



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
THE ADMINISTRATOR

Mr. William D. Ruckelshaus
Administrator
U.S. Environmental Protection
Agency
Washington, D.C. 20460

Dear Mr. Ruckelshaus:

In November, 1982, the Environmental Engineering Committee of the Science Advisory Board (SAB) was asked to review the scientific and technical adequacy of proposed revisions to the Agency's secondary treatment regulations (40 CFR 133). The review has now been completed, and we are pleased to forward to you our report.

We appreciate the opportunity to have worked with the Office of Water Program Operations on this interesting and challenging project, and will be happy to review the regulations in their final form if that is desirable.

If you have any questions, or should you wish further action on our part, please call on us.

Sincerely,

A handwritten signature in cursive script, reading "Ernest F. Gloyna".

Ernest F. Gloyna
Chairman, Executive
Committee

Science Advisory Board

cc: A. Alm
R. Hamner
T. Yosie ✓
H. Longest
M. Tiemens
A. Hais
C. Mooar
D. Ehreth



REPORT
ON THE REVIEW OF
PROPOSED CHANGES TO SECONDARY
TREATMENT REGULATIONS
(40 CFR 133)

by the

ENVIRONMENTAL ENGINEERING COMMITTEE
SCIENCE ADVISORY BOARD
U.S. ENVIRONMENTAL PROTECTION AGENCY

JULY 1983

EPA NOTICE

This report has been written as a part of the activities of the Agency's Science Advisory Board, a public advisory group providing extramural scientific information to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency, and hence its contents do not necessarily represent the views and policies of the Environmental Protection Agency.

U.S. ENVIRONMENTAL PROTECTION AGENCY
SCIENCE ADVISORY BOARD

ENVIRONMENTAL ENGINEERING COMMITTEE

Dr. Gerard A. Rohlich (Chairman)
Professor of Environmental Engineering
and Professor of Public Affairs
Department of Civil Engineering
University of Texas at Austin
Austin, TX 78712

Mr. Harry C. Torno
Executive Secretary, EEC
U.S. Environmental Protection
Agency
Science Advisory Board (A-101 M)
Washington, D.C. 20460

MEMBERS

Mr. Richard A. Conway
Corporate Development Fellow
Union Carbide Corporation
P.O. Box 8361 (770/342)
South Charleston, WV 25303

Dr. J. William Haun
Vice-President, Engineering
Policy
General Mills, Inc.
P. O. Box 1113
Minneapolis, MN 55440

Dr. Stanley N. Davis
Professor of Hydrology and Water
Resources
Department of Hydrology and Water
Resources
University of Arizona
Tucson, AZ 85721

Dr. George M. Hidy
General Manager
Environmental Research and
Technology
2625 Towngate Road
Suite 360
Westlake Village, CA 92361

Dr. Ben B. Ewing
Professor of Environmental Studies
Department of Civil Engineering and
Institute for Environmental Studies
University of Illinois
408 S. Goodwin
Urbana, IL 61801

Dr. Raymond C. Loehr
Professor of Agricultural
Engineering and Professor
of Environmental Engineering
207 Riley-Robb Hall
Cornell University
Ithaca, NY 14853

Dr. Davis L. Ford
Vice-President
Engineering Sciences, Inc.
3109 N. Interregional
Austin, TX 78722

Dr. Charles R. O'Melia
Professor of Environmental
Engineering
Department of Geography and
Environmental Engineering
The Johns Hopkins University
Baltimore, MD 21218

Mr. George P. Green
Manager, Governmental Licensing
Public Service Company of Colorado
550 15th Street
Denver, CO 80202

CONSULTANTS

Mr. Allen Cywin
Consultant
1126 Arcturus Lane
Alexandria, VA 22308

BACKGROUND

The U.S. Environmental Protection Agency was directed, in 1981 revisions to the Clean Water Act (PL 97-117), to provide design criteria guidance to the states for facilities deemed equivalent to secondary treatment. To respond to this directive, the Agency is proposing a number of changes in its regulations defining secondary treatment.

