Modeling Guidance 6 Final	NH_3-N toxicity and D.O. modeling	
	Rule reference: OAC 3745-2-10 [NH_3-N] and 3745-2-11 [D.O.]	Revision 0, January 30, 1998

D.O. modeling requires project-specific information and very little can be prescribed in rules; thus, the rules are very basic. The information here will assist staff in deciding on model inputs and is compiled from a number of sources (cited). The material contained in this guidance is subject to modification due to site-specific information.

Influent NH_3-N

The influent NH_3-N concentration of a wastewater treatment plant (WWTP) is sometimes needed to determine the effluent concentration since several effluent treatment levels express the effluent NH_3-N level as a percentage removal of the influent concentration. According to the National Guidance for the Simplified Method (U.S. EPA, 1980), the influent NH_3-N concentration for a typical domestic waste varies from 12-35 mg/l. The following guidelines should be used when determining the influent NH_3-N for a municipal WWTP:

1. If data are available, use the average of the influent samples, after considering typical data selection techniques, such as oulier elimination.

2. If no data are available, choose a value between 12-35 mg/l depending on information about the treatment and collection system (e.g., condition of the sewers with respect to infiltration/inflow). If no information is available, assume an influent concentration of 20 mg/l, but consider analyzing the sensitivity of any resulting decision to this assumption.

Source: U.S. EPA, National Guidance for the Simplified Method, 1980.

BOD Relationships

1. Relationship Between Ultimate and 20 day BOD

For domestic wastes or wastes exhibiting the same characteristics as domestic wastes, the 20 day values for BOD and CBOD closely approximate the ultimate values; therefore, in conducting wasteload allocations for municipal dischargers, it is common practice to consider the 20 day and ultimate values to be equal. This may not be valid for some industrial wastes or municipal treatment plants that receive large contributions of industrial wastes. For example, the ultimate CBOD for a paper waste can be much higher than the $CBOD_{20}$. In a case such as this, the modeling should be based on ultimate values, rather than the 20 day values. BOD and CBOD ultimates can be calculated from the daily BOD data.

2. Relationship Between $CBOD_u$ and $CBOD_5$

Site specific data for a wastewater treatment plant can be used to determine the relationship between $CBOD_u$ and $CBOD_5$, if no changes in the treatment process or flow are expected.

The $CBOD_u/CBOD_5$ ratio from another WWTP could also be used if the treatment plants are similar in size, they use the same type of treatment, and they have similar effluent characteristics.

If site specific data are not available or applicable, the following ratios should be used to convert $CBOD_u$ to $CBOD_5$ when conducting allocations for municipal dischargers that have primarily domestic wastes:

Level of Treatment	$CBOD_u$ / $CBOD_5$
Primary	1.5
Secondary	2.0
Advanced (beyond secondary)	2.1-2.3

Based on the discussion presented in #1 above, these relationships may also be applicable for the conversion of $CBOD_{20}$ to $CBOD_5$. These ratios may not be applicable for some industrial wastes or municipal wastes with a high industrial loading. In these cases, site-specific data should be used.

3. Relationship Between $CBOD_5$ and BOD_5

A study was conducted by Ohio EPA to determine the relationship between $CBOD_5$ and BOD_5 for municipal WWTP effluents. Based on the results of this study, the following equation is recommended:

$$BOD_5 = CBOD_5 \times 1.29$$

For further information on this topic, refer to the Ohio EPA paper "Preliminary Report on Predictive Methods for $CBOD_{20}$". Applicable site specific data can be used in lieu of the above equation.

4. Relationships Between BOD, COD, and TOC

The ratios between these parameters are highly variable and are best determined with site specific stream or effluent sampling; however, in all cases, the value for BOD should be less than the COD.

It should also be noted that the ratios between these parameters can be influenced by many factors so caution should be used in the estimation of these ratios.

Sources: Letter from Don Schregardus, U.S. EPA, to Maan Osman, Ohio EPA, 7/22/86.
U.S. EPA National Guidance for the Simplified Method, 1980.
Ohio EPA, Preliminary Report on Predictive Methods for $CBOD_{20}$.

Treatment Levels

BOD/D.O. analyses are typically calculated to correspond with limits for NH_3-N toxicity. The WQS for D.O. is a year-round value and does not require analysis to account for seasonal variation of the WQS. However, the seasonal simulations and resultant allocations for D.O. and BOD are impacted by the seasonal NH_3-N limits and the natural seasonal variation in temperature. Therefore, seasonal limits are typically provided for BOD.

