

Modeling Guidance 5 Final	Antidegradation and the Wasteload Allocation Process	
	Rule reference: OAC rule 3745-1-05; OAC Chapter 3745-2	Revision 0, March 17, 1999 Revision 1, August 5, 2003

The purpose of this document is to educate the reader on the application of the antidegradation rule (OAC rule 3745-1-05) in the wasteload allocation process. Wasteload allocation rules are contained in OAC Chapter 3745-2. It is assumed that the reader is familiar with OAC Chapter 3745-2 and related guidance documents. This document does not provide an exhaustive review of either the antidegradation or wasteload allocation rules. It merely provides guidance in those areas where the two rules intersect. This document is divided into the following sections:

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Section 5.1 of this document discusses the necessity of D.O. modeling in the set aside determination.

Section 5.2 explains how to implement OAC rule 3745-1-05 in the wasteload allocation process. Illustrations of valid methods of calculations are provided.

5.1 Methods to Implement OAC Rule 3745-1-05

5.1.1 Dissolved Oxygen Modeling

Dissolved oxygen and biochemical oxygen demand are considered to be essentially the same attribute because biochemical oxygen demand is a key determinant of dissolved oxygen. The set aside determination will be done via an ammonia based analysis unless there is a calibrated and verified dissolved oxygen model available that would substantially improve the decision making. There may be special circumstances where the Agency may require the applicant to supply the information needed for a calibrated and verified dissolved oxygen model. Such circumstances include the review of a proposed major source of oxygen demanding wastewater on a sensitive water body (e.g., Coldwater Habitat or Exceptional Warmwater Habitat) with existing dissolved oxygen levels near saturation.

5.2 Implementation of OAC Rule 3745-1-05 in the Wasteload Allocation Process

5.2.1 Set Aside for Outstanding State Waters and Superior High Quality Waters (other than Lake Erie)

As provided for in OAC rule 3745-1-05(C)(6)(a) and (c), for Outstanding State Waters and Superior High Quality Waters (other than Lake Erie), a portion of the remaining available pollutant assimilative capacity will be reserved. Therefore, any determination of allowable effluent loads must consider this reserve. The following example will address the expansion of a WWTP to an Outstanding State Water, will use NH₃-N as the parameter for the analysis, and will determine the maximum allowable load increase that will not exceed the reserved portion of the remaining available pollutant assimilative capacity.

Example:

The following information is assumed:

Assume that a WWTP is proposing to expand from 2.0 to 3.0 cfs.

Effluent Data:

Existing design flow = 2.0 cfs

Existing permit limit for NH₃-N = 2.0 mg/l

Expanded effluent flow = 3.0 cfs

Upstream Data:

Upstream 30Q10 = 5.2 cfs

Upstream NH₃-N = 0.05 mg/l

Downstream Data:

WQS for NH₃-N = 1.1 mg/l

Step 1 - Determine the WLA to maintain water quality criteria for NH₃-N toxicity at the expanded WWTP design flow of 3.0 cfs.

$$\frac{1.1(5.2 + 3.0) - 5.2(0.05)}{3.0 \text{ cfs}} = 2.92 \text{ mg/l}$$

Step 2 - Determine the remaining available pollutant assimilative capacity with the WWTP discharging at its existing design flow and existing permit limit.

downstream flow under 30Q10 conditions = 5.2 + 3.0 = 8.2 cfs

*Waterbody Pollutant Assimilative Capacity = 8.2 cfs * 1.1 mg/l * CF = 22.069 kg/d*

*Background Pollutant Load = 5.2 cfs * 0.05 mg/l * CF = 0.636 kg/d*

*Current Permit Load = 2.0 cfs * 2.0 mg/l * CF = 9.787 kg/d*

Note: CF means conversion factor

Remaining Available Pollutant Assimilative Capacity =

22.069 kg/d Waterbody Pollutant Assimilative Capacity

0.636 kg/d Background Pollutant Load

9.787 kg/d Current Permit Load

11.646 kg/d Remaining Available Pollutant Assimilative Capacity

Step 3 - Determine the reserved portion of the remaining available pollutant assimilative capacity. 70% of the remaining available pollutant assimilative capacity was reserved.

$$0.7 * 11.646 = 8.152 \text{ kg/d reserved}$$

Step 4 - Determine the available load for the expansion. 8.152 kg/d was reserved; therefore, there is still 3.494 kg/d available for the expansion.