The Environmental Engineering Committee (EEC) of the Science Advisory Board was asked, in November 1982, to review the proposed changes, concentrating on the following questions:

1. Whether or not an optional substitution of carbonaceous biochemical oxygen demand (CBOD₅) for biochemical oxygen demand (BOD₅) as a measure of treatment plant performance should be allowed, and if so, should alternative effluent limits be set.
2. Whether or not the existing requirement mandating 85% removal of BOD and suspended solids (SS) should be eliminated.
3. Whether or not newly-designed trickling filters could reasonably be expected to meet current secondary treatment effluent limits (i.e., 30 mg/l BOD / 30 mg/l suspended solids).
4. Whether permit adjustments in the effluent limits for trickling filters should be allowed during cold-weather conditions on all trickling filters, regardless of when built.
5. Whether or not the current two million gallon per day (mgd) limitation for waste stabilization ponds eligible for adjustment of suspended solids' effluent limitations should be eliminated.

The EEC formed a Subcommittee consisting of Dr. Davis Ford (Chairman), Dr. Gerard Rohlich, Dr. Ben Ewing, Mr. Richard Conway and Mr. Allen Cywin to review these issues. The Subcommittee was assisted in its review by Dr. Edwin Barth, U.S. EPA Municipal Environmental Research Laboratory, Cincinnati. In the course of its review, the Subcommittee received extensive background material from Dr. Barth and from the Facilities Requirements Division, including a report by Hazen and Sawyer entitled "Review of Performance of Municipal Secondary Treatment Plants." The Hazen and Sawyer report is the primary technical basis for the proposed rule. In addition

to the principal issues, the Subcommittee has reviewed the summary and conclusions of the Hazen and Sawyer report, and comments on them are included as an appendix to this report.

GENERAL DISCUSSION

The proposed rules allow an optional substitution of CBOD₅ for BOD₅ and a reduction of the 30mg/l maximum concentration limitation to 25mg/l. The rules allow adjustments in effluent limitations for trickling filter plants which were constructed prior to 1973 (pre-P.L. 92-500 construction). The rules would also allow permit adjustments during cold weather conditions on all trickling filters, regardless of when built. These rules would also provide for the elimination of the mandatory 85% removal requirement, allow states to make permit adjustments within established effluent ranges for publicly owned treatment works (POTWs) using any treatment system equivalent to secondary treatment, and remove the two million gallon per day limitation for waste stabilization ponds eligible for adjustment of suspended solids' effluent limitations.

Substitution of CBOD₅ for BOD₅ (POTW's only)

1. The EEC agrees that CBOD₅ is a better measure of technology-based plant efficiency in terms of carbonaceous constituents and that the nitrogenous effect should be handled separately.
2. The EEC agrees that the nitrogenous portion of the uninhibited BOD₅ does not reflect the true nitrogenous oxygen demand of an effluent on a receiving water.
3. The inhibition of nitrification in the CBOD₅ test eliminates much of the variation which is inherent in the BOD₅ test and at the same time does not introduce fixed error in the measurement of the carbonaceous demand. An essential aspect of this question is that CBOD₅ can be measured practically with suitable accuracy and precision. Reliable references, supplied both by EPA and by SAB members, show that this has been and can continue to be done. TCMP (2chloro-6-trichloromethyl pyridine), when added at low levels to a BOD₅ bottle, specifically inhibits the oxidation of ammonia in domestic wastewater, does not interfere signifi-

cantly with the oxidation of organic matter in domestic wastewater, and does not itself exert a significant oxygen demand.

