Report of

Water Quality

and

Heavy Metals Analysis

for

February 24, - November 2, 1976

and

April 6 - October 19, 1976

to

Metropolitan Edison Company

Three-Mile Island Nuclear Station

(TMI-1)

by



Millersville State College

January 1977

Thomas Greco

THOMAS G. GRECO, Ph.D.

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LIST OF ILLUSTRATIONS

## Introduction

Section 4.2.1. of the Environmental Technical Specifications (E.T.S.) for Three-Mile Island (TMI-1) Nuclear Station requires the monthly sampling of surface water from invertebrate monitoring stations 2 and 3 (Figure 1) and analysis for heavy metals (Cu, Cr, Fe, Mn, Ni and Zn). Station 2 serves as the upstream site, while station 3 serves as the plant discharge site. This report presents the above-required data for samples collected by Ichthyological Associates, Inc. (I.A.) from February 24, 1976 to November 2, 1976. Unfavorable weather conditions prevented sample collection during both January and December.

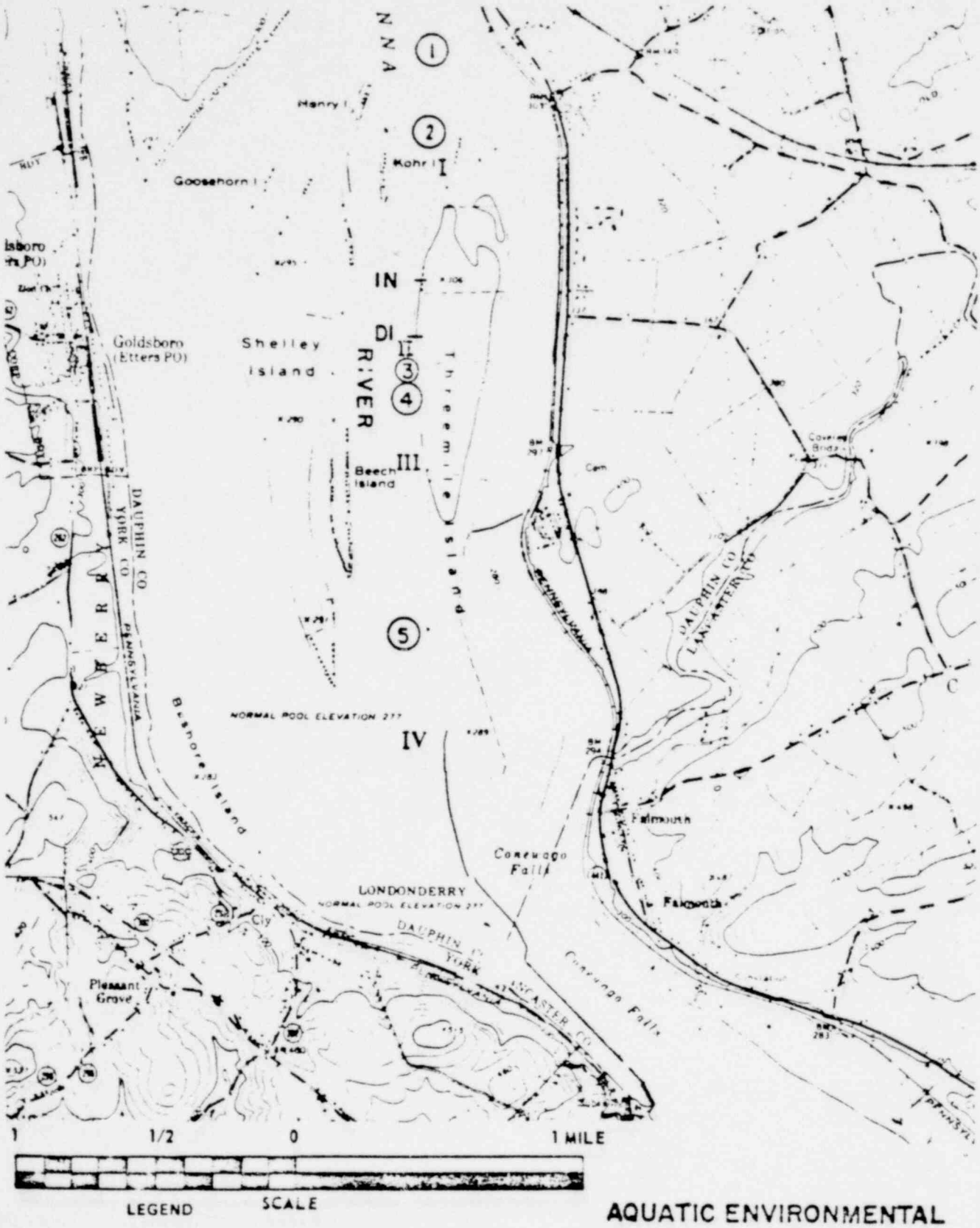
As required by section 4.2.2 of the E.T.S., surface samples from all five stations were collected semi-monthly by I.A. from April 6, 1976 to October 19, 1976. Samples were analyzed for heavy metals (see above), calcium, magnesium, sodium, potassium, and phenols. The analytical results are presented below.

All results have been forwarded on a monthly basis to personnel of the Radiation Safety and Environmental Engineering Section of the Metropolitan Edison Company.

## Procedures

All procedures used were those from the U.S.E.P.A. Manual of Methods for the Chemical Analysis of Water and Wastes[1]. Metals were analyzed via atomic absorption, and phenols were done using the 4-aminoantipyrine-distillation method.

FIGURE 1




AQUATIC ENVIRONMENTAL MONITORING STATIONS

I TO IV FISH LOCATIONS

IN - INTAKE

①TO⑤ INVERTEBRATE

DI - DISCHARGE

Results

A. E.T.S., Section 4.2.1: Monthly Heavy Metals Analysis

The results of the monthly heavy metals analysis for 1976 are shown in Table 1. The "above intake" results are those found for samples collected at invertebrate station 2, and the "discharge" results are those for samples collected at station 3.

Table 2 lists the mean concentration, the highest and lowest values, and the standard deviation from the mean for each metal at the two stations for 1976. Also shown are the data from previous reports for 1974[2] and 1975[3]. Data below concentration reporting limits were not used to calculate the mean values.

In 1976, for all metals except iron, the mean values at the intake and discharge were within the standard deviations of the range of values at each station. This indicates that no major difference in metal concentration exists between the two stations. For iron, the mean concentration of 1.34 ppm at discharge is slightly above the upper range of the mean standard deviation above intake value, which is 1.03 + 0.28 ppm = 1.31 ppm. Also, the mean concentration at intake, 1.03 ppm, is slightly below the mean standard deviation at discharge, 1.34 - 0.21 = 1.13 ppm. This difference is so small, however, that one can say that the increase in the iron concentration at the discharge is virtually insignificant. As can be seen

TABLE 1

Monthly Heavy Metals Results, 1976
Values in ppm

| Date | Location | Cu | Cr | Fe | Mn | Ni | Zn |
|---|---|---|---|---|---|---|---|
| Jan., '76 | | NA | NA | NA | NA | NA | NA |
| 2/24/76 | | | | | | | |
| | Above Intake | 0.0044 | 0.0180 | 1.30 | 0.26 | 0.0075 | 0.025 |
| | Discharge | 0.0064 | 0.0210 | 1.40 | 0.32 | 0.0012 | 0.034 |
| 3/18/76 | | | | | | | |
| | Above Intake | 0.0081 | 0.0052 | 1.25 | 0.44 | 0.45 | 0.083 |
| | Discharge | 0.012 | 0.0068 | 1.40 | 0.51 | 0.48 | 0.036 |
| 4/6/76 | | | | | | | |
| | Above Intake | 0.0048 | <.0020 | 0.95 | 0.29 | 0.017 | 0.0092 |
| | Discharge | 0.0055 | <.0020 | 1.30 | 0.29 | 0.016 | 0.0096 |
| 5/4/76 | | | | | | | |
| | Above Intake | 0.011 | 0.0030 | 1.32 | 0.34 | 0.022 | 0.085 |
| | Discharge | 0.013 | 0.0044 | 1.28 | 0.34 | 0.024 | 0.038 |
| 6/1/76 | | | | | | | |
| | Above Intake | 0.0087 | <.0020 | 0.86 | 0.31 | 0.031 | 0.018 |
| | Discharge | 0.0067 | <.0020 | 0.87 | 0.28 | 0.027 | 0.027 |
| 7/6/76 | | | | | | | |
| | Above Intake | 0.011 | <.0020 | 0.86 | 0.17 | 0.022 | 0.0092 |
| | Discharge | 0.025 | <.0020 | 1.50 | 0.25 | 0.027 | 0.026 |
| 8/3/76 | | | | | | | |
| | Above Intake | 0.0094 | 0.0012 | 0.44 | 0.16 | 0.040 | 0.037 |
| | Discharge | 0.023 | 0.0022 | 1.10 | 0.20 | 0.053 | 0.046 |
| 9/7/76 | | | | | | | |
| | Above Intake | 0.009 | 0.0086 | 1.00 | 0.34 | 0.036 | 0.0086 |
| | Discharge | 0.013 | 0.0088 | 1.40 | 0.32 | 0.056 | 0.017 |
| 10/5/76 | | | | | | | |
| | Above Intake | 0.012 | <.0020 | 1.00 | 0.29 | 0.030 | 0.032 |
| | Discharge | 0.014 | <.0020 | 1.50 | 0.26 | 0.052 | 0.057 |
| 11/2/76 | | | | | | | |
| | Above Intake | 0.0063 | <.0020 | 1.30 | 0.40 | 0.095 | 0.011 |
| | Discharge | 0.012 | <.0020 | 1.60 | 0.40 | 0.11 | 0.012 |
| Dec., '76 | | NA | NA | NA | NA | NA | NA |

NA = data not available.

in Table 4, page 10, this slight increase in iron is easily diluted by the stream, and no problems can be seen.

