Missouri Department of Natural Resources
Water Protection Program
Water Pollution Control Branch

3 Part III: Effluent Limit Procedures: Technology-Based Effluent Limits

3.1 Effluent Limitations

An effluent limitation is any restriction imposed by the department on quantities, discharge rates, and concentrations of pollutants that are discharged from point sources into waters of the state. Effluent limits can be a narrative requirement such as a Storm Water Pollution Prevention Plan, but for the purposes of this section 'effluent limitations' refers to numeric effluent limitations. The effluent limit determination and derivation process considers current effluent requirements, background water quality, nearby discharges, antidegradation requirements, and best professional judgment. Effluent limits are either treatment effluent guidelines technology-based, alternative analysis technology-based (based upon discharger's and permit writer's best professional judgment of the proposed wastewater treatment technology capacity), or water quality-based requirements that are imposed and enforced through the Missouri State Operating Permit (MSOP) issued to the facility. Operating permit effluent limits can be mass- or concentration-based values that, when derived with regard to facility effluent variability, will ensure water quality standards are met within the receiving water. Two types of permit limits are typically developed: daily maximum limits and monthly average limits. The daily maximum limit is the maximum daily value for any daily sample. The monthly average limit is the maximum allowable value for all daily values averaged over one month. Because the focus of this guidance will be the development of water quality-based effluent limits, development of technology-based effluent limits will not have a detailed discussion. More details on the process can be found in the EPA NPDES Permit Writer's Manual, Chapter 5, or within the Water Protection Program Permit Manual

3.2 Pollutants of Concern

According to 10 CSR 20-2.010(55), a pollutant is any "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewer sludge, munitions, chemical waste, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, filter backwash or industrial, municipal or agricultural waste discharged into water." Discharged pollutants, or pollutants proposed for discharge that affect beneficial use(s) in waters of the state. In addition, according to the AIP, pollutants of concern (POCs) include pollutants that create conditions unfavorable to beneficial uses in the water body receiving the discharge or proposed to receive the discharge. For the purpose of implementing the NPDES program, EPA categorized pollutants that are expected to be discharged from point sources into the following categories:

- **Conventional Pollutants** – Pollutants typical of municipal sewage and for which municipal secondary treatment plants are typically designed; defined by federal regulation as BOD, TSS, fecal coliform and Escherichia coli (E. coli) bacteria, oil and grease, and pH [40 CFR §401.16].

- **Non-Conventional Pollutants** – All pollutants that are not included in the list of conventional or toxic pollutants in 40 CFR Part 401. These include chemical oxygen demand, total organic carbon, nitrogen, and phosphorous.

- **Toxic Pollutants** – Pollutants or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring. Toxic pollutants include, but are not limited to, the one hundred twenty-six (126) priority pollutants identified by EPA pursuant to Section 307(a) of the Federal Clean Water Act or any pollutant listed under Section 405(d) which relates to sludge management.

- **Priority Pollutants** – Those pollutants considered to be of principal importance for control under the CWA. A list of these pollutants is provided as Appendix A to 40 CFR Part 423.

In addition to the classification scheme listed above, pollutants are also categorized by their ability to be transformed or degraded within the environment. The two terms commonly used are:

- **Conservative Pollutants** – Pollutants which are not normally physically or chemically transformed to non-toxic substances in the receiving water. These include, but are not limited to, salts and metals.

- **Non-Conservative Pollutants** – Pollutants which are transformed to non-toxic substances through physical, chemical, or biological processes in the receiving water. These include biochemical oxygen demand, ammonia, and certain other organic compounds.

Conservative pollutants tend to be stable, long-lived compounds that persist within the environment. Non-conservative pollutants can transform or degrade into other compounds, but the rate of transformation depends on the physical, chemical, and biological conditions occurring within the receiving water environment. Knowledge of the conservative or non-conservative nature of a pollutant can be important, especially when determining whether a particular wasteload allocation or modeling strategy can be used to establish effluent limits protective of water quality.

