Technical Procedure Document

Subject: Peaking Factor

Introduction

In September 2007, the City of Charleston (City) passed a stormwater ordinance incorporating the federally mandated requirements of the National Pollution Discharge Elimination System (NPDES) Phase II stormwater program. Part of this ordinance included the authorization to develop and implement a Stormwater Design Standards Manual (SWDSM) to be used by the City when reviewing, approving, and permitting construction, development, and re-development projects. The SWDSM standardized engineering and construction practices serves multiple purposes, including "providing technical design standards to eliminate the implementation of sub-optimal design and installation practices". One of the parameters in the technical design standards included the requirement of using a hydrograph Peaking Factor of 323 to reflect the ability of watersheds to retain and delay runoff.

This Technical Procedure Document describes the City's justification for increasing the Peaking Factor to 484 as a design computation requirement in the new SWDSM.

Design Computation Requirements

Hydrologic Requirements (SWDSM Section 3.4.1)

Hydrologic computations shall be completed using volume/peak/duration-based hydrograph methods acceptable to the Department of Stormwater Management. The SWDSM uses a design storm duration based on the 24-hour design storm event with a NRCS Type III rainfall distribution and a 484 Peaking Factor. Typical hydrologic inputs include, but are not limited to, the following:

- Rainfall depth or intensity
- NRCS soil classification and hydrologic soil group
- Land use
- Time of concentration
- Initial abstraction (surface storage and/or vegetative capture)

Peaking Factor

When developing hydrographs (graphs of stormwater runoff rates versus time) using the Natural Resources Conservation Service (NRCS) method, the unit hydrographs are multiplied by a peaking factor. The peaking factor is based on a wide range of watershed characteristics and reflects the ability of the watershed to retain and delay flow. The peaking factor essentially controls the volume of water on the rising and recession limbs. This constant may not be consistently applicable to all watershed types.

Steep terrain and high impervious urban areas tend to produce higher early peaks and therefore values of the peaking factor are generally close to 600. In contrast, flat swampy regions tend to retain and store water, resulting in a delayed, lower peak with peaking factor values tending towards 300 or lower (Wanielista, et al. 1997). Various Peaking Factors based on general watershed characteristics are listed in **Table 1**.

Table 1. Hydrograph Peaking Factors and Recession Limb Ratios

General Descriptions	Peaking Factors	Limb Ratio (Recession to Rising)
Urban Areas, Steep Slopes	575	1.25
Typical SCS	484	1.67
Mixed Urban/Rural	400	2.25
Rural, Rolling Hills	300	3.33
Rural, Slight Slopes	200	5.5
Rural, Very Flat	100	12.0

Source: Wanielista, et al., 1997; NOAA 2005

Peaking Factor Value of 484

The peaking factor in the 2007 and 2013 versions of the SWDSM was 323, but the updated SWDSM requires a peaking factor of 484. The increase is based on the typical peaking factor used by NRCS, developed from land use classifications of mostly urban and moderate slopes (neither too steep nor flat). The shift to a more conservative Peaking factor and other design parameters is to consider the change in climate which includes the increased intensities and magnitude of storm events along with the response times of the watersheds within the City. In general, watersheds within the City are predominantly urbanized, have poorly drained or altered soils (increases the runoff potential), do not have significant surface storage, and high ground water tables. These factors contributed to the City’s decision to increase the base Peaking Factor to 484 for hydrologic analyses and design computations.

Basin Specific Peaking Factor Determination

The City understands the variety of landscapes that exist within its jurisdictional boundaries. West Ashley is an example of a mixed-urban landscape with sub-urban residential subdivisions and highly impervious commercial areas. Downtown Charleston is considered an urban landscape that includes mixed-use multi-family residential and commercial areas that generally do not include storage areas for surface runoff. In contrast, Johns Island is a largely undeveloped rural area trending towards urban cores with mixed-use development and surrounding sub-urban residential subdivisions.

Because of the diversity of different areas, the City allows designers the opportunity to justify a lower peaking factor than 484. Justification must be included as part of the Stormwater Technical Report narrative that may include, but not limited to, topography, contributing drainage area, which includes the presence of wetlands, associated Zoning classification and/or impervious area determination with a resulting minimum peaking factor of 323. Designers should communicate with the City early in the design process if they intend to seek a different peaking factor.

Modified Peaking Factor Approval Process

This section details how the designers will justify a modified peaking factor for their project site (pre-development and post-development conditions) as well as the overall contributing watershed. There is no specific set of criteria that can be established for different peaking factor values since they are site specific and cannot be generalized. Because of this, communication with the City early in the design process about a modified peaking factor is key to avoid unnecessary delays.

If there is already a model developed, the peaking factor used in the model should be utilized because most of the models are analyzed based on Future Conditions/Built-out conditions. If a model is not developed for a specific watershed or the designer wishes to modify the peaking factor, then appropriate supporting documentation should be submitted to the City in order to justify a modified peaking factor. The following must be submitted to the City in the Stormwater Technical Report:

- Peaking Factor (Default peaking factor of 484 or a modified peaking factor (400 or 323) with justification)
- Model Assumptions, Inputs, and Outputs for Pre-development and Post-development conditions
- Any Record Drawings, Stormwater Technical Reports used to build the model
- Maps and Figures
  - For Overall Contributing Drainage Area
    - Watershed Boundary
    - Watershed Topography
    - Watershed Point of Discharge
    - Zoning Classification
    - Impervious Area
    - Groundwater Table Characteristics
  - For Site Specific Drainage Area
    - Site Drainage Area Boundaries
    - Site Topography
    - Site Point of Discharge
    - Slope Determination
    - Impervious Area (Pre and Post development conditions)
    - Groundwater Table characteristics

References

National Oceanic and Atmospheric Administration (NOAA). 2005. Unit Hydrograph (UHG) Technical Manual. NOAA National Weather Service Office of Hydrology. Available at https://www.nohrsc.noaa.gov/technology/gis/uhg_manual.html.

Natural Resource Conservation Service (NRCS) National Engineering Handbook. 2007. United States Department of Agriculture. Available at https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17755.wba

Wanielista, Martin, Robert Kersten, & Ron Eaglin, 1997. Hydrology: Water Quantity and Quality Control, 2nd Edition, Wiley and Sons, Inc., New York, NY.