Dilution Factor and Effluent Limitation Calculations for Massachusetts

Prior to completing the NOI requirements for the Remediation General Permit (RGP), the State must be contacted to confirm the 7Q10 of the receiving water, dilution factor (DF), other appropriate hydrologic conditions, or to confirm site-specific limiting factors, including additional water quality-based effluent limitations (WQBELs). See Part 4.6 of the RGP for contact information.

I. Dilution Factors

A DF for sites that discharge to freshwater receiving waters in Massachusetts is calculated using the equation below. Alternate calculation methods for DFs may be acceptable if approved by EPA. A DF for sites that discharge to saltwater receiving waters in Massachusetts is assumed to be 1:1, unless otherwise approved on a case-by-case basis by the State.

A. Determine 7Q10:

1. Using DFLOW: DFLOW 4.0 is an EPA-developed tool for calculating flow statistics. Version 4.0 is contained within the larger watershed planning tool BASINS 4.1. The BASINS program can be downloaded from EPA's website at: https://www.epa.gov/exposure-assessment-models/basins.

2. Using StreamStats: This online application is appropriate for determining drainage area ratios for nearby gages, and uses the 7Q10s for available gages from the U.S. Geological Gazetteer reports (1984 Wandle et al.). StreamStats is available at: http://water.usgs.gov/osw/streamstats/massachusetts.html.

B. Calculate Dilution Factor:

1. The equation used to calculate the dilution factor is:

$$\text{Dilution Factor} = \frac{Q_R + (Q_P \times 1.55)}{Q_P \times 1.55}$$

Where:

Q_R = Estimated 7Q10 for the receiving water upstream of the outfall, in cubic feet per second (cfs)
Q_P = Effluent flow, in million gallons per day (MGD)
1.55 = Factor to convert MGD to cfs

II. Effluent Limitation Calculations

The calculation instructions provided below are used in calculating WQBELs for discharges to freshwater receiving waters in Massachusetts (for saltwater receiving waters, refer to II.A.3, II.B.2 and II.C.3, only). The freshwater WQBEL calculated in accordance with these

instructions for a parameter included in the RGP only applies to a discharge if: 1) the projected downstream concentration of a parameter calculated in accordance with C.1, below, is greater than the WQC calculated for that parameter in accordance with A, below; and 2) the WQBEL calculated in accordance with B, below, is less than the TBEL in Part 2.1.1 of the RGP for that parameter. EPA anticipates providing additional resources to assist applicants in following the calculation methodology for effluent limitations in this Appendix.

A. Calculate Water Quality Criterion:

This calculation must be completed to: 1) convert the WQBELs expressed in terms of dissolved metal to total recoverable metal; and 2) adjust the WQBEL for any parameter that is hardness-dependent. Use the equations and appropriate factors for each parameter as specified in EPA's *National Recommended Water Quality Criteria: 2002*, and a mass balance equation recommended in EPA's *Technical Support Document for Water Quality Based Toxics Control* (EPA 1991) (TSD) with the values for design flow, receiving water 7Q10, and hardness as $CaCO_3$. Operators are required to collect hardness data, used to calculate the criteria as follows:

1. If the receiving water is a saltwater waterbody, calculate downstream hardness as:

$$C_r = \frac{Q_d C_d + Q_s C_s}{Q_r}$$

Where:

C_r = Hardness below outfall in mg/L
Q_d = Discharge flow in MGD[1]
C_d = Discharge hardness in mg/L[2]
Q_s = Upstream flow (i.e., 7Q10) in MGD
C_s = Upstream hardness in mg/L[3]
Q_r = Receiving water flow below outfall in MGD[4]

2. If a given parameter is hardness-dependent (e.g., copper, lead, zinc), calculate the chronic total recoverable water quality criteria adjusted for hardness as:

$$\text{Total Recoverable Criteria} = \exp\{m_c [\ln(h)] + b_c\}$$

Where:

m_c = Pollutant-specific coefficient
b_c = Pollutant-specific coefficient
ln = Natural logarithm
h = Hardness calculated in Step 1

[1] Equal to the design flow of the discharge or 1.0 MGD, whichever is less.
[2] Note that for sample sizes less than 10, the maximum reported effluent value is used for C_d. For samples sizes of 10 or greater, the operator may choose to use the 95^{th} percentile of the effluent values. Influent values may be substituted for effluent values if in accordance with Appendix IV of the RGP.
[3] If the sample size is greater than 1, the median value may be used.
[4] May be equal to the sum of the upstream 7Q10 and the effluent flow or a downstream 7Q10.

