Appendix B: Equations used to update municipal facility loadings

Variable Definition

$Q_{mun,new}$ = updated municipal flow rate (MGD)
$Q_{mun,old}$ = original municipal flow rate (MGD)
Q_{meat} = flow rate from the meat-processing facility (MGD)
Q_o = flow rate to municipality from other (non-meat) sources (MGD)

$C_{mun,new}$ = updated municipal concentration (mg/L)
$C_{mun,old}$ = original municipal concentration (mg/L)
C_{meat} = concentration in the meat-processing facility's effluent (mg/L)
C_o = concentration in the flow from other (non-meat) sources (mg/L)

f = fraction of pollutant retained after treatment

Flow Balance

$Q_{mun,old} = Q_{mun,new} + Q_{meat}$

Therefore
$Q_{mun,new} = Q_{mun,old} - Q_{meat}$

Mass Balance

Mass in – Mass out – Mass depleted = 0 (Steady-state)

$$(Q_{meat}C_{meat} + Q_oC_o) - Q_{mun,old}C_{mun,old} - (1-f)(Q_{meat}C_{meat} + Q_oC_o) = 0$$

$$(Q_{meat}C_{meat} + Q_oC_o)f - Q_{mun,old}C_{mun,old} = 0$$

$$Q_oC_o = \frac{Q_{mun,old}C_{mun,old}}{f} - Q_{meat}C_{meat}$$

$$C_o = \left[\frac{Q_{mun,old}C_{mun,old}}{f} - Q_{meat}C_{meat}\right] * \frac{1}{Q_o}$$

$$C_{mun,new} = fC_o = \frac{1}{Q_o} * \left[Q_{mun,old}C_{mun,old} - fQ_{meat}C_{meat}\right]$$

$$Q_o = Q_{mun,new}$$