Is Q=CiA Dimensionally Consistent?

Shed runoff flow rate Q has been computed under the Rational Method using the equation:

$$Q = CiA$$

for a very long time, but ever so often, a new user would ask if this equation is dimensionally consistent.

In this equation, the units of Q is cfs (cubic feet per second, or ft^3/sec). C is the runoff coefficient, which is dimensionless, i is the rainfall intensity in inches per hour (in/hr)), and A is the tributary watershed area, in acres. If the equation were dimensionally consistent, then shouldn't the units of Q be (in*ac/hr)? If it is, then is in*ac/hr = ft^3/sec? This is examined below.

Convert in*ac/hr to ft^3/sec as follows:

in*ac/hr	= (1/3600)*in*ac/sec
	= (1/12)*(1/3600)*ft*ac/sec
	= (1/12)*(1/3600)*43560*ft*ft^2/sec
	= (43560/(12 * 3600)) ft^3/sec
	= 1.0083*ft^3/sec.

Thus, strictly speaking, Q = 1.0083*CiA for English units, which is usually rounded to Q = CiA. Thus, Q = CiA is indeed dimensionally consistent. The Ration Method equation, however, slightly underestimates Q, by 0.83 percent, for English units.

Similarly, it may shown that the metric equation:

$$Q = (1/360)*CiA,$$

where Q is the watershed runoff flow rate with units of m^3/sec, C is the dimensionless runoff coefficient, i is the rainfall rate in mm/hr, and A is the tributary watershed area in hectares, is dimensionally consistent, without the need for rounding. The Rational Method equation does not underestimate (or overestimate) Q for metric units.