For purposes of AIP reviews, pollutants of concern are pollutants that are reasonably to be expected in the waste water discharge and affect beneficial uses of the receiving water body. POCs include pollutants that create conditions unfavorable to beneficial uses in the water body receiving the discharge or proposed to receive the discharge. For example, where pH, temperature, and dissolved oxygen are in noncompliance with applicable

numeric criteria….applicant should list these as POCs. **Table A of 10 CSR 20-7** contains numeric water quality criteria for some pollutants. Some POCs have no criterion or are not amendable to antidegradation analysis; therefore, for most discharge cases, no antidegradation review are currently required for these POCs beyond meeting technology-based effluent limits, if established, or limits developed to be protective of water quality standards.

> Example: A municipal wastewater treatment facility receiving only domestic wastewater would have the following POCs to address: BOD_5, DO, pH, TSS, bacteria, Ammonia as N, Oil & Grease, and total residual chlorine (TRC), depending on the disinfection method. Note: TSS is listed because it affects general criteria and has regulatory effluent limitations; and pH is listed because it has a water quality standard and regulatory effluent limitations. More explanation of these pollutants is provided in sections below.

See Section 3.3.2.4 and Water Quality-based Effluent Limits section of Part IV for more details on each POC.

3.3 Technology-Based Effluent Limits (TBELs)

The Water Quality Reviewer must understand the national standards, importance difference between the standards, and when they should be applied. This section describes the various types of performance-based standards, their origin, and to which classes of pollutants they apply. The first step in the effluent limit determination process involves the application of a minimum level of treatment for suspected pollutants or categories of pollutants in a facility discharge. **Best Practicable Control Technology Currently Available (BPT)** was the first technology-based standard established by the Clean Water Act in 1972 to control pollutants discharged to waters of the United States. BPT effluent limitations guidelines are generally based on the average of the best existing performance by plants within an industrial category or subcategory. BPT effluent limitations apply to all pollutants (conventional, non-conventional, and toxic).

Pollutant	Level of Treatment
Conventional	BPT, BCT
Non-conventional	BPT, BAT
Toxic	BPT, BAT

Table 6: Classes of Pollutants and Performance-based Standard

The initial BPT effluent limitations guidelines were later improved by requiring the application of updated technology-based standards. **Best Conventional Pollutant Control Technology (BCT)** became the technology-based standard for the discharge of conventional pollutants from existing industrial point sources. For municipal point sources, EPA developed and promulgated “secondary treatment” as the technology-based

standard for the discharge of conventional pollutants. **Best Available Technology Economically Achievable (BAT)** became the technology-based standard established for controlling the direct discharge of non-conventional and toxic pollutants. BAT effluent limitations guidelines, in general, represent the best existing performance of treatment technologies that are economically achievable within an industrial point source category or subcategory. While municipal point sources do not have BAT limits per se, BAT effluent limitations can be imposed by the municipality upon industrial discharges to their collection system through an established municipal pretreatment program.

It is important to recognize that BPT, BCT, and BAT are all "technology-based" standards that were established on the basis of what a particular treatment technology could reasonably achieve. The level of protection offered by technology-based standards may not be sufficient to protect water quality in the receiving stream for existing or designated uses. Technology-based effluent limits are therefore the minimum level of control that must be imposed in a discharge permit issued by the state.

3.3.1 Industrial (Categorical) Technology-Based Effluent Limits

As part of the 1972 Clean Water Act, the EPA **was to establish** effluent limit guidelines representing application of BPT, BAT, and New Source Performance Standards (NSPS); however, EPA did not establish guidelines until the 1977 revision of the Clean Water Act. Presently, technology-based standards have been established for 56 categorical industries (for example, metal finishing facilities, steam electric power plants, iron and steel manufacturing facilities) through effluent guidelines promulgated by EPA in 40 CFR Parts 405-471, Subchapter N.

