



THE
ONTARIO WATER RESOURCES
COMMISSION

**REQUIRED DENSITY
of
WATER QUALITY SAMPLING STATIONS
at
NANTICOKE, LAKE ERIE**

August - September, 1968

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WATER QUALITY SAMPLING STATIONS
AT
NANTICOKE, LAKE ERIE**

August - Sept., 1968

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REQUIRED DENSITY OF WATER QUALITY SAMPLING STATIONS AT NANTICOKE, LAKE ERIE

ABSTRACT

Three stations approximately two miles apart were sampled at two hour intervals for ten hours. Multiple readings of dissolved oxygen (DO), pH, alkalinity and total phosphates were taken at the mid-depth at each station on each run. As a result of a parametric analysis of variance, two-way classification, fixed effects model with multiple readings per cell, the following was determined:

1. There is a significant difference between stations 5004, 994 and 501 in measured alkalinity and total phosphate values for the test period using existing equipment and sampling techniques.
2. There is a significant difference with time for measured DO, pH, alkalinity and total phosphate values for the test period using existing equipment and sampling techniques.

The following stations were accepted as the sampling grid meeting the water quality and biological sampling requirements of The Hydro-Electric Power Commission of Ontario, the Ontario Department of Lands and Forests, The Steel Company of Canada Limited and the Ontario Water Resources Commission (see map):

<u>Stations</u>	
994	5016
501	810
5008	648
112	518

Sampling of the stations should occur at the same time of day within a few hours.

REQUIRED DENSITY OF WATER QUALITY SAMPLING STATIONS AT NANTICOKE, LAKE ERIE

INTRODUCTION

With the construction of a thermal generating station and the proposed industrial development in the Nanticoke area on Lake Erie, it is necessary to determine the existing water quality in the area before and after development occurs to assess the changes, if any, to the water environment. To do this economically, with existing survey techniques, it was necessary to determine the required sampling station density, such that each station would provide unique information and not duplicate results from other stations.

The Water Quality Surveys Branch carried out two detailed studies on the 1st of August and 10th of September, 1968, extending over 24 and 10 hour periods respectively, to determine the station density requirements in the area. The studies also provided information on the diurnal effects on water quality parameters. Once the density of stations required was determined, surveying efforts in the area will then be restricted to these stations. Both biological and chemical samples will be collected at time intervals over the year to provide an accurate as of the existing environment.

PURPOSE

1. To test the hypothesis:
 - (a) There is no significant difference in water quality (dissolved oxygen (DO), pH, alkalinity, and total phosphate) for stations spaced approximately two miles apart in the Nanticoke area with existing equipment and sampling techniques.
 - (b) There is no significant time difference (10 hour variation) in water quality (DO, pH, alkalinity and total phosphates) at the chosen stations with existing equipment and techniques.
2. To confirm the results of Nanticoke study, August 1-2, 1968.
3. To gather information on other water quality parameters for The Steel Company of Canada Limited.

PROCEDURE

The following stations were sampled over a 10 hour period at 2 hour intervals:

Stations

5004

994

501

These stations are approximately two miles apart (see map). Multiple samples were taken for DO, pH, alkalinity and total phosphate at the mid-depth. Each of the samples was analyzed independently. For the results, see Appendix 1.

RESULTS

The results of the analysis of variance are tabulated in Appendix 2 and summarized as follows:

1. There is a significant difference between stations 5004, 994 and 501 in measured alkalinity and total phosphate values while there is no significant difference for measured DO and pH values for the test period.
2. There is a significant difference with time for measured values of DO, pH, alkalinity and total phosphates for the test period.

A problem exists in the application of a two-way analysis of variance if the interaction terms are significant as they are for DO, pH and total phosphate. However, the results are valid in that overall treatment effects do exist as determined by the two-way analysis, but to specify exactly how the treatment differ one must look within levels of the other factor (Hays, 1963) or do analysis as several one-ways (Bowker, 1959). As we are concerned only with the overall differences between stations to determine a reasonable sampling grid, the two-way analysis results are valid.

When the results of this study were compared with the results of the study on August 1 (see Appendix 3) which was for stations spaced approximately one mile apart the following is observed:

1. **Differences**

Parameter	Source of Variation	August 1 Station Spacing 1 mile	September 10 Station Spacing 2 miles
pH	Between stations	Significant	Not Significant
Alkalinity	Between stations	Not Significant	Significant
Total Phos.	Between stations	Not Significant	Significant
Conductivity	Between stations	Significant	-

2. **Similarities**

Parameter	Source of Variation	August 1 Station Spacing 1 mile	September 10 Station Spacing 2 miles
DO, pH, Alkalinity & Total Phos.	Time	Significant	Significant
DO	Stations	Not Significant	Not Significant
Conductivity	Time	Not Significant	-

Based upon the preceding comparisons the two mile station spacing is required to detect significant differences in water quality and it is extremely important that the stations be sampled at the same time of day, within a few hours, otherwise false differences will occur between the stations.