Comparing data from the three years, it can be seen that the copper and zinc results for 1976 fall in the same range as those for the two previous years. Manganese and iron data show a slight decrease in 1976, but the standard deviations of the mean for manganese indicate that the difference in values is only slight. Note also, that for iron, the large "high" values of 1974 and 1975 are not present in 1976, but the "low" values of all three years generally fall into similar ranges. The data for chromium and nickel show an increase in concentration in 1976 from both 1974 and 1975, mainly because of the larger "high" values in 1976. Once again, however, the standard deviation of the range of 1976 data indicates that the increase in 1976 may only be slight at most. It also should be noted that the chromium concentration was below reporting limit* (0.002 ppm) for five (5) samplings, so the "true" mean values should be lower than those shown in Table 2, in which values below .002 ppm were omitted from computation.



*reporting limit = lowest concentration of standard used.

TABLE 2

1974, 1975 and 1976 Mean (average) Values, ppm
Monthly Heavy Metals

| | | Cu | Cr | Fe | Mn | Ni | Zn |
|---|---|---|---|---|---|---|---|
| 1974 | Above Intake | | | | | | |
| | Mean | 0.010 | 0.0029 | 2.40 | 0.40 | 0.012 | 0.031 |
| | High | 0.029 | 0.0057 | 11.0 | 1.70 | 0.051 | 0.13 |
| | Low | 0.0020 | 0.0011 | 0.42 | 0.16 | 0.0029 | 0.0098 |
| | Discharge | | | | | | |
| | Mean | 0.012 | 0.0039 | 2.40 | 0.40 | 0.011 | 0.041 |
| | High | 0.029 | 0.0080 | 8.00 | 1.30 | 0.041 | 0.12 |
| | Low | 0.0020 | 0.0016 | 0.66 | 0.21 | 0.0026 | 0.017 |
| 1975 | Above Intake | | | | | | |
| | Mean | 0.0058 | 0.0028 | 1.60 | 0.43 | 0.024 | 0.020 |
| | High | 0.011 | 0.0068 | 3.10 | 0.82 | 0.082 | 0.042 |
| | Low | 0.0027 | 0.0004 | 0.60 | 0.24 | 0.0051 | 0.0060 |
| | Discharge | | | | | | |
| | Mean | 0.0098 | 0.0038 | 2.00 | 0.40 | 0.031 | 0.033 |
| | High | 0.021 | 0.0071 | 3.20 | 0.77 | 0.11 | 0.10 |
| | Low | 0.0039 | 0.0008 | 1.40 | 0.18 | 0.0073 | 0.0092 |
| 1976 | Above Intake | | | | | | |
| | Mean | 0.0085 | 0.0072 | 1.03 | 0.30 | 0.075 | 0.032 |
| | Std.dev. | 0.0026 | 0.0066 | 0.28 | 0.09 | 0.13 | 0.029 |
| | High | 0.012 | 0.018 | 1.32 | 0.44 | 0.45 | 0.095 |
| | Low | 0.0044 | 0.0012 | 0.44 | 0.16 | 0.0075 | 0.0086 |
| | Discharge | | | | | | |
| | Mean | 0.013 | 0.0086 | 1.34 | 0.32 | 0.085 | 0.030 |
| | Std.dev. | 0.0070 | 0.0073 | 0.21 | 0.09 | 0.140 | 0.015 |
| | High | 0.025 | 0.021 | 1.60 | 0.51 | 0.48 | 0.057 |
| | Low | 0.0055 | 0.0022 | 0.87 | 0.20 | 0.0012 | 0.0096 |

D. F.T.S., Section 4.3.3: Invertebrate Stations - Water Quality Results

The individual results of each semi-monthly sampling at the five stations are given in Appendix A at the end of this discussion. Appendix B shows the minimum reporting concentration for each parameter for 1976. Figures 2 through 12 display the plots of yearly average concentration vs. station number for each parameter. Stations 1 and 2 are upstream of the discharge (station 3), and stations 4 and 5 are downstream of the discharge. Table 3 shows a summary of the 1976 mean concentrations of the parameters at each station. The number of values used to calculate the mean, the mean value itself, and the standard deviation of the values from the mean are given. Also shown is the mean and standard deviation values, which were calculated after omitting the high and low values. This data should help eliminate any effects due to unusually high or low values in the set. It can be seen that the mean values change only slightly when the high and low values are discarded, indicating that all the values in the range may be considered to fall within the normal range.

Table 4 shows the comparison of the 1976 mean values with the mean values from 1974(2) and 1975(3).



reporting limit = lowest concentration of standard used.

Discussion

Comparisons of upstream and downstream values in Table 3 show little difference (also see Figures 2-11). This indicates that even relatively large increases in concentration at the discharge, such as those shown by Fe, Cu, Ni, Zn, Ca, Na and K, are easily accomodated by the stream, and that there is no overall effect on the elemental levels in the stream. In fact, all the mean values downstream are well within the standard deviations from the mean values upstream. This also is an indication that the downstream concentrations are the same as those upstream.

The large range in values can be seen to originate from the variation of stream conditions with time and weather. This is best observed by referring to the data in Appendix A. Even in most of the individual results, the downstream and upstream concentrations are very close.

Table 4 indicates no appreciable differences between mean values for the three years for all but iron, which has a generally lower concentration in 1976 than the previous years. In general, however, the water parameters have remained relatively constant on a year-to-year basis.

In summary, the data indicate no unusual discharges or influences on the water quality at TMI.

TABLE 3

Summary of Semi-Monthly Results, ppm
April, 1976 - October, 1976

| | Cu | Cr | Fe | Mn | Ni | Zn | Ca | Mg | Na | K | phenol |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 1 | | | | | | | | | | | |
| # of values* | 14 | 8 | 14 | 14 | 14 | 13 | 14 | 14 | 14 | 14 | 11 |
| Mean | 0.0082 | 0.0038 | 0.88 | 0.26 | 0.028 | 0.023 | 27.6 | 8.9 | 8.5 | 2.0 | 0.0047 |
| Std. dev. | 0.0029 | 0.0023 | 0.50 | 0.11 | 0.014 | 0.024 | 8.7 | 2.8 | 3.0 | 0.6 | 0.0035 |
| Mean** | 0.0081 | 0.0034 | 0.86 | 0.25 | 0.026 | 0.022 | 27.3 | 9.1 | 8.3 | 1.9 | 0.0040 |
| Std. dev. ** | 0.0025 | 0.0017 | 0.42 | 0.07 | 0.008 | 0.025 | 8.0 | 2.2 | 2.5 | 0.4 | 0.0029 |
| Station 2 | | | | | | | | | | | |
| # of values* | 14 | 7 | 14 | 14 | 14 | 13 | 14 | 14 | 14 | 14 | 8 |
| Mean | 0.0087 | 0.0038 | 0.94 | 0.29 | 0.031 | 0.024 | 26.7 | 7.8 | 8.1 | 2.1 | 0.0042 |
| Std. dev. | 0.0022 | 0.0022 | 0.38 | 0.12 | 0.012 | 0.022 | 6.2 | 2.7 | 2.4 | 0.6 | 0.0020 |
| Mean** | 0.0087 | 0.0031 | 0.91 | 0.28 | 0.029 | 0.020 | 26.7 | 7.9 | 7.9 | 2.1 | 0.0043 |
| Std. dev.** | 0.0019 | 0.0004 | 0.28 | 0.09 | 0.008 | 0.014 | 6.0 | 1.9 | 1.7 | 0.5 | 0.0016 |
| Station 3 | | | | | | | | | | | |
| # of values* | 14 | 9 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 9 |
| Mean | 0.0140 | 0.0042 | 1.22 | 0.31 | 0.040 | 0.033 | 32.6 | 9.9 | 11.9 | 3.0 | 0.0034 |
| Std. dev. | 0.0050 | 0.0022 | 0.44 | 0.10 | 0.019 | 0.018 | 10.7 | 3.7 | 5.9 | 1.2 | 0.0018 |
| Mean** | 0.0140 | 0.0038 | 1.21 | 0.31 | 0.038 | 0.032 | 32.2 | 9.9 | 10.9 | 3.0 | 0.0030 |
| Std. dev.** | 0.0040 | 0.0013 | 0.36 | 0.08 | 0.015 | 0.015 | 8.8 | 2.7 | 2.7 | 1.0 | 0.0011 |
| Station 4 | | | | | | | | | | | |
| # of values* | 14 | 8 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 8 |
| Mean | 0.0100 | 0.0040 | 0.90 | 0.27 | 0.039 | 0.018 | 24.7 | 8.2 | 8.2 | 2.2 | 0.0042 |
| Std. dev. | 0.0050 | 0.0025 | 0.38 | 0.10 | 0.024 | 0.012 | 9.3 | 2.6 | 2.1 | 0.7 | 0.0011 |
| Mean** | 0.0100 | 0.0035 | 0.90 | 0.26 | 0.035 | 0.018 | 24.7 | 8.2 | 8.1 | 2.2 | 0.0040 |
| Std. dev.** | 0.0020 | 0.0017 | 0.30 | 0.07 | 0.012 | 0.009 | 7.1 | 1.8 | 1.6 | 0.6 | 0.0008 |
| Station 5 | | | | | | | | | | | |
| # of values* | 13 | 6 | 14 | 14 | 14 | 13 | 14 | 14 | 14 | 14 | 9 |
| Mean | 0.0100 | 0.0042 | 0.86 | 0.25 | 0.036 | 0.018 | 25.8 | 8.2 | 8.2 | 2.1 | 0.0039 |
| Std. dev. | 0.0040 | 0.0022 | 0.39 | 0.10 | 0.017 | 0.011 | 10.0 | 2.6 | 2.0 | 0.7 | 0.0014 |
| Mean** | 0.0100 | 0.0040 | 0.83 | 0.24 | 0.034 | 0.017 | 26.2 | 8.1 | 8.2 | 2.2 | 0.0038 |
| Std. dev.** | 0.0040 | 0.0017 | 0.24 | 0.08 | 0.013 | 0.008 | 8.3 | 1.6 | 1.9 | 0.6 | 0.0011 |

* Values below reporting limits are not included.
**High and Low values are omitted from calculation.

