CHAPTER 1
STORMWATER COLLECTION SYSTEMS

GENERAL

The term “stormwater collection system” applies to the set of inlets, pipes, and channels used to drain an area of interest, such as a subdivision, parking lot or street. The design storm used varies from region to region, but it is usually in the range of the two- to twenty-five year storm, with the ten-year storm predominating. The Guilford County Development Ordinance requires piped drainage to be designed to the 10-year storm and open channel drainage to be designed to the 100-year storm event. In most cases, the selection of a design storm that recurs fairly frequently reflects a judgment that the consequences of a system overload are minor -- usually the nuisance of a flooded yard or intersection for a few minutes.

The design storm is stated in terms of the return period, given in years. A ten-year storm has a return period of ten years. The ten-year flood is expected to be equaled or exceeded, on the average, once in ten years. It has a probability of occurrence in a given year of ten percent, or 0.10. It is incorrect to think that ten years will transpire between ten-year floods. In a ten-year period, one such flood is expected, but more than one can occur. Likewise, a one hundred year storm has a probability of occurrence in a given year of one percent (1%).

Certain conventions, judgments and assumptions have emerged over the years to simplify what would otherwise be an impossibly complex system to design. The first of these is the use of the Rational Equation as the model of choice in setting design discharges at points of interest in the system. The second is to select pipes such that they will flow just full in uniform steady flow at the peak of the design storm. The system thus obtained is likely to be conservatively designed.

It has become conventional to separate the design into two fairly independent operations -- inlet location and pipe sizing. Inlets are located such that they will perform at or near the “threshold of misbehavior” in the design storm. The threshold of misbehavior exists when the highest level of flow is reached, beyond which some adverse behavior takes place such as:

a) Flow is too deep; something is flooded
b) Flow is too fast; something is eroded
c) Flow is too wide; it bypasses an inlet, or it becomes a barrier

An inlet is placed to relieve the surface channel of flow that it could not handle acceptably.

Since most storm drainage in rural areas is conveyed by open channel flow, design of inlets will not be covered in this manual. Areas served by City of Greensboro water and sewer must have streets and drainage designed to City of Greensboro standards. Roads under NC Department of Transportation maintenance shall have the roadway and drainage designed by NCDOT criteria.

Pipes are sized to flow just full according to the Manning Equation. The discharge into each pipe is computed by the Rational Equation, with the runoff coefficient composited of all contributing drainage areas, and with the time of concentration based upon the overland flow time from the most remote location to the inlet, plus the time of flow in the pipe or pipes upstream of the pipe under consideration. This is less than the flow one would get by adding all inlet inflows.

In recent years, designers have been advised to become more sensitive to the major-minor storm concept (APWA, 1981). The design storm for which system sizes are set is the minor storm having a typical return period of ten years. The probability is greater than 90 percent that such a storm will be exceeded at least once in a 25-year period. It is prudent therefore to provide for the major storm an emergency route-along-streets and, between structures to minimize property damage. For some systems the major storm may be routed intuitively or by inspection. For others, quantitative routing is justified.

MATHEMATICAL MODELS

The principal mathematical models used in the design of stormwater collection systems are:

1. Rational Method -- used for estimating design discharge at a point of interest in the system.
2. Weir equations - used for sizing inlets that behave as weirs.
3. Orifice equation -- used for sizing inlets judged to behave as orifices.
4. Manning equation -- used to represent the behavior of gravity flow in pipes.
5. Energy balance -- used to compute the approximate position of the hydraulic grade line in systems having high tailwater to ensure against an unsatisfactory backup of water in the system.