Step 5 - Determine the possible effluent load after the expansion. The WWTP could increase their discharge by 3.494 kg/d.

$$3.494 + 9.787 \text{ (existing permit load)} = 13.281 \text{ kg/d}$$

At the expanded design flow of 3.0 cfs, the WWTP could increase their discharge to 13.281 kg/d and not exceed the reserved portion of the remaining available pollutant assimilative capacity. A discharge of 13.281 kg/d at an effluent flow of 3.0 cfs would result in an effluent $\text{NH}_3\text{-N}$ of 1.8 mg/l.

Step 6 - Consider Best Available Demonstrated Control Technology (BADCT). Any new flow must be treated to a level no less restrictive than Best Available Demonstrated Control Technology (BADCT). The result of mixing the current design flow at the existing permit limit with the additional flow at BADCT is:

$$\frac{2.0 (2.0) + 1.0(1.0)}{3.0} = 1.7 \text{ mg/l } \text{NH}_3\text{-N}$$

The BADCT mix $\text{NH}_3\text{-N}$ of 1.7 mg/l is more restrictive than the 1.8 mg/l determined above, which is the maximum discharge level that will not exceed the reserved portion of the remaining available pollutant assimilative capacity. Therefore, the WWTP could not discharge more than 1.7 mg/l $\text{NH}_3\text{-N}$ at the expanded design flow of 3.0 cfs.

5.2.2 Set Asides for CBOD

The issue of determining a set-aside for CBOD is complex because there is no water quality criterion for CBOD. Instead, CBOD is important as a water quality parameter because of its impact on instream dissolved oxygen levels. In addition, $\text{NH}_3\text{-N}$ also exerts a demand on instream D.O. levels. Dissolved oxygen water quality models are used to predict the impact of effluent CBOD and $\text{NH}_3\text{-N}$ on instream D.O.

As provided for in OAC rule 3745-1-05(C)(6)(a) and (c), for Outstanding State Waters and Superior High Quality Waters (other than Lake Erie), a portion of the remaining available pollutant assimilative capacity will be reserved. Therefore, any determination of allowable effluent loads must consider this reserve. The following example will address the expansion of a WWTP to a Superior High Quality Water, and will determine the maximum allowable load increase that will not exceed the reserved portion of the remaining available pollutant assimilative capacity for $\text{NH}_3\text{-N}$ and CBOD. Since there is no water quality criteria for CBOD, D.O. modeling must be used to determine assimilative capacity for CBOD. However, as discussed in Section 5.1.1, set asides for D.O. should be based on an $\text{NH}_3\text{-N}$ toxicity analysis, except in limited circumstances. The following example will assume that a calibrated and verified dissolved oxygen model is available, and that the use of this model is necessary to improve the decision making by the Agency.

Example

Assume that a WWTP is proposing to expand from 2.0 to 3.0 cfs, and currently has summer permit limits of 33.0 mg/l CBOD₅, 2.0 mg/l NH₃-N, and 5.0 mg/l D.O. For this example, assume that 70% of the remaining available pollutant assimilative capacity has been reserved. The following data will be used in the example:

Upstream Data:

30Q10 = 5.2 cfs

7Q10 = 4.0 cfs

NH₃-N = 0.05 mg/l

Downstream Data:

stream use designation = Warmwater Habitat

pH = 8.0 S.U.

Temperature = 23.0 °C

WQS for NH₃-N = 1.1 mg/l

Step 1 - Determine if the current permit limits are adequate to maintain the water quality criteria for NH₃-N toxicity at the existing WWTP design flow.

$$\text{WLA for NH}_3\text{-N} = \frac{1.1(5.2 + 2.0) - (5.2 * 0.05)}{2.0} = 3.8 \text{ mg/l NH}_3\text{-N}$$

The current permit limit of 2.0 mg/l is more restrictive than the WLA of 3.8 mg/l and is adequate to maintain water quality criteria for NH₃-N toxicity at the existing WWTP design flow.

Step 2 - Use the calibrated and verified D.O. model to assess the impact of the current permit flow and load on instream D.O. The model results showed a predicted minimum D.O. of 5.36 mg/l downstream of the WWTP. Therefore, the existing permit limits are adequate to maintain the WQS for D.O. at the existing design flow under summer 7Q10 conditions.

