Hydrology Standards

VOLUME 2 of the Sacramento City/County Drainage Manual

PART 1:

Methods and Design Charts

Chapter 1

Overview

Introduction

City/County Drainage Manual

These Hydrology Standards are part of a five-volume *City/County Drainage Manual* developed jointly by the Sacramento County Water Resources Division and the City of Sacramento Department of Utilities Division of Engineering Services. The *City/County Drainage Manual* consists of the following five volumes:

- Volume 1 - Goals and Policies
- **Volume 2 - Hydrology Standards**
- Volume 3 - Hydraulic Structures Design Standards
- Volume 4 - Design of Joint-Use Stormwater Detention Standards
- Volume 5 - New Development Stormwater Quality Standards.

Objective

The objective of this volume is to present the accepted methods for estimating surface water runoff peak flows and volumes for the analysis and design of drainage facilities in the City and County of Sacramento.

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Introduction (continued)

Background

Sacramento County has been estimating runoff flows for the design of drainage facilities since the early 1960's using charts and equations developed by George S. Nolte Consulting Civil Engineers. Use of these charts and equations has historically been referred to as the Nolte method. The City of Sacramento has used constant unit discharge rates similar to those given on the Nolte charts for small areas. More recently, the City and County of Sacramento have developed the Sacramento method, based on the Bureau of Reclamation urban unit hydrograph. The new method takes advantage of the advances in computer modeling techniques and the availability of current rainfall and runoff data. The Sacramento method can be used for all drainage design but is especially suited for design of large drainage facilities and masterplanning studies. A third hydrologic method has been developed by J.F. Sato and Associates to determine the runoff storage volume required for the design of water quality detention basins. These three methods, Nolte, Sacramento, and Sato are described in this volume, with a primary focus on the Sacramento method.

Design Methods

Nolte Method

The Nolte method has provided design flows for basins of all sizes and land uses since the early 1960's. The predominant use of the Nolte method has been the Nolte design charts for areas less than 2 square miles (520 hectares). The drainage facilities designed with the Nolte charts over the past 30 years have been found adequate and will continue to be used for street drainage and storm drain design in Sacramento County. The City of Sacramento will continue use of the constant unit discharge rates to size pipes for infill developments (areas connecting to older drainage infrastructure), but may also use the Nolte charts at their discretion.

Sacramento Method

The Sacramento method is a hydrograph method recently developed by the City and County of Sacramento. The method uses the Bureau of Reclamation urban unit hydrograph as a basis for estimating runoff hydrographs. The method uses the U.S. Army Corps of Engineers, Flood Hydrograph Program, HEC-1, to calculate, route and combine runoff hydrographs. An HEC-1 preprocessor, SACPRE, was developed which processes local hydrologic parameters and precipitation to create the HEC-1 input. Design charts have also been created to expedite design flow calculations for basins less than 640 acres (260 hectares).

The Sacramento method is to be used for major drainage facility design, masterplanning, contributing drainage areas greater than 640 acres (260 hectares), and for street and storm drain design which the City or County determines are subject to special circumstances.

Sato Method

Urban stormwater management has been expanded to address water quality issues in addition to the traditional water quantity issues. One of the most common best management practices recommended for water quality enhancement is the dry-extended detention basin. J.F. Sato and Associates have developed a method to determine the optimum volume of storage for water quality detention given the impervious percentage of a drainage area. A design chart, specific to the City and County of Sacramento, was developed using the Sato method. The Sato design chart is to be used for sizing water quality detention basins which have less than 640 acres (260 hectares) of contributing drainage.

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Design Methods (continued)

Summary of Design Methods

The design methods, Nolte, Sacramento, and Sato are to be used for runoff calculations in the City and County of Sacramento. The recommended design methods, their appropriate applications, design tools provided, and locations of additional information in this volume are summarized below.

Application		Agency	Method	Basin Size	Hydrologic Calculation	Design Tools	Reference
Design of: • street drainage • storm drains • culverts not associated with channels	Standard	County	Nolte	<640 ac <260 ha	Flow	Design Charts	Chapter 2
	Infill*	City	0.20 to 0.30 cfs/acre				
Design of: • street drainage • storm drains • culverts associated with channels	Special Case	County	Sacramento	<640 ac <260 ha	Flow	Design Charts, or HEC-1 and SACPRE	Chapter 2 Part 2
	Standard	City					
Master Plans Design of: • open channels • bridges • culverts not associated with channels • detention basins	Standard	City and County	Sacramento	No limit	Flow and Volume	HEC-1 and SACPRE	Part 2
Water Quality Detention Basins	Standard	City and County	Sato	<640 ac <260 ha	Volume	Design Chart	Chapter 2

*Unit flow rates will be used in the City only in infill areas, and only if it gives higher design values than the Sacramento method (see Chapter 2).