4. It was noted that the data base consists of total BOD₅ and total CBOD₅ values, and any distortions by the suspended solids' contribution to these values were not defined. The reference paper entitled "The Effect of Nitrification in the BOD₅ Test" by P. G. Bird supports the validity of questioning the effect of the suspended solids contribution.¹
5. It is recognized that CBOD₅ will be equal to or less than BOD₅. It is difficult to establish a mechanistic correlation using the current data base, as the mean cell residence time (MCRT), influence of total suspended solids (TSS), and other variables could affect this correlation. A correlation between CBOD₅ and BOD₅ made by EPA showed that the CBOD₅ value was about 5mg/l less than BOD₅ at 30mg/l. The statistical analysis approach used by EPA is sound.

Mandatory 85% Removal of BOD and TSS

6. The 85 percent removal requirement in effect penalized plants receiving significant infiltration/inflow flow, inferring treatment to better than 30 mg/l BOD and TSS. Moreover, it does not recognize that the BOD concentration in domestic flow varies depending on water use patterns. The EEC agrees that the 85 percent removal requirement should be eliminated and that technology-based mass loading (flow x concentration), as well as concentration limitations, should be included in the future.

Performance of Newly Designed Trickling Filters

7. There was some question in the data base mainly with respect to performance of trickling filters at various air and wastewater temperature conditions.

¹Bird, P.G., "The Effect of Nitrification in the BOD Test," Journal of the Institute of Water Pollution Control, Vol. 80, No. 3, 1981.

The Subcommittee requested that separate tables describing warm weather performance for pre- and post-1973 trickling filter plants be provided. From the data submitted and reviewed, the Subcommittee concluded that it was possible to meet the current 30/30 standard with newly designed trickling filters during all weather periods.

8. Although not a scientific matter per se, there is concern that trickling filter plants are the only treatment process units being considered for secondary treatment revisions and special cold weather adjustments for effluent BOD₅ and TSS.
9. The Hazen and Sawyer Report indicates that certain allowances should be incorporated into BOD and TSS effluent concentrations at various temperatures. These allowances are made for both rock and plastic media for trickling filters only in terms of BOD, whereas the TSS allowance is only for rock media filters. The EEC believes that there is insufficient data to justify these specific allowances based on the report and questions allowances only for the trickling filter process. Moreover, it should be noted that these allowances are in terms of BOD, and no reference is made to CBOD, as previously discussed. As the nitrogenous oxygen demand (NOD) exerted would be less in the winter, and assuming CBOD is substituted as proposed, this would tend to minimize the necessity for an allowance even in trickling filter plants. This potential contradiction in philosophies should be noted by EPA.
10. The Hazen and Sawyer Report delineates BOD allowances for summer and winter related specifically to media. This likely will force the selection of media based on permit criteria and may set a bad precedent. The EEC questions the necessity of separating plastic and rock media for exclusions to permits.

Removal of 2.0 mgd Limitation for Waste Stabilization Pond BOD and TSS Exclusion

11. The EEC agrees that BOD limits for waste stabilization ponds and the TSS effluent limitations attributable to algae should be reevaluated. The EEC agrees, in concept, that the 2 mgd flow limitation should be removed and that final BOD and TSS limitations for ponds be established on a case-by-case basis, as allowed in the 1977 amendments to PL 92-500.

CONCLUSIONS AND RECOMMENDATIONS

The Environmental Engineering Committee:

1. Concludes that CBOD₅ is a better measure of POTW efficiency in terms of carbonaceous constituents and that nitrogenous effects must be handled separately when the CBOD₅ test is used.
2. Recommends that the mandatory '85%' removal of BOD and suspended solids (SS) be eliminated and that technology-based mass loadings, as well as concentration limitations, be included.
3. Concludes that trickling filters can be designed and operated to meet current secondary treatment effluent limitations during all weather conditions.
4. Conceptually agrees with allowing permit adjustments for trickling filters during cold-weather periods, but concludes that the data presented do not alone justify the specific allowances in the proposed rule.
5. Agrees, in concept, that the 2 mgd flow limitation for waste stabilization ponds eligible for adjustment of SS effluent limitations should be eliminated, and recommends that the limits on BOD and the limits on TSS attributable to algae be evaluated on a case-by-case basis.
6. The EEC has also reviewed the conclusions and recommendations section of the Hazen and Sawyer report. This section and the SAB comments thereon are included as appendices A and B.

