Volume 1, Chapter 5 - **Runoff:**

Users' Guidance:

If a UDFCD *Section* number in this chapter is **skipped**:
It was adopted as is; please refer to that Section in the **corresponding UDFCD Manual**, Volume, Chapter and *Section.*

If a UDFCD *Section* number in this chapter is **amended or a new COFC *Section* in this Chapter is added**:
It is **listed below**; please refer to it in **this document**.

If a UDFCD *Section* in this chapter is **deleted then** it was **not** adopted by the City of Fort Collins;
The deleted UDFCD *Section* number will be **identified as deleted in the text below**.

(1) *Section 1.0* is deleted in its entirety.

(2) A new *Section 1.1* is added, to read as follows:

1.1 Runoff Methodologies

(a) There are two runoff determination methodologies that are approved by the City, the Rational Method and the Stormwater Management Model (SWMM). The City is the determining authority with respect to the appropriate methodology to use under different circumstances. Early contact with the City is encouraged for the timely determination of the appropriate runoff methodology to use.

(b) The Rational Method may only be used to determine the runoff from drainage basins that are less than ninety (90) acres in size. The Stormwater Management Model (SWMM) must be used to model drainage basin areas of ninety (90) acres or more.

(c) All runoff calculations made in the design of both 2-year and 100-year drainage systems must be included with the Storm Drainage Report and all storm drainage facilities designed must be shown on Storm Drainage Plans.

(3) A new *Section 2.8* is added, to read as follows:

2.8 Rational Method Runoff Coefficients

(a) The runoff coefficients to be used in the Rational Method can be determined based on either zoning classifications or the types of surfaces on the drainage area. Zoning classifications may be used to estimate flow rates and volumes for an Overall Drainage Plan (ODP) submittal, if the types of surfaces are not known. Table RO-10 lists the runoff coefficients for common types of zoning classifications in the city of Fort Collins.

(b) For a Project Plan or Final Plan submittal, runoff coefficients based on the proposed land surface types must be used. Since the actual runoff coefficients may be different

from those specified in Table RO-10, Table RO-11 lists coefficients for the different types of land surfaces. The runoff coefficient used for design must be based on the actual conditions of the proposed site.

Table RO-10

Rational Method Minor Storm Runoff Coefficients for Zoning Classifications

Description of Area or Zoning	Coefficient
R-F	0.3
U-E	0.3
L-M-In	0.55
R-L, N-C-L	0.6
M-M-N, N-C-M	0.65
N-C-B	0.7
Business:	
C-C-N, C-C-R, C-N, N-C, C-S	0.95
R-D-R, C-C, C-L	0.95
D, C	0.95
H-C	0.95
C-S	0.95
Industrial:	
E	0.85
I	0.95
Undeveloped:	
R-C, T	0.2
P-O-L	0.25

For guidance regarding zoning districts and classifications of such districts please refer to Article Four of the City Land Use Code, as amended.

Table RO-11

Rational Method Runoff Coefficients for Composite Analysis

Character of Surface	Runoff Coefficient
Streets, Parking Lots, Drives:	
Asphalt	0.95
Concrete	0.95
Gravel	0.5
Roofs	0.95
Recycled Asphalt	0.8
Lawns, Sandy Soil:	
Flat <2%	0.1
Average 2 to 7%	0.15
Steep >7%	0.2
Lawns, Heavy Soil:	
Flat <2%	0.2
Average 2 to 7%	0.25
Steep >7%	0.35

(4) A new *Section 2.9* is added, to read as follows:

2.9 Composite Runoff Coefficient

Drainage sub-basins are frequently composed of land that has multiple surfaces or zoning classifications. In such cases a composite runoff coefficient must be calculated for any given drainage sub-basin.

The composite runoff coefficient is obtained using the following formula:

$$C = \frac{\sum_{i=1}^{n} (C_i * A_i)}{A_t} \qquad \text{(RO-8)}$$

Where: C = Composite Runoff Coefficient
C_i = Runoff Coefficient for Specific Area (A_i)
A_i = Area of Surface with Runoff Coefficient of C_i, acres or feet^2
n = Number of different surfaces to be considered
A_t = Total Area over which C is applicable, acres or feet^2

(5) A new *Section 2.10* is added, to read as follows:

2.10 Runoff Coefficient Adjustment for Infrequent Storms

The runoff coefficients provided in tables RO-10 and RO-11 are appropriate for use with the 2-year storm event. For storms with higher intensities, an adjustment of the runoff coefficient is required due to the lessening amount of infiltration, depression retention, evapo-transpiration and other losses that have a proportionally smaller effect on storm runoff. This adjustment is applied to the composite runoff coefficient.

These frequency adjustment factors are found in Table RO-12.

Table RO-12

Rational Method Runoff Coefficients for Composite Analysis

Storm Return Period (years)	Frequency Factor C_f
2 to 10	1.00
11 to 25	1.10
26 to 50	1.20
51 to 100	1.25

Note: The product of C times C_f cannot exceed the value of 1, in the cases where it does a value of 1 must be used

(6) *Section 3.1* is deleted in its entirety.

