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M E M O R A N D U M

State of Washington
Department of Ecology

To: Ron Devitt

Thru: Ron Pine

From: Jim Knudson JK

Re: Statistical Analysis of Data from Weyerhaeuser, Everett Secondary Treatment Survey Conducted February 20 to March 9, 1973

Date: August 6, 1973

This memorandum is an addendum to your report of May 31, 1973 concerning the subject survey. I have attempted to extract and utilize as much information as possible from your measurements and to arrive at conclusions that will aid in the planning of our next industrial survey. For instance, one major finding in addition to the system meeting our permit requirements, is that the type of composite sampler does not appear to effect the results for B.O.D. but becomes more significant for S.C.S. In addition C.O.D. while interesting does not appear useful for our purposes because it does not correlate well with B.O.D.

After you have reviewed these findings, we should send a copy of both reports to Weyerhaeuser for their review and comment.

Summary of Findings

Table I summarizes the statistical tests employed.

1. The Weyerhaeuser Co., Everett (kraft) secondary treatment system meets the 85% B.O.D. reduction at the 95% confidence level using a one sided t - test. Because all values of S.C.S. fell below the effluent limit of 0.3 lbs/1000 gallons no statistical tests were necessary to conclude that the system meet the permit limits for S.C.S. as well.

2. The F test (analysis of variance) was employed on B.O.D. and S.C.S. findings in the effluent and the influent to determine whether significant differences occurred in the means due to:

   a. D.O. E. lab analysis versus WeyCo lab analysis

   b. D.O.E. composite sampler versus WeyCo composite sampler.

The analysis of variance, (A.V.) shows that the significant difference in B.O.D. means can be attributed to laboratory analysis, on both effluent and influent samples, but not to composite samplers.

This means that future B.O.D. surveys for secondary treatment systems can be conducted using composite samplers employed by the industry with good assurance that little or no effect will occur due to the choice of composite sampler.

The laboratory analysis differences especially on the influent where we found B.O.D.'s of up to 200 ppm, may be due to the delay as the samples were in transport by bus or automobile to Olympia before D.O.E. analysis. Our lower results may be due to the instantaneous B.O.D. exerting itself during the transportation of samples.

To explain the higher D.O.E. - B.O.D. results on the effluent, Bert Bowen has suggested that die-off of organisms in transit (releasing nutrient and B.O.D. substances) may be responsible for the higher findings. Such organisms would be much more numerous after secondary treatment than before because of the principal of its operation. In addition, the chemical oxygen demand is about 50% the influent values and would not exert as great an effect in transit as it may on the influent samples.

Although my tests show no significant difference in means of S.C.S. findings for either composite sampler or laboratory analysis, the much higher F ratio for composite sampler differences indicates that the design/operation of composite samplers for effluent surveys should be more closely standardized and examined. Perhaps some design feature of the D.O.E. composite sampler biases samples toward the low side or a design feature of the Weyerhaeuser composite sampler accumulates fibers and biases the sampler on the high side. A series of grab and composite samples would be needed on either sampler to determine which was giving the truer value.

3. t tests were run on the differences in C.O.D. analyses between samplers and no significant differences were found at the 95 per cent confident levels, for both influent and effluent samples.

4. Correlation coefficients run on C.O.D. versus B.O.D. showed poor correlation, (.369 for influent samples and .249 for effluent samples) indicating that C.O.D. is not useable for determining B.O.D. by the shorter chemical test, for secondary treatment systems on kraft pulp mills.

JCK:dn

cc: Saadat Hassouneh
Larry Ashley

TABLE I. SUMMARY OF STATISTICAL TESTS PERFORMED ON WEYERHAEUSER CO., EVERETT (KRAFT) SECONDARY TREATMENT SYSTEM (95 PER CENT CONFIDENCE LEVEL)

Measurement	Statistical Test	Hypothesis	Cal.Sa. Statistic	Dist. Statistic	Accept Hypothesis
% B.O.D. Reduction	t[b] (one sided)	≥ 85%	t = -.258	t = - 1.94	Yes
SCS	none	≤ .3 lb/1000 gal.	_ c	_ c	Yes
B.O.D. (Influent)					
1. D.O.E. vs WeyCo Lab.	A.V.[a]	= means	F = 7.1	F = 4.0+	No[d]
2. D.O.E. vs WeyCo Comp.	A.V.	= means	F = 0.6	F = 4.0+	Yes
3. Interaction of 1 & 2	A.V.	No interaction	F = 0	F = 4.0+	Yes
B.O.D. (Effluent)					
1. D.O.E. vs. WeyCo Lab.	A.V.	= means	F = 1 29	F = 4.0+	No[d]
2. D.O.E. vs. WeyCo Comp.	A.V.	= means	F = 0	F = 4.0+	Yes
3. Interaction of 1 & 2	A.V.	No interaction	F = .27	F = 4.0+	Yes
S.C.S. (Effluent)					
1. D.O.E. vs WeyCo Lab	A.V.	= means	F = .21	F = 4.0+	Yes
2. D.O.E. vs WeyCo Comp.	A.V.	= means	F = 2.15	F = 4.0+	Yes
3. Interaction of 1 & 2	A.V.	No interaction	F = .03	F = 4.0+	Yes
C.O.D.					
1. Influent - D.O.E. vs WeyCo Composite	t[b]	= means	t = 0.225	t = 2.07	Yes
2. Effluent - D.O.E. vs WeyCo Composite	t	= means	t = 0.248	t = 2.10	Yes
3. C.O.D. vs B.O.D. Influent	Correlation coefficient	-	.369	-	poor cor.
4. C.O.D. vs B.O.D. effluent	Correlation coefficient	-	.249	-	poor cor.

Footnotes

a. A.V. = Analysis of variance

b. t = Student t test

c. All values $\leq$ .3 lb/1000 gallons and so no test needed.

d. "No" means that there is a significant difference in the means.