TABLE 4

Comparison of 1976 Semi-monthly averages with 1974 and 1975 averages, ppm.

| | | Cu | Cr | Fe | Mn | Ni | Zn | Ca | Mg | Na | K | phenol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 1 | 1974 | 0.0079 | 0.0067 | 1.70 | 0.31 | 0.0110 | 0.031 | 26.0 | 9.9 | 8.5 | 2.5 | 0.0060 |
| | 1975 | 0.0095 | 0.0050 | 2.10 | 0.41 | 0.0230 | 0.021 | 19.0 | 9.9 | 8.1 | 2.5 | 0.0062 |
| | 1976 | 0.0082 | 0.0038 | 0.88 | 0.26 | 0.0280 | 0.023 | 27.6 | 8.9 | 8.5 | 2.0 | 0.0047 |
| Station 2 | 1974 | 0.0062 | 0.0061 | 1.20 | 0.26 | 0.0066 | 0.021 | 25.0 | 8.5 | 7.6 | 2.6 | 0.0031 |
| | 1975 | 0.0044 | 0.0046 | 2.00 | 0.33 | 0.0240 | 0.019 | 20.0 | 8.5 | 7.3 | 2.6 | 0.0065 |
| | 1976 | 0.0087 | 0.0038 | 0.94 | 0.29 | 0.0310 | 0.024 | 26.7 | 7.8 | 8.1 | 2.1 | 0.0042 |
| Station 3 | 1974 | 0.0083 | 0.0065 | 1.40 | 0.29 | 0.0080 | 0.027 | 28.0 | 9.4 | 8.8 | 2.8 | 0.0041 |
| | 1975 | 0.0081 | 0.0052 | 2.50 | 0.32 | 0.0300 | 0.031 | 24.0 | 11.0 | 10.0 | 3.4 | 0.0062 |
| | 1976 | 0.0140 | 0.0042 | 1.22 | 0.31 | 0.0400 | 0.033 | 32.6 | 9.8 | 11.9 | 3.0 | 0.0034 |
| Station 4 | 1974 | 0.0060 | 0.0064 | 1.30 | 0.26 | 0.0074 | 0.025 | 26.0 | 9.1 | 8.1 | 2.5 | 0.0043 |
| | 1975 | 0.0052 | 0.0046 | 2.10 | 0.31 | 0.0260 | 0.022 | 20.0 | 9.1 | 8.3 | 2.7 | 0.0059 |
| | 1976 | 0.0100 | 0.0040 | 0.90 | 0.27 | 0.0390 | 0.018 | 24.7 | 8.2 | 8.2 | 2.2 | 0.0042 |
| Station 5 | 1974 | 0.0061 | 0.0070 | 0.99 | 0.24 | 0.0082 | 0.023 | 25.0 | 9.2 | 8.2 | 2.4 | 0.0034 |
| | 1975 | 0.0037 | 0.0042 | 1.80 | 0.25 | 0.0260 | 0.016 | 20.0 | 9.4 | 8.0 | 2.6 | 0.0051 |
| | 1976 | 0.0100 | 0.0042 | 0.86 | 0.25 | 0.0360 | 0.018 | 25.8 | 8.2 | 8.2 | 2.1 | 0.0039 |

FIGURE 2

Yearly Average Copper Concentration for Water Quality Sampling Stations. 1-5.

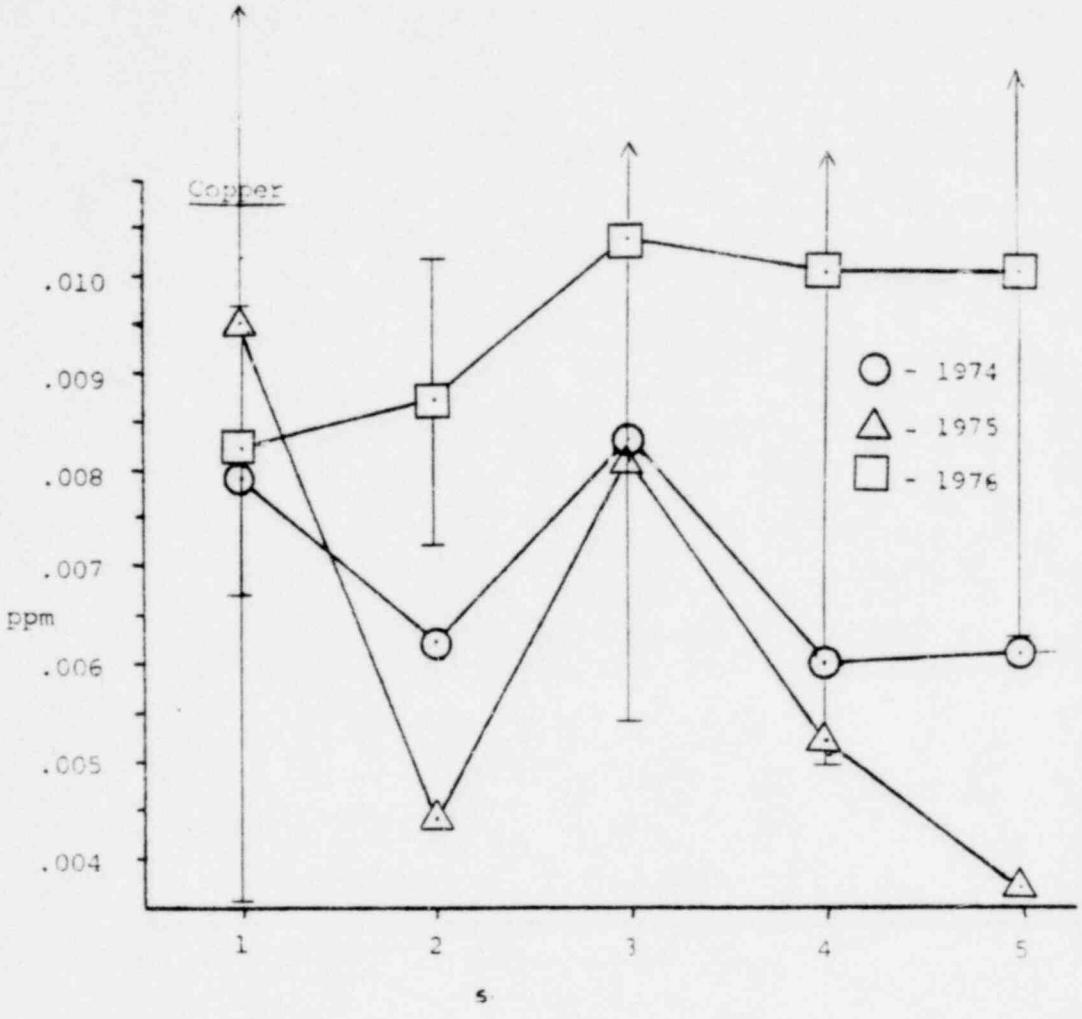


FIGURE 3

Yearly Average Chromium Concentrations for Water Quality Sampling Stations. 1-5.

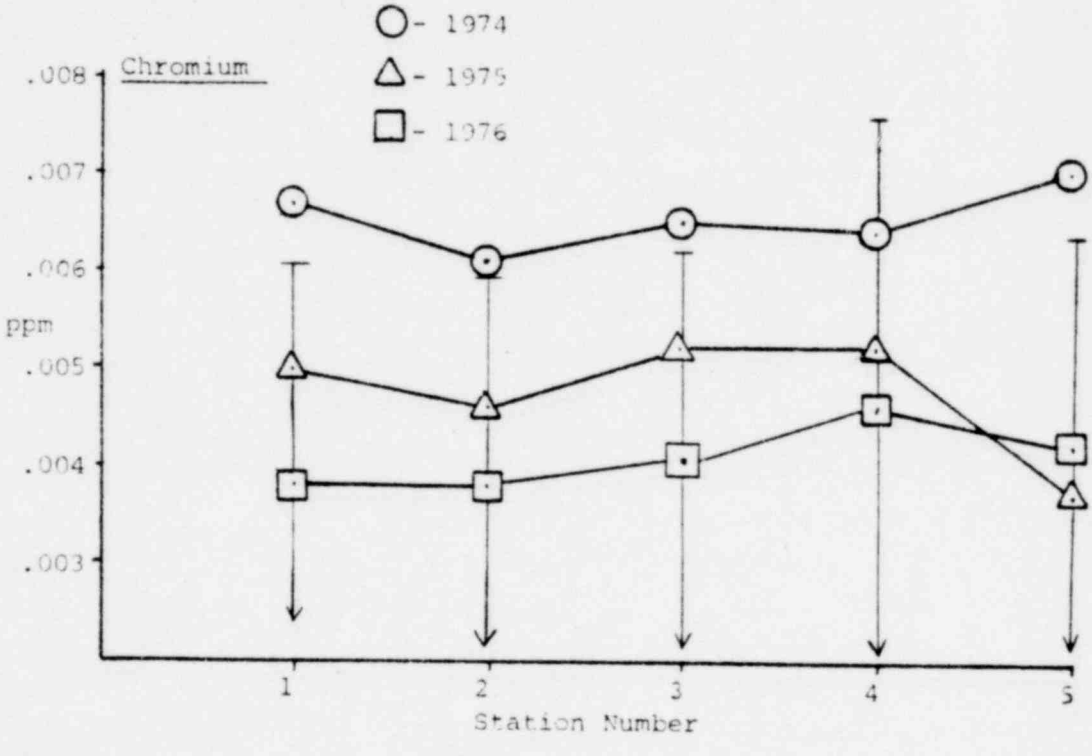


FIGURE 4

Yearly Average Iron Concentration for Water Quality Sampling Stations. 1-5.



