WATER QUALITY DATABASE EVALUATION AND TREND ANALYSIS FOR: WAPPAPELO LAKE

Prepared for

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Date Prepared: February, 2007

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1.0 EXECUTIVE SUMMARY

The purpose of this report is to provide a statistical analysis of water quality conditions within Wappapelo Lake during the period 2001-2005.

Statistical evaluations were performed using water quality data values acquired during the referenced period on a wide variety of organic, inorganic and biological parameters from a number of sampling points spread throughout the lake. Analytical data reviewed consisted of Wappapelo Lake water quality data has been collected from lake surface waters at three (3) sites and from one subsurface site. Additional data have been acquired from samples taken at sites located upriver and downriver of the body of the lake. The samples were collected by the Corps of Engineers, St. Louis District, Environmental Quality Section. Statistical analysis and the results were evaluated for seventeen (17) parameters for all sites that contained sufficient data (i.e. data from two years or more and/or a sufficient number of data points above the detection limit) on a combined and individual basis.

The data collected indicated a generally improving to stable water quality within Wappapelo Lake.

2.0 INTRODUCTION

Water quality monitoring within the lakes and rivers under the control of the U.S. Army Corps of Engineers is essential to assure that environmental conditions are safe for human and wildlife contact and general usage. The Corps of Engineers, St. Louis District, Environmental Quality Section has maintained a database of monitoring sites within Wappapelo Lake since 1989. The data as collected is reviewed to assure that immediate environmental conditions are within acceptable ranges. The data is then archived within a database file.

The values regarding water quality in Wappapelo Lake which are presented herein were acquired during the calendar years 2001 to 2005. Statistical analysis of the data was performed on data sets from individual sampling sites within the lake system. The statistical results obtained are compared to applicable water quality standards currently in force by regulation (State and/or Federal). In those cases where there is no regulatory limited the values observed are compared to those which are generally accepted as a good range for water quality. Missouri regulations for water quality appear in Rules of the Department of Natural Resources, Division 20, Clean Water Commission, Title 10 CSR 20-7.031.

3.0 WAPPAPELO LAKE WATER QUALITY DATA EVALUATION

3.1 Data Sets

Data sets evaluated for Wappapelo Lake originated from field sampling by the St. Louis District Corps of Engineers Environmental Quality Section at a total of seven (7) sites. Figure 1 shows the locations of these sites.

3.2 Evaluation

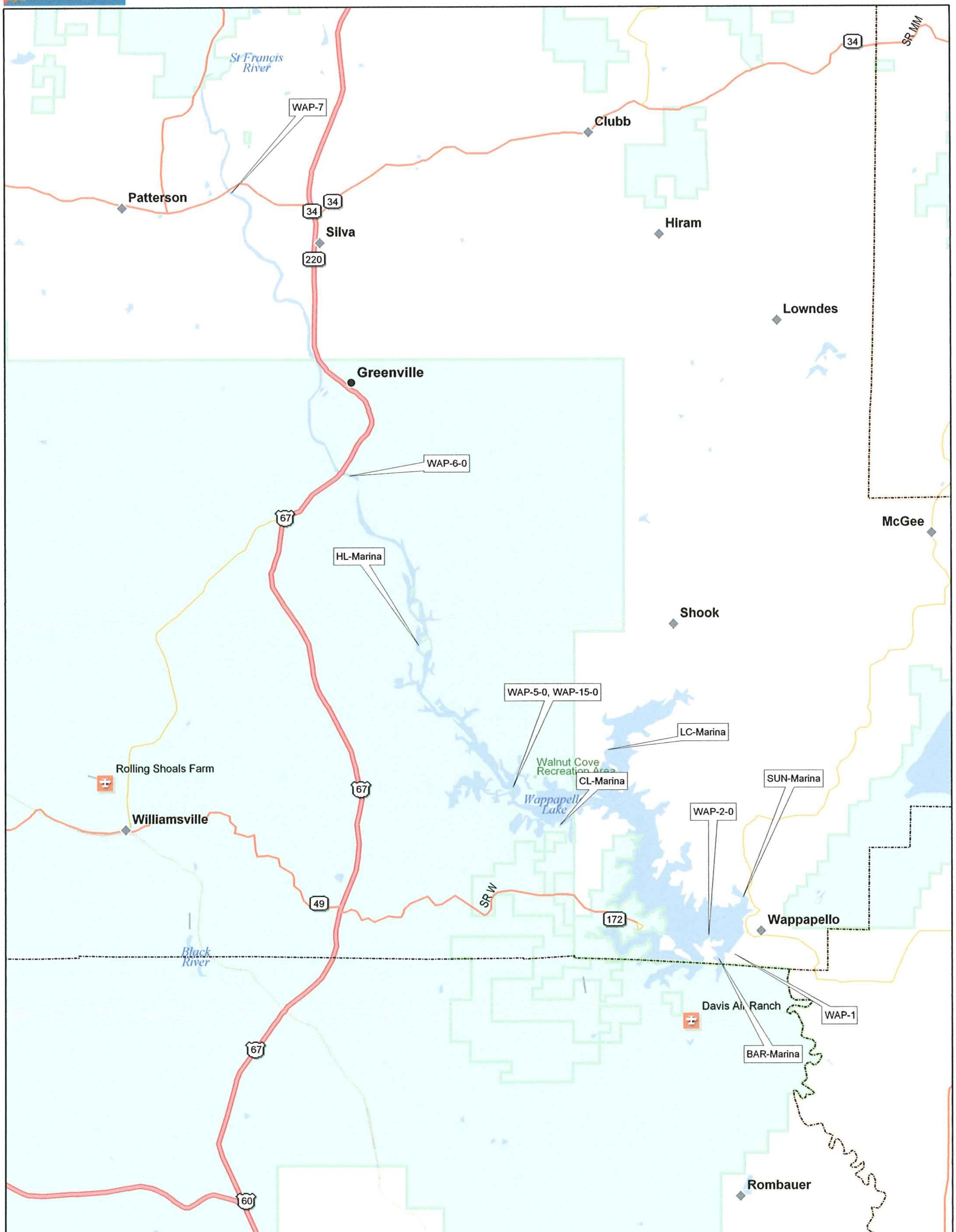
Evaluation of data was performed in two ways: 1) the combined values for each parameter observed at all sites; and 2) the values for each parameter observed at each site. A descriptive statistical summary of each parameter for all sites taken as a whole and for each site individually appears in Sections 3.3 and 3.4, below. As noted, the current levels are compared to State and/or Federal regulatory limits where such limits have been set. Trend analysis plots and descriptive statistics for all sites combined are provided in the various figures and tables in the referenced sections. The equation for the trendline appears in the upper right hand corner of all plots. All data utilized from the monitored sites for this evaluation is provided in electronic format on CD which is attached hereto as an Appendix.. The files on the disk can be accessed with Microsoft Excel.

3.2.1 Trend and Descriptive Statistics Analysis Summary

The descriptive statistics calculated and reviewed for the combined data sets are defined in Table 1.

FIGURE 1 - Wappapelo Lake Site Location Map

Street Atlas USA® 2006



TN MN (0.1°W)

Scale 1 : 200,000

1" = 3.16 mi Data Zoom 10-0

3.3 Data From All Sites

3.3.1 Dissolved Oxygen

Figure 2 shows the data from all sites for Dissolved Oxygen (DO). The descriptive statistics for those data appear in the table below the plotted values.

Dissolved oxygen levels depend on temperature and atmospheric pressure as well as on the chemical and biological activities occurring in an aqueous system.

Review of the figure will show that in general the observed values are in an approximate range of 5 to 10 mg/L. The mean, median and mode for the observed data were 8.0, 8.1 and 7.8 mg/L, respectively. Missouri has adopted a level of 5.0 mg dissolved oxygen/L as a standard for protection of aquatic life in both warm and cool water fisheries but has not applied that requirement to other waters.

Although approximately a dozen values below 5 mg/L were observed at various sites, the acquired data indicate that D.O. levels in the system are acceptable.

Note: A number of values were reported which were well above the maximum solubility of oxygen even in frigid waters. These high values were excluded from the statistics and were not plotted.

3.3.2 pH

The value for pH is a logarithmic expression of the concentration of hydrogen ions. It is governed by the combined effects of dissolved gases (principally carbon dioxide) and the levels of the various salts which are present. A "neutral" system is pH 6 to 8. The pH of an acidic system is less than 6 and that of a basic system is greater than 8.

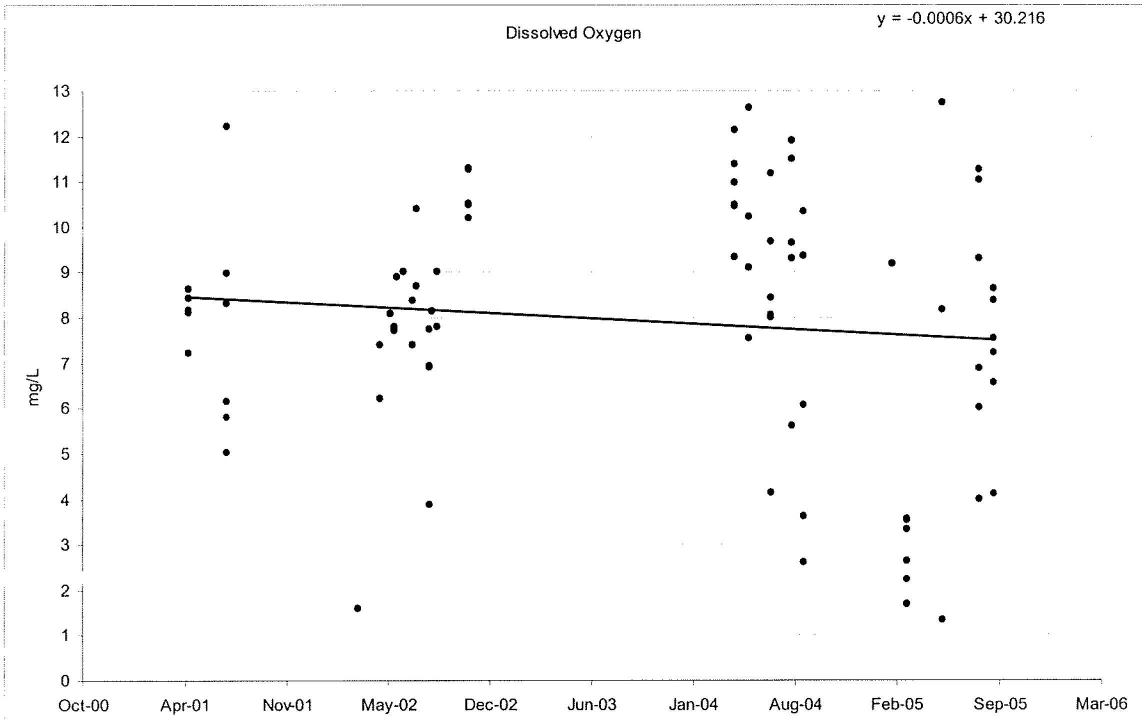
Figure 3 is a logarithmic plot of the 104 measurements of pH performed during the subject study. The descriptive statistics for those data appear in the table below the plotted values. The plot shows that individual measurements were closely similar in all sites at all times. The values, however, can be strongly influenced temporarily by local conditions associated with unusually hot or cold temperatures, flooding, increased runoff due to rainfall, erosion from land disturbances caused by agricultural activities or land development.

Missouri regulations specify a characteristic pH in the range 6.5 to 9 for waters of the state. Of the pH values acquired, three (pH 9.2, 9.3 and 6.4) were outside state regulations. The mean, median and mode of the data are at or near to neutrality and are well within state guidelines. The trendline for the parameter over the five year period reflected in the plot is virtually flat, indicating that the current general conditions will remain stable in the future.

Table 1 – Definitions for Descriptive Statistics

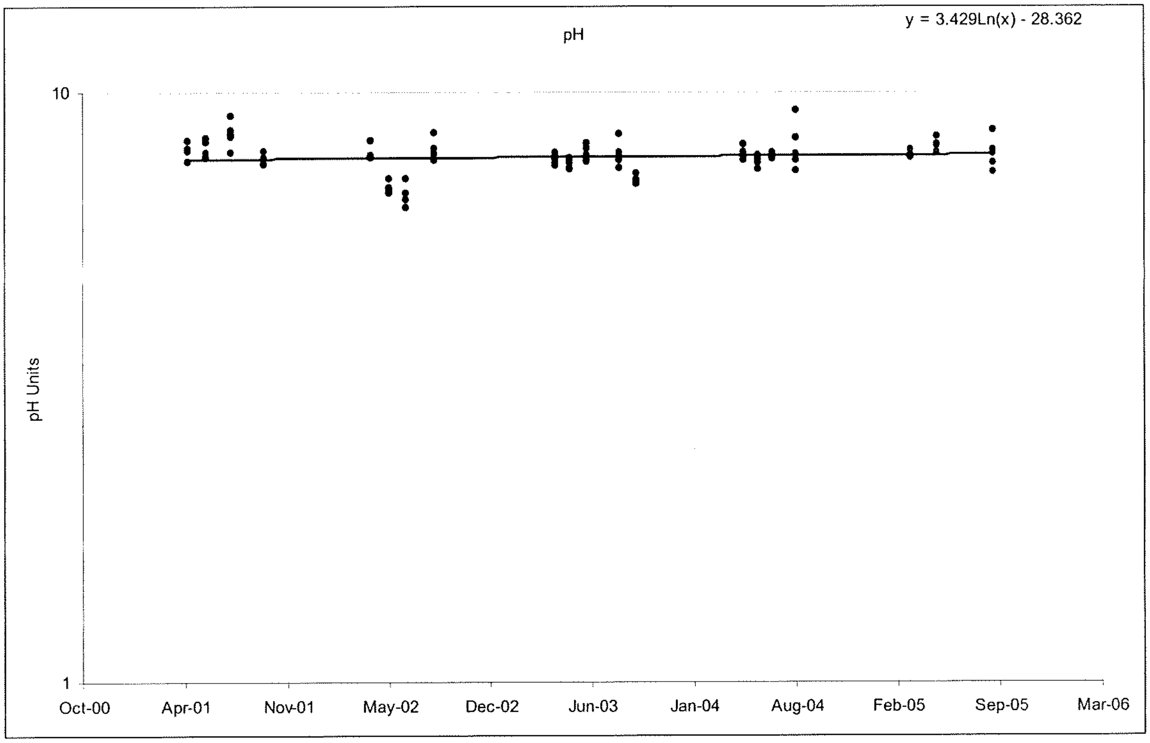
Statistic	Definition
Mean	Arithmetic average of all the data points.
Standard Error	Measure of the amount of error in the prediction of the Y(parameter of interest) data point for an individual X data point. The statistic is a function of standard deviation and the number of measurements made.
Median	Number in the middle of a set of numbers; that is, half the numbers have values that are greater than the median, and half have values that are less.
Mode	Most frequently occurring, or repetitive, value in an array or range of data.
Standard Deviation	Measure of how widely values are dispersed from the average value
Variance	Calculation of potential difference from the norm/mean.
Kurtosis	Characterizes the relative peakedness or flatness of a distribution compared with the normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution
Skewness	Characterizes the degree of asymmetry of a distribution around its mean. Positive skewness indicates a distribution with an asymmetric tail extending toward more positive values. Negative skewness indicates a distribution with an asymmetric tail extending toward more negative Values

Figure 2



Statistic	Value
Average	8.016
Standard Error	0.444
Median	8.080
Mode	7.840
Standard Deviation	2.739
Sample Variance	7.502
Kurtosis	1.20
Skewness	-0.57
Range	11.70
Minimum	1.300
Maximum	13.00
Sum	305
Count	38

Figure 3



Statistic	Value
Average	7.778
Standard Error	0.047
Median	7.800
Mode	7.900
Standard Deviation	0.479
Sample Variance	0.229
Kurtosis	1.38
Skewness	-0.12
Range	2.93
Minimum	6.360
Maximum	9.29
Sum	809
Count	104

3.3.3 ORP (Oxidation Reduction Potential)

Figure 4 shows the data from all sites for ORP. The descriptive statistics for those data appear in the table below the plotted values.

ORP is reported in millivolts. It is a logarithmic function dependent upon the net effects and the balance of the complex interactions of dissolved components, pH, temperature and other variables. A positive ORP indicates an excess of oxidizing components and a negative ORP indicates an excess of reducing agents. In general terms, a positive ORP is considered beneficial since the system is healthy and operating aerobically. A negative ORP, however, can indicate that a system is operating anaerobically, a condition which generally leads to generation of objectionable odors through putrefaction.

Values of ORP data are plotted in Figures 4. Review of the plot will show that during the period studied, the mean of the values observed for ORP decreased steadily from a high of approximately 300 mv to a low in the order of 200. The data indicate that this trend will continue.

Note: A negative value for ORP (-75 mv) was observed in a samples collected in May 2005 at Site WAP-1. These value is included in calculation of the statistics for this property but is not plotted The instance is an isolated one and does not appear to have any significance relative to the quality of lake water.

No specific regulations for ORP in general purpose waters have been generated by the states or federal government.

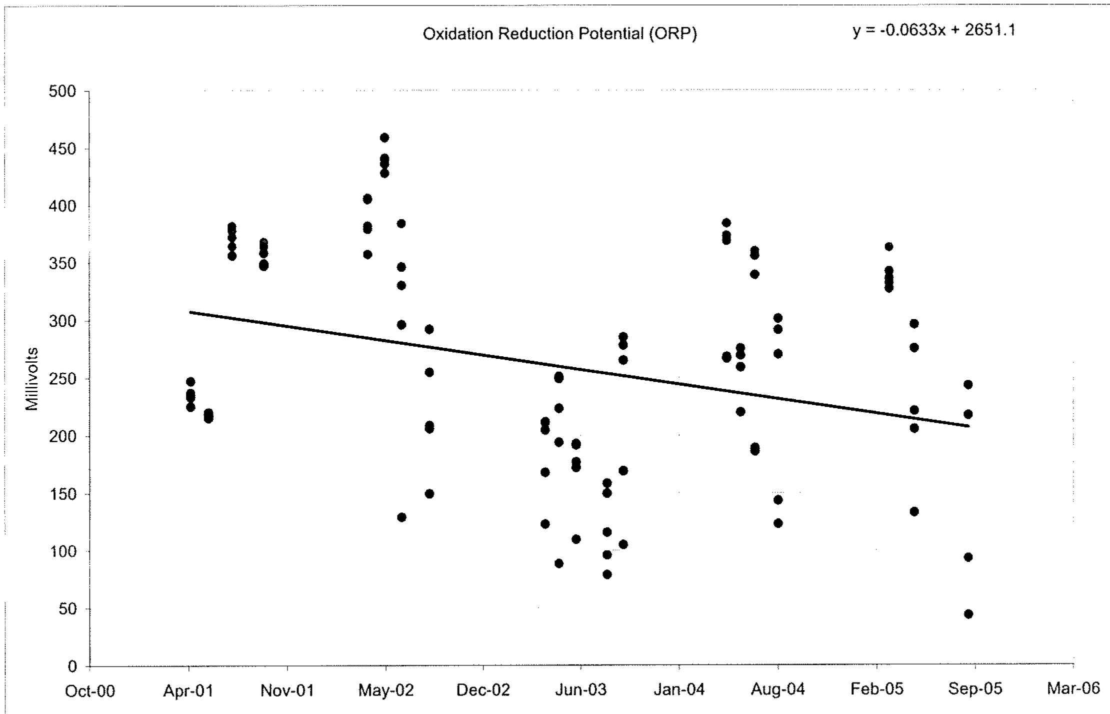
3.3.4 Conductivity

The data for conductivity appears in Figure 5.. The descriptive statistics for those data appear in the table below the plotted values.