APPENDICES

- A. SUMMARY OF CONCLUSIONS (CHAPTER 6)
HAZEN AND SAWYER REPORT (DRAFT)
- B. ENVIRONMENTAL ENGINEERING COMMITTEE
REVIEW OF DRAFT HAZEN AND SAWYER
REPORT'S CONCLUSIONS AND RECOMMENDATIONS

APPENDIX A
SUMMARY OF CONCLUSIONS--HAZEN AND SAWYER REPORT

1. Analyzing performance of selected publicly owned treatment works (POTWs) can provide useful guidance on how appropriate existing technology-based effluent limits are for specific secondary treatment process categories. Analyzing parallel effluent data on BOD₅ and carbonaceous BOD₅ (CBOD₅) can indicate the extent to which nitrogenous oxygen demand (NOD) is responsible for failure of plants to meet existing BOD₅ limits.
2. Random selection of POTWs for this study was not deemed necessary or desirable. Selection, instead, aimed to represent ranges of size and climate expected for each category, excluding extremely overloaded or underloaded plants, plants with significant industrial loads, and plants where unusually good or poor performance was due to special permit limits, to process additions beyond normal secondary, or to clearly-identified, unacceptable flows in design or operation. Data gathering efforts focused on states with the most data readily available for a representative selection of plants. The final data base included up to two years worth of records for a total of 324 plants in eight process categories. In addition, parallel BOD₅/CBOD₅ data were compiled for a total of 48 plants nationwide.
3. Daily performance data were found to be far from random, displaying strong short lag (1-day, 2-day, etc.) autocorrelation plus distinct month-to-month variation in many cases. As a result, monthly and weekly averages proved far more variable than would be expected if the daily values were random.
4. For most plants, correlation analysis showed only weak, inconsistent relations between effluent quality and other parameters such as loading, flow, temperature, and plant size.
5. No single parametric distribution, normal, log normal, or empirical consistently fits the daily data for most plants. In view of this and the disturbing effects of non-randomness on relation between the distributions of daily values and weekly or monthly averages, primary attention was directed to analysis of actual performance over the 7 and 30-day averaging periods to which existing numerical secondary limits are referenced. Furthermore, theoretical arguments for use of geometric rather than arithmetic averaging were rejected.
6. Because the existing limits for 7-day averages are generally much less of a restriction than the limit for 30-day averages, the double effort of calculating and reporting values for both periods is difficult to justify. Hence, the analysis aimed only at suggesting appropriate 30-day limits.
7. Because much existing infiltration/inflow (I/I) has not proved

economically correctable, the majority of plants in all categories will continue to receive influent concentrations below 200 mg/l. As a result, a significant portion of the well performing plants in each category are out of compliance solely on the basis of the 85 percent removal requirement. Since these plants already must pay a capital cost penalty to accommodate the I/I flow, they should not be further penalized by requiring treatment to better than 30 mg/l BOD/TSS just to meet 85 percent removal.

8. For each category, compliance tables were generated showing the percentage of plants for which the monthly average effluent BOD and TSS fell in or below various concentration ranges, with various reliability values (i.e., frequency or percentage of time).

The compliance tables are based on 5 mg/l ranges, identified by their midpoints. This recognizes an inherent error in BOD and TSS measurements of 2.5 mg/l. For consistency with this analysis, plants should be permitted a leeway of 2.5 mg/l in meeting numerical limits; i.e., no response or proposed corrective action would be required of a plant unless it exceeded its numerical limits by more than 2.5 mg/l at more than 5 percent frequency (95 percent reliability).