The conflicting results obtained for pH between the two studies is puzzling. There appears to be a local ionic effect detected in the August 1 study area which did not appear in the September 10 study area. It is not economical to select stations spaced one mile apart on the basis of pH differences only. However, by using the guidelines of two mile station spacing and Judiciously selecting the stations such that one of the proposed study stations lies between station 111 and 807 and another proposed station is close to station 459, it is felt that this pH difference will still be detected.

CONCLUSIONS

Sampling stations in the Nanticoke area should be spaced two miles apart and sampling at the stations should occur at the same time of day within a few hours.

As a result of discussions with The Hydro-Electric Power Commission of Ontario, the Ontario Department of Lands and Forests, The Steel Company of Canada Limited and the Ontario Water Resources Commission a sampling grid consisting of (see map):

<u>Stations</u>	
994	5016
501	810
5008	648
112	518

was adopted as meeting the water quality and biology survey requirements in the area.

REFERENCES

Bowker, A. and Lieberman, G., 1959. Engineering Statistics. Prentice Hall,
p. 286 - 342.

Hays, W., 1963. Statistics for Psychologists, Holt, Rinehard, Winston p. 391.

**APPENDIX I
 MULTIPLE SAMPLING RESULTS
 NANTICOKE
 SEPTEMBER 10, 1968
 DISSOLVED OXYGEN - PERCENT SATURATION**

TIME					
Station	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	87	96	100	101	97
	90	98	101	101	100
	96	95	99	100	100
994	94	96	98	102	100
	95	91	98	99	100
	97	95	95	100	99
501	98	97	97	99	98
	95	98	99	98	99
	97	96	97	98	99

pH (Su) TIME					
Station	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	8.1	8.5	8.2	8.6	8.6
	8.3	8.5	8.3	8.6	8.6
	8.3	8.5	8.5	8.7	8.7
994	8.2	8.5	8.5	8.2	8.6
	8.3	8.5	8.5	8.4	8.6
	8.5	8.6	8.5	8.4	8.6
501	8.4	7.8	8.4	8.6	8.4
	8.5	8.3	8.5	8.6	8.4
	8.2	8.4	8.6	8.5	8.5

MULTIPLE SAMPLING RESULTS
NANTICOKE
SEPTEMBER 10, 1968
ALKALINITY CaCO₃ ppm

TIME

Station	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	100	104	102	104	101
	103	99	100	99	98
	104	101	104	100	98
994	104	99	100	98	101
	101	103	95	99	95
	100	102	100	98	100
501	100	97	100	98	94
	101	100	96	98	97
	100	103	101	99	97

TOTAL PHOSPHATES

PO₄ ppm

TIME

Station	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	0.10	0.11	0.12	0.05	0.04
	0.10	0.09	0.10	0.04	0.06
	0.12	0.09	0.07	0.04	0.04
994	0.09	0.08	0.06	0.05	0.04
	0.10	0.09	0.06	0.04	0.04
	0.10	0.09	0.05	0.05	0.04
501	0.10	0.08	0.06	0.05	0.05
	0.09	0.10	0.05	0.04	0.04
	0.09	0.10	0.05	0.04	0.03

OTHER PARAMETERS

Station 5004	1200 Hrs.	
	Suspended Solids	16 ppm
	Dissolved Solids	196 ppm
	Total Solids	212 ppm
	Iron	0.25 ppm
	Tin	<0.1ppm
	Zinc	0.0
	Ether Soluble	1.0ppm

**APPENDIX 2
TABLE OF RESULTS
ANALYSIS OF VARIANCE
NANTICOKE
SEPTEMBER 10, 1968**

Stations Compared -5004, 994, 501

Time Period-1000 hrs. to 1900 hrs in 2 hr. intervals

Parameter	Source of Variation	Test
1. Dissolved Oxygen Percent Saturation	Between stations Time Interaction	Not Significant 0.10 Significant 0.001 Significant 0.005
2. pH Su	Between stations Time Interaction	Not Significant 0.10 Significant 0.005 Significant 0.005
3. Alkalinity ppm CaCO ₃	Between stations Time Interaction	Significant 0.025 Significant 0.025 Not Significant 0.10
4. Total Phosphate ppm PO ₄	Between stations Time Interaction	Significant 0.005 Significant 0.001 Significant 0.01

**APPENDIX 3
TABLE OF RESULTS
ANALYSIS OF VARIANCE
NANTICOKE
AUGUST 1, 1968**

Stations Compared- 111, 459, 807

Time Period- 24 Hrs. 6 runs at 4 hour intervals

Parameter	Source of Variation	Test
1. Dissolved Oxygen Percent Saturation	Between stations	Not Significant 0.10
	Time	Significant 0.001
	Interaction	Not Significant 0.10
2. pH Su	Between stations	Significant 0.001
	Time	Significant 0.001
	Interaction	Not Significant 0.10
3. Alkalinity ppm CaCO ₃	Between stations	Not Significant 0.10
	Time	Significant 0.025
	Interaction	Not Significant 0.10
4. Total Phosphate	Between stations	Not Significant 0.10
	Time	Significant 0.001
5. Conductivity µmhos/cm	Between stations	Significant 0.025
	Time	Not Significant 0.10

