17.46. **Model:** There are two interacting systems: the nuclear reactor and the water. The heat generated by the nuclear reactor is used to raise the water temperature.

Solve: For the closed reactor-water system, energy conservation per second requires

$$Q = Q_{\text{reactor}} + Q_{\text{water}} = 0\,\text{J}$$

The heat from the reactor in $\Delta t = 1$ s is $Q_{\text{reactor}} = -2000\ \text{MJ} = -2.0 \times 10^9$ J and the heat absorbed by the water is

$$Q_{\text{water}} = m_{\text{water}} c_{\text{water}} \Delta T = m_{\text{water}}(4190\ \text{J/kg K})(12\ \text{K})$$

$$\Rightarrow -2.0 \times 10^9\ \text{J} + m_{\text{water}}(4190\ \text{J/kg K})(12\ \text{K}) = 0\ \text{J} \Rightarrow m_{\text{water}} = 3.98 \times 10^4\ \text{kg}$$

Each second, 3.98×10^4 kg of water is needed to remove heat from the nuclear reactor. Thus, the water flow per minute is

$$3.98 \times 10^4\ \frac{\text{kg}}{\text{s}} \times \frac{60\ \text{s}}{\text{min}} \times \frac{1\,\text{m}^3}{1000\ \text{kg}} \times \frac{1\ \text{L}}{10^{-3}\ \text{m}^3} = 2.39 \times 10^6\ \text{L/min}$$