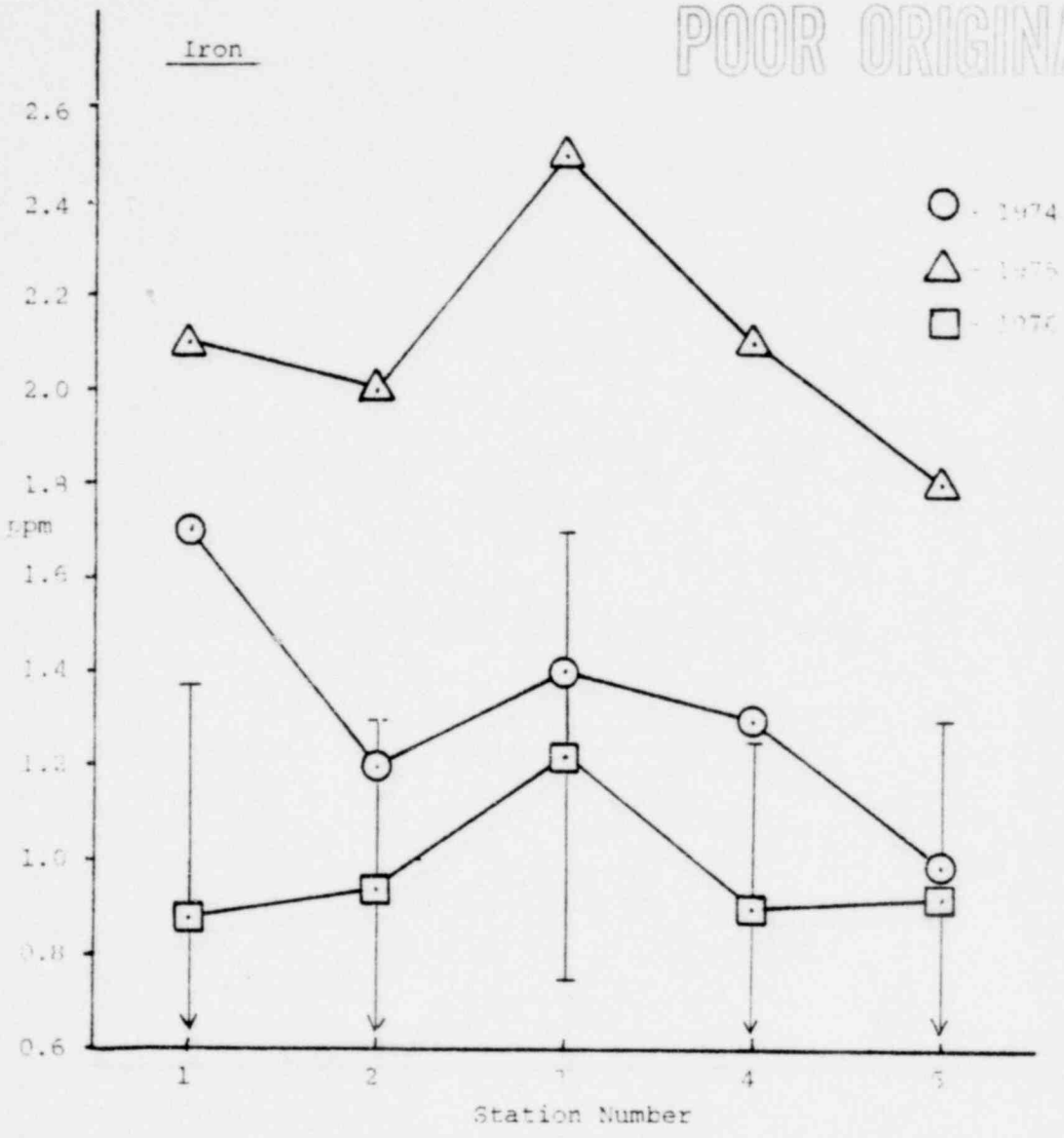


FIGURE 5

Yearly Average Manganese Concentration for Water Quality Sampling Stations. 1-5.



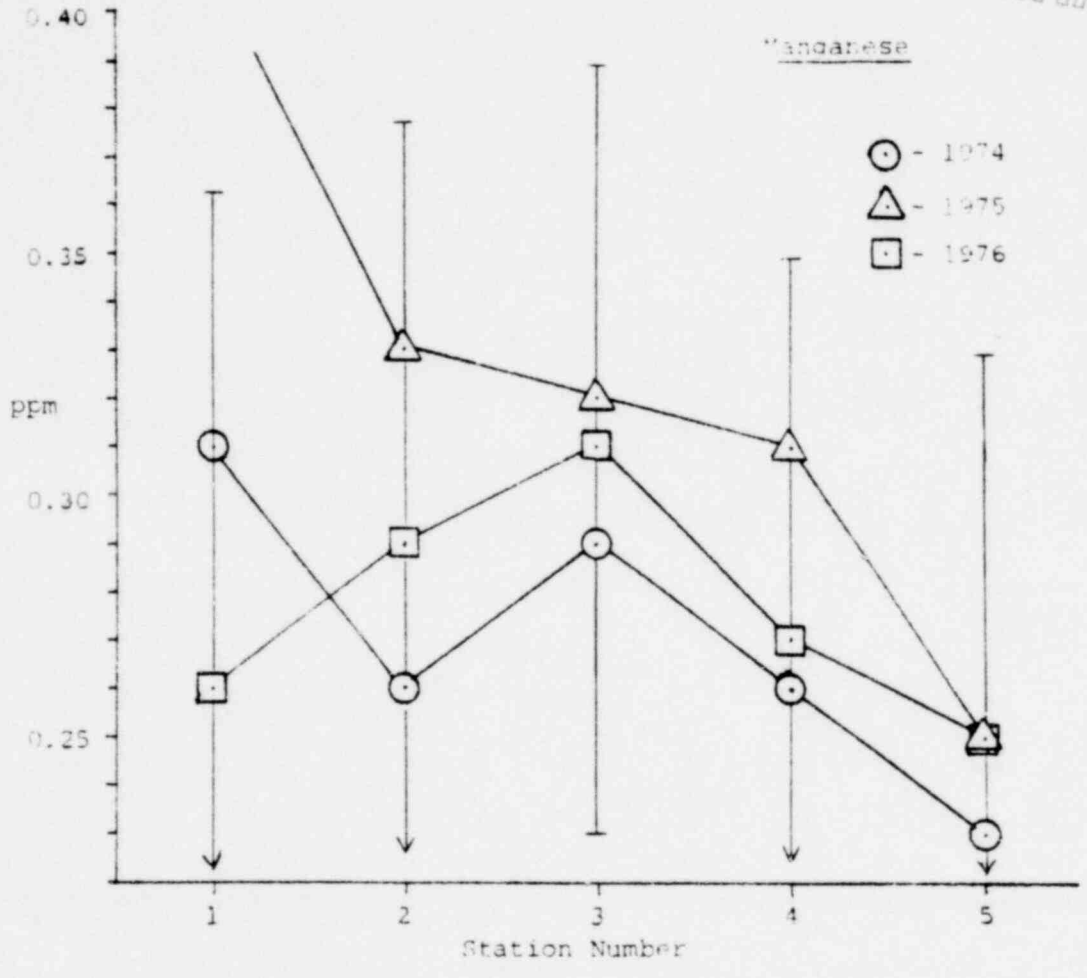


FIGURE 6

Yearly Average Nickel Concentration for Water Quality Sampling Stations. 1-5.



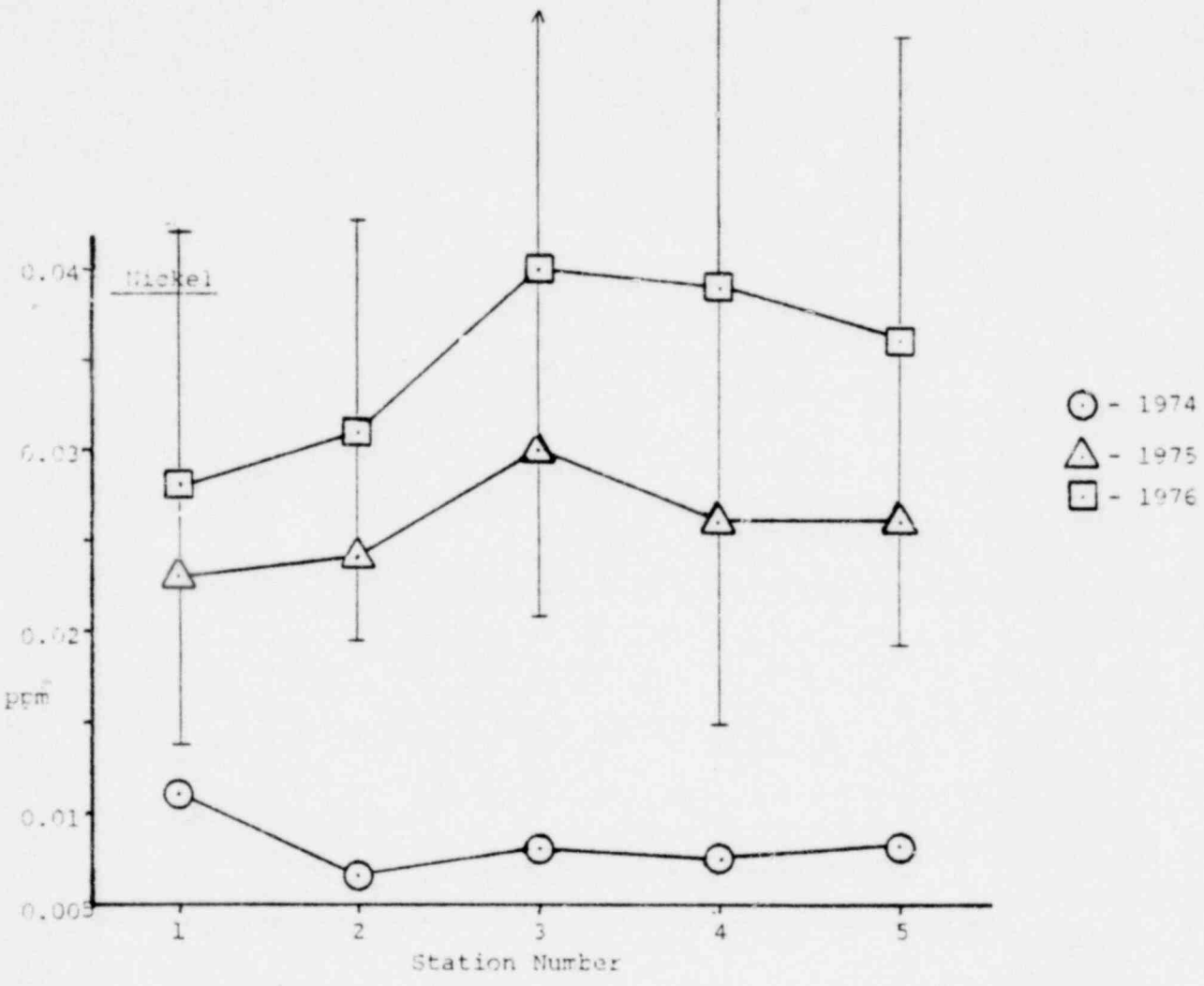


FIGURE 7

Yearly Average Zinc Concentration for Water Quality Sampling Stations. 1-5.

