PIERCE COUNTY DEPARTMENT OF PUBLIC WORKS AND UTILITIES

SEWER UTILITY DIVISION

Calculation of Minimum Pipe Slopes to Obtain

Self-Cleaning Velocities in Sanitary Sewers

The following design parameters must be used when providing supporting self-cleaning velocity calculations for sanitary sewer pipes designated at less than 1% slope. These parameters are not meant to be used for pipe sizing calculations.

1. Design Parameters:
    a. Minimum Self-Cleaning Velocity = 2 ft/sec
    b. Use Peak Dry Weather Flow (PDWF), therefore, assume Inflow/Infiltration = 0 gpd.
    c. Residential Equivalent = 1.0 R.E. = 220 gpd Average Dry Weather Flow (ADWF)
        i. Single Family Resident (SFR) units = 1.0 R.E.
        ii. Duplex and multi-family dwelling units (MFDU) = 0.83 R.E.
    d. Assume Open Channel Flow for gravity pipes. Use Manning's Equation (report from hydraulic design software is acceptable)
    e. Manning's Roughness Coefficient = n = 0.013 (for all pipe types).
    f. PDWF = ADWF x Peaking Factor
    g. Use Figure 1 (attached) to determine the appropriate Peaking Factor. If ADWF< 0.033 MGD, use a peaking factor of 6.0.
    h. The off-site sewage contribution, in R.E.'s should be estimated by multiplying the tributary area (not including roads and critical areas) by the maximum dwelling unit density allowed by current zoning. For commercial zoning, use a contribution factor of 1,000 gallons per acre. Developed residential properties less than 1 acre in area should be counted as fully developed.
    i. If the pipe in question is 8 inches in diameter (nominal), then the Engineer may simply reference Figure 2 (attached) to determine the minimum allowable pipe slope for an estimated number of R.E.'s within the tributary area.

2. Example:

A new development proposes 37 single family residences, 32 multi-family dwelling units, and 5 acres of commercial development. The applicant proposes an 8-inch diameter off-site PVC sewer main with a slope of 0.45% to bring sewer service to the property. There is also 40 acres of undeveloped MSF zoned property tributary to the proposed off-site sewer main. Is the proposed slope adequate to obtain a minimum self-cleaning velocity at full build-out of the tributary area?

ADWF = (37 SFR x 1.0RE/SFR x 220 gpd/RE) + (32 MFDU x 0.83 RE/MFDU x 220 gpd/RE) + (5 ac x 1,000 gpd/ac) + (40 ac x 6 du/ac X 1.0 RE/du X 220 gpd/RE)

=71,783.20 gpd

From Figure 1, Peaking Factor = 4.70

PDWF = 71,783.20 gpd x 4.70 = 337,381 gpd

Assuming an n-value of 0.013,

Manning's Equation calculates a mean velocity of 2.47 fps > 2.0 fps

Therefore, an 8-inch diameter PVC sewer main with a slope of 0.45% is acceptable.

Self-Cleaning Velocity Example Calculation

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00450	ft/ft
Diameter	8.00	in
Discharge	0.337381	mgd

Results

Normal Depth	4.67	in
Flow Area	0.21	ft^2
Wetted Perimeter	1.16	ft
Top Width	0.66	ft
Critical Depth	0.34	ft
Percent Full	58.4	%
Critical Slope	0.00707	ft/ft
Velocity	2.47	ft/s
Velocity Head	0.09	ft
Specific Energy	0.48	ft
Froude Number	0.77	
Maximum Discharge	0.87	ft^3/s
Discharge Full	0.81	ft^3/s
Slope Full	0.00187	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	58.38	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Figure 1