Conductivity in an aqueous system is governed by the concentrations, mobility, oxidation state and other properties of dissolved ionized substances. Conductivity is also directly proportional to temperature and an approximate 2% rise in conductance of water occurs for every 1° C rise in temperature in the system. Many of the ionized substances present in natural waters (especially carbonates which also impact system pH) are leached from local and watershed soil and rocks and many more are introduced by runoff from agricultural and land development activities. Most of the nutrients from agricultural runoff are ionized.

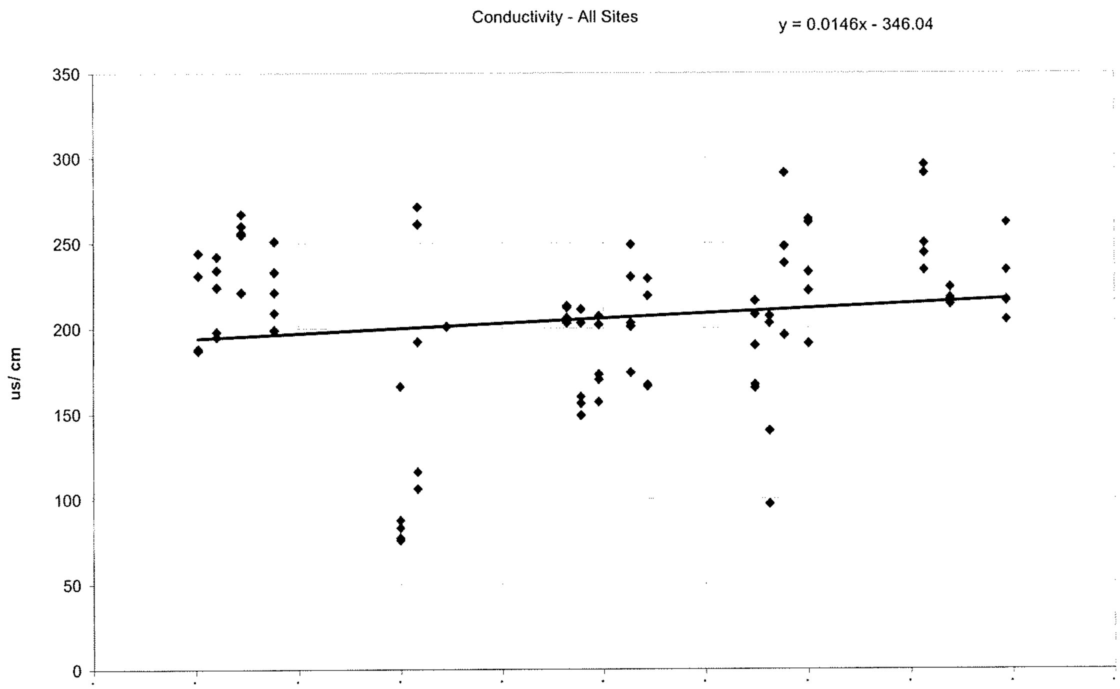
The maximum observed during the study was 296 uS/cm. The mean, mode and median of the values were in close agreement at approximately 200 uS/cm. There is a slight upward trend in those values but the data suggest that future values for this property will be of magnitudes similar to those found during the current study.

Figure 4



Statistic	Value
Average	257.898
Standard Error	9.964
Median	252.850
Mode	218.000
Standard Deviation	101.615
Sample Variance	10325.564
Kurtosis	-0.05
Skewness	-0.28
Range	534.30
Minimum	-75.300
Maximum	459.00
Sum	26821
Count	104

Figure 5



Statistic	Value
Average	206.215
Standard Error	4.730
Median	213.500
Mode	203.000
Standard Deviation	45.858
Sample Variance	2102.937
Kurtosis	1.20
Skewness	-0.92
Range	220.20
Minimum	75.800
Maximum	296.000
Sum	19384
Count	94

There is no Missouri standard for conductivity in waters of the state.

Note: Several values of less than 1 uS/cm were observed during the study. Conductivity of that order is typically observed in reagent waters which have been distilled , deionized or otherwise processed to removed ionic solutes. Since the reported values were in the range characteristic of natural waters they not included in the plot of the data and were not utilized in calculation of the statistics.

3.3.5 Total Suspended Solids

The data for total suspended solids appears in Figure 6.. The descriptive statistics for those data appear in the table below the plotted values.

Suspended solids affect the clarity and appearance of water. In general, these solids are soil and/or plant particulates introduced to the system by local or watershed erosion or biomaterials produced by aquatic flora and fauna. Individual measurements taken at separate sites in the system are quite often highly variable because of these localized effects. Five values in the range 400 to 1000 were observed during the during the study and were not plotted to avoid scaling problems in the chart. Except for those high values, the data acquired are in reasonable agreement. The data indicate that this property is stable and that it will remain in the range shown in the plot for the foreseeable future.

No quality standard has been set by Missouri for suspended solids in waters of the state.

3.3.6 Volatile Suspended Solids

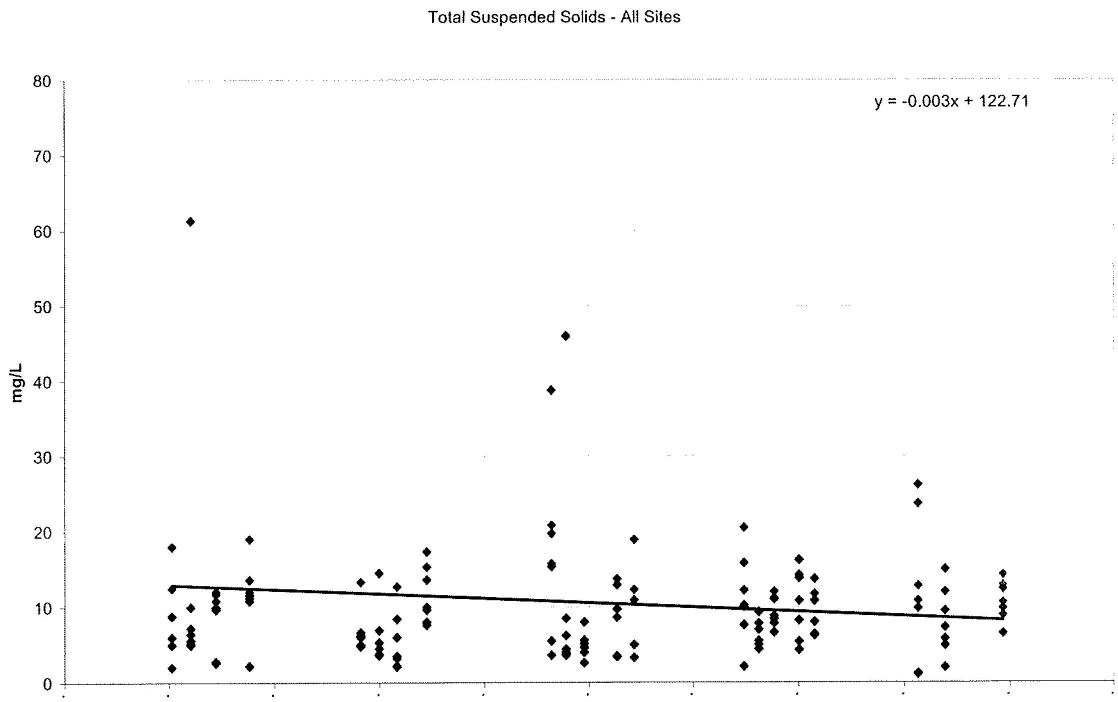
The data for volatile suspended solids appears in Figure 7.. The descriptive statistics for those data appear in the table below the plotted values.
Volatile suspended solids are usually organic and impact on the oxygen levels as they degrade. In general, those materials were found in low concentration at levels that were approximately one quarter of total solids. The trendline is flat, indicating that the current values are stable and that future determinations will be similar in distribution and magnitude.

There is no standard set by Illinois for volatile suspended solids in general purpose waters

3.3.7 Total Phosphorus

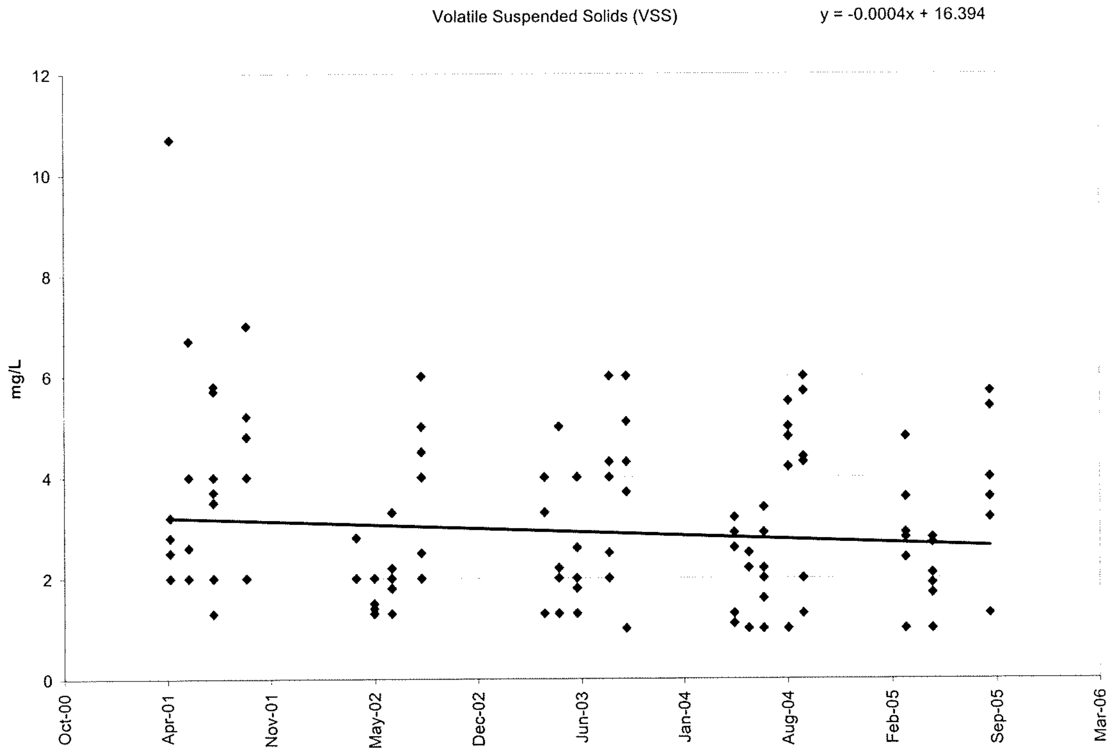
The data for total phosphorus appears in Figure 8. The descriptive statistics for those data appear in the table below the plotted values.

Figure 6



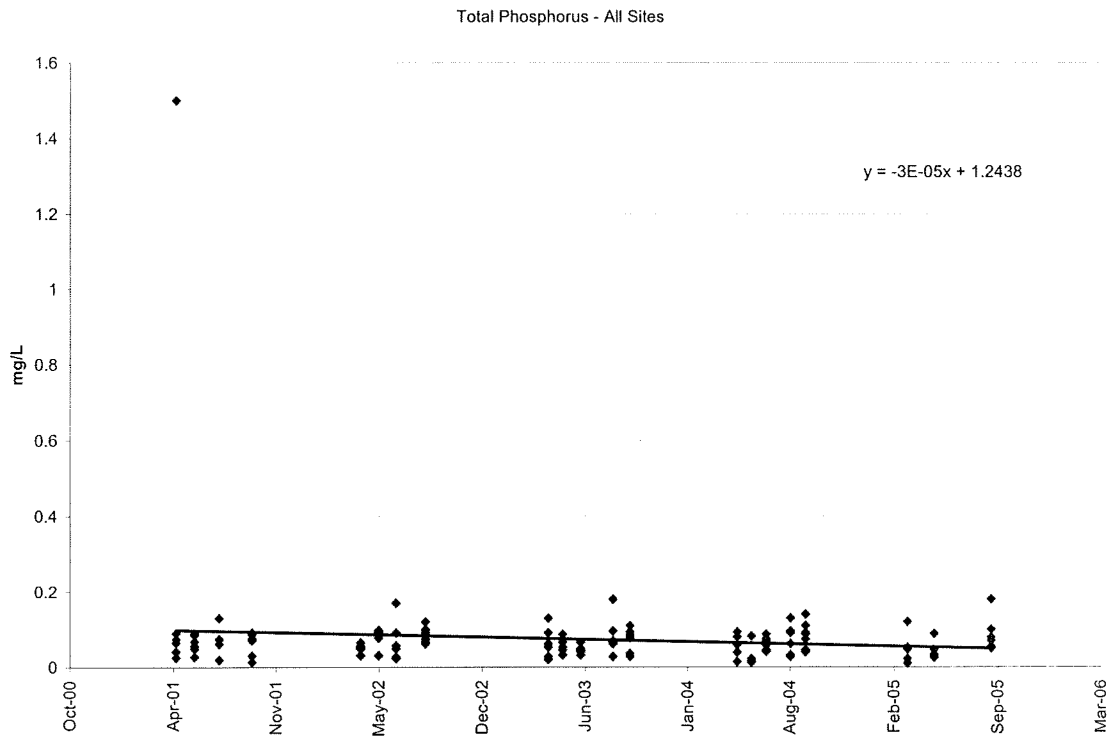
Statistic	Value
Average	10.538
Standard Error	1.079
Median	8.450
Mode	12.000
Standard Deviation	13.388
Sample Variance	179.239
Kurtosis	74.42
Skewness	7.70
Range	146.90
Minimum	1.100
Maximum	148.00
Sum	1623
Count	154

Figure 7



Statistic	Value
Average	2.910
Standard Error	0.128
Median	2.500
Mode	2.000
Standard Deviation	1.587
Sample Variance	2.520
Kurtosis	2.82
Skewness	1.29
Range	9.70
Minimum	1.000
Maximum	10.70
Sum	448
Count	154

Figure 8



Statistic	Value
Average	0.073
Standard Error	0.010
Median	0.062
Mode	0.091
Standard Deviation	0.120
Sample Variance	0.014
Kurtosis	131.24
Skewness	11.03
Range	1.49
Minimum	0.010
Maximum	1.50
Sum	11
Count	154

Phosphorus is an active nutrient. Elevated levels of the element in virtually any form (and other nutrients as well) adds to the risk of algal blooms and other problems associated with eutrophication-related water quality problems. The principal source of these materials is runoff from agricultural activities. The trendline is flat indicating that the characteristic is stable and that future data will parallel the values shown in the figure.

The average and median value for these data are approximately 0.07 and 0.06 mg/L. A limit of 0.05 mg phosphorus/L is set by Missouri water quality standards.

3.3.8 Soluble Phosphorus (ortho Phosphate)

The data for ortho-phosphate appears in Figure 9. The descriptive statistics for those data appear in the table below the plotted values.

The data plotted in Figure 9 show the soluble fraction of the total phosphorus values in Figure 8. The remarks relative to the action, environmental threat potential and origin of total phosphorus entities apply to soluble forms as well. The data indicate that the profile of the nutrient in lake waters is stable.

There is no water quality standard for this characteristic published by Missouri.

3.3.9 Nitrate

The data for nitrate appears in Figure 10. The descriptive statistics for those data appear in the table below the plotted values.

Nitrate, like phosphorus, is an active nutrient and can have a detrimental environmental effect when it degrades to nitrite, a nutrient for algae. Nitrates may be introduced into water systems by the decay of nitrogenous organic matter or runoff from both agricultural or industrial sites.

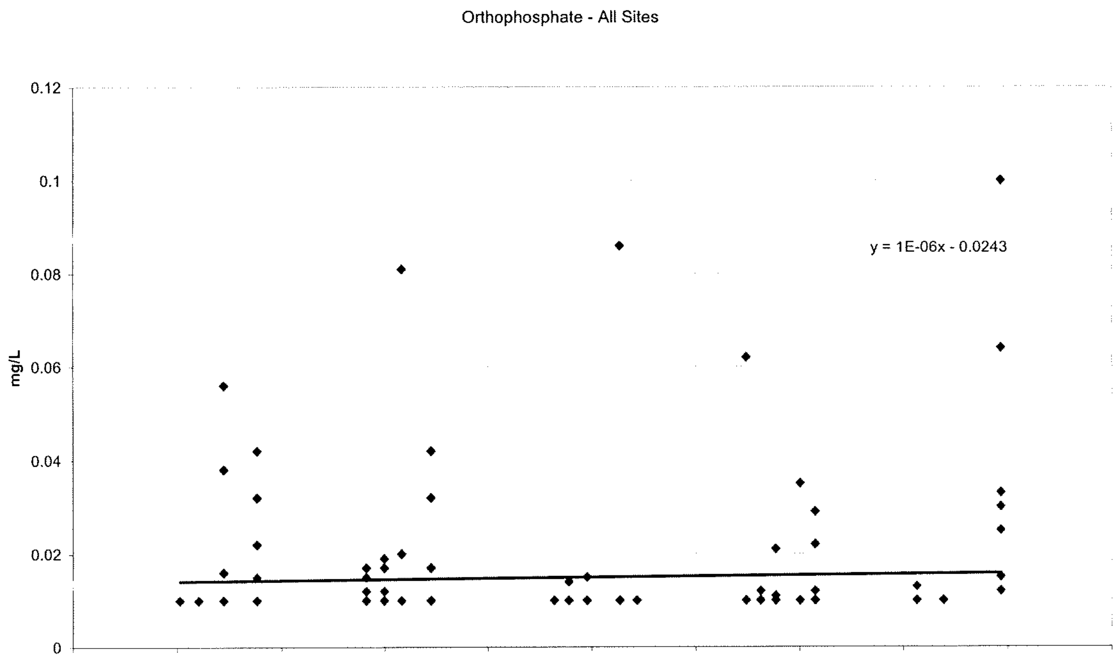
The Missouri water quality standard for nitrate is 10 mg/L. The limit applies to drinking water, ground water and sources which may be used for watering livestock or wildlife. The data show that the concentrations of this nutrient in Wappapelo Lake are significantly lower than this standard.

3.3.10 Ammonia

The data for ammonia appears in Figure 11. The descriptive statistics for those data appear in the table below the plotted values.