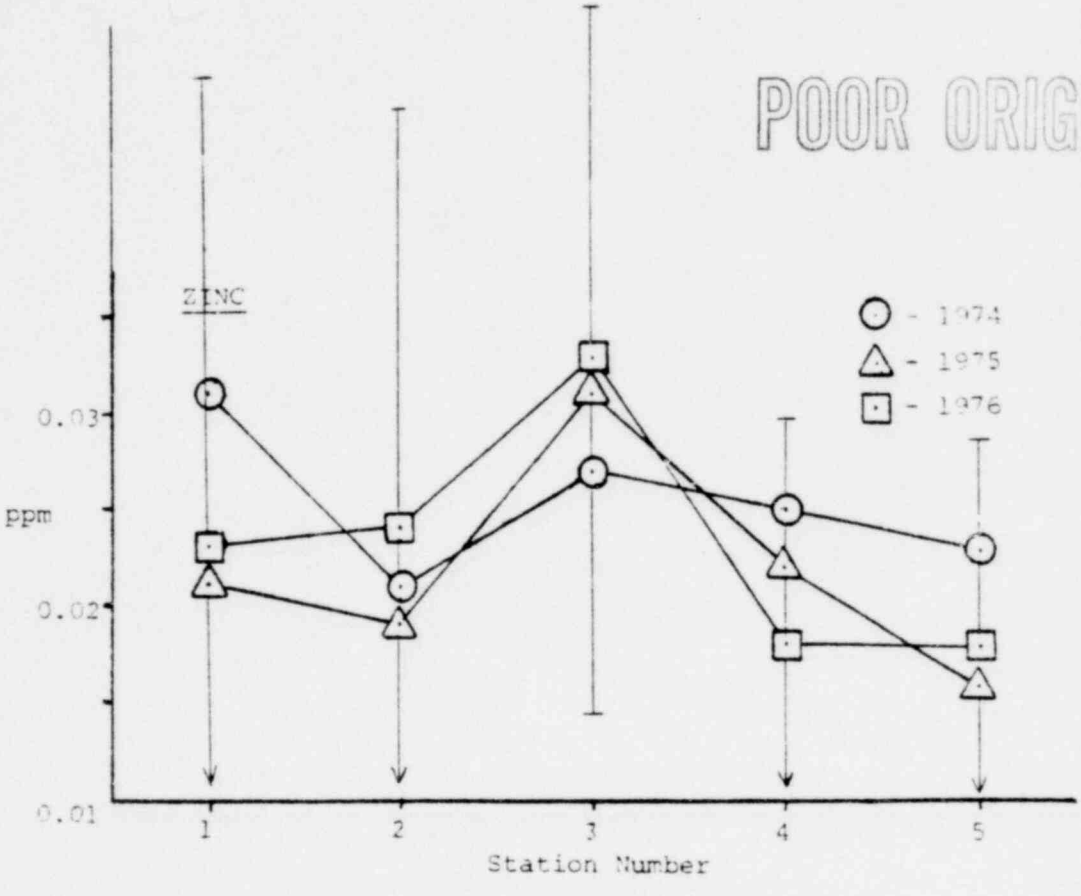


FIGURE 8

Yearly Average Calcium Concentration for Water Quality Sampling Stations. 1-5.



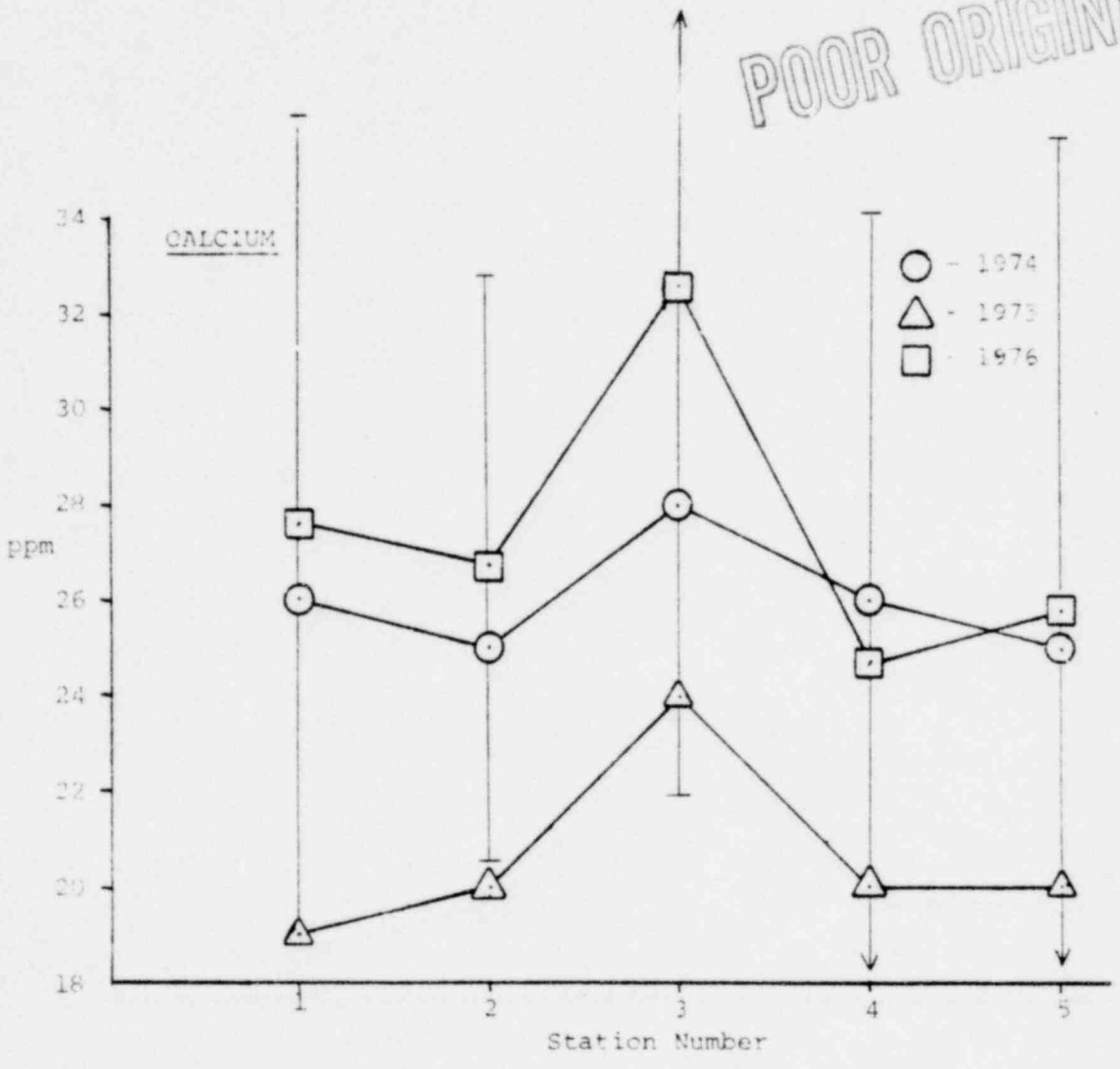


FIGURE 9

Yearly Average Magnesium Concentration for Water Quality Sampling Stations. 1-5.



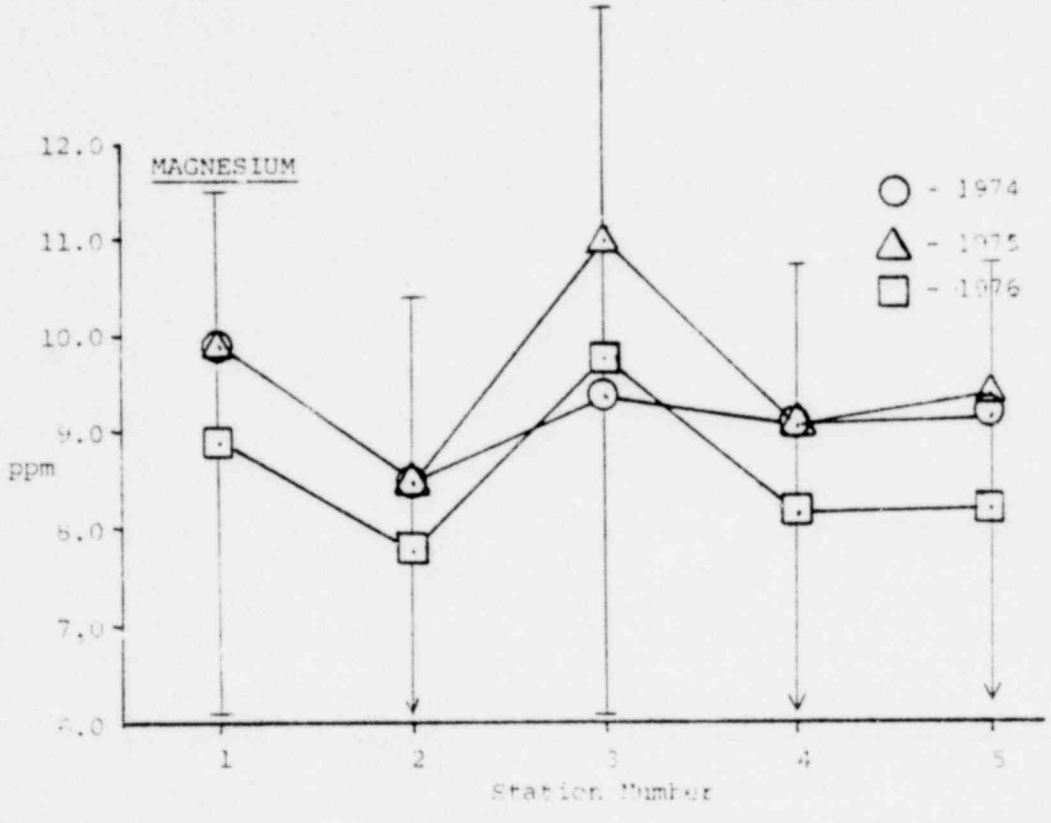


FIGURE 10

Yearly Average Sodium Concentration for Water Quality Sampling Stations. 1-5.



