Dilution Factor and Effluent Limitation Calculations for New Hampshire

Prior to completing the NOI requirements for the Remediation General Permit (RGP), the State must be contacted to determine and/or 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 Factor

A DF for sites that discharge to freshwater receiving waters in New Hampshire is calculated using a 10% reserve of the receiving water's assimilative capacity according to Env-Wq 1705.01 (or as revised) as specified below. Alternate calculation methods for DFs may be acceptable if approved by the State. A DF for sites that discharge to saltwater receiving waters in New Hampshire is assumed to be 1:1, unless otherwise approved on a case-by-case basis by the State.

A. Determine 7Q10:

1. Using DFLOW: NHDES uses DFLOW 3.1, an EPA-developed tool for calculating flow statistics. Version 3.1 can be accessed from EPA's website at: https://www.epa.gov/waterdata/dflow.

2. Using U.S. Geological Survey Data: U.S. Geological Survey's (USGS) National Water Information System (NWIS) can be accessed at: http://waterdata.usgs.gov/nwis/sw. U.S. Geological Survey's WaterWatch may be used to identify the gage located nearest to a site, accessed at: http://waterwatch.usgs.gov/. USGS published 7Q10s may also be available.

3. Using the Dingman Equation for ungaged streams.[1]

B. Calculate Dilution Factor:

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

$$\text{Dilution Factor} = \frac{Q_R + (Q_P \times 1.55)}{Q_P \times 1.55} \times 0.9$$

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
0.9 = Factor to reserve 10 percent of the receiving water's assimilative capacity

[1] Dingman, S.L., and Lawlor, S.C. 1995. *Estimating Low-Flow Quantiles from Drainage-Basin Characteristics in New Hampshire and Vermont*. American Water Resources Association, Water Resources Bulletin: pp 243-256.

2. Where gage information is being used, but the gage is not located in the vicinity of the discharge location, the 7Q10 may be estimated by the ratio of the drainage area to the gage 7Q10 as:

$$\frac{\text{7Q10@Gage}}{\text{Drainage Area@Gage}} = \frac{\text{7Q10@Discharge Point}}{\text{Drainage Area @Discharge Point}} .$$

Where appropriate, NHDES may use the ratio of the flow calculated using the Dingman Equation as in A.3, above, rather than the ratio of the drainage areas.

II. Effluent Limitation Calculations

The calculation instructions provided below are used in calculating WQBELs for discharges to freshwater receiving waters in New Hampshire (for saltwater receiving waters, refer to II.A.3, II.B.2 and II.C.3, only). WQBELs are calculated using a 10% reserve of the receiving water's assimilative capacity according to Env-Wq 1705.01 (or as revised) as specified below. 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 NH standards Env-Wq 1703.23 and Env-Wq 1703.24 (or as revised), 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[2]
C_d = Discharge hardness in mg/L[3]
Q_s = Upstream flow (i.e., 7Q10) in MGD

[2] Equal to the design flow of the discharge or 1.0 MGD, whichever is less.
[3] 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 of the RGP.

C_s = Upstream hardness in mg/L[4]
Q_r = Receiving water flow below outfall in MGD[5]

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[6]

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:

$$\text{Total Recoverable Criteria} = \frac{\text{dissolved WQC}[7]}{\text{dissolved to total recoverable conversion factor}[8]}$$

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 multiplied by the factor 0.9 for the resultant in-stream concentration (C_r). Note that if a limit is calculated to be lower than the criterion multiplied by 0.9, then the limit is set at the criterion.

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

$$C_d = \frac{[Q_r (C_r * 0.9) - Q_s C_s]}{Q_d}$$

Where:
C_r = WQC[9]

[4] If the sample size is greater than 1, the median value may be used.
[5] May be equal to the sum of the upstream 7Q10 and the effluent flow or a downstream 7Q10.
[6] If the calculated downstream hardness is greater than 25 mg/L (or as revised), use that calculated value. If less than or equal to 25 mg/L, use 25 mg/L as the default value as required in Env-Wq 1703.22(f) (or as revised). EPA anticipates that the applicable revised default hardness found in Env-Wq 1700 shall be incorporated into the RGP for sites in New Hampshire. Based on the proposed revision for this value, 20 mg/L, EPA expects to change the default value from 25 mg/L to 20 mg/L once final.
[7] Dissolved WQC from Env-Wq 1703.21 (or as revised).
[8] Dissolved to total recoverable conversion factors from Env-Wq 1703.23 (or as revised).
[9] Compare to the WQC as calculated in this appendix, when required for a parameter; for all other parameters, use the WQBEL listed in Part 2.1.1 of the RGP.

Q_d = Effluent flow in MGD[10]
C_d = WQBEL
Q_s = Upstream flow (i.e., 7Q10) in MGD
C_s = Upstream concentration in mg/L[11]
Q_r = Receiving water flow below outfall[12]
0.9 = Factor to reserve 10 percent of the receiving water's assimilative capacity

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 NHDES has approved a dilution factor on a case-by-case basis as:

WQBEL = WQC * Dilution Factor * 0.9

C. Determine if a WQBEL applies:

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

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

Where:
C_r = Projected downstream concentration
Q_d = Effluent flow in MGD
C_d = Discharge concentration in mg/L, maximum value reported[13]
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 NHDES, 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.

[10] Equal to the design flow of the discharge or 1.0 MGD, whichever is less.
[11] If the sample size is greater than 1, the median value may be used.
[12] May be equal to the sum of the upstream 7Q10 and the effluent flow or a downstream 7Q10.
[13] 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.