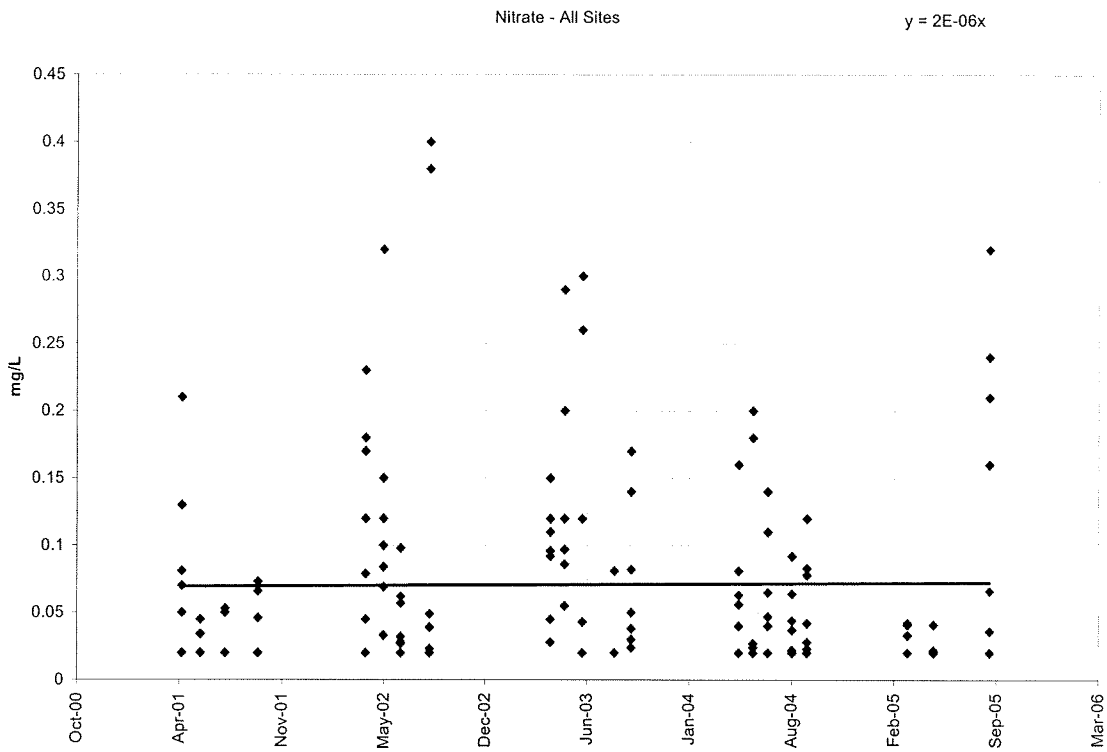
Like phosphorus and nitrate, ammonia is an active nutrient. It may be present in runoff from agricultural or industrial sites, may form in aqueous systems from the decay of nitrogenous wastes or may indicate the presence of improperly treated discharges from waste treatment plants.

Figure 9



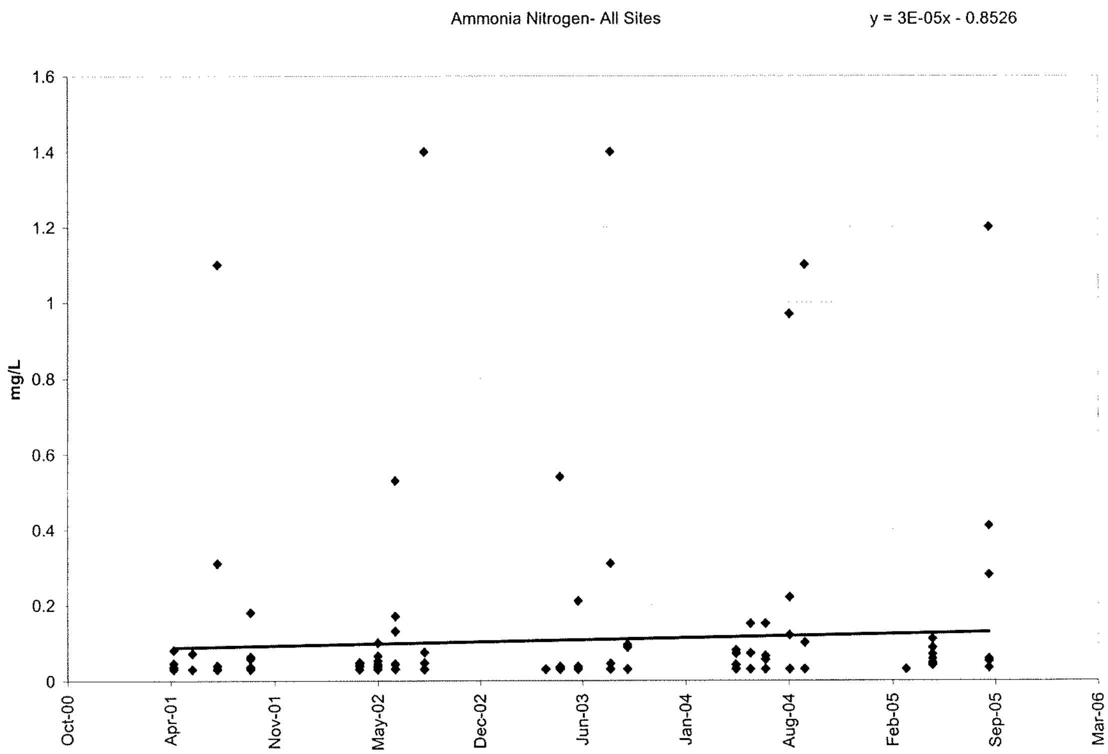
Statistic	Value
Average	0.015
Standard Error	0.001
Median	0.010
Mode	0.010
Standard Deviation	0.014
Sample Variance	0.000
Kurtosis	16.99
Skewness	3.94
Range	0.09
Minimum	0.010
Maximum	0.100
Sum	2
Count	154

Figure 10



Statistic	Value
Average	0.071
Standard Error	0.006
Median	0.040
Mode	0.020
Standard Deviation	0.076
Sample Variance	0.006
Kurtosis	4.72
Skewness	2.14
Range	0.38
Minimum	0.020
Maximum	0.400
Sum	11
Count	153

Figure 11



Statistic	Value
Average	0.108
Standard Error	0.019
Median	0.034
Mode	0.030
Standard Deviation	0.235
Sample Variance	0.055
Kurtosis	18.16
Skewness	4.26
Range	1.37
Minimum	0.030
Maximum	1.400
Sum	17
Count	154

The levels of ammonia observed in lake samples are acceptable. Missouri water quality standards for ammonia are set based on pH and temperature. The concentrations found in Lake Wappapelo during the subject study are well within those standards.

3.3.11 Manganese

Manganese was evaluated in samples collected from two sites. The data are plotted in Figure 12. Statistics calculated from the data appear in the table below the chart.

Manganese was observed in virtually all samples. The median of the observed data was slightly more than 1 mg/L, however, the low levels of the median and mode (0.29 and 0.11 mg/L, respectively) show that most of the values were substantially less than that.

The water quality standards of Missouri specify a limit of 0.05 mg/L in ground water. The secondary maximum contaminant level (SMCL) for manganese in drinking water set by the federal Clean Water Act is 0.05 mg/L. SMCL values are set on aesthetic grounds and imply no health hazard.

3.3.12 Iron

Iron was evaluated in samples collected from two sites. The data are plotted in Figure 13 and statistics calculated from them appear in the table below the chart.

Iron was detected in all samples but one and all values observed were 2.0 mg/L or less. The data indicate the iron concentrations in lake waters are stable.

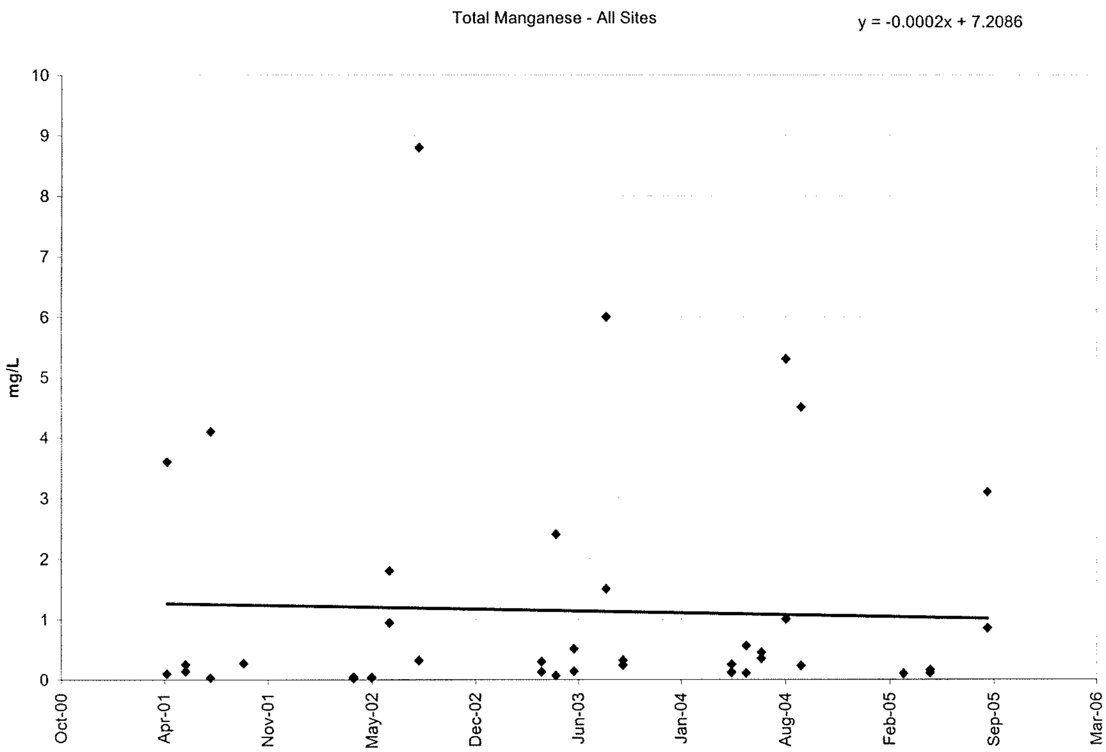
There is no regulatory limit for general use waters in Illinois for iron. The secondary maximum contaminant level (SMCL) for iron in drinking water is 0.3 mg/L. SMCL values are set on aesthetic grounds and imply no health hazard.

3.3.13 Chlorophyll

The data for chlorophyll at all sites appears in Figure 14. The descriptive statistics for those data appear in the table below the plotted values.

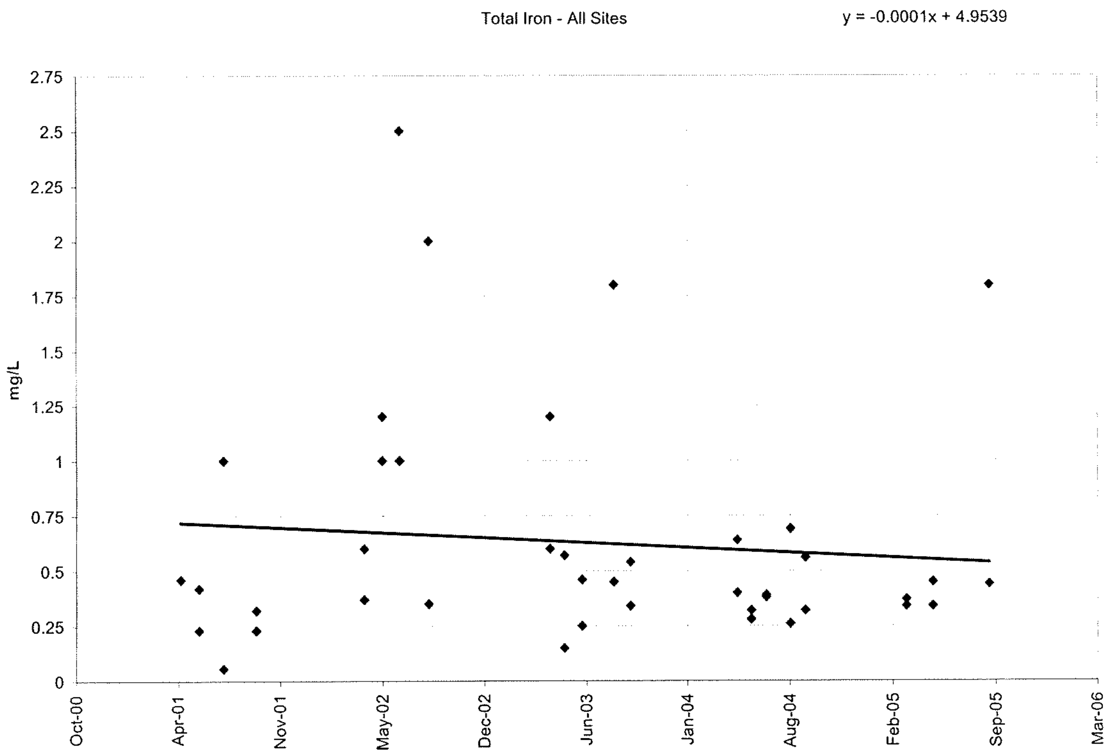
Chlorophyll is the photosynthetic pigment present in all plant except the fungi and bacteria. There are three forms of the pigment, chlorophyll A, B and C. The concentration of chlorophyll is an indicator of the rate of formation of organic carbon in the plant bodies from atmospheric carbon dioxide.

Figure 12



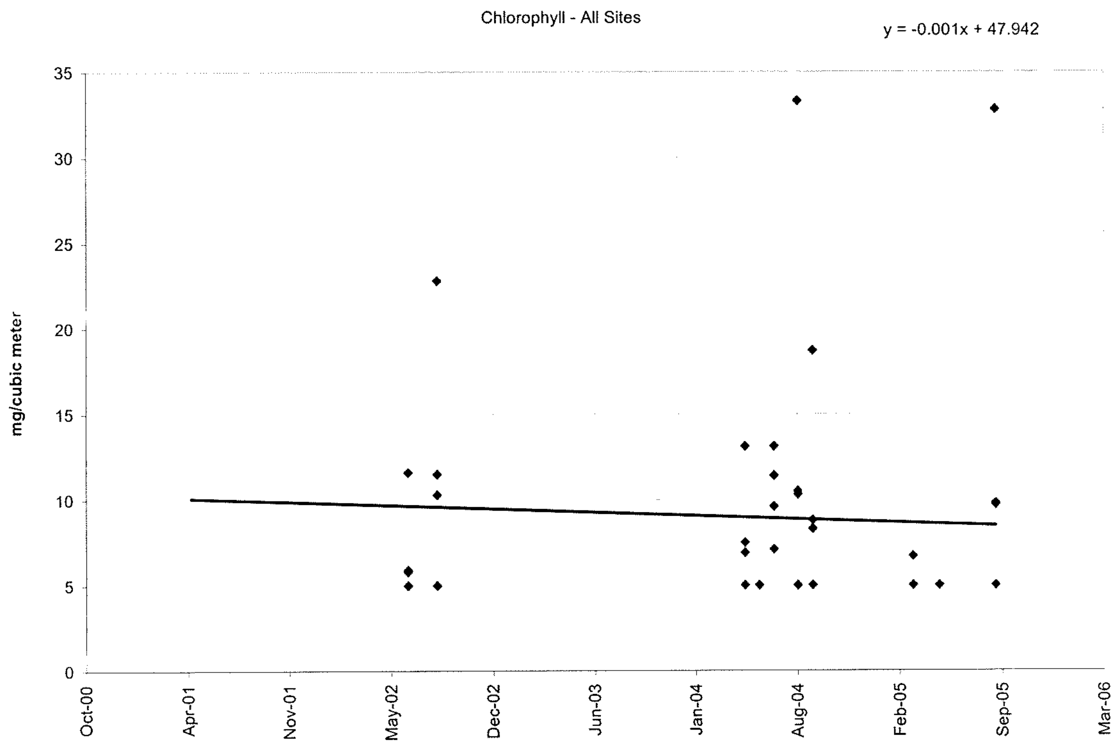
Statistic	Value
Average	1.135
Standard Error	0.291
Median	0.260
Mode	0.110
Standard Deviation	1.930
Sample Variance	3.724
Kurtosis	5.65
Skewness	2.37
Range	8.78
Minimum	0.021
Maximum	8.800
Sum	50
Count	44

Figure 13



Statistic	Value
Average	0.625
Standard Error	0.081
Median	0.440
Mode	0.340
Standard Deviation	0.528
Sample Variance	0.279
Kurtosis	3.96
Skewness	2.05
Range	2.44
Minimum	0.057
Maximum	2.500
Sum	27
Count	43

Figure 14



Statistic	Value
Average	8.914
Standard Error	0.992
Median	6.300
Mode	5.000
Standard Deviation	6.580
Sample Variance	43.299
Kurtosis	7.21
Skewness	2.62
Range	28.30
Minimum	5.000
Maximum	33.300
Sum	392
Count	44

Chlorophyll was evaluated in samples during three years of the study (2002, 2004 and 2005). The mean and median values for this property were within a few points and there was a decreasing trendline in the data. Evaluation of data indicates that primary productivity of life forms utilizing chlorophyll is stable in lake waters.

There is no regulatory limit for chlorophyll.

3.3.14 Pheophytin

The data for pheophytin at all sites appears in Figure 15. The descriptive statistics for those data appear in the table below the plotted values.

Pheophytin is a photosynthetic pigment and degradation product of chlorophyll. It is a general indicator of the health of the chlorophyll available in the system. There is no regulatory limit for the compound.

Pheophytin was evaluated in samples collected during all years of the study. It was above the method detection limit in only a few instances. By convention, non-detects are plotted as the reporting limit for the method, 5.0 mg/cubic meter. The data suggest that the life cycles in lake wasters utilizing photosynthesis are stable and healthy.

There is no regulatory limit for pheophytin.

3.3.15 Total Organic Carbon

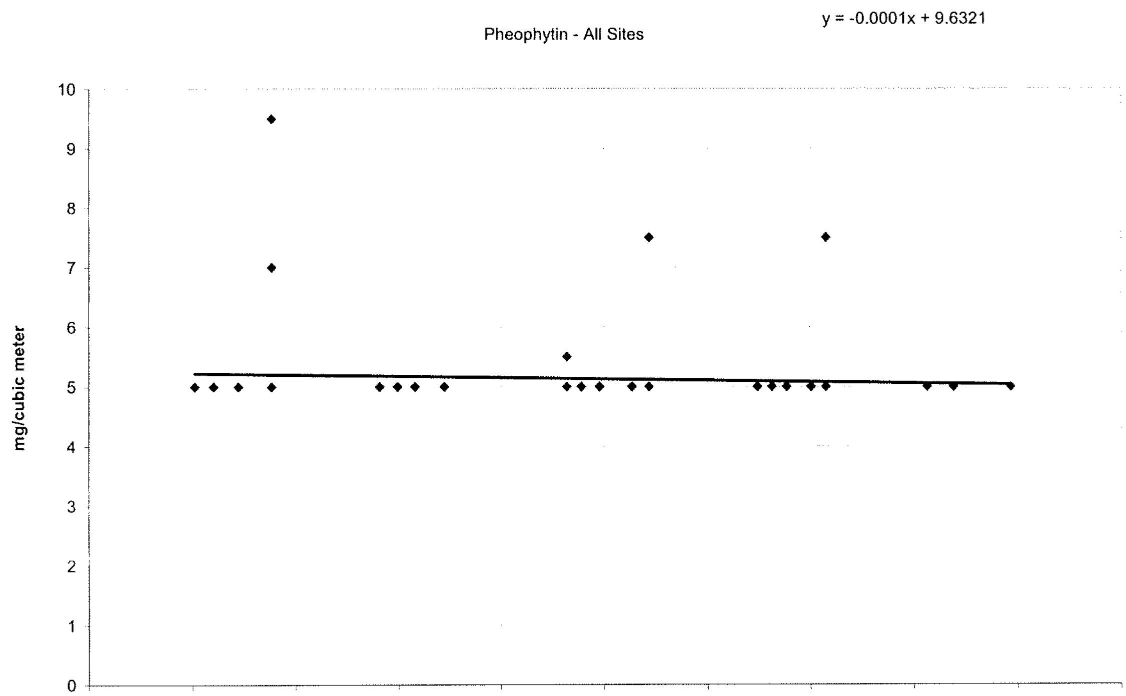
The data for total organic carbon at all sites appears in Figure 16. The descriptive statistics for those data appear in the table below the plotted values.