Consult with the City and County of Sacramento regarding specific design criteria for proposed new developments that connect to existing pipe drainage facilities with limited capacity and/or restricted overland release to an open channel. The agencies may require use of the Sacramento method for analysis.

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Design Methods (continued)

Other Methods

The three methods just described provide a regional approach to hydrologic analysis. Alternative hydrologic parameters or methods may be used with concurrence of the City or County when site specific data is available that provides a better determination of hydrologic parameters or when an alternative method is more appropriate. If the Corps of Engineers hydraulic program UNET is used, inflow hydrographs should be determined using SACPRE, where applicable.

Consistency

In general, the Sacramento method generates higher values than the Nolte design charts. Differences in design flows from the two methods must be accounted for in both facility design and masterplanning.

Design

Infrastructure designed with the Sacramento method will have a greater capacity than infrastructure designed with the Nolte method. Therefore, if the upper portion of a basin is designed according to the Sacramento method, the lower portion should be also be designed with the Sacramento method. Should the lower portion of the basin have existing infrastructure designed to the Nolte method, storage should be provided to attenuate flows to the capacity of downstream facilities and/or ensure that there is adequate overland release.

Masterplanning

The Sacramento method will be used for masterplans and the design of major facilities. Masterplans of large basins will include smaller subbasins with infrastructure designed to the Nolte method. Runoff from the subbasins designed with the Nolte method will be attenuated as a result of the lower capacity infrastructure. This should be reflected in the HEC-1 Sacramento method models through the basin lag time, flow diversions, or storage routing techniques as discussed in Part 2, Chapter 8.

Design Aids

Design Charts for Areas <640 Acres (260 Hectares)

Design charts have been created for determining runoff to drainage facilities with less than 640 acres (260 hectares) of contributing area. The peak flow charts are to be used for street drainage and storm drain design and were developed according to either the Nolte or Sacramento method. A design chart is also included for determining the quantity of storage required for water quality detention basins using the Sato method. These charts are presented and discussed more thoroughly in Chapter 2.

HEC-1 Flood Hydrograph Package

HEC-1 is a mathematical watershed model developed by the U.S. Army, Corps of Engineers, Hydraulic Engineering Center. The model is primarily designed to simulate the surface water runoff response from one basin or from a network of hydraulically connected basins.

Input

The model requires an input file which contains the design storm, the hydrologic characteristics of the basins and the hydraulic characteristics of the drainage network which conveys the flows from these basins.

Output

The model output contains computed runoff hydrographs at desired locations within the basin.

Technical assistance and computer versions of the HEC-1 program are available through private sector vendors.

HEC-1 Preprocessor, SACPRE

Included with this volume on 3 1/2-inch computer disk is an interactive program, SACPRE, which is a preprocessor for the Corps of Engineers, HEC-1 program. The preprocessor was developed to facilitate and standardize the creation of HEC-1 input files. The program consists of interactive computer screens which prompt the user to input the required information for hydrologic calculations according to the Sacramento method. The program also aids the user in determining appropriate hydrologic and hydraulic parameters for runoff calculations. Additional information on the preprocessor is provided in Part 3.

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Design Aids (continued)

Tables and Assumptions on Disk

In addition to SACPRE, the computer disk also contains files (in both WordPerfect 5.2 and ASCII text formats) for all SI tables and various other tables used in this volume, and are noted as (disk). These are provided in digital rather than print form for ease in presenting the main topics. Additionally, the disk contains files that list the assumptions used in deriving certain figures.

Maps

Some hard copy maps which provide information for hydrologic calculations are included with this volume. All of the maps are available as AutoCad drawings on diskette upon request to the Sacramento County Water Resource Division (excluding topography). A summary of the maps is given below.

Map	Information	Included in this volume
7 1/2 minute quadrangle maps of Sacramento City and County	• Topography • Hydrologic soil types • Major drainage basins	Yes
Drainage Basin Masterplan Watershed Boundaries	• Detailed subbasin boundaries for drainage basins which have been masterplanned.	No
Sacramento County General Plan	• Sacramento County Land Use	No
Elliptical Isohyetal Storm Patterns	• Isohyetal patterns for all design frequencies	No
Sacramento City and County Precipitation Map	• Precipitation zones for Sacpre method • Average annual precipitation • Rain gage locations in the County	Yes

Technical Reports

During the development of the Sacramento method, various analyses were conducted to evaluate the new hydrologic method, and the sensitivity of the method to several key parameters. These analyses are documented in various technical reports in the Appendix.