9. A target reliability of 95 percent is recommended for technology-based secondary standards. This level was chosen to minimize the departure from the present never-to-exceed basis while avoiding statistical uncertainties in interpreting data at more extreme frequencies.
10. Compliance data, at 95 percent reliability, was plotted to identify "knee-of-the-curve" locations, i.e., points where the slope of concentration vs. percent of plants breaks sharply. Above the knee, a given relaxation of the limits brings proportionately fewer plants into compliance; below the knee, tightening the limit puts proportionately more plants out of compliance. Table 5.3.4 summarizes the knee location for the BOD and TSS relations in each category and shows the percentage of plants at or below the 30 mg/l range (monthly average), all at 95 percent reliability.
11. Moving averages were used in the compliance tables and plots described above. Comparison of compliance results based on 30-day calendar and moving averages showed no significant difference. Hence, judgments as to numerical limits based on moving averages can be applied without serious error even if compliance continues to be checked on a calendar average basis.
12. Performance of pre- and post-PL 92-500 conventional activated plants was not sufficiently different to justify developing separate effluent limits. This observation applies to all other categories except rock trickling filters and stabilization ponds, for which the data base consists mainly of pre-PL 92-500

plants.

13. Analysis of seasonal and climatic differences shows that performance of trickling filter plants--both rock and plastic media--is adversely affected by temperature. For these two categories, a warm weather base limit is suggested, with additional allowances as follows:

<u>Monthly Average Air Temperature</u>	<u>Allowance--mg/l</u>	
	<u>BOD</u>	<u>TSS</u>
40°F	10	5
40-55°F	5	2.5

The TSS allowance is needed only for rock media filters.

14. The study indicates no present basis for changing the present 30 mg/l BOD limit for any of the activated sludge variations (conventional, contact stabilization, extended aeration, and oxidation ditch). At least two-thirds of the plants in each category are presently meeting this limit. For most of those that do not, the problem appears to be correctable without major reconstruction.
15. For the trickling filter categories, appropriate base BOD limits appear to be 40 mg/l for rock media and 30 mg/l for plastic. At least three-quarters of the normally-loaded plants in the study meet these limits.
16. Keeping the 30mg/l BOD limit also appears appropriate for the rotating biological contactor category. Only 59 percent of the plants in the sample met this limit, but we expect most of the remainder can be brought into compliance by a simple flow path modification to feed units in parallel rather than series.
17. In the stabilization pond category, relaxation of BOD limits to at least 45 mg/l appears appropriate. At this level over 90 percent of the Michigan ponds (seasonal discharge) are in compliance. Only 47 percent of ponds in other states (continuous discharge) meet this level. A policy decision is needed whether to require seasonal discharge or other upgrading measures or to relax the BOD limits further than 45 mg/l.
18. Except for stabilization ponds and pre-PL 92-500 rock trickling filters, there is no present basis for setting TSS limits above 30 mg/l on a category-wide basis. To be consistent with other categories, an appropriate warm weather base limit for TSS from rock media trickling filters would be 45 mg/l. There is already a special basis for determining TSS limits for stab-

ilization ponds. Applying this to ponds in this study indicates a TSS limit between 71 and 115 mg/l. This is based on ponds (largely from Michigan) which met the 30 mg/l BOD limit. Further analysis is needed to establish a TSS limit consistent with the suggested BOD limit of 45 mg/l for seasonal discharge ponds. In all remaining categories, particularly conventional activated sludge and oxidation ditch, TSS performance for a number of plants was worse than BOD performance. Where detailed investigation shows that such plants require costly improvements to correct liquid/solids separation problems, more relaxed TSS limits--say 40 mg/l--should be considered on an individual plant basis.