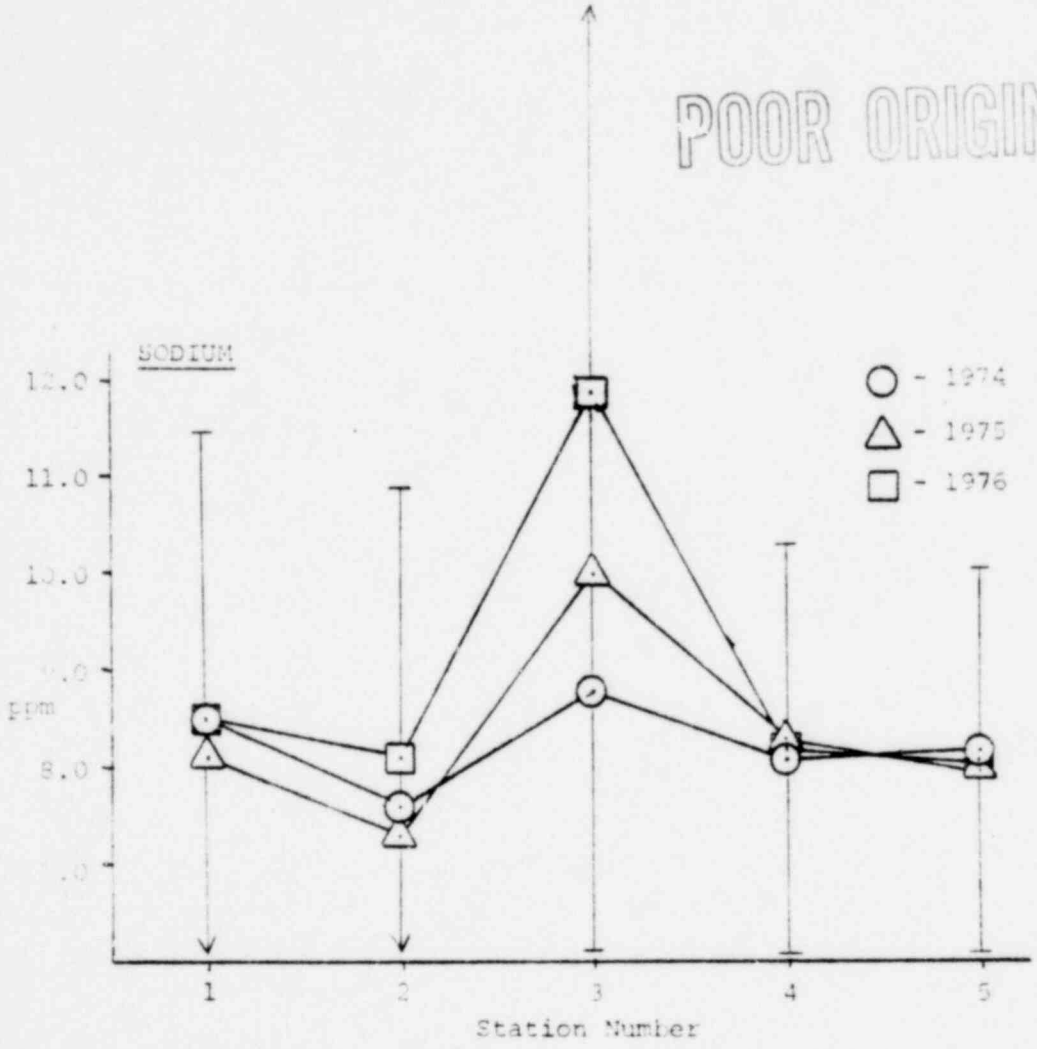


FIGURE 11

Yearly Average Potassium Concentration for Water Quality Sampling Stations. 1-5.

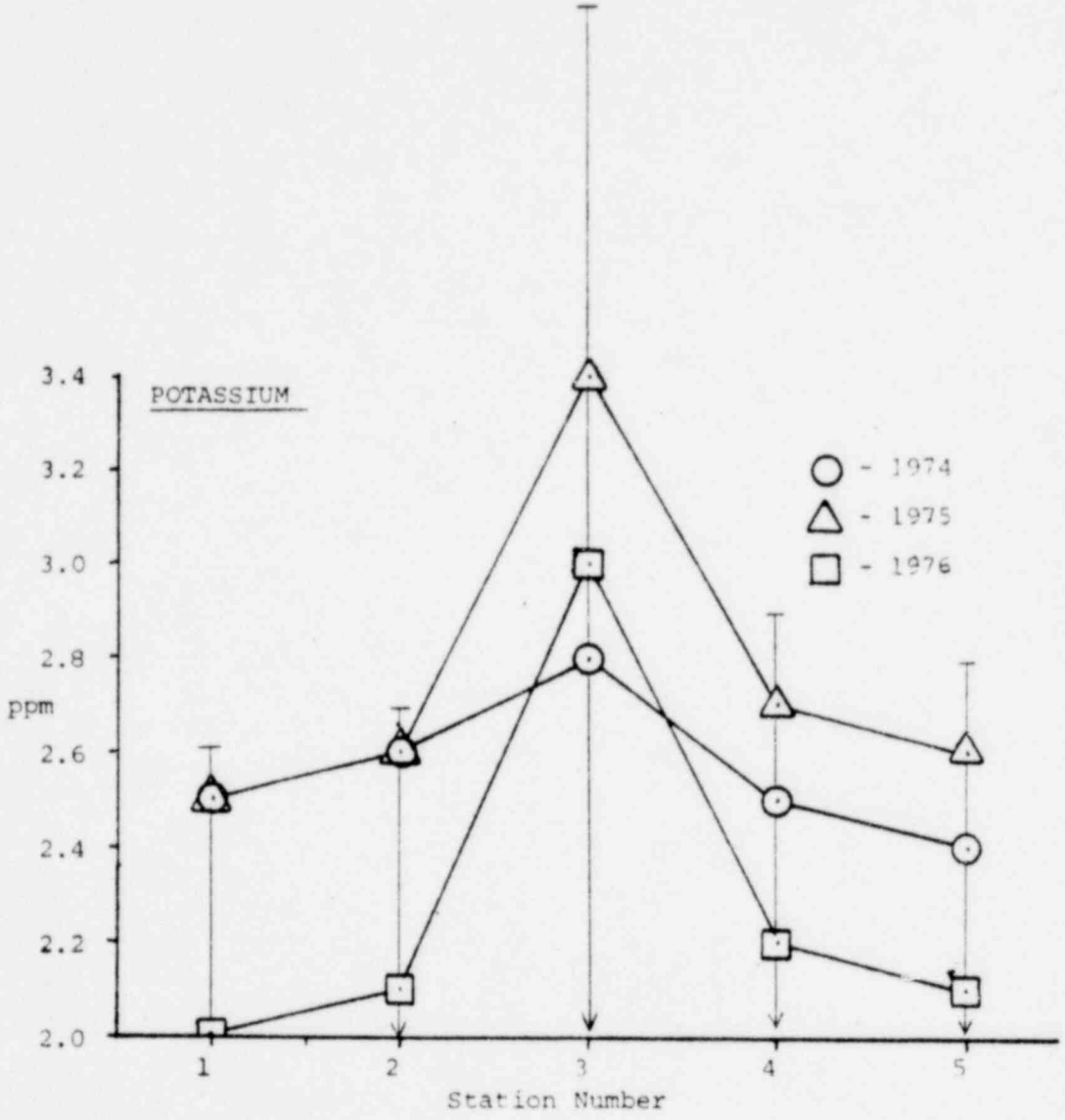
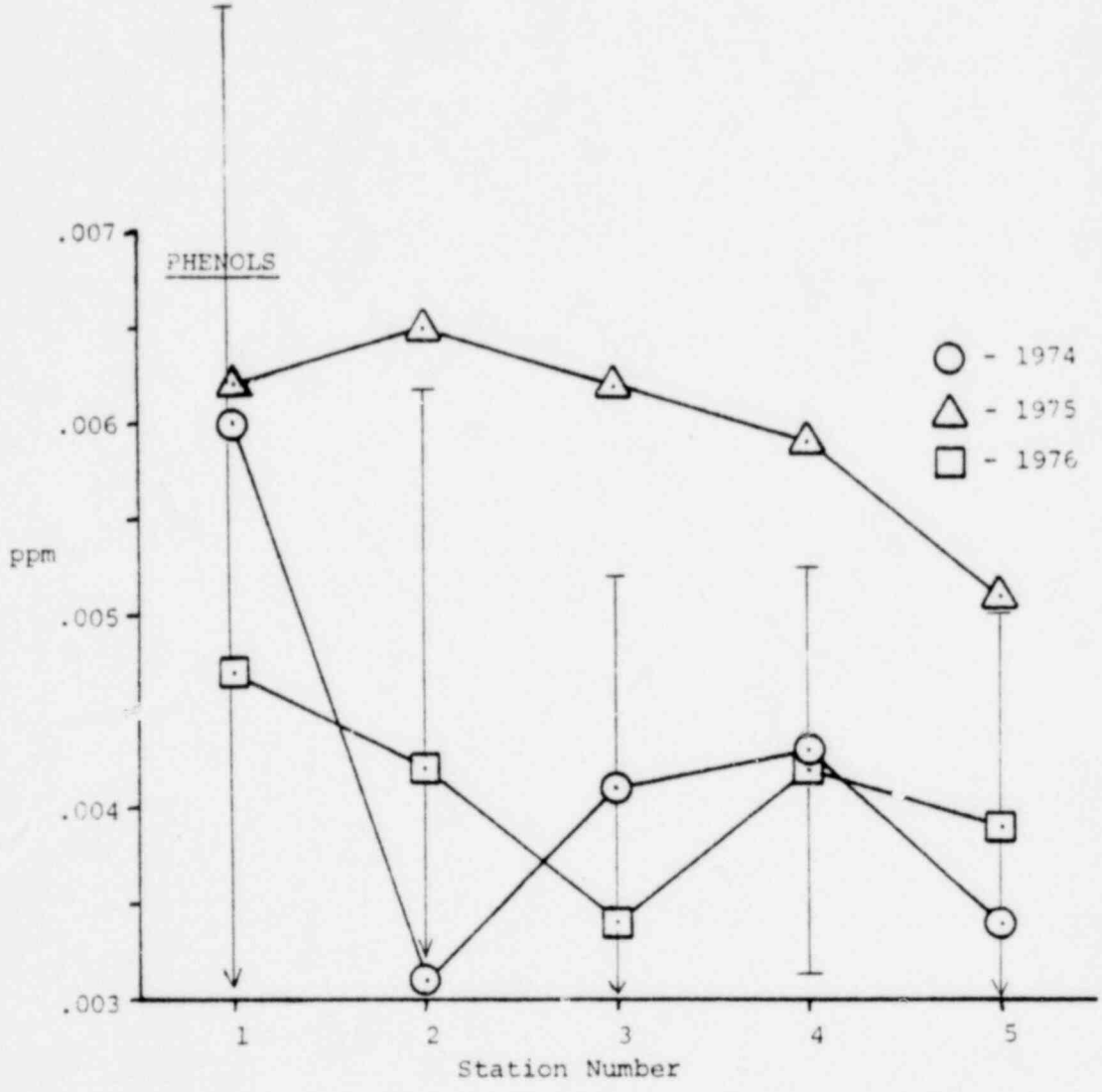