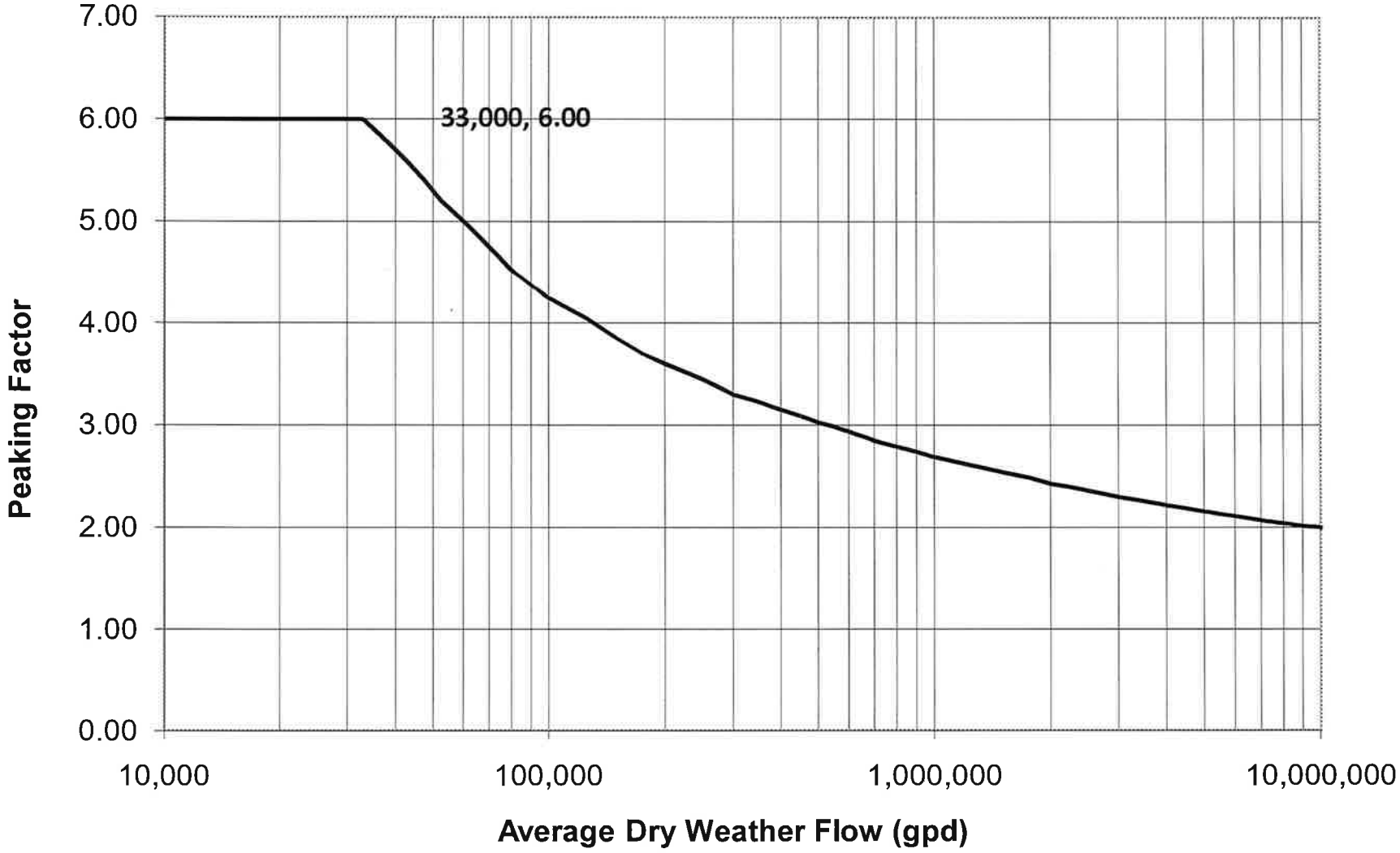
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
33,000, 6.00
Peaking Factor
10,000
100,000
1,000,000
10,000,000
Average Dry Weather Flow (gpd)

Figure 2

Pierce County Department of Public Works and Utilities - Sewer Utility Division

Minimum Allowable Slope vs. Tributary Residential Equivalents (R.E.)