(7) *Section 3.2* is deleted in its entirety.

(8) *Section 3.3* is deleted in its entirety.

(9) A new *Section 4.3* is added, to read as follows:

4.3 Computer Modeling Practices

(a) For circumstances requiring computer modeling, the design storm hydrographs must be determined using the Stormwater Management Model (SWMM). Basin and conveyance element parameters must be computed based on the physical characteristics of the site.

(b) Refer to the SWMM Users' Manual for appropriate modeling methodology, practices and development. The Users' Manual can be found on the Environmental Protection Agency (EPA) website (http://www.epa.gov/ednnrmrl/models/swmm/index.htm).

(c) It is the responsibility of the design engineer to verify that all of the models used in the design meet all current City criteria and regulations.

4.3.1 Surface Storage, Resistance Factors, and Infiltration

Table RO-13 provides values for surface storage for pervious and impervious surfaces and the infiltration rates to be used with SWMM. Table RO-13 also lists the appropriate infiltration decay rate, zero detention depth and resistance factors, or Manning's "n" values, for pervious and impervious surfaces to be used for SWMM modeling in the city of Fort Collins.

Table RO-13

SWMM Input Parameters

Depth of Storage on Impervious Areas	0.1 inches
Depth of Storage on Pervious Areas	0.3 inches
Maximum Infiltration Rate	0.51 inches/hour
Minimum Infiltration Rate	0.50 inches/hour
Decay Rate	0.0018 inches/sec
Zero Detention Depth	1%
Manning's n Value for Pervious Surfaces	0.025
Manning's n Value for Impervious Surfaces	0.016

4.3.2 Pervious-Impervious Area

Table RO-14 should be used to determine preliminary percentages of impervious land cover for a given land-use or zoning. The final design must be based on the actual physical design conditions of the site.

Table RO-14

Percent Imperviousness Relationship to Land Use*

LAND USE OR ZONING	**PERCENT IMPERVIOUS (%)**
Business:	
T	20
CCN, CCR, CN	70
E, RDR, CC, LC	80
C, NC, I, D, HC, CS	90
Residential:	
RF,UE	30
RL, NCL	45
LMN,NCM	50
MMN, NCB	70
Open Space:	
Open Space and Parks (POL)	10
Open Space along foothills ridge (POL,RF)	20
RC	20

*For updated zoning designations and definitions, please refer to Article Four of the City Land Use Code, as amended

4.3.3 Conveyance Element Methodology

Embedded conveyance elements must begin at the midpoint of the sub-basin in order to appropriately represent the basin based on its actual physical characteristics.

4.3.4 Basin Width

Basin width must be calculated as the area of the basin divided by the length of the basin. The basin length is defined as the length of the concentrated flow.

4.3.5 Dynamic Flow Analysis

Conditions may arise where a steady flow hydraulic analysis may not provide sufficient information on the operation of drainage facilities. This is especially of concern when analyzing detention ponds inter-connected by culverts or storm sewers and where release rates and pond volumes may be affected. In such cases, if the Utilities Executive Director determines that additional analysis is required for an adequate evaluation of proposed drainage facilities, an unsteady flow hydraulic analysis using hydrographs generated from SWMM and the EXTRAN block of SWMM may be required.

(10) *Section 5.0* is deleted in its entirety.

(11) *Section 5.1* is deleted in its entirety.

(12) *APPENDIX A* is deleted in its entirety.

(13) *Table RO-1* is deleted in its entirety.

(14) *Table RO-6* is deleted in its entirety.

(15) *Table RO-7* is deleted in its entirety.

(16) *Table RO-8* is deleted in its entirety.

(17) *Table RO-9* is deleted in its entirety.

(18) *Table RO-A1* is deleted in its entirety.

(19) *Table RO-10* Rational Method Minor Storm Runoff Coefficients for Zoning Classifications is added.

(20) A new *Table RO-11* Rational Method Runoff Coefficients for Composite Analysis is added.

(21) A new *Table RO-12* Rational Method Frequency Adjustment Factors is added.

(22) A new *Table RO-13* SWMM Input Parameters is added.

(23) A new *Table RO-14* Land Use Versus percent Imperviousness is added.

(24) *Figure RO-9* is deleted in its entirety.

(25) *Figure RO-10* is deleted in its entirety.

(26) *Figure RO-A1* is deleted in its entirety.

(27) *Figure RO-A2* is deleted in its entirety.

(28) *Figure RO-A3* is deleted in its entirety.

(29) *Figure RO-A4* is deleted in its entirety.

(30) *Figure RO-A5* is deleted in its entirety.

(31) *Figure RO-A6* is deleted in its entirety.

(32) *Figure RO-A7* is deleted in its entirety.

(33) *Figure RO-A8* is deleted in its entirety.

(34) *Figure RO-A9* is deleted in its entirety.

(35) *Figure RO-A11* is deleted in its entirety.