Effluent limitations guidelines (ELGs) are technology-based effluent limits created by EPA under Section 306 of the Clean Water Act. ELGs are also called "categorical limits or standards." EPA has developed daily and monthly limits for certain industries based on the production of the facility, or more commonly, a simple concentration-based limit. Both daily and monthly limits must be included in the permit. When designing a treatment system, the applicant/permittee must target the design of its treatment system to meet the average monthly limit rather than the daily limits. In most cases the daily limit is higher than the average monthly limit, and is intended to account for occasional variation in treatment efficacy that may result in effluent concentration above the monthly limit. For further information on applying the ELG to the review process, consult the MDNR Permit Manual, Use of Effluent Limits Guidelines.

3.3.2 Municipal and Domestic Technology-Based Effluent Limits

While BCT is the technology-based standard for the discharge of conventional pollutants from existing industrial point sources, for municipal point sources or Publicly-owned Treatment Works (POTWs) EPA developed and promulgated "secondary treatment" as the technology-based standard for the discharge of conventional pollutants.

3.3.2.1 Secondary Treatment

The main treatment component of a municipal treatment plant (normally biological) is termed secondary treatment and is usually preceded by simple settling (primary treatment). Secondary treatment standards are established by EPA in 40 CFR 133.102 for publicly-owned treatment works (POTWs) and reflect the performance of secondary wastewater treatment plants (e.g. activated sludge, oxidation ditch, sequencing batch reactors (SBRs)). These technology-based regulations apply to all municipal wastewater treatment plants and represent the minimum level of effluent quality attainable by secondary treatment, as reflected in terms of 5-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) removal. In some cases an alternative to biological treatment can be employed, such as chemical addition, flocculation & sedimentation, or filtering. These alternative treatment technologies must still meet the secondary treatment standards. Domestic waste discharges that serve industrial, commercial, or residential developments may also have secondary treatment standards applied as effluent limits.

The standard secondary treatment technology-based parameters are five-day biochemical oxygen demand (BOD_5), five–day carbonaceous biochemical oxygen demand ($CBOD_5$) as a substitute for BOD_5 (approved by department on a case-by-case basis where significant nitrification in treatment is interfering with BOD5 test results), TSS also called nonfilterable residue (NFR), and pH. In addition to the standard permit limits, oil and grease, Escherichia Coli (E. Coli), and total residual chlorine may also be required depending on the beneficial uses of the receiving stream. Also, in accordance with provisions found in 40 CFR Part 133, percent removal requirements for BOD_5 and TSS must be included in the water quality review and consistent with the secondary treatment requirement for 85% removal. Below are the Missouri State Effluent Regulatory Limits (10 CSR 20.7.015) that reflect the secondary treatment standards that apply to the all waters of the state, including Missouri and Mississippi rivers and all others waters of the state except those mentioned paragraphs (1) (A) 1-6 of the Effluent Regulations.

Water Body	BOD_5	$CBOD_5$	TSS	pH
Missouri and Mississippi Rivers	30*/45*	25/40	30/45	6.5-9.0
All other waters of the state	30/45	25/40	30/45	6.5-9.0

/--average monthly/weekly average limits in mg/L

The secondary treatment standards also provide for special considerations regarding combined sewers, industrial wastes, waste stabilization ponds, and less concentrated influent wastewater for combined and separate sewers. In addition, the secondary treatment standards also provide alternative standards established on a case-by-case basis for treatment facilities considered equivalent-to-secondary treatment (trickling filters and waste stabilization ponds). See Chapter 5, Section 5.2, U.S. EPA NPDES Permit Writer's

Manual for information related to application of secondary treatment standards for municipal discharges.

The 85% removal efficiency is determined as follows:

$$\% \text{ Removal} = \frac{(\text{influent flow})(\text{influent concentration}) - (\text{effluent flow})(\text{effluent concentration})}{(\text{influent flow})(\text{influent concentration})} \times 100$$

3.3.2.2 Equivalent-to-Secondary Treatment

When EPA created the secondary treatment requirement, Congress was concerned that EPA had not approved of the use of treatment that produced significant reduction in BOD and TSS. To prevent construction of costly new facilities, Congress requested that the EPA create alternative limits or equivalent-to-secondary treatment limits for alternative biological treatments such as trickling filters and wastewater stabilization lagoons.