Total organic carbon measurements are important in water quality monitoring. The measurement provides an index for estimating the levels of toxins, teratogens and other organic materials which may increase the demand for available oxygen in the system.

Organic carbon was detected in only a few samples. As with pheophytin, non-detects are recoded and plotted as the reporting limit for the method. The data acquired strongly suggest that all aspects of dealing with organic material in the waters of Wappapelo Lake are stable and operating well.

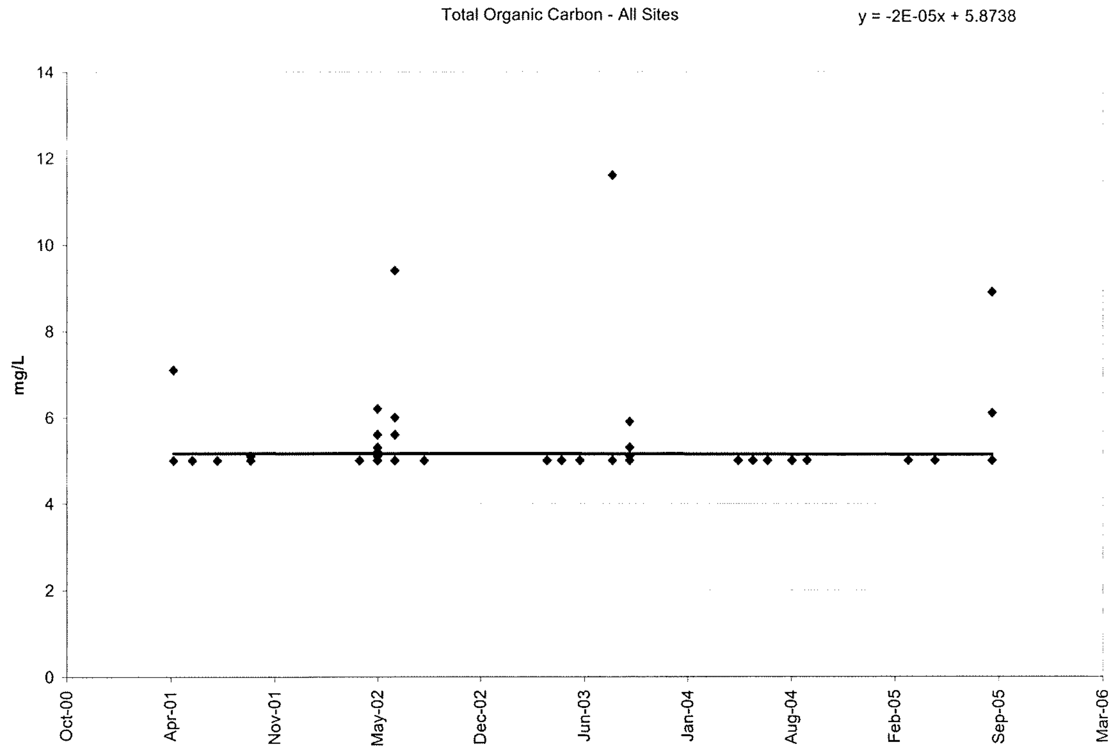
There is no regulatory limit set for this property

Figure 15



Statistic	Value
Average	5.130
Standard Error	0.065
Median	5.000
Mode	5.000
Standard Deviation	0.624
Sample Variance	0.389
Kurtosis	30.95
Skewness	5.38
Range	4.50
Minimum	5.000
Maximum	9.500
Sum	472
Count	92

Figure 16



Statistic	Value
Average	5.153
Standard Error	0.060
Median	5.000
Mode	5.000
Standard Deviation	0.743
Sample Variance	0.551
Kurtosis	47.62
Skewness	6.59
Range	6.60
Minimum	5.000
Maximum	11.600
Sum	794
Count	154

3.4 Individual Sites

3.4.1 Overview

Surface waters from three sites on the lake proper and subsurface water from one of those sites were evaluated during performance of the subject study. The locations of these sites are shown in Figure 1, above. As shown in the figure, WAP-1 is located on the lake overflow in the south. WAP-2-0 and -2-10 are located at a central point in the southern reach of the lake. WAP-5-0 and WAP-15-0 are located in the northern reach the lake. WAP-6-0 and WAP-7 are in the north in the watershed of the lake.

In the text below the data are compared between sites and to the values found at all sites. Plots of the levels found for properties evaluated at each site appear in Appendix 1. Two statistics (average and median) calculated from those data appear in Table 2.

As review of that table and the plots of the data acquired during the study shows water quality values in samples taken from the body of the lake were generally nominal. The exceptions to that trend are noted in the paragraphs below. Those exceptions are often associated with the values found in samples taken from WAP-6-0 and WAP-7.

3.4.2 Chemical/Physical Properties

3.4.2.1 Dissolved Oxygen

Except for observations made at all sites in July, 2001 and another made at WAP-1 in May, 2003, all reported values are either at, above or just slightly less than 5.0 mg/L. The average and median of readings at Site-2-0 were higher than any other sampling points but, in general, the results observed were in good agreement. The average reading at all sites increased at approximately the same rate as the study progressed.

3.4.2.2 pH

Except for those found in samples from all sites collected in May and June, 2002 (pH 6.4 to 6.9), all observed values were in the range of pH 7.0 to 9.3. In all cases, trend lines were flat.

3.4.2.3 Oxidation-Reduction Potential (ORP)

When data from all sites were considered as a single group (see Figure 4) there was a time related reduction in ORP as the study progressed. Evaluation of those results a each individual site shows that the downward trend was accentuated in on-lake sites (WAP-1, -2 and -5) but was minimal in the watershed sites (WAP-6 and -7).

Table 2 - Individual Site Statistics

		WAP-1	WAP-15-0	WAP-2-0	WAP-2-10	WAP-5-0	WAP-6-0	WAP-7
Dissolved Oxygen	mean	7.86	---	10.9	---	6.90	8.65	8.29
	median	7.88	---	10.9	---	7.44	8.62	7.49
pH	mean	7.82	---	8.08	---	7.80	7.60	7.59
	median	7.90	---	8.15	---	7.85	7.68	7.65
ORP	mean	208	---	223	---	271	293	291
	median	205	---	194	---	265	275	296
Conductivity	mean	195	---	187	---	197	227	226
	median	204	---	191	---	212	226.5	218
TSS	mean	11.2	9.5	8.2	23.6	9.6	6.3	5.4
	median	12.0	9.6	8.0	14.4	9.7	5.8	4.6
VSS	mean	3.4	3.0	3.6	4.3	2.9	1.8	1.4
	median	3.0	2.8	3.3	4.0	2.7	1.45	1.3
Total Phosphorus	mean	0.075	0.066	0.059	0.166	0.068	0.049	0.031
	median	0.088	0.067	0.061	0.093	0.068	0.041	0.028
Soluble Phosphorus	mean	0.014	0.012	0.013	0.026	0.011	0.014	0.014
	median	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Nitrate	mean	0.054	0.086	0.059	0.062	0.065	0.090	0.081
	median	0.033	0.047	0.037	0.039	0.042	0.042	0.050
Ammonia	mean	0.093	0.036	0.060	0.432	0.036	0.060	0.038
	median	0.069	0.030	0.030	0.130	0.030	0.037	0.03
Manganese	mean	0.315	---	---	1.95	---	---	---
	median	0.135	---	---	0.48	---	---	---
Iron	mean	0.41	---	---	0.85	---	---	---
	median	0.34	---	---	0.56	---	---	---
Alachlor	---	---	---	---	---	---	---	---
	---	---	---	---	---	---	---	---
Atrazine	---	---	---	---	---	---	---	---
	---	---	---	---	---	---	---	---
Chlorophyll	mean	---	7.7	13.7	---	8.5	5.8	---
	median	---	7.5	6.9	---	8.8	5.0	---
Pheophytin	mean	5.7	5.0	5.5	---	5.0	5.0	5.0
	median	5	5.0	5.0	---	5.0	5.0	5.0
TOC	mean	5.21	5.11	5.4	5.35	5.03	5.01	5.00
	median	5.00	5.00	5.0	5.00	5.00	5.00	5.00

3.4.2.4 Conductivity

Trend lines rose slightly for all sites. Readings in the upstream off-lake sites (WAP-6 and WAP-7) were generally higher than the values observed in sites on-lake or in the lake outfall. Those higher readings upstream of the lake body may be related to increased agricultural or land development activities in the areas drained.

3.4.3 Total and Volatile Suspended Solids

As shown in the table below, except for the increased levels of TSS found subsurface at Site -2, there is general agreement in the values for both volatile and total suspended solids observed in on-lake sites. In samples taken from both watershed sites the values for both kinds of solids are substantially lower. The data suggest that those increases are due to the activity levels of agricultural and/or land development in the areas surrounding the lake itself.

		WAP-1	WAP-15	WAP-2-0	WAP-2-10	WAP-5	WAP-6	WAP-7
TSS	mean	11.2	9.5	8.2	23.6	9.6	6.3	5.4
	median	12.0	9.6	8.0	14.4	9.7	5.8	4.6
VSS	mean	3.4	3.0	3.6	4.3	2.9	1.8	1.4
	median	3.0	2.8	3.3	4.0	2.7	1.45	1.3

3.4.4 Nutrients

As shown in tables below, date related patterns of variation in the observed levels of some nutrients were noted in the data acquired during the study. These variations may be related to agricultural activity in the area.

3.4.4.1 Phosphorus

In general, the levels of total phosphate are higher in on-lake sites than in waters taken from watershed sites.

As shown in the table below, the levels of total phosphorus vary with the month in which collection occurred. These variations are most likely due to agricultural practices in the area.

April	May	Jun	July	August	September
0.071	0.106	0.084	0.073	0.049	0.029

3.4.4.2 Nitrate

There is general agreement in the nitrate levels found at all sites. There is, however, a month related cycle was also observed in the concentrations of nitrate found. The values are shown in the table below. The changes are probably associated with seasonal agricultural practices

April	May	Jun	July	August	September
0.059	0.046	0.034	0.027	0.122	0.123

3.4.4.3 Ammonia

Levels of ammonia higher than 1 mg/L were found in several samples collected at WAP-2-10. These high concentrations at this site and at others were usually observed in June, July or August. Preliminary evaluation suggested that there was a time-related variation in ammonia concentration similar to that observed for phosphate and nitrate. Further study showed, however, that the apparent variation was an artifact created by the extraordinarily high levels of the compound found at Site 2-10.

3.4.4.4 Iron and Manganese

Levels of these two metals were evaluated at two sites, WAP-1 and WAP-2-10. The highest levels of both metals were found in WAP-2-10. The concentrations appeared to be stable.

3.4.5 Organics

3.4.5.1 Chlorophyll/Pheophytin

Chlorophyll and Pheophytin concentrations were evaluated irregularly during the study and the absence of data sometimes hampered trendline evaluations. In those cases trendline values have been omitted from the plots of individual site data.

Chlorophyll concentrations were low in February and March, rose to a peak in May and thereafter declined steadily. Pheophytin was less than detection limits in a substantial proportion of the samples. By convention, non-detects are recorded on the charts at the reporting limit of 5 mg/cubic meter.

3.4.5.2 Total Organic Carbon (TOC)

Excepting occasional high levels of TOC observed in all samples, most contained less than the minimum detectible level. That situation is reflected in the plots of these data by the heavy concentration of points at the 5 mg/L level. These was no significant difference in this property observed in any particular month or year of the study

4.0 CONCLUSIONS AND RECOMMENDATIONS

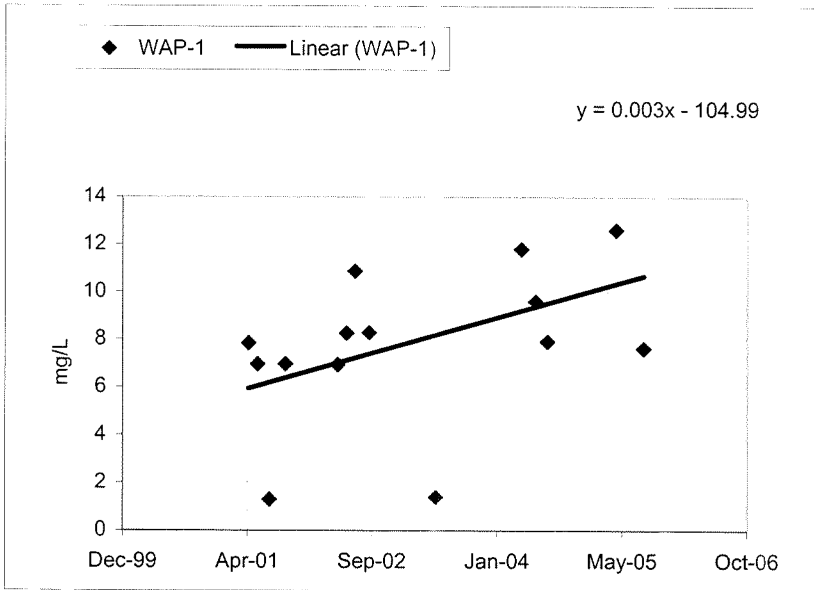
The result of the evaluations in this document are compared in the table below to those described in the referenced previous report

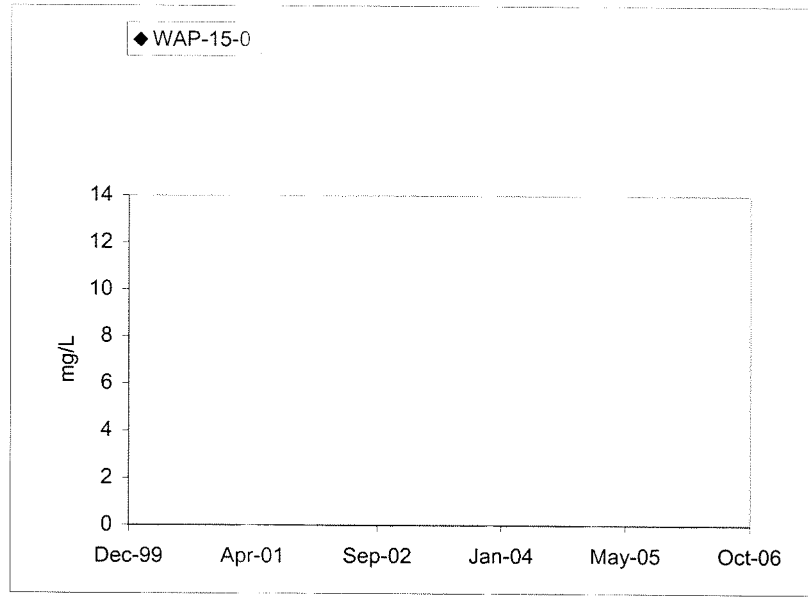
PARAMETER	TREND
Dissolved Oxygen	Stable
pH	Stable
Oxidation Reduction Potential	Improving
Conductivity	Stable
Total Suspended Solids	Stable
Volatile Suspended Solids	Stable
Total Phosphorus	High, cyclic
Soluble Phosphorous (ortho-Phosphate)	Stable
Nitrate	Cyclic
Ammonia	Stable
Manganese	Stable
Iron	Stable
Chlorophyll	Stable
Pheophytin	Stable
Total Organic Carbon (TOC)	Stable

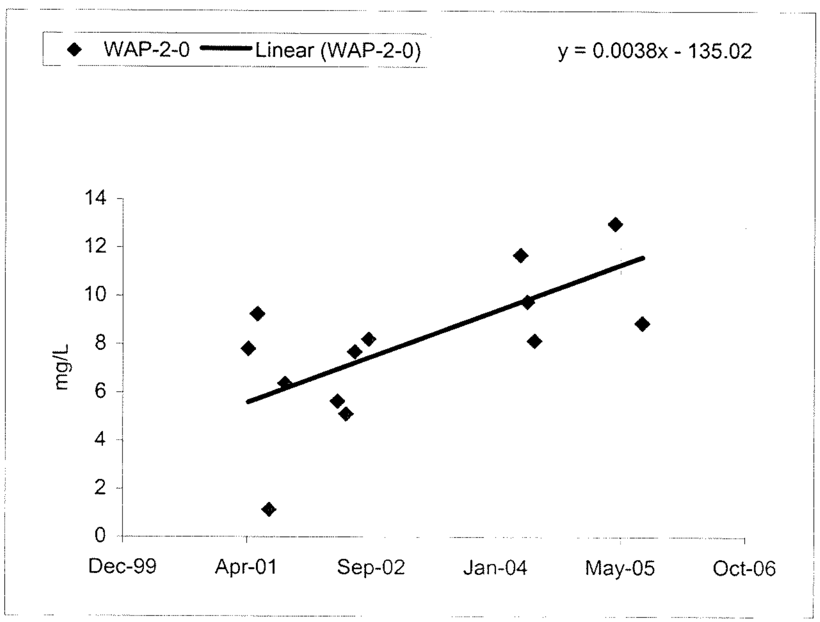
The trends noted suggest that the condition of Wappapelo Lake has improved and is stable.

