CHAPTER 13

STORM DRAINAGE

Chapter Table of Contents

13. 1 Introduction

This Chapter provides information for the planning and design of storm drainage. The methodology is intended for those with an understanding of basic hydrologic and hydraulic methods and some experience in the design of hydraulic structures.

Much of the information in this chapter was originally presented in the FHWA's "Hydraulics Engineering Circular No. 22 – Urban Drainage Design Manual" (HEC-22) and "American Association of State Highway and Transportation Officials Model Drainage Manual".

13. 2 Design Objectives

The placement and hydraulic capacity of storm drainage systems should be evaluated early in project development to take into consideration damage to adjacent property, the design traffic service requirements, available funds, and to secure as low a degree of risk of traffic interruption by flooding as is consistent with the importance of the road.

The design of a drainage system must address the needs of the traveling public as well as those of the local community through which it passes. The drainage system for a roadway traversing an urbanized region is more complex than for roadways traversing sparsely settled rural areas.

This is often due to:

- the wide roadway sections, flat grades, both in longitudinal and transverse directions, shallow water courses, absence of side channels;
- the more costly property damages which may occur from ponding of water or from flow of water through built-up areas;
- the fact that the roadway section must carry traffic, but also act as a channel to convey the water to a disposal point. Unless proper precautions are taken, this flow of water along the roadway will interfere with or possibly halt the passage of highway traffic.

13. 3 Definitions

Definitions of terms which will be important in a storm drainage analysis and design are provided in this section. These and other terms defined in the manual glossary will be used throughout the remainder of this chapter in dealing with different aspects of storm drainage analysis.

Crown - The crown, sometimes known as soffit, is the top inside of a pipe.

Grate Perimeter - The sum of the lengths of all sides of a grate, except that any side adjacent to a curb is not considered a part of the perimeter in weir flow computations.

Inlet Efficiency - The ratio of flow intercepted by an inlet to total flow in the gutter.

Lateral Line - Sometimes referred to as a lead, has inlets connected to it but has no other storm drains connected. It is usually 15 inches or less in diameter and is tributary to the trunk line.

Sag Point - A low point in a vertical curve.

Sag Point, Local - A localized low point in a warped shoulder or road profile of limited length. Ponding water has an opportunity to reach other downstream inlets if inlets are clogged.

Sag Point, Main Line – A low point in the roadway centerline vertical curve. Ponding water has no other outlet than from inlets in this location.

Sag Point, Major - A major sag point refers to a low point that can overflow only if water can pond to a depth of 1.5 feet or more.

Scupper – A vertical hole through a bridge deck for the purpose of deck drainage. Sometimes, a horizontal opening in the curb or barrier is called a scupper.

Side-Flow Interception - Flow which is intercepted along the side of a grate inlet, as opposed to frontal interception.

Trunk Line - A trunk line is the main storm drain line. Lateral lines may be connected in at inlet or access structures. A trunk line is sometimes referred to as a "main".

13. 4 Design Guidelines

Storm drainage systems can be classified into two major categories based on design: (1) pavement drainage (2) storm drainage. Pavement drainage design consists of gutter flow analysis, and inlet capacity and spacing analysis. Storm drainage design consists of access structure analysis, pipe sizing, and hydraulic grade line analysis.

The goal is to design a storm drainage system to remove surface water from highway pavement and/or prevent runoff from reaching the roadway. For designs to meet this purpose requires balancing the risk of future damages from runoff events against the initial construction cost. Therefore, aspects of pavement drainage and storm drainage guidelines that address this design goal are included in this chapter or in their respective chapters.

The design of a storm drainage system is generally a process that evolves as a project develops. The components to this process are listed below in a general order by which they may be carried out. The components to this process include data collection, coordinating the design with other agencies, hydrology calculations, designing/analyzing pavement and storm drainage features (gutters and ditches, inlets, access structures, storm drains, drywells, outfall energy dissipators), preparing contract plans, specifications and/or special provisions.

Guidelines for the following topics can be located in their respective chapters:

- Data Collection – **Chapter 6**
- Coordinating the design with other agencies – this is a very important element to the design process of storm drainage. Coordinating ODOT work with cities and counties would:
  - inform the designer of local drainage ordinances that ODOT projects must satisfy.
  - benefit ODOT because it allows for local agencies demonstrating a need to participate in defining the scope of the project and presents an opportunity for cost sharing.
- Hydrology – **Chapter 7**
- Designing/analyzing drainage features:
  - Gutters and ditches – **Chapter 8**
  - Inlets (capacity and spacing) – Chapter 13, Appendix C and Appendix D
  - Access Structures – **Chapter 13**, Appendix E
  - Storm drains – **Chapter 13**, Appendix F
  - Hydraulic Grade line – **Chapter 13**, Appendix G
  - Drywells – **Chapter 14**
  - Energy dissipators – **Chapter 11**
- Prepare contract plans – ODOT Contract Plans and Development Guide
- Prepare specifications and/or special provisions – ODOT Specification Manual

13. 5 Documentation

Chapter 4 provides documentation guidelines for stormwater drainage systems. The documentation guidelines provided in **Chapter 4** for standard stormwater designs and significant facilities are of interest for designers within the agency and consultants.

Standard stormwater designs include roadway inlets, small storm drains and small channels or ditches. This information is part of the drainage design provided to the roadway designer who incorporates the drainage features into the roadway design. It also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently. As discussed in **Chapter 4**, in most cases the package of design documentation (e.g. calculations, assumptions, drainage map, and narrative) should be bound together with a cover letter sealed by the engineer.

Significant facilities design includes storm drain systems with pipes larger than 24 inches in diameter. As discussed in **Chapter 4**, a storm drainage report is typically prepared documenting facility design information such as type, size, location, critical dimensions, and features.

Note: Documentation for a stormwater design should provide all information needed to review the drainage design and verify that design objectives and standards have been met.

13. 6 Design Recurrence Interval

The design recurrence interval is a significant variable in the design of highway storm drainage. Selecting the recurrence interval involves decisions regarding acceptable risks of accidents, traffic delays, existing and future conveyance capacity needs, and system costs. The selected recurrence interval that provides reasonable safety for traffic and pedestrians is used to evaluate and design all components of highway drainage such as gutter flow, inlet capacity, drainage piping, open channels and energy dissipators. Storm drainage design recurrence intervals are summarized in **Chapter 3** and in the following appendices.

13. 7 Hydrologic Methods

13.7.1 Rational Method

The design discharge used in sizing storm drainage systems is determined by the rational method.

The rational method is the most common and most simple method in use for the design of storm drains when the momentary peak flow rate is desired. Its use should be limited to systems with drainage areas of 200 acres or less. Additional rational method limitations and assumptions are presented in **Chapter 7**, Appendix F.

13.7.2 Other Hydrologic Methods

Other methods are often used to calculate peak discharge rates and runoff hydrographs from larger or more hydraulically complex basins. Refer to **Chapter 7** for additional discussion of these methods and example applications.