Step 3 - Determine the WLA to maintain water quality criteria for NH₃-N toxicity at the expanded WWTP design flow of 3.0 cfs. As mentioned previously, 70% of the remaining pollutant assimilative capacity is reserved.

downstream flow under 30Q10 = 5.2 + 3.0 = 8.2 cfs

Waterbody Pollutant Assimilative Capacity = 8.2 cfs * 1.1 mg/l * CF = 22.069 kg/d

Background Pollutant Load = 5.2 cfs * 0.05 mg/l * CF = 0.636 kg/d

Current Permit Load = 2.0 cfs * 2.0 mg/l * CF = 9.787 kg/d

Remaining Available Pollutant Assimilative Capacity =

22.069 kg/d Waterbody Pollutant Assimilative Capacity

0.636 kg/d Background Pollutant Load

9.787 kg/d Current Permit Load

11.646 kg/d Remaining Available Pollutant Assimilative Capacity

70% of the remaining available pollutant assimilative capacity, or 8.152 kg/d (0.7 * 11.646), is reserved; therefore, there is still 3.494 kg/d available for the expansion. The WWTP could increase their discharge by 3.494 kg/d, for a total effluent load of 13.281 kg/d (9.787 + 3.494) and not exceed the reserved portion of the remaining available pollutant assimilative capacity.

A discharge of 13.281 kg/d at an effluent flow of 3.0 cfs would result in an effluent NH₃-N of 1.8 mg/l.

Step 4 - Apply BADCT for NH₃-N to the additional flow. Any new flow must be treated to a level no less restrictive than Best Available Demonstrated Control Technology (BADCT). The result of mixing the current design flow at the existing permit limit with the additional flow at BADCT is:

$$\begin{array}{r} 2.0 (2.0) + 1.0(1.0) = 1.7 \text{ mg/l NH}_3\text{-N} \\ \hline 3.0 \end{array}$$

The BADCT mix NH₃-N of 1.7 mg/l is more restrictive than the 1.8 mg/l determined above, which is the maximum discharge level that will not exceed the reserved portion of the remaining available pollutant assimilative capacity. Therefore, the WWTP could not discharge more than 1.7 mg/l NH₃-N at the expanded design flow of 3.0 cfs.

Step 5 - Evaluate BADCT for CBOD and D.O. The next step in the analysis is to calculate the BADCT mix level for CBOD, and to determine if the BADCT mix is more restrictive than the allowable CBOD level that considers the reserved portion of the remaining available pollutant assimilative capacity. The result of mixing the current design flow at the existing permit limit with the additional flow at BADCT is:

$$\begin{array}{r} 2.0 (33.0) + 1.0(23.0) = 30.0 \text{ mg/l CBOD}_{20} \\ \hline 3.0 \end{array}$$

Effluent D.O. must also be determined using the BADCT mix calculation. The result is:

$$\begin{array}{r} 2.0 (5.0) + 1.0(6.0) = 5.3 \text{ mg/l D.O.} \\ \hline 3.0 \end{array}$$

Step 6 - Determine the assimilative capacity for CBOD. In order to determine the reserved load for CBOD, the total assimilative capacity with the WWTP discharging at 3.0 cfs under summer 7Q10 conditions must be determined. The D.O. model will be used to determine the allocation to maintain the WQS for D.O., and therefore, the waterbody pollutant assimilative capacity for CBOD.

From the model output, it can be determined that the waterbody pollutant assimilative capacity for CBOD₂₀ is 13.56 mg/l under these summer design conditions.

Step 7 - Determine remaining available pollutant assimilative capacity. The allowable loads can be determined as follows:

$$\begin{array}{l} \text{downstream flow under 7Q10 conditions} = 4.0 + 3.0 = 7.0 \text{ cfs} \\ \text{Waterbody Pollutant Assimilative Capacity} = 7.0 \text{ cfs} * 13.56 \text{ mg/l} * \text{CF} = 232.24 \text{ kg/d} \\ \text{Background Pollutant Load} = 4.0 \text{ cfs} * 2.0 \text{ mg/l} * \text{CF} = 19.57 \text{ kg/d} \\ \text{Current Permit Load} = 2.0 \text{ cfs} * 33.0 \text{ mg/l} * \text{CF} = 161.48 \text{ kg/d} \end{array}$$

Remaining Available Pollutant Assimilative Capacity =

$$\begin{array}{r} 232.24 \text{ kg/d} \quad \text{Waterbody Pollutant Assimilative Capacity} \\ 19.57 \text{ kg/d} \quad \text{Background Pollutant Load} \end{array}$$

161.48 kg/d	Current Permit Load

51.19 kg/d	Remaining Available Pollutant Assimilative Capacity

Step 8 - Determine the additional load that is available for the expansion. 70% of the remaining available pollutant assimilative capacity, or 35.83 kg/d ($0.7 * 51.19$), is reserved. Therefore, an additional 15.36 kg/d of $CBOD_{20}$ is available for the expansion.

