

Instructions for BOD₅ to CBOD₅ Substitution in NPDES Permits

Revision 3.0



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1. Intent/Purpose/Statement of Need

This directive clarifies DEQ's policy and implementation procedures on the substitution of five-day carbonaceous biochemical oxygen demand (CBOD₅) for five-day biochemical oxygen demand (BOD₅) in technology-based effluent limits in NPDES permits.

1.1 Authority

Under 40 CFR 133.102, DEQ, at its discretion, may substitute CBOD₅ limits for BOD₅ limits to meet federal secondary treatment standards. Under Oregon Administrative Rules (OAR), including OAR 340-041-0007(15), DEQ has the authority to establish NPDES permit limits to implement state minimum design criteria. Also, under 40 CFR 133.105, where data exist to establish CBOD₅ limits, DEQ may substitute CBOD₅ limits for BOD₅ limits to meet federal equivalent to secondary treatment standards.

1.2 Applicability

This directive provides instructions to Oregon NPDES permit development staff for evaluating and setting technology-based effluent limits in NPDES individual permits for the following conditions:

- The existing permit contains CBOD₅ limits or the facility requests a substitution of CBOD₅ limits for the existing BOD₅ limits;¹ and
- The limits are based on either federal secondary standards, federal equivalent to secondary standards or state basin-specific design standards.

This IMD is not directly applicable to the implementation of BOD wasteload allocations (WLAs) associated with TMDLs, or any BOD water quality-based effluent limits that are more stringent than the applicable technology-based effluent limits.²

1.3 Definitions

- **BOD₅** (five-day biochemical oxygen demand) means a measurement of the amount of oxygen used by the bacteria as they stabilize the organic matter over a five-day period at 20°C.
- **CBOD₅** (five-day carbonaceous biochemical oxygen demand) means a measurement of the amount of oxygen demand over a five-day period exerted by organic (carbonaceous) compounds, excluding the oxygen demand exerted by the nitrogenous compounds.
- **NOD** (nitrogenous biochemical oxygen demand) means the oxygen demand exerted by nitrogenous compounds.
- **Conversion factor** means an arithmetic multiplier for converting a quantity expressed in BOD₅ into an equivalent expressed in CBOD₅.

¹ This could be for either the scenario where the existing permit already includes the substitution, or where the existing permit contains BOD₅ limits.

² Any effluent limit associated with a TMDL WLA will need to be consistent with the TMDL.

2. Summary

The Clean Water Act requires that wastewater treatment plants provide a minimum level of treatment. For publicly owned treatment works (POTWs), federal regulations establish Secondary Treatment Standards for BOD₅, suspended solids (SS) and pH. Problems have arisen with the use of the BOD₅ testing at some municipal secondary facilities. When sufficient numbers of nitrifying-bacteria are present in the test sample, they can exert a significant nitrogenous oxygen demand (NOD) in the BOD₅ test that would not be exerted in their absence.³ This may lead to inaccurate assessment of compliance with federal secondary standard limitations and state design criteria. To address this concern regarding secondary standards, 40 CFR 133.102(a)(4) and 40 CFR 133.105(e) provide the permitting authority (DEQ) the option to substitute the BOD₅ effluent limit with a CBOD₅ limit.

EPA has established CBOD standards for cases where secondary treatment standards or equivalent to secondary treatment standards are applied. However, implementation of Oregon's Minimum Design Criteria⁴ may result in BOD₅ limits for treated sewage⁵ that are more stringent than the applicable federal secondary standards. The federal rules do not address this situation. When including permit limits based on these design criteria, the DEQ permit writer may use the guidance in this IMD to substitute CBOD₅ for BOD₅ in accordance with the methods described in this IMD.