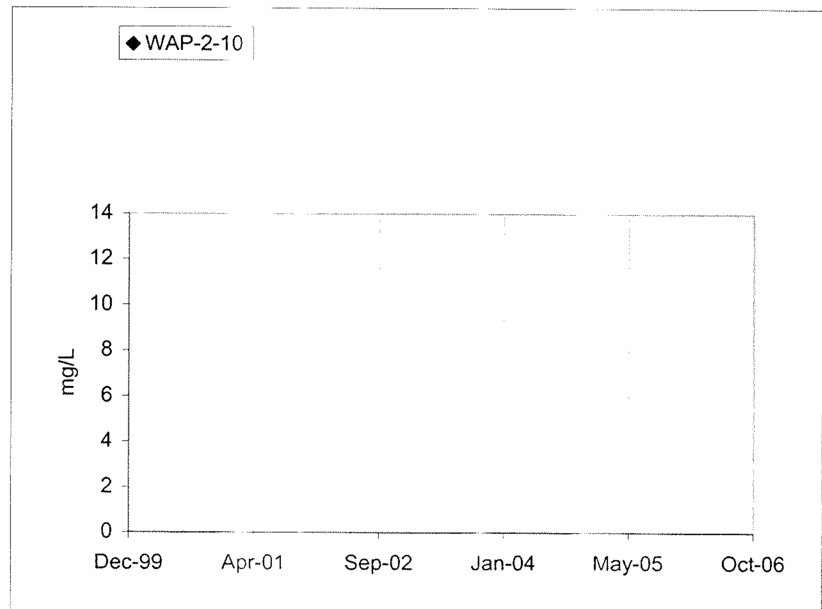
Appendix 1 – Plots of Data Collected from Individual Sample Sites

Dissolved Oxygen

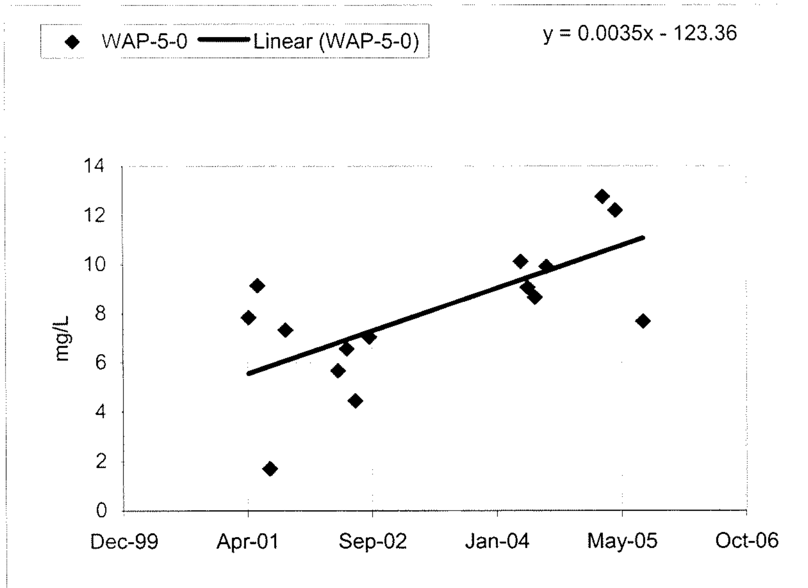


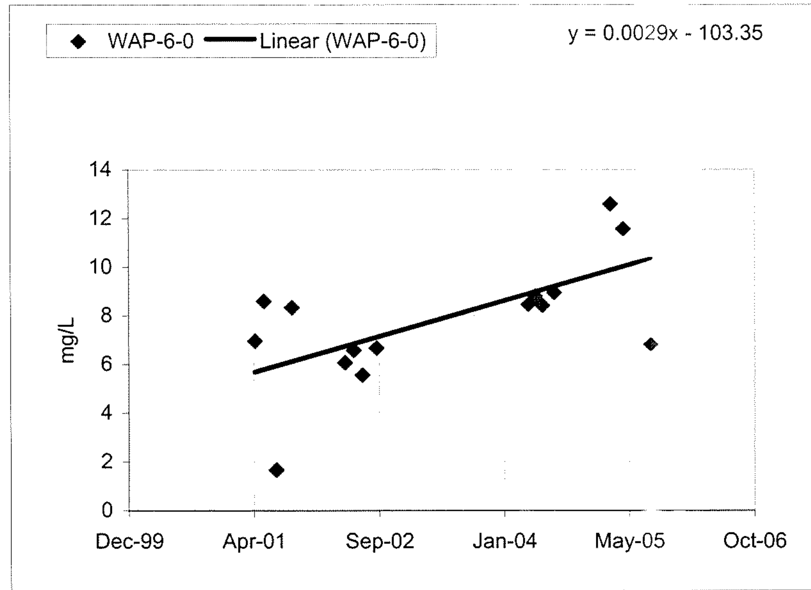


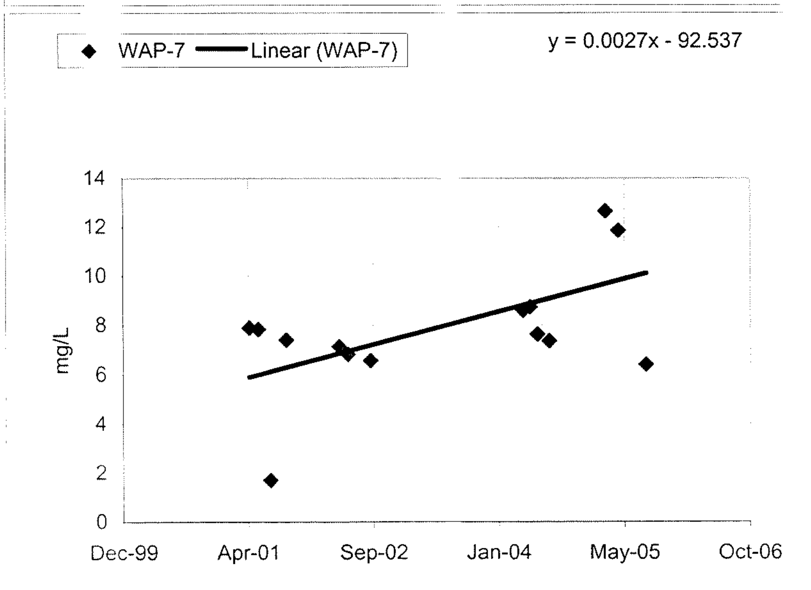




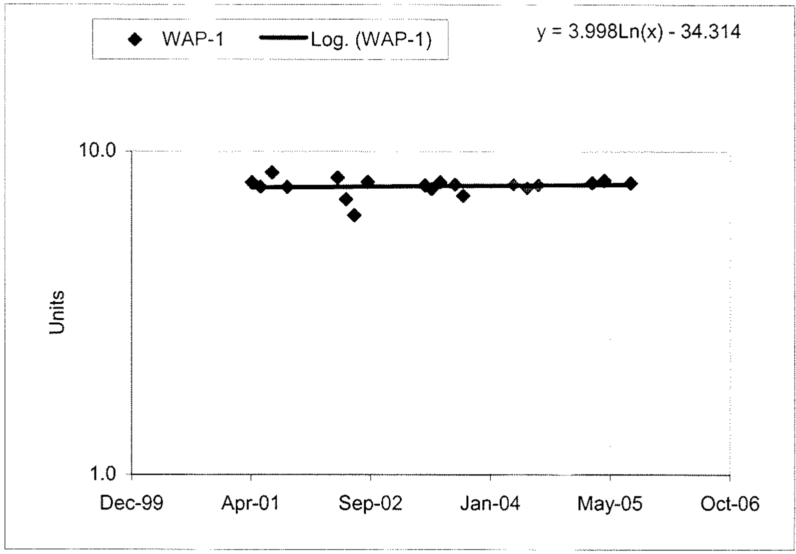
Dissolved Oxygen

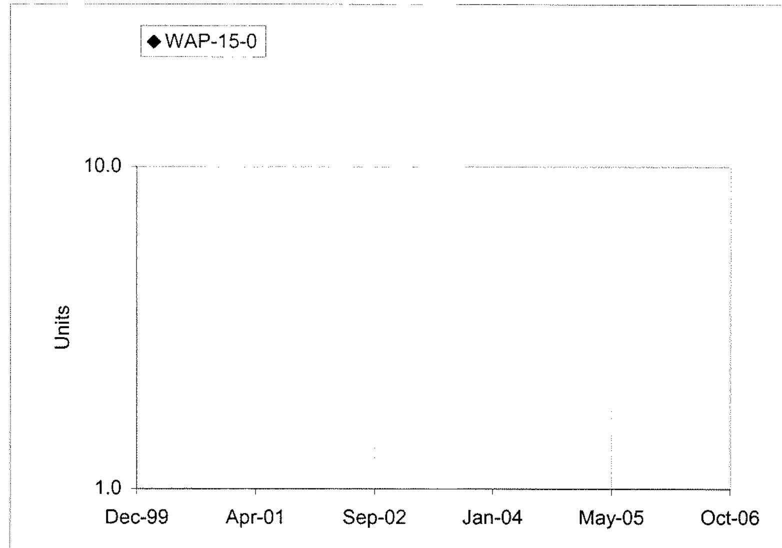


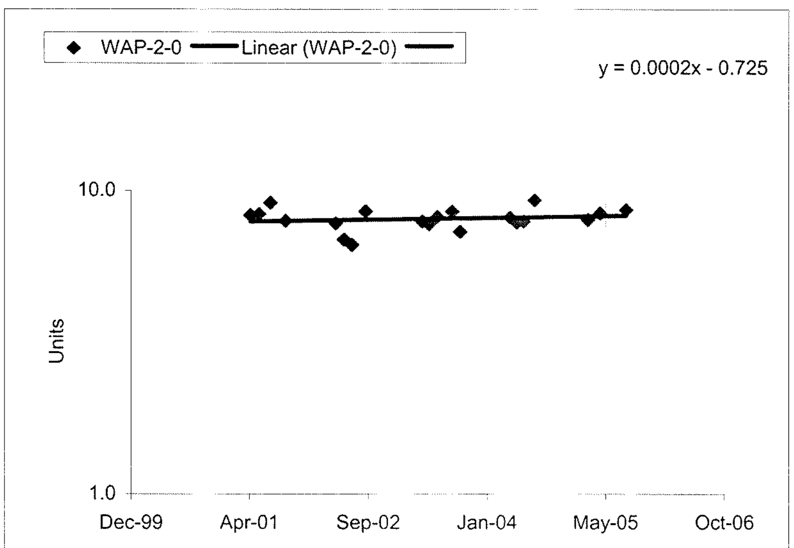


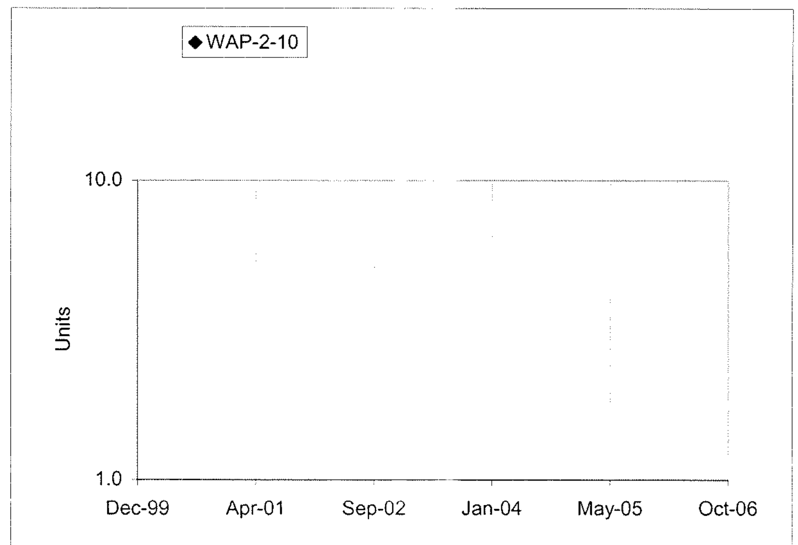


pH

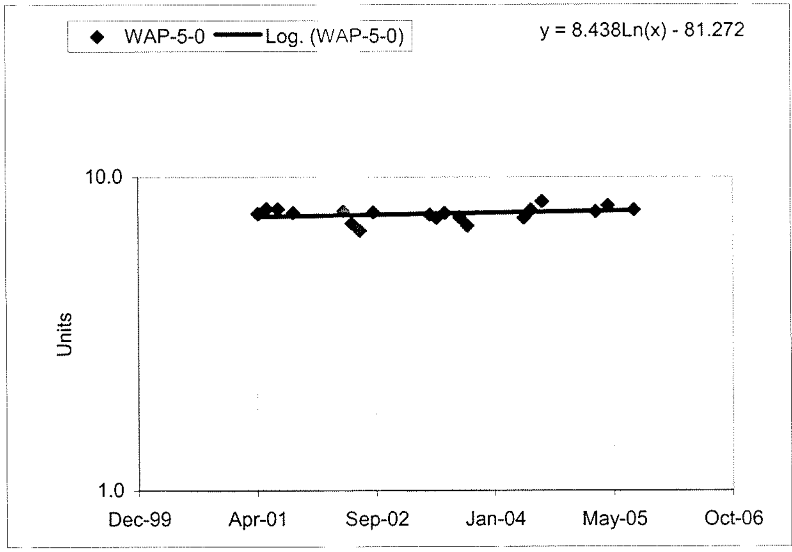

WAP-1
Log. (WAP-1)
y = 3.998Ln(x) - 34.314
10.0
Units
1.0
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

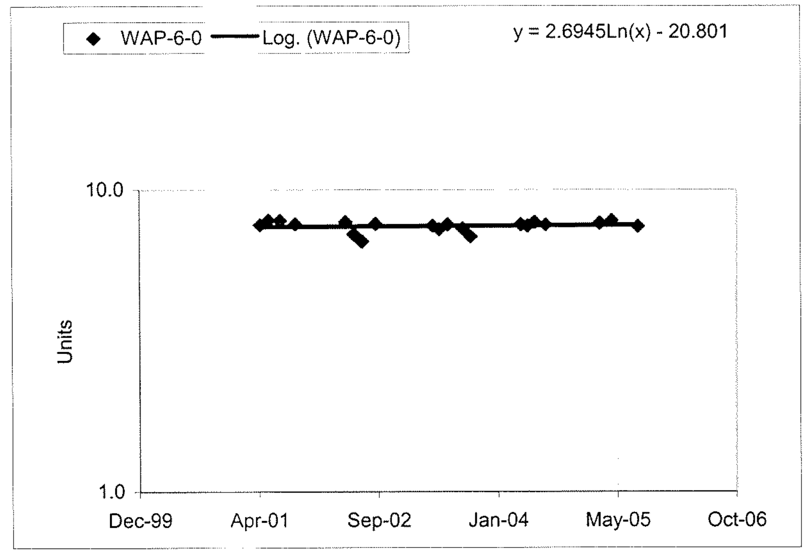

WAP-15-0
10.0
Units
1.0
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

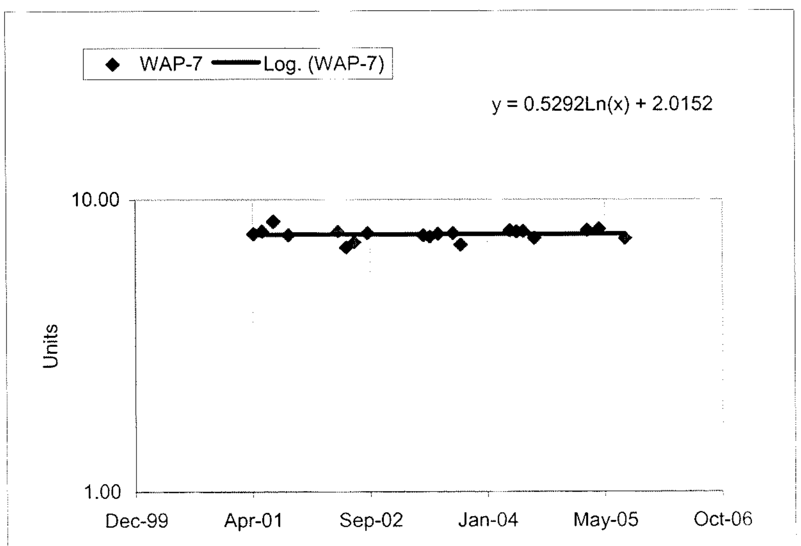

WAP-2-0
Linear (WAP-2-0)
y = 0.0002x - 0.725
10.0
Units
1.0
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06


WAP-2-10
10.0
Units
1.0
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

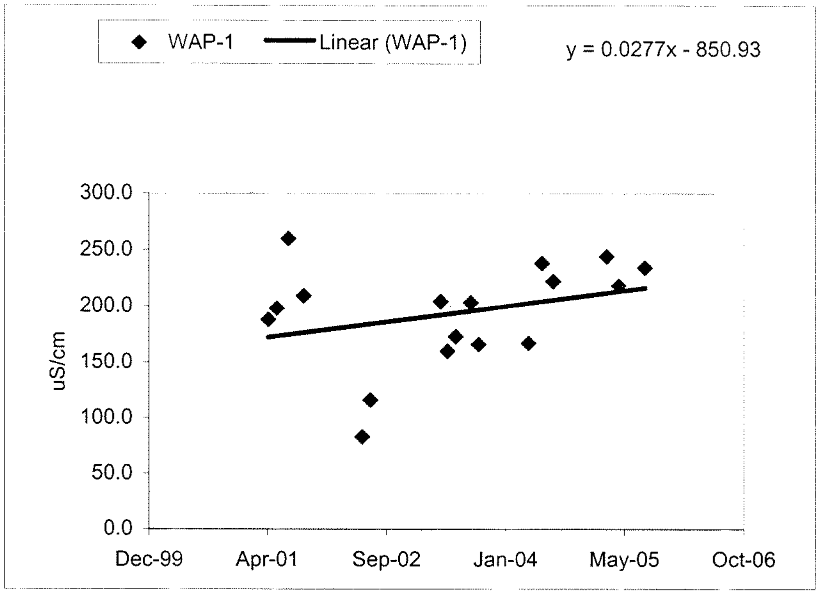
pH

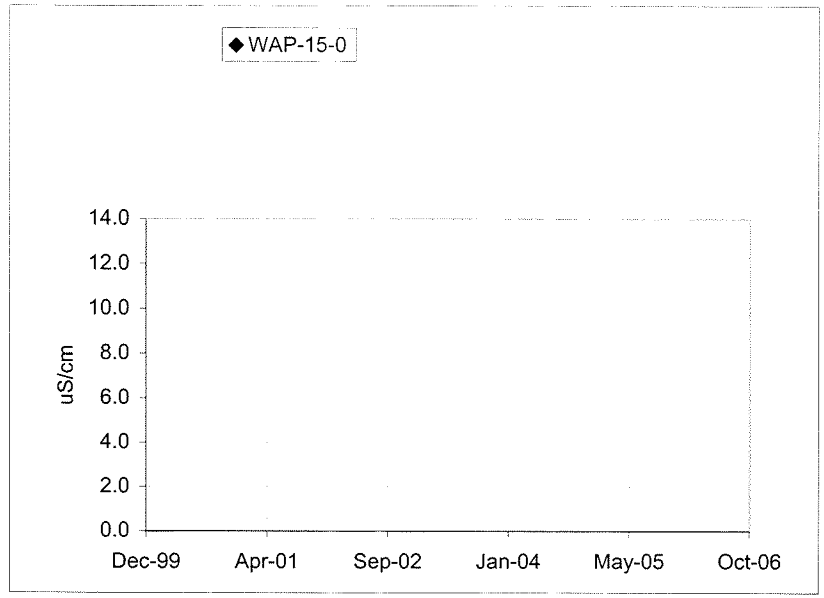

WAP-5-0
Log. (WAP-5-0)
y = 8.438Ln(x) - 81.272
10.0
1.0
Units
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