19. The results of Composite Connection Programs (CCPs) carried out to bring plants into compliance should be statistically analyzed--as soon as a significant number have been completed--to determine any conditions under which unreasonably costly remedial measures are being required. This may indicate further basis for modifying effluent limits.
20. Analysis for the conventional activated sludge category showed that half of the plants meeting monthly BOD limits of 30 mg/l with 95 percent reliability did not exceed 60 mg/l on a daily basis, and over 85 percent did not exceed 100 mg/l. In applying new secondary numerical limits and reliability requirements, permitting agencies should review the water quality modeling that showed a given plant to need any secondary treatment. Such review should take into account the estimated likelihood of exceeding 30 mg/l by various margins. If it is not apparent from the review that there is little chance of significant water quality impacts, more detailed water quality analysis should be undertaken. This would aim to establish maximums for the occasional exceedances of the secondary limits.

APPENDIX B
REVIEW OF CONCLUSIONS AND RECOMMENDATIONS--HAZEN AND SAWYER REPORT

The EEC has reviewed the conclusions and recommendations sections (Chapter 6) of the draft Hazen and Sawyer report, and comments on this section follow:

1. Conclusions #1-6 are background statements and require no comment.
2. The EEC agrees with conclusion #7 that the 85 percent removal requirement should be eliminated and that technology-based mass loading (flow x concentration), as well as concentration limitations, should be included in the future.
3. Conclusion #8 is ambiguous and should be rewritten. The compliance tables are evidently based on 5 mg/l ranges, which "recognizes an inherent error in BOD and TSS measurements of 2.5 mg/l." This is confusing because the inference here is that the accuracy of these particular analyses is within this range. These are two separate accuracies of measurement and should be delineated.
4. Conclusion #9 states that a target reliability of 95 percent is recommended for technology-based secondary standards. There should be further substantiation of this reliability, as in some of the industrial guidelines, in which 98 and 99 percentile values are used. The EEC does not have a recommendation for the selected percentile, although this difference should be noted by EPA.
5. Conclusions #10-12 are background statements and require no specific comment.
6. Conclusion #13 indicates that certain allowances should be incorporated into BOD and TSS effluent concentrations at various temperatures. These allowances are made for both rock and plastic media, for trickling filters only, in terms of BOD, whereas the TSS allowance applies only for rock media filters. The EEC believes that there is insufficient data in the report to justify these specific allowances, and questions

the allowances being made only for the trickling filter process. Moreover, it should be noted that these allowances are in terms of BOD, and no reference is made to CBOD, as previously discussed. As the exerted NOD would be less in the winter, and assuming CBOD is substituted as proposed, this would tend to minimize the necessity for an allowance even in trickling filter plants. This potential contradiction in philosophies should be noted by EPA.

7. Conclusion #15 delineates BOD allowances for summer and winter related specifically to media. This likely will force the selection of media based on permit criteria and may set a bad precedent. The EEC questions the necessity of separating plastic and rock media for exclusions to permits.
8. Conclusion #16 states that only 59 percent of the rotating biological contactor (RBC) plants met the 30mg/l limit, but stated that "we can expect most of the rest to be brought in compliance by simple flow path modification." This appears to be subjective, and to arbitrarily infer that the 41 percent of plants out of compliance can easily be brought into compliance may be both misleading and non-factual. The EEC, therefore, suggests that the contractor be questioned on the ease of accomplishing total compliance within the RBC category.
9. The EEC agrees that BOD limits for waste stabilization ponds should be reevaluated, as well as the TSS effluent limitations attributable to algae. The EEC agrees, in concept, that the 2 mgd flow limitation should be removed and that final BOD and TSS limitations for ponds be established on a case-by-case basis, as allowed in the 1977 amendment to PL 92-500.
10. The statement in Conclusion #18, "where detailed investigation shows such plants require costly improvements to correct liquid solid separation problems, more relaxed TSS limits--say 40 mg/l--

should be considered on an individual plant basis," should be deleted. This is a subjective comment and not substantiated by specific data.

11. The EEC has no comment on Conclusions #19 and 20.