3. Background

In 1984, EPA promulgated rule revisions allowing for the substitution of CBOD₅ for BOD₅ when implementing federal secondary and equivalent to secondary standards. The federal register promulgating these rule revisions⁶ explained the rationale for the changes:

The Agency is allowing substitution of the CBOD₅ parameter for the BOD₅ parameter, because it believes that this parameter is a better reflection of the understood meaning of secondary treatment in terms of measuring the removal of carbonaceous organic materials by secondary treatment for certain POTWs. In addition, the Agency believes that implementation of CBOD₅ test procedures should eliminate the counter-productive operating practices that were noted above since incidental nitrification will no longer affect test results.⁷

The rule revisions pertain to the implementation of both secondary standards for BOD₅, and equivalent to secondary standards for BOD₅. These rules and their implementation are discussed in more detail below.

In addition to the federal secondary standards for BOD₅, OARs contain general and basin-specific minimum design criteria for the treatment and control of sewage wastes. These design criteria include

³ From Federal Register/Vol.49, No. 184/Sept. 20, 1984, page 36988: <https://cdn.loc.gov/service/ll/fedreg/fr049/fr049184/fr049184.pdf>.

⁴ OAR 340-041-0007(15).

⁵ "Sewage" is defined in OAR 340-041-0002(57) as the water-carried human or animal waste from residences, buildings, industrial establishments, or other places together with such groundwater infiltration and surface water as may be present. The admixture with sewage of industrial wastes or wastes, as defined in this rule, may also be considered "sewage" within the meaning of this division.

⁶ Federal Register/Vol.49, No. 184/Sept. 20, 1984 <https://cdn.loc.gov/service/ll/fedreg/fr049/fr049184/fr049184.pdf>.

⁷ Ibid, page 36988.

BOD₅ concentrations and may be implemented in permits as either CBOD₅ or BOD₅ limits. These rules and their implementation are discussed in more detail below.

4. Directive

4.1 Implementing Federal Secondary Standards

Secondary Standards

Under federal regulations and guidance,⁸ a permit writer may substitute CBOD₅ for BOD₅ when applying federal secondary standards. This substitution should take place if a permittee requests the substitution, or if a permit containing CBOD₅ limits is being renewed and the permittee has not requested BOD₅ limits.⁹ The monitoring requirements included in permits to determine compliance with the CBOD₅ limits must be for CBOD₅ in order to conform to federal and state requirements.

The CBOD₅ limits that will be included in these permits, when used, are:

- 25 mg/L as a monthly average
- 40 mg/L as a weekly average
- 85% removal as a monthly average

These limits are substitutes for the 30 mg/L (monthly average), 45 mg/L (weekly average), 85% removal (monthly average) BOD₅ limits used to address federal secondary standards. The substitution may be applied seasonally or year-round.

Equivalent to Secondary Standards

Federal regulations and guidance also allow permit writers to substitute CBOD₅ for BOD₅ when applying federal equivalent to secondary standards. However, the applicable regulation¹⁰ only allows this substitution “(w)here data are available to establish CBOD₅ limitations ...”. The federal register promulgating these rule revisions explains that the required data are expected to be parallel CBOD₅ and BOD₅ data submitted by the permittee. These data would be used by DEQ to help establish CBOD₅ limits when applying federal equivalent to secondary standards. The federal regulations state that the resulting CBOD₅ limits may not be less stringent than the following:

- 40 mg/L as a monthly average
- 60 mg/L as a weekly average
- 65% removal as a monthly average

In order to substitute CBOD₅ for BOD₅ when applying federal equivalent to secondary standards, the permittee should request the substitution, and submit parallel CBOD₅ and BOD₅ effluent data. The data should be collected during periods of cool weather and while the facility is achieving at least the 45 mg/L (monthly average), 65 mg/L (weekly average), and 85% removal (monthly average) BOD₅ limits. DEQ permitting staff will then analyze the data to determine the relationship between the CBOD₅ and BOD₅

⁸ 40 CFR 133.102 and U.S EPA’s *NPDES Permit Writer’s Manual*, September 2010, page 5-10.

⁹ As explained in the federal register promulgating these rule revisions, no facility-specific data or information is required to implement this substitution (Federal Register/Vol.49, No. 184/Sept. 20, 1984, p. 36999).