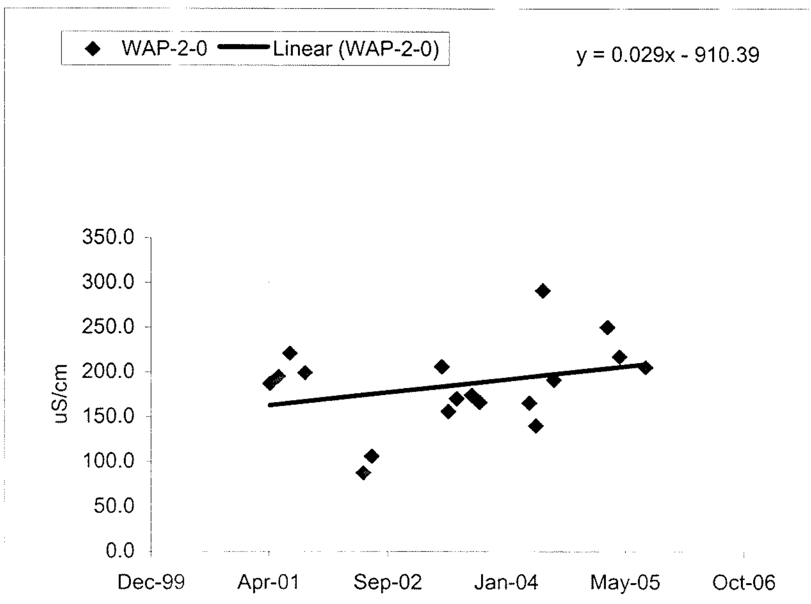

WAP-6-0
Log. (WAP-6-0)
y = 2.6945Ln(x) - 20.801
10.0
1.0
Units
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

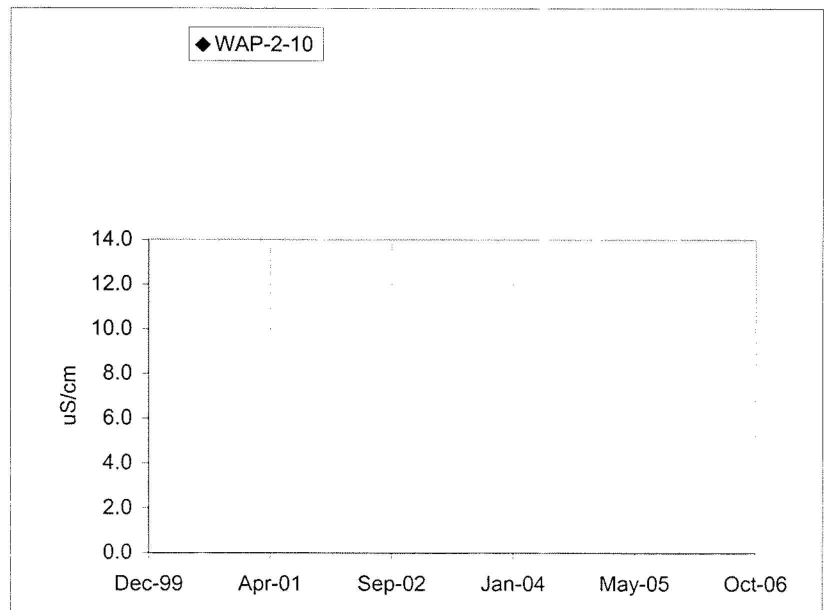

WAP-7
Log. (WAP-7)
y = 0.5292Ln(x) + 2.0152
10.00
1.00
Units
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

Conductivity

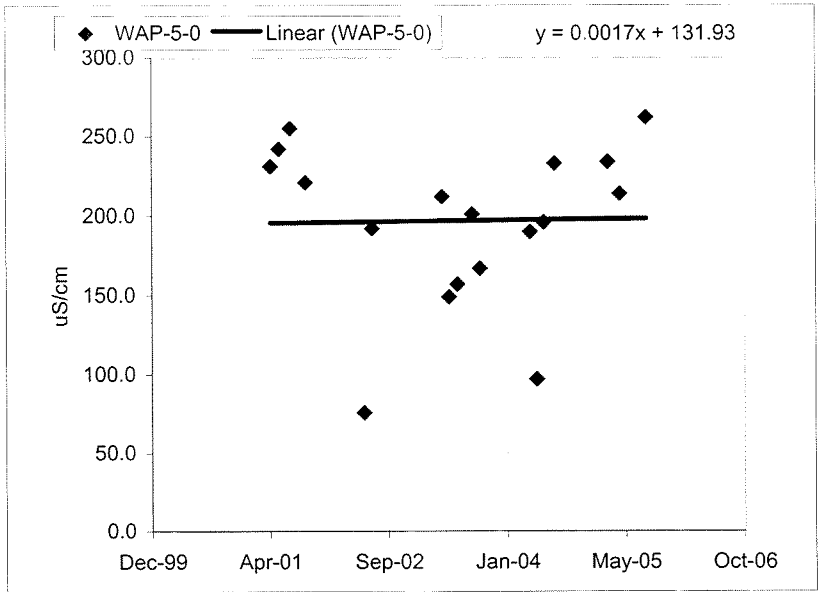


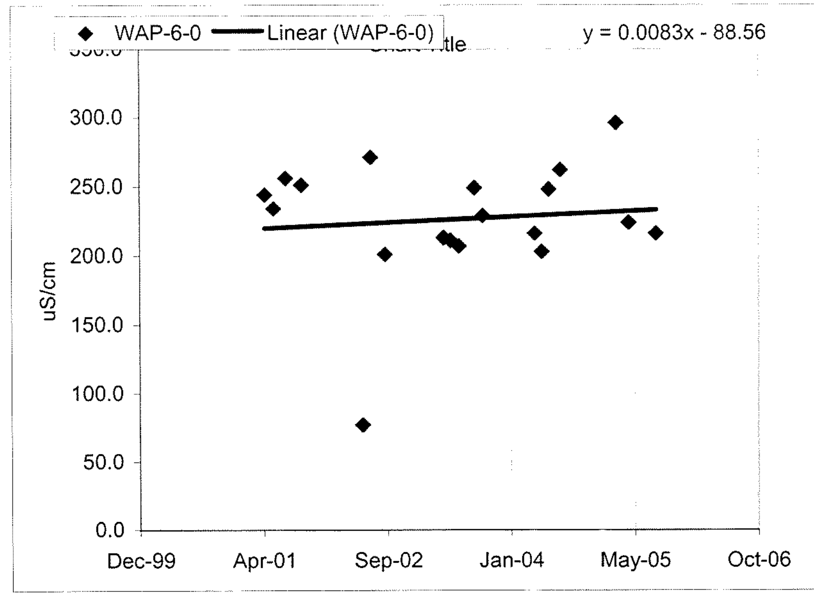


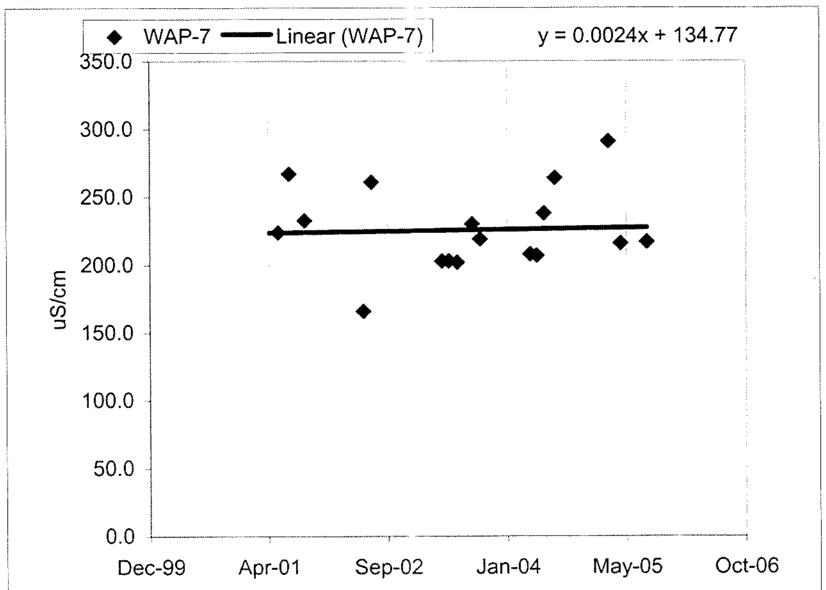




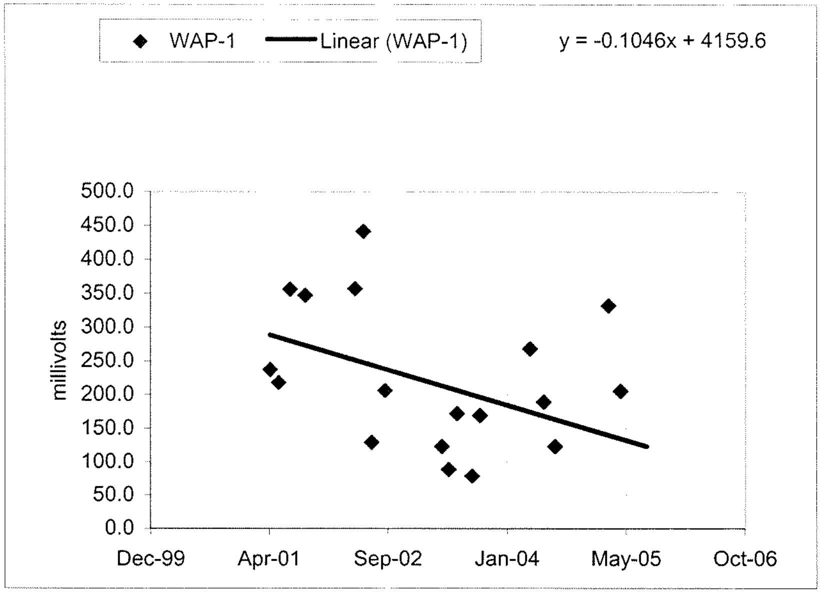
Conductivity

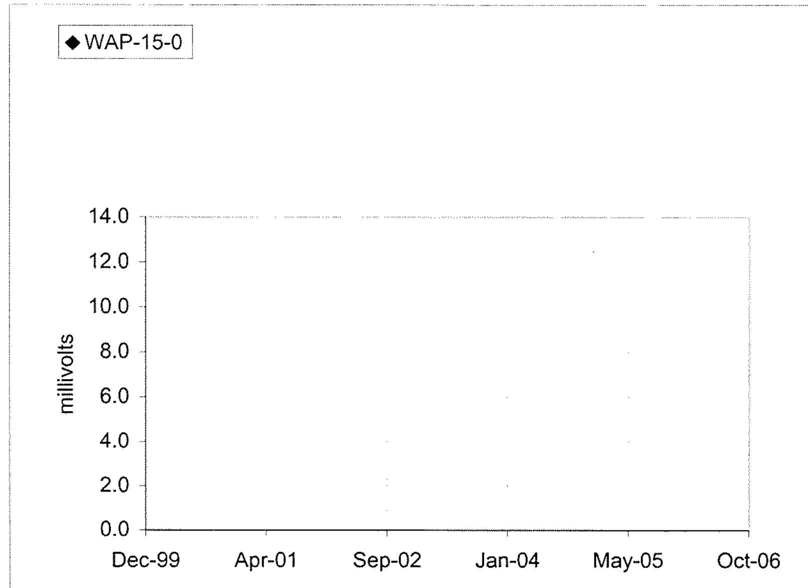


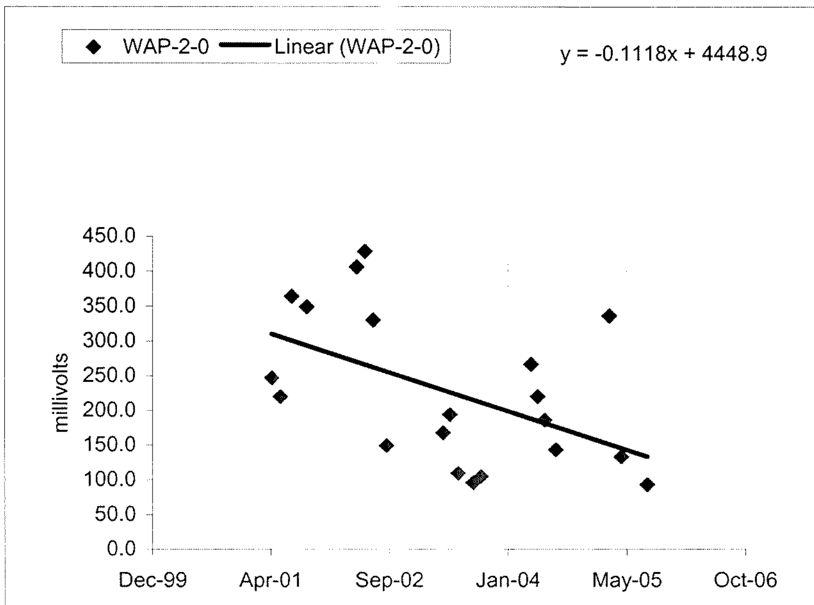


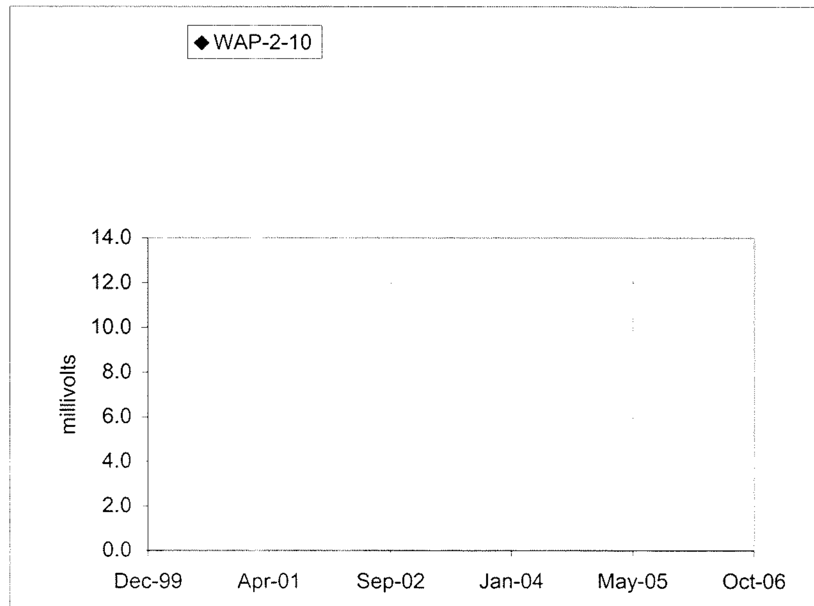


Oxidation Reduction Potential (ORP)

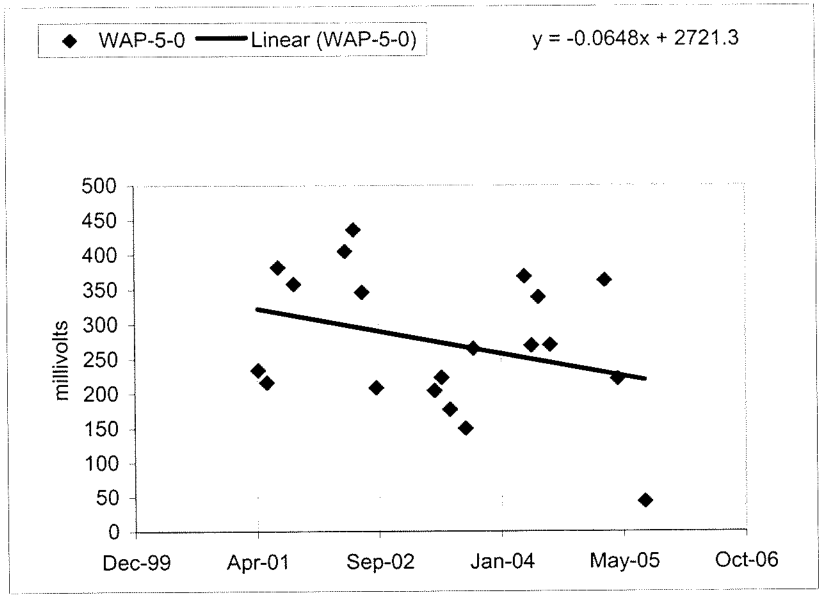


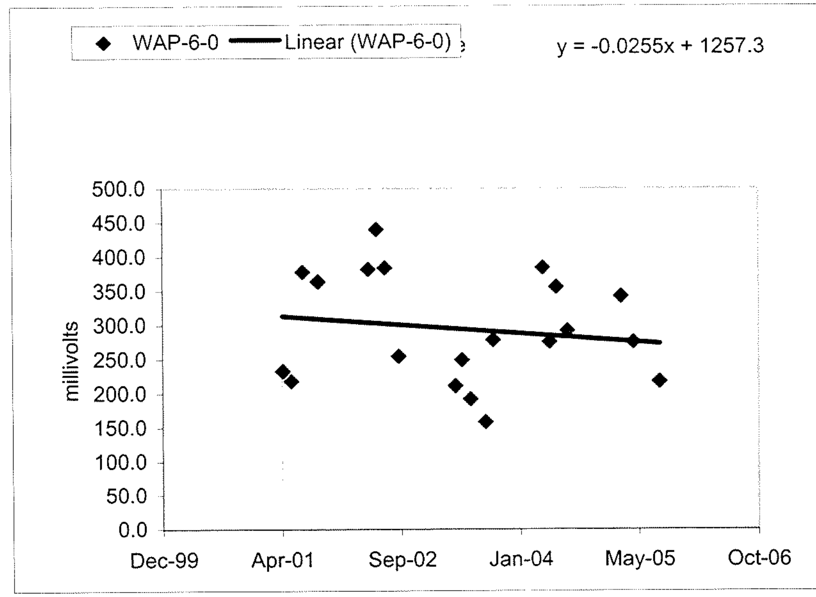


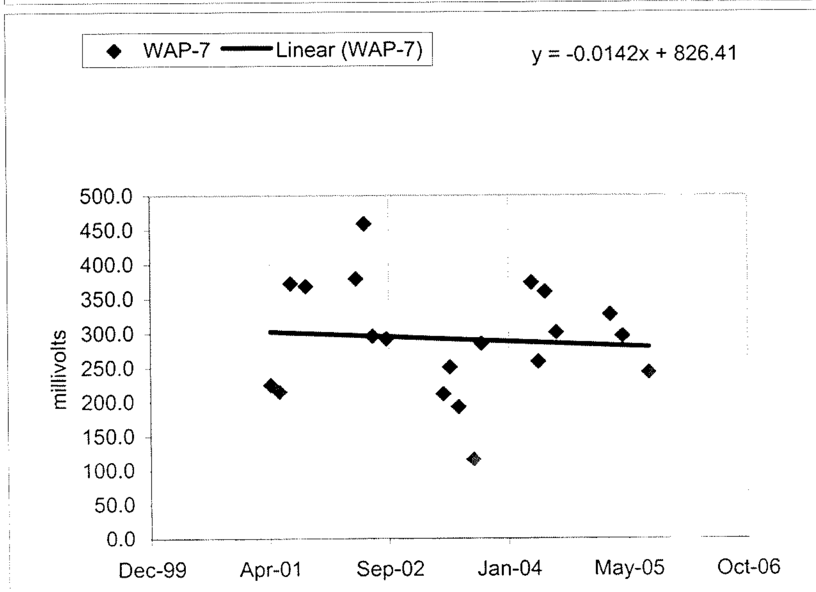




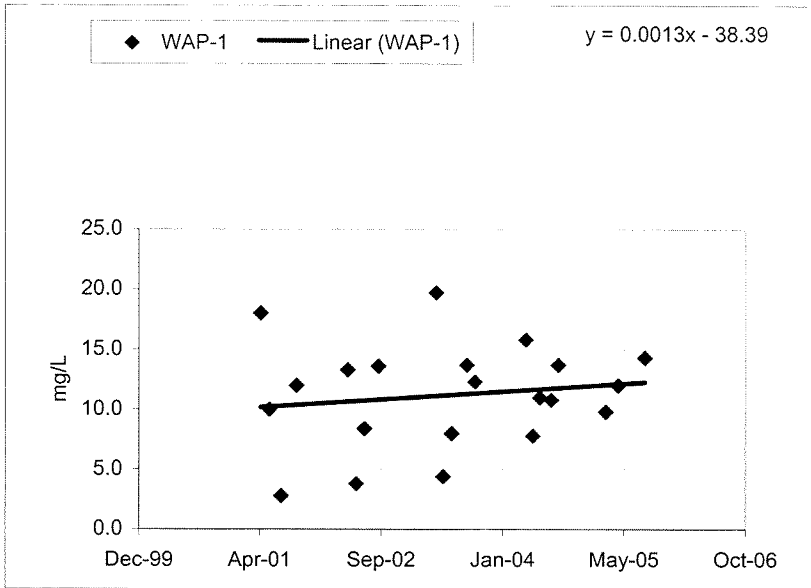
Oxidation Reduction Potential (ORP)