EPA and the department require the following to determine eligibility for equivalent-to-secondary treatment limits:

1) Must be operating a lagoon or trickling filter,
2) Effluent quality is consistently above 30 mg/L for TSS and BOD5,
3) Water quality of receiving waterbody must not be adversely impacted,
4) Over a 30-day period, 65% removal efficiency of BOD5 is consistently maintained. Alternate percent removal requirements may be allowed for equivalent-to-secondary treatment (65% removal) where justified. The 65% removal efficiency is determined as follows:

$$\% \text{ Removal} = \frac{(\text{influent flow})(\text{influent concentration}) - (\text{effluent flow})(\text{effluent concentration})}{(\text{influent flow})(\text{influent concentration})} \times 100$$

The following are Missouri State effluent regulatory limits for existing lagoons and trickling filters that have completed a water quality impact study showing that alternative limitation from secondary treatment limits will not cause violation of water quality standards or impairment of uses.

Water Body	BOD_5	$CBOD_5$	TSS	pH
Lagoons	45*/65*	75*/115*	80*/120*	> 6.5
Trickling Filters	45*/65*	40*/60*	45*/65*	6.5-9.0

/--average monthly/weekly average limits in mg/L,

There are provisions in the state effluent regulations that allow the department to set more stringent limits based upon the facilities performance and/or review of a new facility's design capacity study.

Equivalent-to-secondary technology-based limits are not allowed for discharges to geologically losing streams, discharges to groundwater, or discharges within one-half (1/2) stream mile of classified lakes. For more information on lagoon limits, the reviewer should refer to the *Lagoon Operating Permit Renewal Guidance* or the effluent regulations or the MDNR *Permit Manual.*

3.3.2.3 Advanced Treatment

Advanced treatment is defined as any process designed to produce a higher effluent quality than achieved by secondary treatment processes. In many cases secondary treatment has proved insufficient to protect the receiving waters. Thus, additional treatment steps have been added to wastewater treatment plants to provide for further organic and solids removals or to provide for removal of nutrients and/or toxic materials. Other pollutants that commonly affect water quality such as bacteria are also significantly reduced through these advanced treatment processes.

For discharges to losing streams, the Missouri State Effluent Regulations require advanced treatment as listed in the table below. If a facility is discharging within in 2 miles of a losing stream, then we require losing stream limits. The losing stream segment determination may have been established in the water quality standard in Table J or by way of a site-specific Geohydrologic Evaluation conducted by the department's Division of Geology and Land Survey. If a new facility is proposed within 5 miles of a known losing stream segment, losing stream limits will be required unless a Geohydrologic Evaluation is conducted and shows that the segment is gaining [10 CSR 20-7.031(11)(C)].

Water Body	BOD_5	TSS	pH
Losing Stream	10*/15*	15*/20*	6.5-9.0

/--average monthly/weekly average limits in mg/L,

Additions to conventional secondary treatment could be as simple as the addition of a filter for suspended solids removal or as complex as the addition of many unit processes for organic, suspended solids, nitrogen and phosphorus removal. Chemical addition to wastewater with aluminum- or iron-based coagulants followed by tertiary filtration can reduce total phosphorus concentrations in the final effluent to very low levels. The total phosphorus concentrations achieved by some of these waste water treatment facilities are consistently near or below 0.01 mg/l. Enhanced biological treatment in the secondary treatment processes typically can achieve phosphorus removal to 0.3 mg/L. Missouri requires advanced treatment for phosphorus removal; however, we may apply a water quality-based effluent limit or a technology-based effluent limit to discharge requiring nutrient removal (see *Nutrient and Chlorophyll Criteria for Lakes, Reservoirs and Streams: Implementation Procedure for Permitted Facilities*).