¹⁰ 40 CFR 133.105(e).

data, and then develop a conversion factor to be used to establish appropriate CBOD₅ limits.¹¹ The substitution may be applied seasonally or year-round.

4.2 Implementing State Design Criteria

As noted above, the implementation of Oregon's Minimum Design Criteria¹² may result in BOD₅ limits for treated sewage⁶ that are more stringent than the applicable federal secondary standards. The federal rules do not address the substitution of CBOD₅ limits for BOD₅ limits when applying these criteria.

While state regulations do not specifically address the substitution of CBOD for BOD when establishing permit limits, DEQ has concluded that it is appropriate to do so due to the same rationale presented by EPA when developing their rule allowing the substitution (see Section 3, above). As such, it is DEQ's policy that permit writers may substitute CBOD₅ for BOD₅ when including permit limits to implement Oregon's Minimum Design Criteria. This substitution may take place if a permittee requests the substitution, or if a permit containing CBOD₅ limits is being renewed and the permittee has not requested BOD₅ limits. The substitution may be applied seasonally or year-round. As with substitution of CBOD₅ for BOD₅ for federal standards, the permit must include CBOD₅ (nitrogen inhibited) monitoring to ensure monitoring occurs for the parameter being regulated within the permit.

When including CBOD₅ limits to implement Oregon's Minimum Design Criteria, the use of a CBOD₅/BOD₅ conversion factor is necessary when a permit currently contains BOD₅ limits to implement the design criteria and the permittee requests the substitution of CBOD₅ limits. The two options for calculating and assigning a conversion factor are:

- **Default Conversion Factor (CBOD₅:BOD₅).** Based on the ratios of the CBOD₅ to BOD₅ concentrations used in the implementation of federal secondary standards.
 - 0.8 for the 30-day average limit, derived from the federal substitution relationship of 25 mg/L CBOD₅ to 30 mg/L BOD₅
 - 0.9 for the 7-day average limit, derived from the Federal substitution relationship of 40 mg/L CBOD₅ to 45 mg/L BOD₅
- **Site-specific Conversion Factor.** A site-specific conversion factor may be determined based on a parallel monitoring study or engineering study to quantify the CBOD₅/BOD₅ concentration relationship. The derivation of this conversion factor should generally follow the same process used by EPA for deriving the conversion factor related to the federal equivalent to secondary standards. This includes the proposal and acceptance of a facility/outfall specific CBOD₅ limit with a future approved facility plan.

4.3 Implementation Exceptions

While the above implementation will be applicable to many situations, it cannot take into account all scenarios. The following non-exhaustive list includes the anticipated scenarios that may justify deviating from the direction of this IMD and provide a direction on how to do so.

¹¹ These requirements are based on the data collection and analysis process EPA used to determine the CBOD₅ limits for secondary standards. The process is explained in Federal Register/Vol.49, No. 184/Sept. 20, 1984, p. 37000.

¹² OAR 340-041-0007(15) and associated basin-specific criteria in OAR 340-041.

- Facilities currently operating under the previous DEQ 10 mg/l CBOD₅ policy
 - If a permit containing CBOD₅ limits is being renewed, it is reasonable to proceed with an understanding that the existing CBOD₅ limits were considered to be equivalent control when the design criteria were implemented during facility plan review and approval. In this situation, the existing CBOD₅ limits should be retained. If it has been established (i.e., clearly documented in the facility records) that the existing CBOD₅ limits were not considered to be equivalent control when the design criteria were implemented, then the use of a CBOD₅/BOD₅ conversion factor is appropriate.
- Site specific study:
 - Facilities operating or wanting to operate under the 10 mg/l CBOD₅ limit may choose to conduct a facility specific study, as described in section 4.2.

5. Record of Revisions to IMD

Revision	Date	Changes	Editor
1.0	8/17/2017	First Version	Spencer Bohaboy
2.0	2/1/2018	Final Version	Jeff Navarro
3.0	5/13/2021	Corrections to ensure consistency with rules and guidance	Rob Burkhart
3.1	2/8/2022	Update of possible exception options	Geoff Rabinowitz