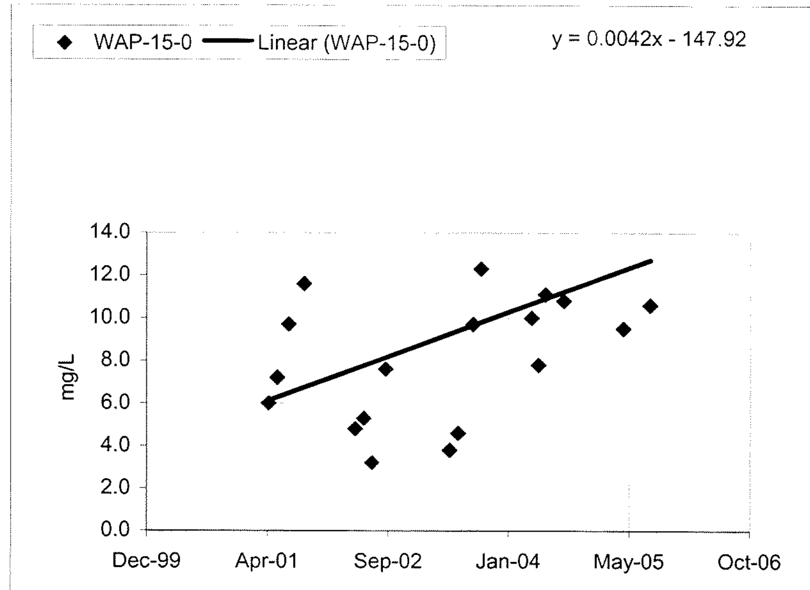


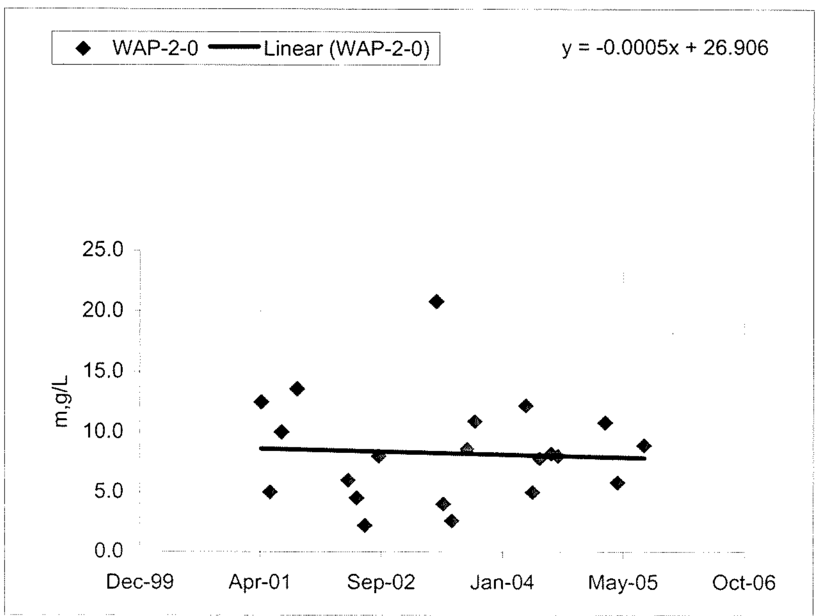


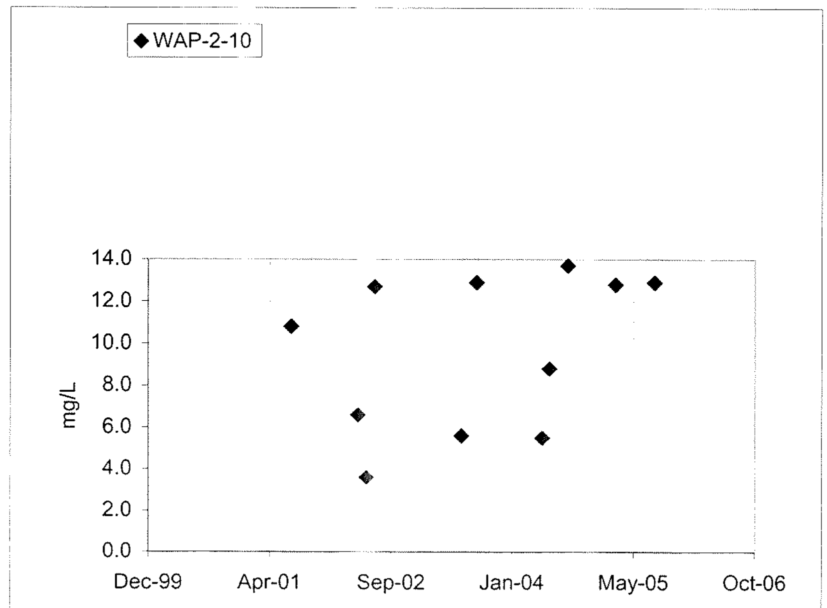


Total Suspended Solids (TSS)

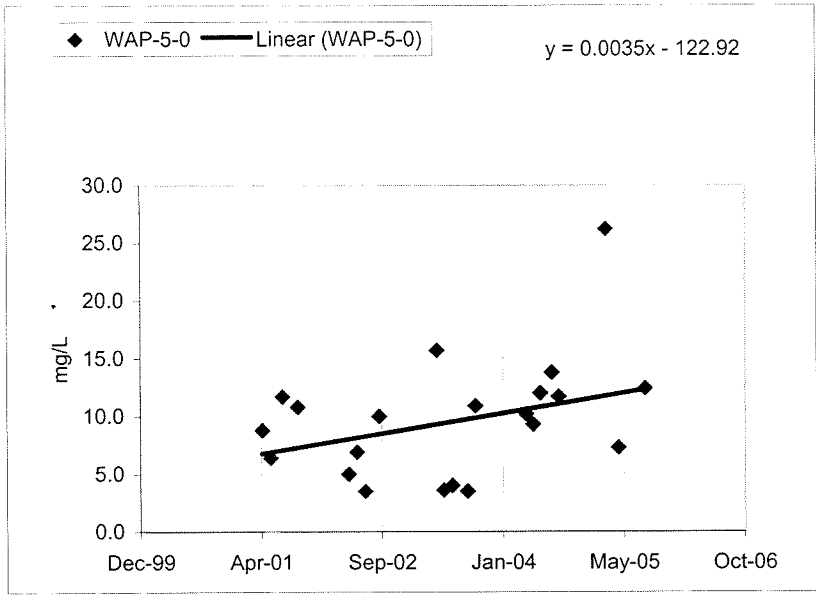


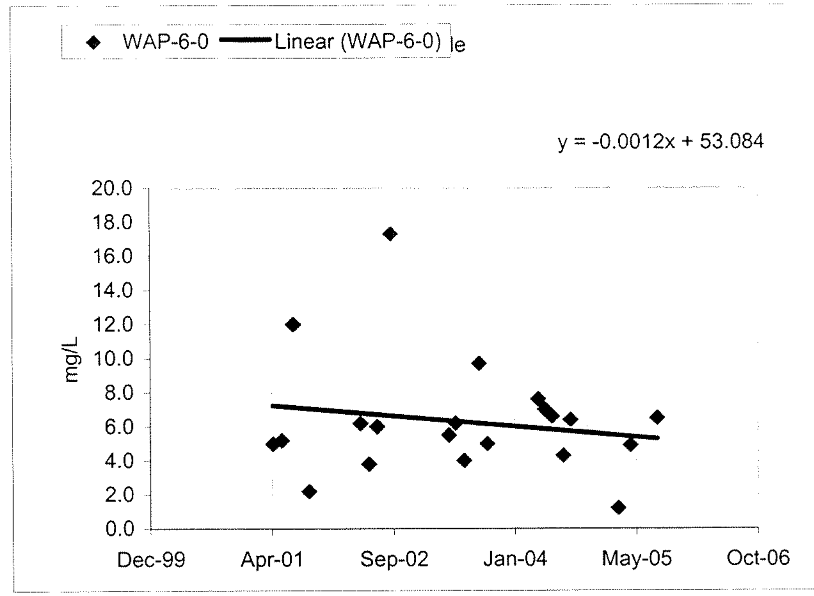


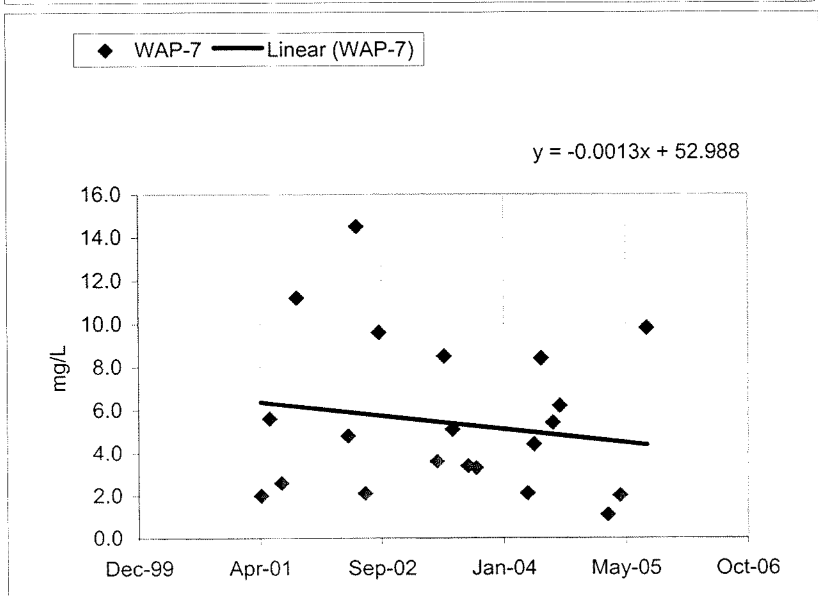




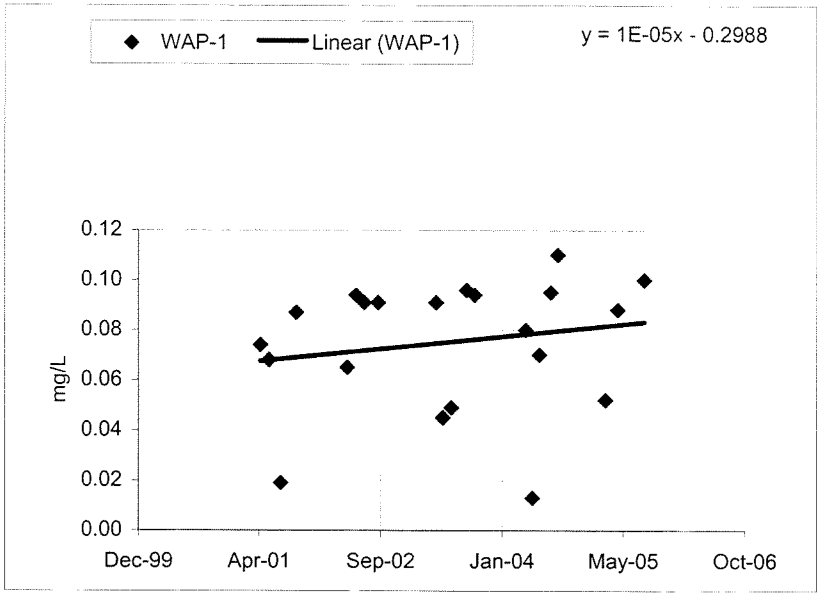
Total Suspended Solids (TSS)