161.48 kg/d	Current Permit Load
15.36 kg/d	available for expansion

176.84 kg/d	Possible permit load after expansion

Conclusion

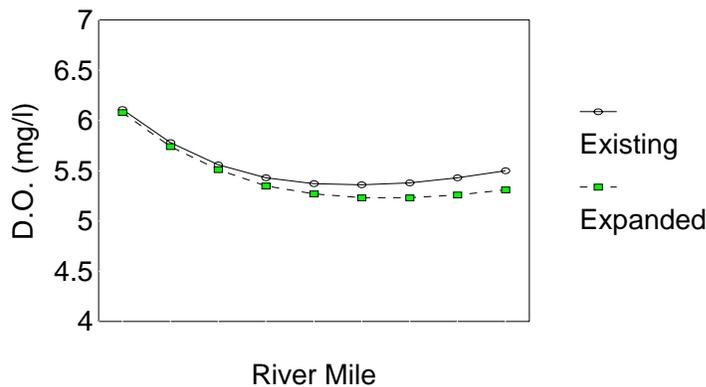
A load of 176.84 kg/d $CBOD_{20}$ results in an effluent quality of 24.1 mg/l $CBOD_{20}$ at 3.0 cfs. This is more restrictive than the BADCT mix level of 30.0 mg/l $CBOD_{20}$. Therefore, the possible effluent limits for the expansion, pending the results of the antidegradation review are:

24.1 mg/l $CBOD_{20}$, 1.7 mg/l NH_3-N , 5.3 mg/l D.O.

The following figure compares the predicted instream D.O. levels with the WWTP discharging under summer 7Q10 conditions at:

- 1) existing flow of 2.0 cfs and existing permit limits
- 2) expanded flow of 3.0 cfs and the limits for the expansion noted above

Predicted Instream D.O. Existing vs. Expanded WWTP



5.2.3 Exclusions

5.2.3.1 OAC Rule 3745-1-05(D)(1)(b)(i) - exclusion for a General High Quality Water. This section of the antidegradation rule details the load increases that qualify for an exclusion. The average wasteload allocation (WLA) is determined as specified in OAC rule 3745-2-05. The 10% and 80% levels specified in the antidegradation rule are then determined as 10% and 80%, respectively, of the average WLA for that facility. It should be noted that for a proposed discharge, it will not be necessary to assess the 80% level since receiving 10% of the allocation can not result in exceeding 80% of the allocation. Two examples follow. The first addresses a

proposed discharge to a General High Quality Water, while the second addresses an expansion to a General High Quality Water.

Example:

The following information is assumed:

*Proposed WWTP flow = 1.0 cfs
Average WLA to maintain WQS = 50. ug/l*

Step 1 - Using the wasteload allocation results, determine the allowable load to maintain WQS.

$$50. \text{ ug/l} * 1.0 \text{ cfs} * CF = 0.122 \text{ kg/d}$$

Step 2 - Determine the deminimis level of 10% of the average WLA

$$0.1 * 0.122 = 0.012 \text{ kg/d}$$

In this case, the discharger can receive a load of up to (but not equal to) 0.012 kg/d (10% of the WLA) without going through a complete antidegradation review. The discharger can receive a larger load, up to the WLA of 0.122 kg/d; however, a complete antidegradation review would be required.

In the case of a proposed discharge of sanitary wastewater, the discharge must be treated to a level no less stringent than Best Available Demonstrated Control Technology (BADCT). Therefore, if BADCT is more stringent than the level required to maintain water quality criteria, the BADCT level must be compared to the 10% and 80% levels to determine if a BADCT discharge would require a complete antidegradation review.

