



Introduction to Stormwater Drainage System Design

Design Manual

Chapter 4

Drainage

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Sections 4A-1 through 4A-10 of this chapter provide policy for stormwater drainage system design. The basis for this policy is [FHWA's Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22](#) (referred to as HEC-22). Consult HEC-22 for further guidance and situations not covered by this chapter.

Stormwater Drainage Systems

The function of stormwater drainage systems is to collect minor design storm runoff and convey major design storm (flood) runoff to a discharge point. A stormwater drainage system can be as simple as a ditch that outlets to a stream or as complex as a system comprising numerous intakes, manholes, and pipes along with ditches, stormwater retention or detention basins, and pump stations.

Stormwater drainage systems consist of two components: the minor system and the major system.

Minor Systems

Minor systems (or “convenience” systems) are designed to carry runoff from a minor design storm event. In this manual, a minor design storm is generally taken to be a storm event that has a 10% probability of being equaled or exceeded in any year (often referred to as the 10-year storm). Minor systems consists of curbs, gutters, inlets, pipe and other conduits, open channels, pumps, detention basins, water quality control systems, etc.

Major Systems

Major systems are designed to convey stormwater flow that exceeds the capacity of the minor system. This usually occurs during a major storm event. In this manual, a major design storm is generally taken to be a storm event that has a 1% probability of being equaled or exceeded in any year (often referred to as the 100-year storm). Major systems consist of designated overland flow routes such as streets, ditches, and swales which direct runoff to natural or manmade channels. Routing paths should be evaluated and appropriate flowage easements obtained for major storm runoff.

Storm probabilities and recurrence intervals are discussed in more detail in Section [4A-5](#).

The objective for roadway stormwater drainage systems is to provide safe passage for vehicular and pedestrian traffic. For these systems to function properly, they must be designed to:

- Quickly drain minor design storm runoff from the pavement surface, and convey this runoff through the minor system to a discharge point, without the system backing up at collection points (intakes) creating the potential for flooding.
- Convey major design storm (flood) flows through the major system to a discharge point.
- Discharge stormwater without adverse on- or off-site impacts and without increasing downstream erosion or sedimentation.

The Design Process

A preliminary design field review of the stormwater drainage system location and associated watershed is advised. This allows designers to become familiar with the area and special drainage concerns that may exist.

A roadway stormwater drainage system may be in place for several decades. When designing the total system, consider potential land use changes and initial system costs.

Documentation should start with information gathering before the preliminary design and continue on through the design, construction, and operation of the final system.

HEC-22 presents a 5 step process for designing stormwater drainage systems.

1. Data collection (discussed further in Section [4A-2](#)). This involves assembling and reviewing data and background information. The types of information to consider include:
 - Watershed, land use (existing and expected future), and soils maps,
 - Flood histories and high water mark elevations,
 - descriptions and performance data for existing drainage systems,
 - Utility plans and descriptions,
 - Existing right-of-way information, and
 - Federal, state, and local regulations.

2. Agency coordination. This may involve coordination with internal offices as well as regulatory and other invested agencies. Depending on the size and location of a stormwater drainage system, several jurisdictions and agencies may be involved with the design of the system. Involving these jurisdictions and agencies early in the design process is essential to designing a system that will suit the needs of all who have an interest in the system.

Federal and state regulations, along with local laws, may affect stormwater drainage system design. Other design elements such as right-of-way and environmental permitting may establish constraints to the drainage system design.

3. Preliminary concept development (discussed further in Section [4A-4](#)). This involves preliminary layout for the proposed stormwater drainage system. For roadway stormwater drainage systems, this includes determining preliminary locations for system components such as intakes and manholes.
4. Concept refinement (hydrologic and hydraulic design) (discussed further in Sections [4A-5](#) through [4A-10](#)). This involves the process of moving from preliminary to final design. This consists of:
 - Computing runoff based on drainage areas determined by the preliminary layout.
 - Refining inlet location and spacing.
 - Sizing system components (e.g. intakes, manholes, and pipes).
 - System layout (schematic)
 - Computing and reviewing the hydraulic grade line.
 - Revising and recalculating until a satisfactory stormwater drainage system is achieved.
5. Finalizing design documentation. This involves finalizing documentation for the design files and construction plans. Documentation includes the information and resources used to complete the first 4 steps of the design process as well as information related to construction and operation of the system. Section [4A-2](#) provides more detail concerning what types of information and resources should be documented.

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