FIGURE 12

Yearly Average Phenols Concentration for Water Quality Sampling Stations. 1-5.



## Statistical Analysis

A. Section 4.2.1 Samples above intake and at discharge

The data collected above the intake (station 2) was statistically compared to the data collected at discharge (station 3) by both the paired comparison Student t Test and the non-parametric Wilcoxon signed rank test.

The results are shown in Table A. The superscripts above the elements indicate the appropriate test and level of significance at which the data above intake differs significantly from that at discharge. It would be expected to see some increase in concentration at discharge, and this is shown by Cu, Cr, Fe and Ni. Neither Mn nor Zn show significant difference at any significant level. Agreement is shown between both tests.

Table A

Mean concentration values (ppm) of monthly samples for 1976

| Sample | $Cu^{a,z}$ | $Cr^{a,x}$ | $Fe^{c,z}$ | Mn | $Ni^{a,x}$ | Zn |
|---|---|---|---|---|---|---|
| Above Intake | 0.0085 | 0.0072 | 1.03 | 0.30 | 0.0750 | 0.032 |
| At Discharge | 0.0131 | 0.0086 | 1.34 | 0.32 | 0.0846 | 0.030 |

1. Paired Comparison Student t Test - Intake differs significantly from discharge at:

   a - $p < 0.05$
   b - $p < 0.02$
   c - $p < 0.01$

2. Non-Parametric Wilcoxon Signed Rank Test - Intake differs significantly from discharge at:

   x - $p < 0.05$
   y - $p < 0.02$
   z - $p < 0.01$

B. Section 4.2.2

The chemical assays of semi-monthly samples from stations 1, 2, 3, 4 and 5 were analyzed statistically using a randomized block analysis of variance. Sample data served as blocks. The Student-Newman-Kuels multirange test was employed to identify station means which differed significantly.

The results are shown in Table B. Means with the same subscript do not differ significantly ($p < 0.05$). Data for Cr and phenol were not analyzed since determinations were frequently below the limit of detection. There are essentially no significant differences between the metal concentrations of the water above the discharge and that below the discharge.

Table B

Mean concentrations (ppm) of semi-monthly metals for April-October, 1976

| Station* | Cu | Fe | Mn | Ni | Zn | Ca | Mg | Na | K |
|---|---|---|---|---|---|---|---|---|---|
| 1 | $0.0082_a$** | $0.88_a$ | $0.26_a$ | $0.028_a$ | $0.0229_a$ | $27.6_a$ | $8.9_a$ | $8.5_a$ | $2.0_a$ |
| 2 | $0.0088_a$ | $0.94_a$ | $0.29_a$ | $0.035_{a,b}$ | $0.0240_a$ | $26.7_a$ | $7.8_a$ | $8.1_a$ | $2.1_a$ |
| 3 | $0.0137_b$ | $1.22_b$ | $0.31_a$ | $0.040_{a,b}$ | $0.0318_a$ | $32.6_b$ | $9.7_b$ | $11.9_b$ | $3.0_b$ |
| 4 | $0.0103_a$ | $0.90_a$ | $0.27_a$ | $0.032_{a,b}$ | $0.0196_a$ | $24.7_a$ | $8.2_a$ | $8.2_a$ | $2.2_a$ |
| 5 | $0.0104_a$ | $0.86_a$ | $0.25_a$ | $0.036_b$ | $0.0182_a$ | $25.7_a$ | $8.2_a$ | $8.2_a$ | $2.1_a$ |

*Station 1 and 2 are above discharge and stations 4 and 5 below discharge.

**For a given metal, means with the same subscript do not differ significantly.

Appendix

APPENDIX A

Semi-Monthly Heavy Metals & Phenol Results
April 6, 1976 - October 19, 1976
Values in ppm

| Date | Station | Cu | Cr | Fe | Mn | Ni | Zn | Ca | Mg | Na | K | phenol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4/6/76 | 1 | 0.0057 | <.0020 | 0.86 | 0.34 | 0.016 | 0.0180 | 18.6 | 2.5 | 4.7 | 1.7 | 0.0016 |
| | 2 | 0.0048 | <.0020 | 0.95 | 0.29 | 0.017 | 0.0092 | 20.4 | 2.2 | 6.9 | 1.5 | <.0010 |
| | 3 | 0.0055 | <.0020 | 1.30 | 0.29 | 0.016 | 0.0096 | 17.8 | 2.0 | 6.7 | 1.3 | <.0010 |
| | 4 | 0.0034 | <.0020 | 1.00 | 0.30 | 0.018 | 0.0130 | 18.0 | 3.1 | 6.5 | 1.2 | <.0010 |
| | 5 | 0.0040 | <.0020 | 0.98 | 0.32 | 0.018 | 0.0068 | 18.4 | 3.0 | 6.2 | 1.0 | <.0010 |
| 4/20/76 | 1 | 0.0092 | 0.0020 | 0.64 | 0.26 | 0.020 | 0.0180 | 40.8 | 11.2 | 14.0 | 1.1 | <.0010 |
| | 2 | 0.0100 | 0.0020 | 0.70 | 0.26 | 0.022 | 0.0082 | 36.0 | 8.2 | 14.0 | 1.3 | <.0010 |
| | 3 | 0.0120 | 0.0024 | 0.86 | 0.25 | 0.022 | 0.0650 | 32.8 | 7.0 | 11.0 | 1.4 | <.0010 |
| | 4 | 0.0120 | 0.0025 | 0.84 | 0.26 | 0.024 | 0.0100 | 32.8 | 7.2 | 11.0 | 1.5 | <.0010 |
| | 5 | 0.0120 | 0.0028 | 0.74 | 0.25 | 0.022 | 0.0140 | 36.0 | 7.2 | 10.0 | 1.4 | <.0010 |
| 5/4/76 | 1 | 0.0120 | 0.0028 | 1.30 | 0.35 | 0.024 | 0.0960 | 25.0 | 7.2 | 6.1 | 1.6 | 0.0024 |
| | 2 | 0.0110 | 0.0030 | 1.32 | 0.34 | 0.022 | 0.0850 | 24.0 | 6.8 | 5.4 | 1.3 | 0.0012 |
| | 3 | 0.0130 | 0.0044 | 1.28 | 0.34 | 0.024 | 0.0380 | 26.0 | 7.6 | 12.1 | 1.7 | 0.0024 |
| | 4 | 0.0120 | 0.0032 | 1.14 | 0.32 | 0.022 | 0.0260 | 24.0 | 7.2 | 5.5 | 1.5 | 0.0060 |
| | 5 | 0.0110 | 0.0032 | 1.22 | 0.34 | 0.022 | 0.0340 | 25.0 | 7.6 | 6.0 | 1.4 | 0.0062 |
| 5/18/76 | 1 | 0.0063 | <.0020 | 0.46 | 0.16 | 0.028 | 0.0068 | 37.0 | 9.6 | 7.7 | 2.0 | 0.0092 |
| | 2 | 0.0067 | 0.0037 | 0.74 | 0.15 | 0.028 | 0.0480 | 33.0 | 7.2 | 7.8 | 2.5 | 0.0015 |
| | 3 | 0.0090 | 0.0057 | 1.10 | 0.15 | 0.036 | 0.0200 | 33.0 | 6.4 | 7.8 | 2.6 | <.0010 |
| | 4 | 0.0088 | 0.0059 | 0.65 | 0.15 | 0.043 | 0.0420 | 32.0 | 6.8 | 7.5 | 2.2 | 0.0042 |
| | 5 | 0.0120 | 0.0074 | 0.72 | 0.17 | 0.051 | 0.0180 | 34.0 | 6.8 | 8.1 | 2.8 | 0.0022 |
| 6/1/76 | 1 | 0.0052 | <.0020 | 0.75 | 0.28 | 0.023 | 0.0100 | 37.5 | 7.0 | 7.2 | 1.3 | 0.0010 |
| | 2 | 0.0087 | <.0020 | 0.86 | 0.31 | 0.031 | 0.0180 | 32.5 | 8.0 | 7.3 | 1.3 | 0.0064 |
| | 3 | 0.0067 | <.0020 | 0.87 | 0.28 | 0.027 | 0.0270 | 37.5 | 7.0 | 7.1 | 1.3 | 0.0032 |
| | 4 | 0.0065 | <.0020 | 0.73 | 0.25 | 0.028 | 0.0260 | 26.0 | 8.0 | 7.4 | 1.3 | 0.0034 |
| | 5 | 0.0075 | <.0020 | 0.74 | 0.24 | 0.030 | 0.0410 | 36.0 | 7.5 | 7.2 | 1.4 | 0.0024 |

