectly to complete the manual.

The contribution of Technical Committee members are also acknowledge herein:
Ministry of Natural Resources and Environment, Ministry of Housing and Local Government, Department of Environment, National Landscape Department, Town and Country Planning Department, Real Estate and Housing Developers' Association Malaysia (REHDA), Association of Consulting Engineers Malaysia (ACEM), Malaysian Institute of Architects (PAM), Institution of Engineers Malaysia (IEM), Construction Industry Development Board (CIDB), Master Builders Association of Malaysia and all other agencies that has contributes directly and indirectly to the completed manual

The insights from the expert international reviewer, Dr. Ben Urbonas of United States of America and Dr. Geoffrey O'Loughlin of Australia are greatly appreciated.

Last but not least, special recognition is expressed for our consultant, PWM Associates Sdn. Bhd. and his key team members who had contributed invaluable part of the process that led to the completed manual. The names of the many individual contributors and reviewers who helped in the development of this manual are listed in the List of Contributors.

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Abbreviations

AARY	Average Annual Rainwater Yield
AASHTO	American Association of State Highway and Transportation Officials
ACT	Australian Capital Territory
AEP	Annual Exceedance Probability
AN	Ammoniacal Nitrogen
ANCOLD	Australian National Committee on Large Dam
API	American Petroleum Institute
AR&R	Australian Rainfall and Runoff
ARC	Atlanta Regional Commission
ARI	Average Recurrence Interval
AS	Australian Standard
ASCE	American Society of Civil Engineers
BIOECODS	Bio-Ecological Drainage System
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
CAD	Computer Aided Design
CDM	Camp Dresser & McKee
CFWP	Centre for Watershed Protection, Australia
CIRIA	Construction Industry Research and Information Association, UK
CMP	Corrugated Metal Pipe
COD	Chemical Oxygen Demand
CWA	Concrete Washout Area
DC	Design Chart
DCP	Discharge Control Pit
DID	Department of Irrigation and Drainage Malaysia
DOE	Department of Environment Malaysia
DOP	Drainage Outlet Protection
ECB	Erosion Control Blanket
ED	Extended Detention
EGL	Energy Grade Line
EL	Elevation
EMC	Event Mean Concentration
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FHWA	Federal Highway Administration, USA
FOS	Factor of Safety
GIS	Geographic Information System
GPTs	Gross Pollutant Traps
GWL	Ground Water Level
GWT	Ground Water Table

HAT	Highest Astronomical Tide
HGL	Hydraulic Grade Line
HW	Head Water
HWL	High Water Level
IDF	Intensity Duration Frequency
JKR	Jabatan Kerja Raya (Public Works Department) Malaysia
LAT	Lowest Astronomical Tide
LOC	Limits of Construction
LSD	Land Survey Datum
LWL	Low Water Level
MAR	Mean Annual Rainfall
MDE	Maryland Department of the Environment, USA
MHHW	Mean Higher High Water
MHWS	Mean Higher Water Spring
MLLW	Mean Lower Low Water
MPCA	Minnesota Pollution Control Agency
MSA	Material Storage Area
MSL	Mean Sea Level
MSMA	Manual Saliran Mesra Alam (Urban Stormwater Management Manual for Malaysia)
MUSLE	Modified Universal Soil Loss Equation
NPS	Non-point Source
NRW	Natural Resources and Water
NSW	New South Wales
NTU	Nephelomatric Turbidity Unit
NZS	New Zealand Standard
O&G	Oil and Grease
OGI	Oil and Grease Interceptor
OSD	On-site Detention
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PSD	Permissible Site Discharge
QUDM	Queensland Urban Drainage Manual
RCD	Reinforced Check Dam
RMHM	Rational Method Hydrograph Method
RWHS	Rainwater Harvesting System
SB	Sediment Basin
SBB	Sand Bag Barrier
SBTR	Sedimentation Basin Trash Rack
SCADA	Supervisory Control and Data Acquisition
SCL	Sediment Control Log
SCS	Soil Conservation Services, USDA
SIRIM	Standards and Industrial Research Institute of Malaysia

SOP	Standard Operation Procedure
SR	Surface Roughening
SSA	Stabilized Staging Area
SSR	Site Storage Requirement
ST	Sediment Trap
SUDS	Sustainable Urban Drainage Systems
TDH	Total Dynamic Head
TH	Total Head
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TPF	Temporal Pattern in Fraction
TRM	Turf Reinforcement Mats
TSC	Temporary Stream Crossing
TSD	Temporary Slope Drain
TSS	Total Suspended Solids
TW	Tail Water
UDFCD	Urban Drainage and Flood Control District, Denver
UPVC	Unplasticised Polyvinyl Chloride
USBR	United States Bureau of Reclamation
USDA	United State Department of Agriculture
USDOT	United States Department of Transportation
USEPA	United State Environmental Protection Agency
USLE	Universal Soil Loss Equation
VTC	Vehicle Tracking Control
WQV	Water Quality Volume
WSE	Water Surface Elevation
WSUD	Water Sensitive Urban Design
YAS	Yield After Spillage
YBS	Yield Before Spillage

INTRODUCTION TO THE MANUAL

This Urban Stormwater Management Manual for Malaysia (MSMA 2nd Edition) is an improved version of the MSMA 1st Edition that provides planning and design guidance to all those involved in the management of stormwater.

Users are advised to read this section before start using the Manual. Chapters 1, 2 and 3 serve as the driver of the Manual while the rest, Chapter 4 to 20, detail the necessary design methods and procedures on relevant stormwater facilities. This edition is supplemented and ended with Annexures; on ecological plants and maintenance.