3. If the receiving water is a saltwater waterbody and the WQC for a parameter must be converted to total recoverable, or if the receiving water is a freshwater waterbody but a given parameter is not hardness-dependent (e.g., arsenic, chromium VI), calculate the chronic total recoverable water quality criteria as:

Total Recoverable Criteria = WQBEL * dissolved to total recoverable ratio

B. Calculate WQBEL:

The freshwater WQBEL is calculated by rearranging the above mass balance equation to solve for the effluent concentration (C_d) by setting the maximum allowable downstream concentration equal to the water quality criterion for the resultant in-stream concentration (C_r). Note that if a limit is calculated to be lower than the criterion, then the limit is set at the criterion.

1. Calculate the WQBEL for a parameter detected in the receiving water as:

$$C_d = \frac{Q_r C_r - Q_s C_s}{Q_d}$$

Where:

C_r = WQC[5]
Q_d = Effluent flow in MGD[6]
C_d = WQBEL
Q_s = Upstream flow (i.e., 7Q10) in MGD
C_s = Upstream concentration in mg/L[7]
Q_r = Receiving water flow below outfall[8]

2. Calculate the WQBEL for a parameter either not detected in the receiving water, for which receiving water sampling is not required in the RGP (e.g., TRC) or for saltwater receiving waters for which MassDEP has approved a dilution factor on a case-by-case basis as:

WQBEL = WQC * Dilution Factor

C. Determine if a WQBEL applies:

1. Project the concentration of a parameter downstream from the discharge as:

$$C_r = \frac{Q_d C_d + Q_s C_s}{Q_r}$$

[5] Compare to the WQC as calculated in A of this appendix, when required for a parameter; for all other parameters, use the WQC listed in Part 2.1.1 of the RGP.
[6] Equal to the design flow of the discharge or 1.0 MGD, whichever is less.
[7] If the sample size is greater than 1, the median value may be used.
[8] May be equal to the sum of the upstream 7Q10 and the effluent flow or a downstream 7Q10.

Where:

C_r = Projected downstream concentration
Q_d = Effluent flow in MGD
C_d = Discharge concentration in mg/L, maximum value reported[9]
Q_s = Upstream flow (i.e., 7Q10) in MGD
C_s = Upstream concentration in mg/L
Q_r = Receiving water flow below outfall

2. The freshwater WQBEL applies if: 1) the projected downstream concentration of a parameter calculated in accordance with C.1, above, is greater than the WQC calculated for that parameter in accordance with A, above; and 2) the WQBEL calculated in accordance with B, above, is less than the TBEL in Part 2.1.1 of the RGP for that parameter. Otherwise, the TBEL in Part 2.1.1 of the RGP for that parameter applies.

3. The saltwater WQBEL is equal to the WQC as calculated in II.A.3, above, as calculated in II.B.2, above, if a dilution factor is approved on a case-by-case basis by MassDEP, or the WQBEL in Part 2.1.1 of the RGP, if II.A.3 and II.B.2 do not apply. The saltwater WQBEL applies if: 1) the discharge concentration of a parameter is greater than the WQBEL calculated for that parameter in accordance with this appendix; and 2) the WQBEL calculated for that parameter in accordance with this appendix is less than the TBEL in Part 2.1.1 of the RGP for that parameter. Otherwise, the TBEL in Part 2.1.1 of the RGP for that parameter applies.

[9] Note that for sample sizes less than 10, the maximum reported effluent value is used for C_d. For samples sizes of 10 or greater, the operator may choose to use the 95th percentile of the effluent values. Influent values may be substituted for effluent values if in accordance with Appendix IV – Part 1 of the RGP.