3.3.2.4 Alterative Analysis-based Effluent Limits

For municipalities and domestic wastewater treatment facilities, the development of effluent limits for POCs can be achieved using the provided technology-based effluent limit from the alternative analysis (see *Missouri Antidegradation Rule and Implementation Procedure,* May 2008, Section II. B). These technology-based effluent limits are based upon the treatment capacity of each POC as determined by the applicant and approved by the department. These alternative analysis-based effluent limits may be those provided by a treatment plant manufacturer or developed based on consultant experience with the operation of a facilities, or current discharge monitoring data that are in compliance with terms of the permit.

First, if non-degrading alternatives are not practicable, a set of treatment alternatives that are economically efficient when compared to the base cost of pollution control are developed. Alternatives that do or do not meet Missouri Water Quality Standards should be noted. The base cost of pollution control (base treatment alternative) is the cost of the controls required to protect existing uses and to achieve the highest statutory and regulatory requirements, i.e., the more stringent of water quality-based effluent limits for existing use protection or TBEL. All subsequent alternatives must achieve better treatment, thus lower wasteload allocations. As a non-binding rule-of-thumb, alternatives less than 120 percent of the base cost of pollution control measures are economically efficient. The economic efficiency analysis considers the increasing costs of higher and better pollutant treatment combined with the corresponding environmental benefits. Finally, the effluent limits for Tier 2 POCs in the preferred or selected alterative are developed to protect of beneficial uses and to retain the remaining assimilative capacity.

The authority to require alternative analysis-based effluent limits can be found in Missouri State regulation and EPA regulation. In the AIP, Section III, Permit Considerations, the department is authorized to develop permit effluent limits based on effluent guidelines, the applicable Water Quality Standards (WQS), EWQ and antidegradation requirements. The Environmental Protection Agency's regulation at 40 CFR 133.105 - Permit Adjustments – "permitting authorities shall require more stringent limitations when adjusting permits if:

(1) For existing facilities the permitting authority determines that the 30-day average and 7-day average BOD_5 and TSS effluent values that could be achievable through proper operation and maintenance of the treatment works, based on an analysis of the past performance of the treatment works, would enable the treatment works to achieve more stringent limitations, or

(2) For new facilities, the permitting authority determines that the 30-day average and 7-day average BOD_5 and TSS effluent values that could be achievable through proper operation and maintenance of the treatment works, considering the design capability of the treatment process and geographical and climatic conditions, would enable the treatment works to achieve more stringent limitations."

3.3.2.4.1 Toxics and Non- Conventional Pollutants

3.3.2.4.1.1 Wasteload Allocation and Limits Determination

Because of the requirement to first meet water quality standards, the wasteload allocation (WLA) for POCs as part of the base treatment alternative can be determined using the water quality-based effluent limit procedures for toxics and non-conventional pollutants or the *Total Ammonia Nitrogen Criteria Implementation Guidance*. The WLA of the preferred alternative is based upon the treatment capability provided to the department by the applicant. The preferred alternative is most economically efficient when compared to the base cost of pollution control.

For toxics and non-conventional pollutants, the procedure is to apply the treatment capacity of the preferred alternative as the WLA. For instance, for non-conventional pollutants, like nutrients, the applicant provides a technology-based WLA, which in the case of nutrients would be the limit of the available technology (see *Nutrient and Chlorophyll Criteria for Lakes, Reservoirs and Streams: Implementation Procedure for Permitted Facilities*).

With the available WLA, for toxics and non-conventional pollutants such as ammonia, we apply the WLA of the preferred alternative as average monthly limit (AML). We then back-calculate using the long-term average (LTA) multiplier for AML at the 95th percentile to obtain the LTA for the maximum daily limit (MDL) calculation (as defined in the US EPA's *Technical Support Document For Water Quality-based Toxics Control* (EPA/505/2-90-001)). We apply the TBEL WLA as AML; but if the regulatory limit (such as a total phosphorus limit) is lower than TBEL, then the regulatory limit is used as AML. If water quality standards exist for a nutrient, the WBEL is developed to compare to TBEL. The lower of the WBEL and TBEL is applied as an effluent limitation. Example calculation for ammonia is below (see Appendix E, *WQAR Instructional Guidance*):

AML = 3.0 mg/L
LTA = 3.0 / 1.19 [CV = 0.6, 95th Percentile, n = 30]
LTA = 2.5 mg/L

MDL = 2.5 (3.11) [CV = 0.6, 99th Percentile]
MDL = 7.8 mg/L

Preferred-alternative effluent limitations (PELs) meet water quality standards but do not necessarily retain the entire water body assimilative capacity for that pollutant of concern. In theory, these limits should take more than 10% of the assimilative capacity but perform better than base case treatment that meets or exceeds WQS.