Stormwater management design requires a multi-skills and multi-disciplinary approach and it should be expected that some Chapters are interrelated. However, each Chapter is simplified, concised and complete in the coverage of its own subject material.

1. GENERAL

1.1 Goal and Objectives

The goal of this Manual is to provide easy guidance to all regulators, planners and designers who are involved in stormwater management implementation, which is often undertaken by a number of organisations. The challenge is to ensure that the administration of the planning, design and maintenance of stormwater management systems is consistent across the relevant Local, State and Federal Authorities and the professions of urban development, environmental, water resources, civil engineering and landscape architecture.

Under this direction, stormwater management will have multiple green and hazards-free objectives within and downstream of development area

- Ensure the safety of the public;
- Control nuisance flooding and provide for the safe passage of less frequent or larger flood events;
- Stabilise the landform and control erosion;
- Minimise the environmental impact of runoff; and
- Enhance the urban landscape and ecology.

1.2 Scope

This Manual covers most of the important aspects and requirements of stormwater management practices for new and existing urban areas.

1.3 Required Knowledge

Engineers, architects, planners and others who are involved in applying the guidelines set out in this Manual should have undertaken an appropriate course of study in their subject. For example, design engineers are expected primarily to have undertaken a course in hydrology and hydraulics, within tertiary civil engineering curriculum or equivalent experience, in order to apply the subject matter in the Manual.

1.4 Related Stormwater Management Documents

The related document "Design Guides for Erosion and Sediment Control in Malaysia (DID, 2010)" should be considered when planning urban development and/or designing stormwater management infrastructure.

2. ENHANCED DESIGN SKILLS

The Manual explains the design methods of each stormwater management control components in subsequent chapters. Users should not limit themselves only to the material available within this Manual but also to have initiatives in research to enhance their design and to continuously build up knowledge in this aspect which can subsequently be added on to enhance their design skills. Users should explore maximum combinations of these components as are practicable to meet their design objectives.

3. CONTENTS

The Chapters were prepared covering mainly administration, quantity control design, quality control design and conveyance design. They are accompanied by Annexures on planting and maintenance. In each design chapter, background information, analysis and simplified design procedures are presented. Where appropriate, supporting basic theory and worked examples are also provided to assist the users.

3.1 Administration and Requirement

These early sections are the key that sets requirement and direction to enable users to start and finish the facility design process of a stormwater facility project. Chapter 1 – Design Acceptance Criteria provides mainly design Average Recurrence Intervals (ARIs) for both quantity control and conveyance system as well as prescribed Water Quality Volume (WQV) for quality control system.

Before proceeding to subsequent design Chapters, design fundamentals for quantity and quality management facilities are provided in Chapters 2 and 3, respectively. They present hydrologic, hydraulic and water quality principles, methods and procedures that are inherent in the stormwater system design.

These three (3) Chapters 1, 2, and 3 are the pre-requisites to the rest of the chapters in the Manual.

3.2 Quantity Control System Design

Quantity control facilities covered in the Manual basically deal with control at premise level; Roof Drainage (Chapter 4), On-site Detention (Chapter 5) and Rainwater Harvesting (Chapter 6) while at community level using Detention Pond (Chapter 7). OSD, combined with rainwater tanks, would be preferred as they reduce more runoff peak at small scale.

Detention pond is regarded as the most cost-efficient mean of reducing peak flood runoff. A step-by-step procedure is detailed out in text and worked example involving pond routing, based on storage-indication curve, in each Chapter 2 and 7.

3.3 Quality Control System Design

Quality control or best management practices (BMPs) design covered in the Manual are for permanent facilities; Infiltration (Chapter 8), Bioretention (Chapter 9), Swales (Chapter 14), Gross Pollutant Traps (Chapter 10), Water Quality Pond and Wetlands (Chapter 11) as well for construction Erosion and Sediment control (Chapter 12).

The main parameters of concern are sediment, total suspended sediment (TSS), total phosphorus (TP) and total nitrogen (TN). TSS is known to have been the most important pollutant for treatment as it is more readily settled out and removed. Attached with it in water column are some heavy metals and oil and grease.

3.4 Conveyance System Design

Design procedures for conveyance system, minor and major, are found in Chapter 13 (Pavement Drainage), Chapter 14 (Drain and Swales), Chapter 15 (Pipe Drain), Chapter 16 (Engineered Channel), Chapter 17 (Bioengineered Channel), Chapter 18 (Culvert) and Chapter 19 (Gate and Pump). Chapter 20 contains various

hydraulic structures as integral components of stormwater facilities. These facilities convey runoff from premise level to receiving waters, lakes, rivers and seas, connecting both quantity and BMPs structures.

Swales are recommended in most areas while lined drain or pipe drain are suitable in highly urbanised zones. Bioengineered systems deals more with visual and ecological objectives of development. Culvert, gate and pump are common practices and their design procedures are found also in most hydraulic documents elsewhere.

Design procedures for gate and pump are provided to guide users in solving stormwater disposal difficulties in high tailwater boundaries normally experienced at lowland areas closed to rivers and shorelines.

3.5 Facility Planting, Maintenance and Care

Each stormwater facility shall involve planting to enhance its ecological, environmental and visual quality purposes. Annexure 1 provide lists and guidance of various ecological plants, obtained locally, for possible application at various sites, primarily Detention Pond (Chapter 7), Infiltration (Chapter 8), Bioretention (Chapter 9), Swales (Chapter 14), Water Quality Pond and Wetlands (Chapter 11) and Bioengineered Stream (Chapter 17).

Annexure 2 independently provides the required inspection, maintenance and caring procedures for most of the stormwater facilities found in the Manual.