APPENDIX A
(cont'd)

| Date | Station | Cu | Cr | Fe | Mn | Ni | Zn | Ca | Mg | Na | K | phenol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/15/76 | 1 | 0.0040 | <.0020 | 0.18 | 0.18 | 0.023 | 0.0140 | 22.0 | 9.0 | 8.5 | 1.6 | 0.0070 |
| | 2 | 0.0055 | <.0020 | 0.61 | 0.47 | 0.035 | 0.0080 | 25.5 | 9.0 | 10.0 | 2.3 | 0.0040 |
| | 3 | 0.0140 | <.0020 | 0.67 | 0.47 | 0.055 | 0.0160 | 39.0 | 13.0 | 14.6 | 3.4 | 0.0030 |
| | 4 | 0.0075 | 0.0020 | 0.50 | 0.43 | 0.048 | 0.0070 | 26.5 | 9.0 | 9.6 | 2.4 | 0.0030 |
| | 5 | 0.0065 | 0.0035 | 0.43 | 0.43 | 0.054 | 0.0100 | 27.5 | 9.5 | 10.3 | 2.3 | 0.0030 |
| 7/6/76 | 1 | 0.0120 | <.0020 | 1.10 | 0.18 | 0.020 | 0.0130 | 22.0 | 11.0 | 7.3 | 1.7 | <.0010 |
| | 2 | 0.0110 | <.0020 | 0.86 | 0.17 | 0.022 | 0.0092 | 24.0 | 12.0 | 7.4 | 1.8 | <.0010 |
| | 3 | 0.0250 | 0.0020 | 1.50 | 0.25 | 0.027 | 0.0260 | 40.0 | 16.0 | 12.0 | 3.6 | 0.0018 |
| | 4 | 0.0250 | <.0020 | 0.88 | 0.14 | 0.024 | 0.0090 | 11.0 | 11.0 | 7.4 | 1.7 | <.0010 |
| | 5 | 0.0150 | <.0020 | 0.76 | 0.13 | 0.022 | 0.0057 | 10.0 | 11.0 | 7.4 | 1.7 | <.0010 |
| 7/20/76 | 1 | 0.0063 | 0.0025 | 0.62 | 0.15 | 0.044 | <.0020 | 22.0 | 11.0 | 7.7 | 1.8 | 0.0018 |
| | 2 | 0.0066 | 0.0031 | 0.57 | 0.19 | 0.042 | <.0020 | 22.0 | 10.0 | 7.7 | 2.1 | <.0010 |
| | 3 | 0.0140 | 0.0041 | 0.53 | 0.46 | 0.056 | 0.0430 | 9.5 | 12.0 | 9.5 | 3.5 | 0.0019 |
| | 4 | 0.0098 | 0.0053 | 0.24 | 0.28 | 0.052 | 0.0024 | 8.0 | 9.5 | 8.5 | 2.7 | 0.0049 |
| | 5 | reject | <.0020 | 0.22 | 0.21 | 0.048 | <.0020 | 7.0 | 9.0 | 8.0 | 2.3 | 0.0030 |
| 8/3/76 | 1 | 0.0062 | 0.0020 | 0.48 | 0.15 | 0.032 | 0.015 | 35.0 | 12.0 | 10.0 | 2.0 | 0.0026 |
| | 2 | 0.0094 | <.0020 | 0.44 | 0.16 | 0.040 | 0.037 | 33.0 | 8.0 | 8.0 | 2.6 | <.0010 |
| | 3 | 0.0230 | 0.0022 | 1.10 | 0.20 | 0.053 | 0.046 | 42.0 | 11.0 | 10.0 | 3.9 | <.0010 |
| | 4 | 0.0120 | <.0020 | 0.55 | 0.18 | 0.044 | 0.018 | 34.0 | 9.0 | 8.1 | 2.8 | <.0010 |
| | 5 | 0.0170 | <.0020 | 0.81 | 0.16 | 0.037 | 0.026 | 34.0 | 9.0 | 8.2 | 2.7 | <.0010 |
| 8/17/76 | 1 | 0.0067 | 0.0043 | 1.80 | 0.24 | 0.012 | 0.022 | 18.0 | 5.0 | 5.8 | 3.2 | 0.0067 |
| | 2 | 0.0110 | 0.0033 | 1.50 | 0.22 | 0.019 | 0.024 | 18.0 | 5.0 | 5.7 | 2.8 | 0.0046 |
| | 3 | 0.0180 | 0.0047 | 2.00 | 0.26 | 0.027 | 0.055 | 32.0 | 9.0 | 11.0 | 4.8 | 0.0042 |
| | 4 | 0.0096 | 0.0022 | 1.50 | 0.24 | 0.021 | 0.024 | 17.0 | 5.0 | 5.8 | 2.9 | 0.0035 |
| | 5 | 0.0150 | 0.0020 | 1.80 | 0.15 | 0.021 | 0.023 | 18.0 | 5.5 | 6.3 | 3.0 | 0.0037 |

APPENDIX A
(cont'd)

| Date | Station | Cu | Cr | Fe | Mn | Ni | Zn | Ca | Mg | Na | K | phenol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/7/76 | 1 | 0.0082 | 0.0065 | 0.52 | 0.25 | 0.030 | 0.0120 | 38.0 | 12.0 | 14.0 | 2.7 | 0.0063 |
| | 2 | 0.0090 | 0.0086 | 1.00 | 0.34 | 0.036 | 0.0086 | 36.0 | 13.0 | 12.0 | 3.0 | 0.0041 |
| | 3 | 0.0130 | 0.0088 | 1.40 | 0.32 | 0.056 | 0.0170 | 53.0 | 15.0 | 16.0 | 4.4 | 0.0046 |
| | 4 | 0.0110 | 0.0088 | 0.92 | 0.29 | 0.049 | 0.0110 | 42.0 | 13.0 | 13.0 | 3.3 | 0.0051 |
| | 5 | 0.0100 | 0.0065 | 0.63 | 0.22 | 0.043 | 0.0098 | 40.0 | 14.0 | 13.0 | 2.8 | 0.0056 |
| 9/21/76 | 1 | 0.0083 | 0.0023 | 0.52 | 0.25 | 0.024 | 0.0160 | 33.0 | 11.0 | 12.0 | 2.5 | 0.0110 |
| | 2 | 0.0074 | 0.0026 | 0.75 | 0.27 | 0.020 | 0.0130 | 28.0 | 7.0 | 8.2 | 2.8 | 0.0057 |
| | 3 | 0.0130 | 0.0031 | 0.97 | 0.28 | 0.025 | 0.0240 | 38.0 | 10.0 | 12.0 | 3.9 | <.0010 |
| | 4 | 0.0098 | 0.0020 | 0.78 | 0.22 | 0.022 | 0.017 | 31.0 | 8.0 | 8.8 | 2.7 | <.0010 |
| | 5 | 0.0130 | <.0020 | 0.73 | 0.23 | 0.022 | 0.014 | 30.0 | 8.0 | 9.3 | 2.7 | 0.0046 |
| 10/5/76 | 1 | 0.0110 | 0.0080 | 1.40 | 0.32 | 0.036 | 0.045 | 18.0 | 7.5 | 7.4 | 2.2 | <.0010 |
| | 2 | 0.0120 | <.0020 | 1.00 | 0.29 | 0.030 | 0.032 | 21.0 | 5.5 | 7.5 | 2.4 | 0.0060 |
| | 3 | 0.0140 | <.0020 | 1.50 | 0.26 | 0.052 | 0.057 | 30.0 | 9.0 | 30.0 | 3.2 | 0.0073 |
| | 4 | 0.0080 | <.0020 | 1.30 | 0.23 | 0.040 | 0.039 | 22.0 | 6.5 | 9.7 | 2.4 | <.0010 |
| | 5 | 0.0042 | <.0020 | 0.94 | 0.16 | 0.031 | 0.024 | 22.0 | 6.5 | 9.1 | 2.3 | 0.0040 |
| 10/19/76 | 1 | 0.0130 | <.0020 | 1.70 | 0.57 | 0.066 | 0.012 | 20.0 | 8.0 | 6.0 | 2.1 | 0.0020 |
| | 2 | 0.0082 | <.0020 | 1.80 | 0.55 | 0.063 | 0.012 | 21.0 | 8.0 | 6.0 | 2.1 | <.0010 |
| | 3 | 0.0120 | <.0020 | 2.00 | 0.50 | 0.081 | 0.013 | 26.0 | 12.0 | 7.4 | 2.7 | 0.0020 |
| | 4 | 0.0090 | <.0020 | 1.60 | 0.48 | 0.011 | 0.012 | 22.0 | 11.0 | 6.3 | 2.1 | 0.0031 |
| | 5 | 0.0077 | <.0020 | 1.30 | 0.46 | 0.078 | 0.011 | 23.0 | 10.0 | 6.2 | 2.1 | <.0010 |