Example

The following information is assumed:

*Existing WWTP design flow = 0.5 cfs
Existing average permit = 30. ug/l
WWTP proposes to expand to 1.0 cfs
Average WLA @ expanded flow of 1.0 cfs = 50. ug/l*

Step 1 - Using the wasteload allocation results, determine the allowable load to maintain WQS.

$$50. \text{ ug/l} * 1.0 \text{ cfs} * CF = 0.122 \text{ kg/d}$$

Step 2 - Determine the deminimis level of 10% of the average WLA

$$0.1 * 0.122 = 0.012 \text{ kg/d}$$

Step 3 - Determine the level of 80% of the WLA.

$$0.8 * 0.122 \text{ kg/d} = 0.098 \text{ kg/d}$$

Step 4 - Determine the current permit load.

$$0.5 \text{ cfs} * 30. \text{ ug/l} * CF = 0.037 \text{ kg/d}$$

Step 5 - Determine the possible increase in effluent load.

$$0.037 \text{ (existing permit load)} + 0.012 \text{ (10\% of WLA)} = 0.049 \text{ kg/d}$$

This value (0.049 kg/d) is less than the 80% level of 0.098 kg/d; therefore, the discharger can receive an increase of up to (but not equal to) 0.012 kg/d (10% of WLA), as long as the total load is less than 0.098 kg/d (80% of the WLA), without going through a complete antidegradation review. A larger increase, or an increase that results in a total effluent load that exceeds 80% of the WLA, may be allowed; however, a complete antidegradation review would be required.

In the case of a proposed expansion for the discharge of sanitary wastewater, OAC rule 3745-1-05 requires that the new additional flow must be treated to a level no less stringent than Best Available Demonstrated Control Technology (BADCT). A mix of the existing permit limits and existing design flow with the new additional flow at BADCT is determined (referred to as "BADCT mix"). Therefore, if the BADCT mix is more stringent than the level required to maintain water quality criteria, the BADCT mix level must be compared to the 10% and 80% levels to determine if the BADCT mix discharge would require a complete antidegradation review

5.2.3.2 OAC Rule 3745-1-05(D)(1)(b)(ii) - exclusion for Superior High Quality Waters (other than Lake Erie) and Outstanding State Waters. A net increase that results in less than a 5% change in ambient water quality does not require a complete antidegradation review, provided the proposed lowering of water quality does not exceed the reserved portion of the remaining available pollutant assimilative capacity. A larger increase may be allowed with a complete antidegradation review; however, in no case can the proposed lowering of water quality exceed the reserved portion of the remaining available pollutant assimilative capacity.

Example:

The following information is assumed:

This example assumes 35% of the remaining available pollutant assimilative capacity is reserved.

The WWTP wants to expand from 2.32 cfs to 4.64 cfs.

Use the following data in the example:

upstream 7Q10 = 9.23 cfs

upstream WQ = 25. ug/l

existing average permit limit = 1500. ug/l

chronic criteria = 600. ug/l

Step 1 - Calculate instream concentration with WWTP at existing design flow and existing permit limit.

$$\frac{9.23(25.) + 2.32(1500)}{11.55} = 321. \text{ ug/l instream}$$

Step 2 - Calculate water body pollutant assimilative capacity with WWTP at the expanded design flow of 4.64 cfs.

$$(9.23 + 4.64 \text{ cfs}) * 600. \text{ ug/l} * CF = 20.361 \text{ kg/d}$$

Step 3 - Calculate Background Load.

$$9.23 \text{ cfs} * 25. \text{ ug/l} * CF = 0.565 \text{ kg/d}$$

Step 4 - Calculate Existing Permit Load.

$$2.32 \text{ cfs} * 1500. \text{ ug/l} * CF = 8.515 \text{ kg/d}$$

Step 5 - Calculate Remaining Available Pollutant Assimilative Capacity.

$$\begin{aligned} &20.361 \text{ kg/d (Water Body Pollutant Assimilative Capacity at expanded design flow)} \\ &- 0.565 \text{ kg/d (Background Load)} \\ &- 8.515 \text{ kg/d (Existing Permit Load)} \\ &11.281 \text{ kg/d (Remaining Available Pollutant Assimilative Capacity)} \end{aligned}$$

Step 6 - Calculate reserved portion of remaining available pollutant assimilative capacity (35% is reserved).

$$0.35 * 11.281 = 3.948 \text{ kg/d is reserved.}$$

Step 7 - Calculate the highest load that the facility can discharge and not exceed the reserved portion of the remaining available pollutant assimilative capacity.

$$\begin{aligned} &20.361 \text{ kg/d (Water Body Pollutant Assimilative Capacity)} \\ &- 0.565 \text{ kg/d (Background Load)} \\ &- 3.948 \text{ kg/d (Reserved)} \\ &15.848 \text{ kg/d (Remaining Available Assimilative Capacity)} \end{aligned}$$

The facility currently has a permitted load of 8.515 kg/d; therefore, the facility could increase their load by 7.333 kg/d to a total effluent load of 15.848 kg/d. Any increase in effluent load that results in a change in the instream water quality of greater than 5% requires a complete antidegradation review. What load causes a 5% change in the instream water quality?