Conventional wastewater treatment can generally be expected to achieve certain levels of effluent quality. The following table summarizes those levels currently used.

$CBOD_{20}$ (mg/l)	$CBOD_5$ (mg/l)	BOD_5 (mg/l)	D.O. (mg/l)	NH_3-N* (mg/l)
50	25	30	2	10%
42	20	25	3	20%
33	15	20	4-5	20%
33	15	20	5-6	50%
33	15	20	5-6	1.5-4.0
23	10	13	5-6	50%
23	10	13	5-7	1.5-4.0
18	8	10	5-7	1.5-4.0

*   Percentage values indicate percent removal of influent NH_3-N.

The results from wasteload allocation programs are produced without regard to treatment processes. In cases where the $CBOD_{20}$ allocation is very high and NH_3-N toxicity is the limiting technology factor, the treatment level table can be used to determine the appropriate $CBOD_{20}$ limit. In cases where the NH_3-N wasteload allocation is high and D.O. is the limiting factor, the treatment level table can be used to determine the appropriate NH_3-N level.

The water quality simulation programs require the user to input effluent $CBOD_{20}$, NH_3-N, and D.O. When allocating with programs that only simulate water quality (such as QUAL2E), the treatment level table can be used to select the proper $CBOD_{20}$ and D.O. levels based on the initial NH_3-N toxicity analysis. In all cases, different BOD ratios or treatment levels can be used if site specific information is available. It should be noted that these treatment levels are most representative of plant performance in summer conditions. Therefore, in certain cases it may be more appropriate to report winter WLA results as calculated, rather than as a treatment level.

Best available design control technology for sewage is defined in 3745-1-05, Table 5-1.

For more information contact:

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Saturated Dissolved Oxygen Concentrations for Ohio Streams (from Standard Methods, 1985)*

Temperature (°C)	D.O. Saturation (mg/l) Per Average Stream Elevation (ft. AMSL)					
	500	700	900	1100	1300	1500
0	14.41	14.30	14.20	14.10	14.00	13.89
1	14.01	13.91	13.81	13.71	13.61	13.51
2	13.63	13.53	13.43	13.34	13.24	13.14
3	13.26	13.17	13.07	12.98	12.88	12.79
4	12.92	12.82	12.73	12.64	12.55	12.45
5	12.58	12.49	12.40	12.31	12.22	12.13
6	12.27	12.18	12.09	12.00	11.91	11.83
7	11.96	11.88	11.79	11.70	11.62	11.53
8	11.67	11.59	11.50	11.42	11.33	11.25
9	11.39	11.31	11.23	11.14	11.06	10.98
10	11.12	11.04	10.96	10.88	10.80	10.72
11	10.87	10.79	10.71	10.63	10.55	10.47
12	10.62	10.54	10.47	10.39	10.31	10.24
13	10.38	10.31	10.23	10.16	10.08	10.01
14	10.15	10.08	10.01	9.93	9.86	9.79
15	9.94	9.86	9.79	9.72	9.65	9.58
16	9.72	9.65	9.58	9.51	9.44	9.37
17	9.52	9.45	9.38	9.32	9.25	9.18
18	9.33	9.26	9.19	9.12	9.06	8.99
19	9.14	9.07	9.01	8.94	8.87	8.81
20	8.96	8.89	8.83	8.76	8.70	8.63
21	8.78	8.72	8.65	8.59	8.53	8.46
22	8.61	8.55	8.49	8.42	8.36	8.30
23	8.45	8.39	8.33	8.26	8.20	8.14
24	8.29	8.23	8.17	8.11	8.05	7.99
25	8.14	8.08	8.02	7.96	7.90	7.84
26	7.99	7.93	7.87	7.82	7.76	7.70
27	7.85	7.79	7.73	7.68	7.62	7.56
28	7.71	7.65	7.60	7.54	7.48	7.43
29	7.58	7.52	7.46	7.41	7.35	7.29
30	7.44	7.39	7.33	7.28	7.22	7.17

*Assumptions:

- Atmospheric Pressure = 30.011 inches of Mercury at mean sea-level (based on 1963-1974 records for eight Ohio weather stations).
- Pressure Variation = 0.1048 inches of Mercury per 100 ft. increase in elevation (based on the Smithsonian Meteorological Tables, Sixth Revised Edition, 1971).
- Chloride Concentration = 0.00 mg/l.
- Values may be interpolated between elevations and/or temperatures.