3.3.2.4.2 Conventional Pollutants

3.3.2.4.2.1 WLA and Limit Determination

For conventional pollutants, because the requirement to first meet water quality standards, the wasteload allocation (WLA) for POCs as part of the base treatment alternative can be determined using the water quality-based effluent limit procedures or the dissolved oxygen modeling guidance. For the reasons provided below, the reviewer cannot calculate an assimilative capacity for oil and grease, E. coli, BOD, TSS, or pH; therefore, the reviewer may apply the following:

Oil and Grease. If the facility is a publicly-owned treatment facility (POTW), then the requirements in 10 CSR 20-7.031 Table A apply. Permit limits for oil and grease are routinely set to meet a MDL and AML of 15 mg/L and 10 mg/L, respectively. These limits are water quality based and created to prevent a sheen on surface water. Therefore, there are no antidegradation requirements for oil and grease beyond meeting the above limits.

BOD_5. Streeter-Phelps or Qual2K DO water quality model should be used to verify that proposed BOD_5. limits are protective of water quality criteria or existing water quality for dissolved oxygen. For a classified stream, results from the model will suggest discharging a defined concentration of BOD_5. (i.e., this could be a technology-based limits based on the treatment capability or a concentration that is reasonably expected to be discharged) that will result in a critical DO concentration that is below the water body's existing water quality but must be greater than the DO criterion. The DO deficit may significantly degrade water quality, which the AIP allows when the applicant assumes degradation for this POC. A DO sag below the water quality standard is allowed in an unclassified stream but must be restored at the confluence with the classified waterbody. The Water Quality and Antidegradation Review (WQAR) should conclude that the proposed BOD_5 average monthly limit (AML), that is converted to an average weekly limitation (AWL) using approved procedures below, is protective of DO criteria (See *Dissolved Oxygen Modeling and Biochemical Oxygen Demand Effluent Limit Development Administrative Guidance,* hereafter, *DO Modeling Administrative Guidance*).

Total Suspended Solids. Because TSS has no criterion, it is not possible to calculate an assimilative capacity. Therefore, there are no antidegradation requirements for TSS beyond meeting technology-based effluent limits.

Note: Effluent limit determination for BOD_5. and TSS are based on the capacity of the treatment and protection of the water quality standards. As mentioned above the results of the Streeter-Phelps or Qual2k analysis will provide the basis for the limits. TSS will mirror the limits of BOD5 as EPA indicated that treatment capacity typically is the same for both POCs. For this process, the limit will follow the recommendations found in the *DO Modeling Administrative Guidance* where the average monthly limit from the

Streeter Phelps or Qual2K is the value considered protective of DO, and the AWL is determined by:

Average Weekly Limit (MDL) = AML * 1.5 = XX mg/L.

pH. Because the criterion for pH is expressed as a range of values, it is not possible to calculate an assimilative capacity. Therefore, there are no antidegradation requirements for pH beyond meeting its water quality standard or effluent regulation.

E. coli. Current requirements for E. coli are limited to requiring default limits based on treatment system designed for nearly complete removal of bacteria. For E. coli in the future, alternative water quality-based permit limits that are protective of downstream recreational uses may be proposed with additional supporting studies.

Below is a list and brief description of revisions made to Part 3:

Version	Date Completed	Description
Draft	August 2, 2006	Introduction and outline part of the original draft document
Version 1.0	June 10, 2009	Part III written by Todd Blanc