From Step 1 above, the instream water quality with the facility discharging at its current permitted flow and load = 321. ug/l.

Step 8 - Calculate a 5% increase in instream water quality.

$$321. \text{ ug/l} * 1.05 = 337. \text{ ug/l}$$

Step 9 - Calculate the discharge quality at the expanded design flow of 4.64 cfs that will result in a predicted instream water quality of 337. ug/l (5% increase).

$$\begin{array}{r} 337.(9.23 + 4.64) - 9.23(25.) = 958. \text{ ug/l} \\ \hline 4.64 \end{array}$$

$$958. \text{ ug/l} * 4.64 \text{ cfs} * CF = 10.876 \text{ kg/d}$$

Conclusion:

The facility, at the expanded design flow of 4.64 cfs, can discharge a total load of up to 10.876 kg/d, without going through a complete antidegradation review. This would be an increase of up to 2.361 kg/d above the current permit load of 8.515 kg/d, would cause less than a 5% change

in the projected ambient water quality, and would not exceed the reserved portion of the remaining available pollutant assimilative capacity. With a complete antidegradation review, the facility could possibly discharge up to 15.848 kg/d (an increase of up to 7.333 kg/d). This level of discharge would result in greater than a 5% change in the projected ambient water quality, but would not exceed the reserved portion of the remaining available pollutant assimilative capacity.

5.2.3.3 OAC Rule 3745-1-05(D)(1)(b)(iii) - Exclusions for direct discharges to Lake Erie. The average WLA is determined as specified in Rule 3745-2-05 of the Administrative Code. This value is then converted to a load using the effluent design flow. The 10% level specified in the antidegradation rule is then determined as 10% of the average WLA, which has been converted to load.

Example:

The following information is assumed:

The facility would like to increase their design flow from 3.0 to 4.0 cfs.

Use the following data in this example:

existing average permit limit = 40.0 ug/l

existing effluent design flow = 3.0 cfs

background concentration = 0.25 ug/l

chronic criteria = 5.0 ug/l

Step 1 - Calculate Water Body Pollutant Assimilative Capacity with facility at expanded design flow.

$$(11 * 5.0 \text{ ug/l}) - (10 * 0.25 \text{ ug/l}) * 4.0 \text{ cfs} * CF = 0.514 \text{ kg/d}$$

Step 2 - Calculate 10% of Water Body Pollutant Assimilative Capacity

$$0.10 * 0.514 = 0.051 \text{ kg/d}$$

Step 3 - Calculate current permit load

$$3.0 \text{ cfs} * 40.0 \text{ ug/l} * CF = 0.294 \text{ kg/d}$$

Conclusion:

The facility can receive an increase in their permitted load of up to (but not equal to) 0.051 kg/d, for a total load of 0.345 kg/d (0.294 kg/d + 0.051 kg/d = 0.345 kg/d), without going through a complete antidegradation review. A larger increase would require a complete antidegradation review.

5.2.4 Downstream Classifications

In the wasteload allocation process, the OAC rules require that downstream use designations be considered. For example, assume a WWTP discharges to RM 0.2 of an unnamed tributary that is designated as a Limited Resource Water. The unnamed tributary joins a stream that is designated as Exceptional Warmwater Habitat. Therefore, the WLA must be calculated to maintain the LRW criteria in the unnamed tributary and the EWH criteria in the next stream.

Analyses for antidegradation must also consider downstream classifications. Using the situation in the preceding paragraph, assume that the unnamed tributary is a General High Quality Water, and that the next stream is a Superior High Quality Water. Both paragraphs (D)(1)(b)(i) and (D)(1)(b)(ii) of OAC rule 3745-1-05 must be applied in the evaluation of whether or not an exclusion applies.

As in the determination of effluent limits to maintain water quality criteria, depending on the distance to the next stream in the network, time of travel, parameter being evaluated, etc., it may not be necessary to consider the downstream classification.

For more information contact:

Ohio EPA, Division of Surface Water
Modeling and Assessment Section
(614) 644-2001

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