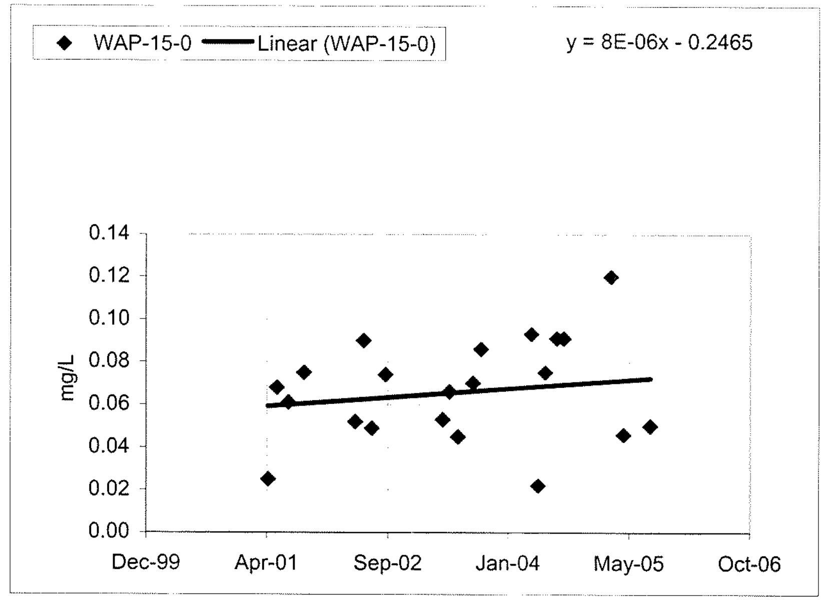


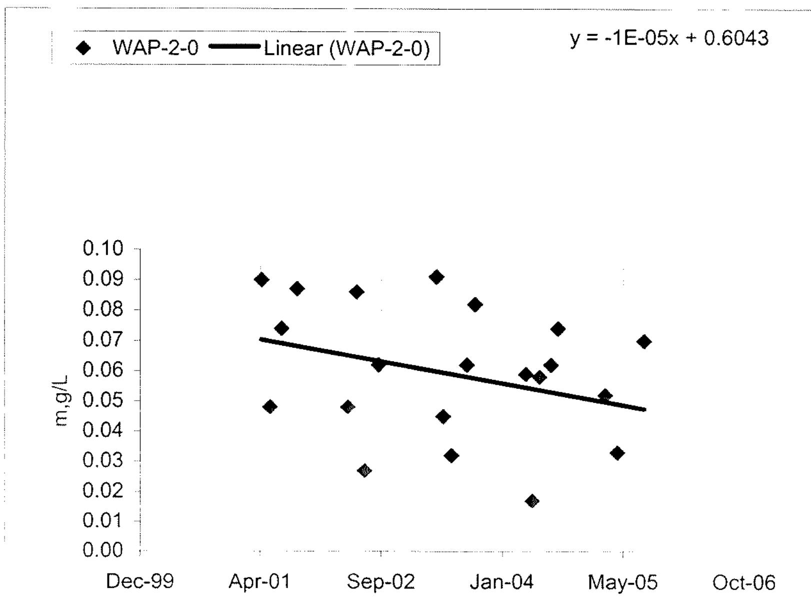


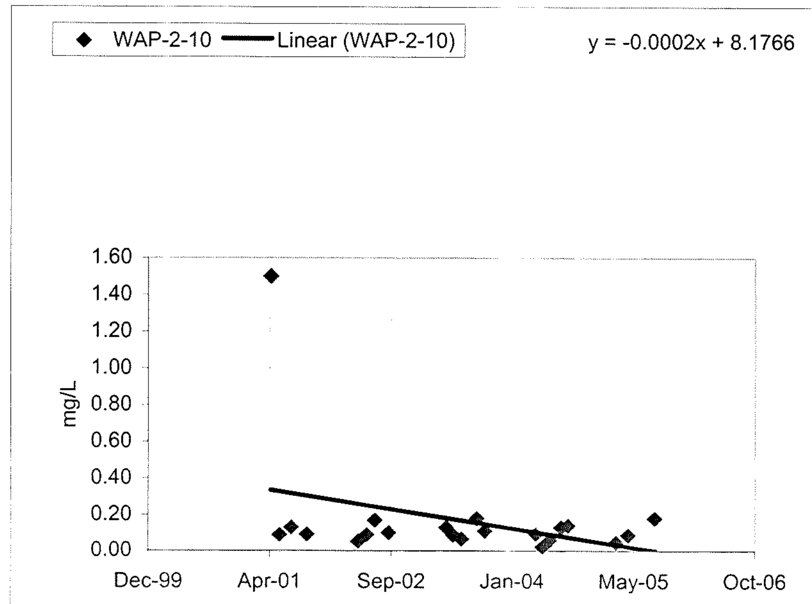


Total Phosphorus

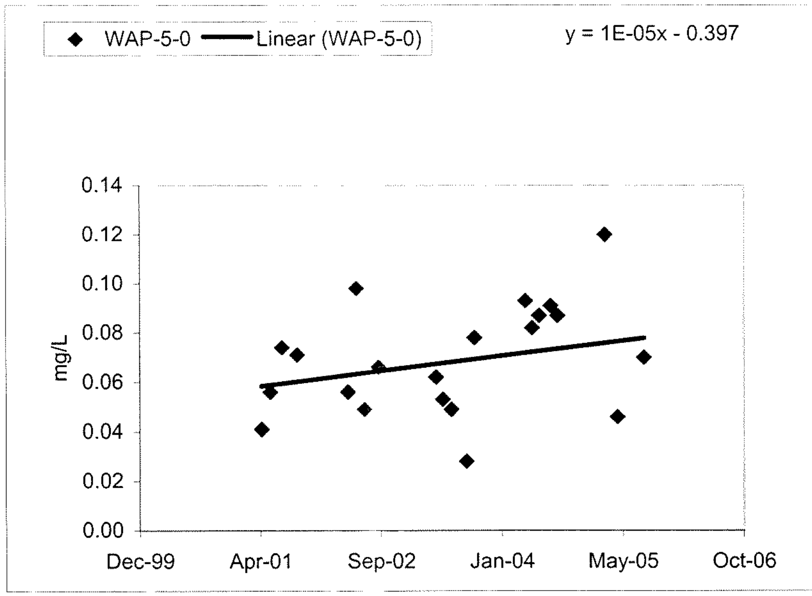


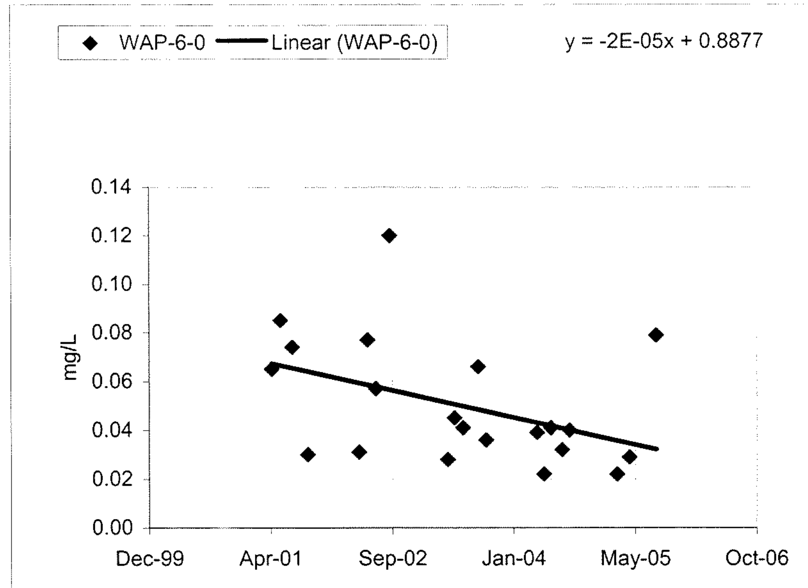


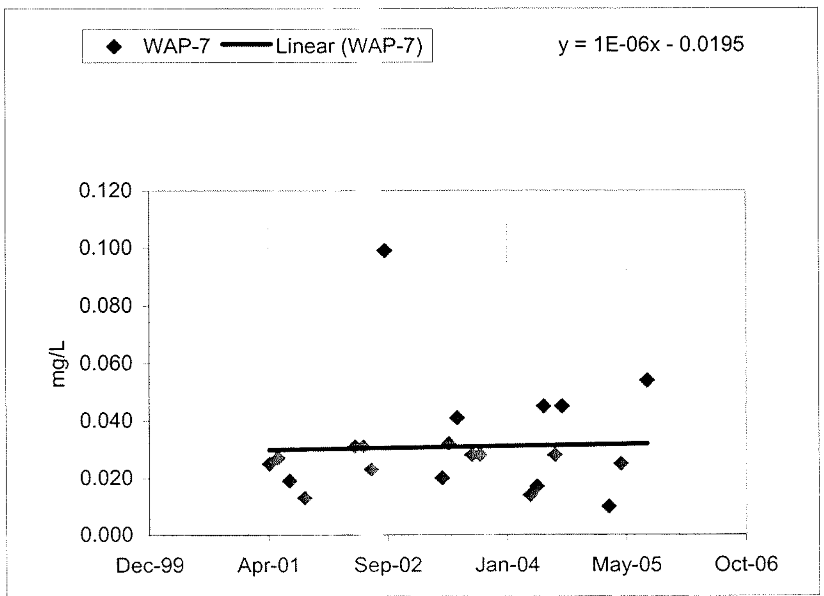




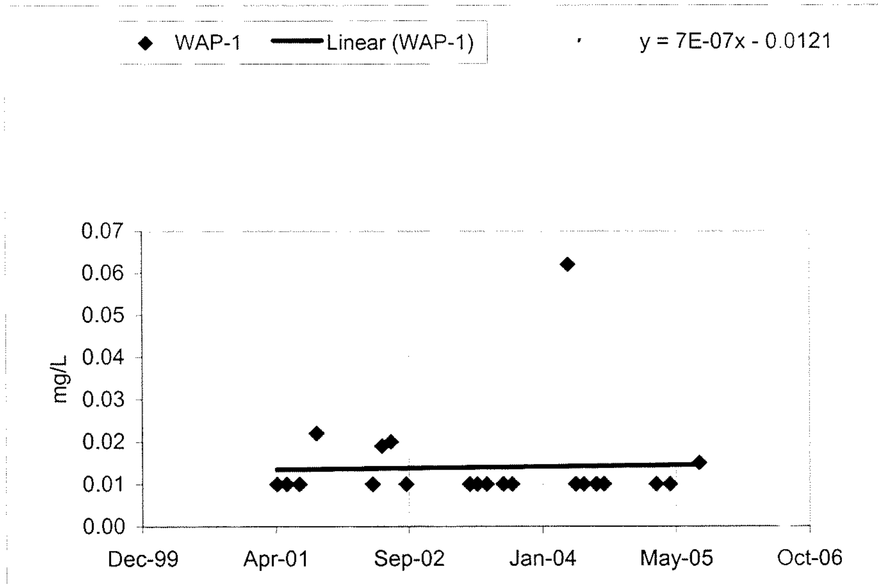
Total Phosphorus

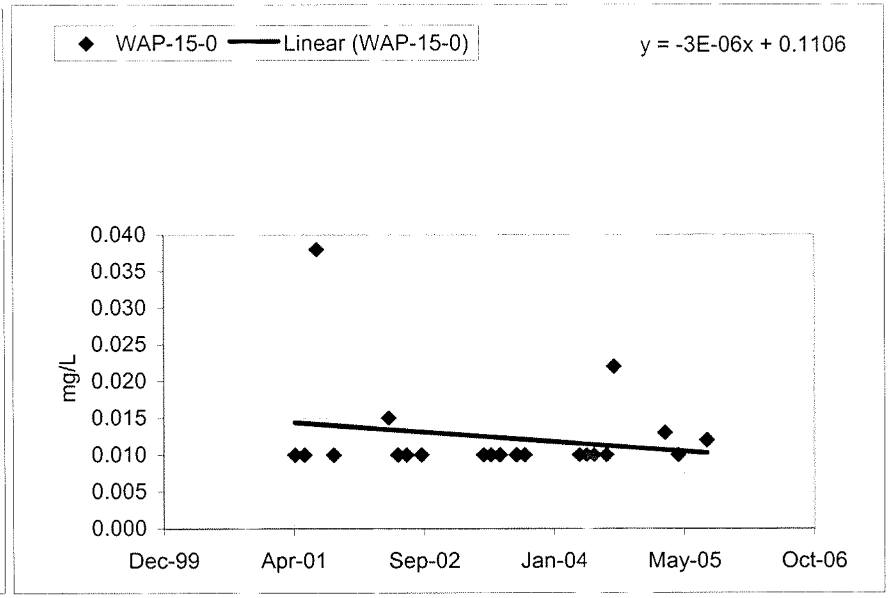


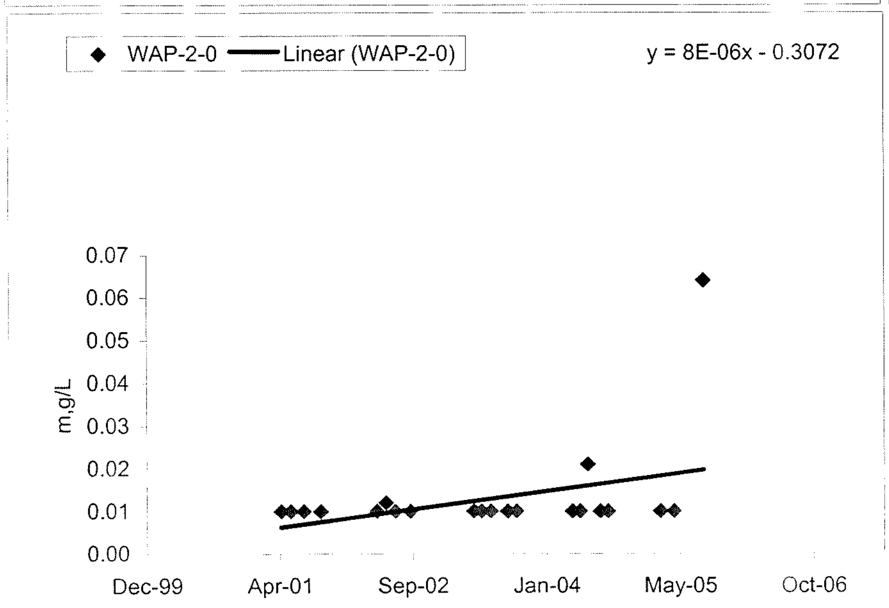


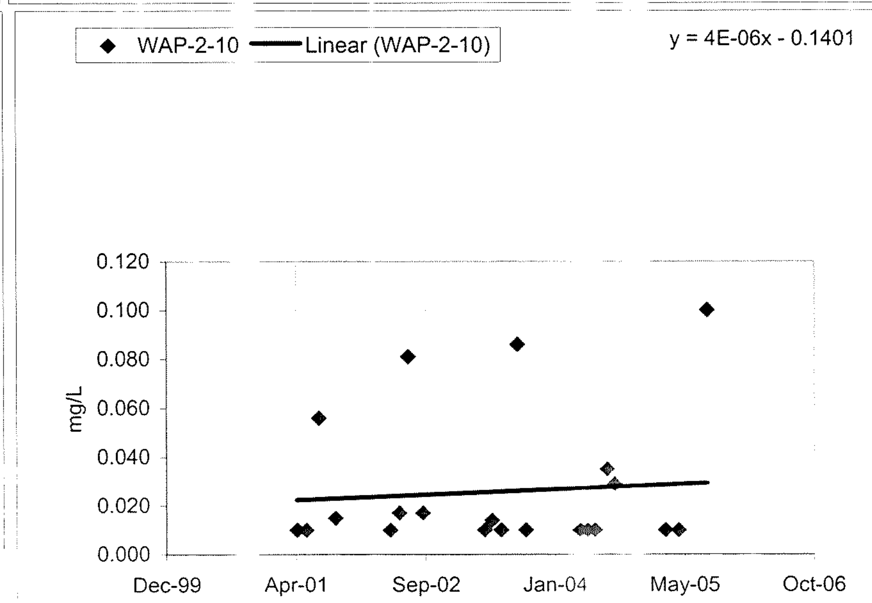


Soluble Phosphorus (o-PO4)

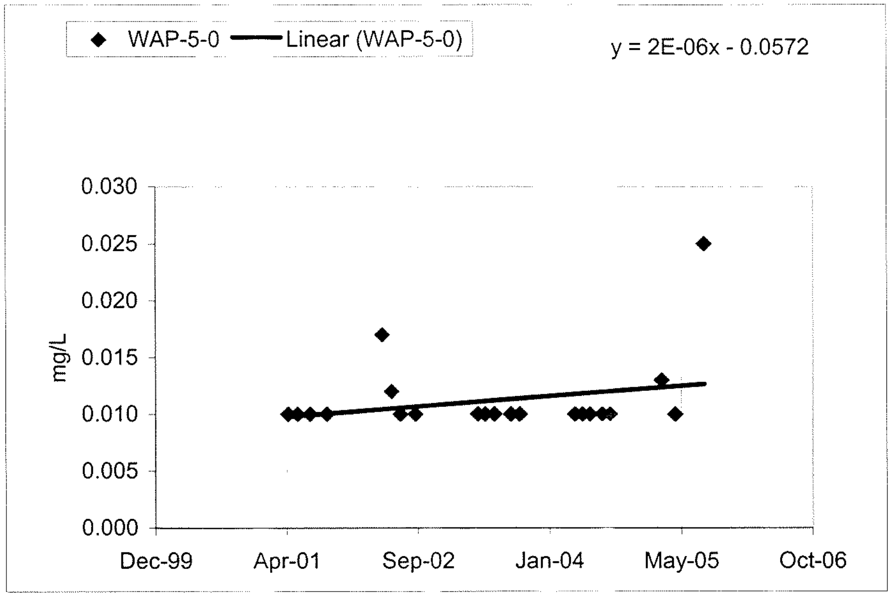


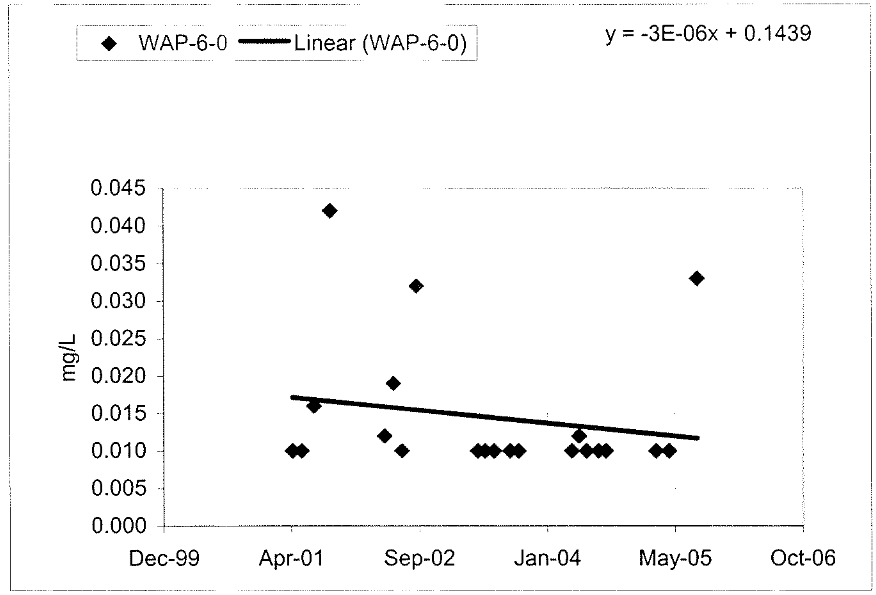


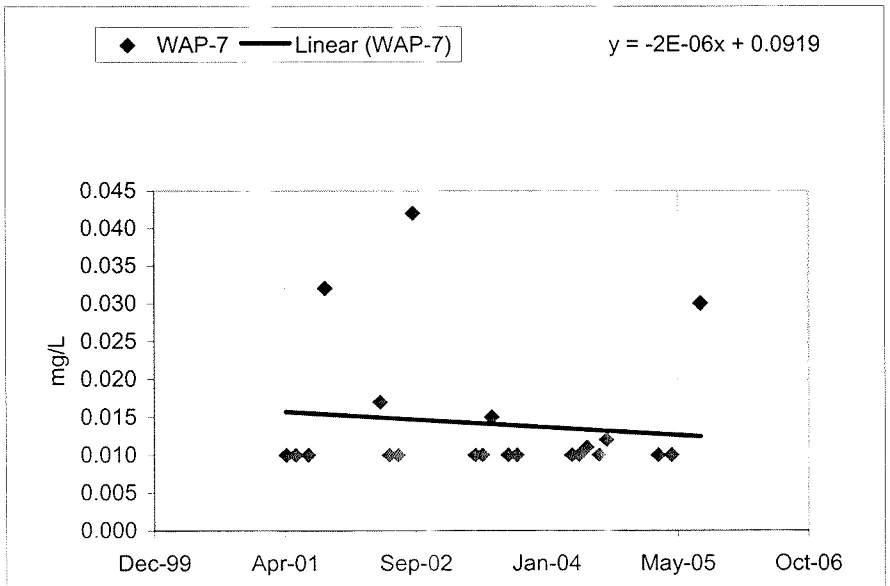




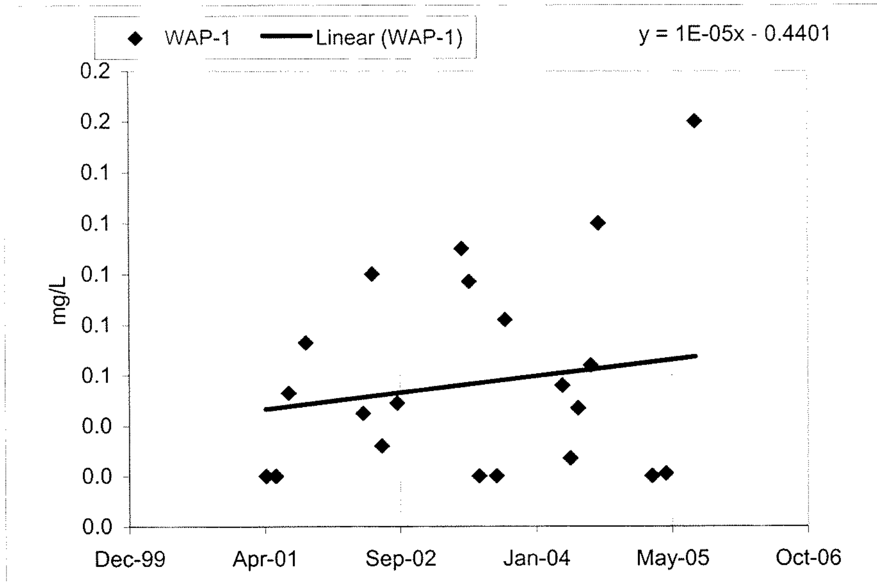
Soluble Phosphorus (o-PO4)

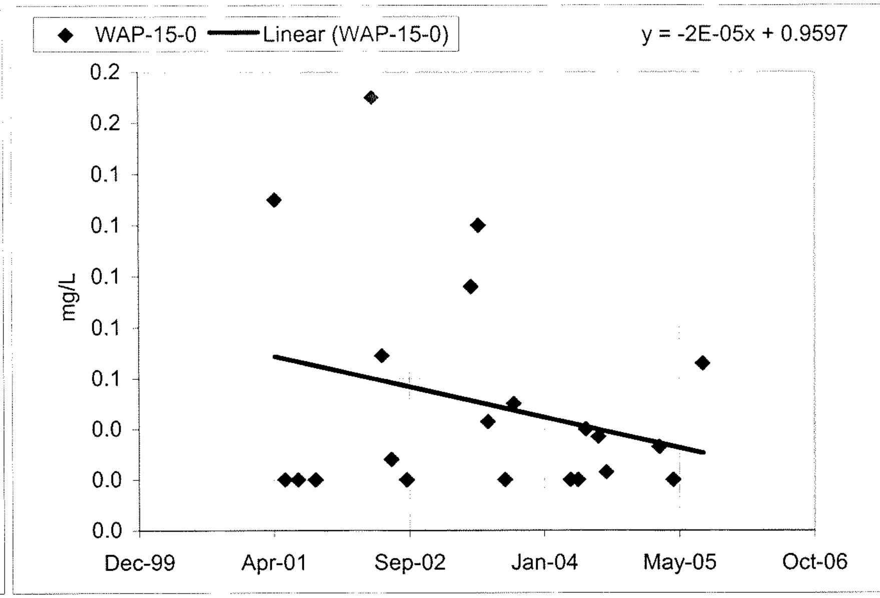


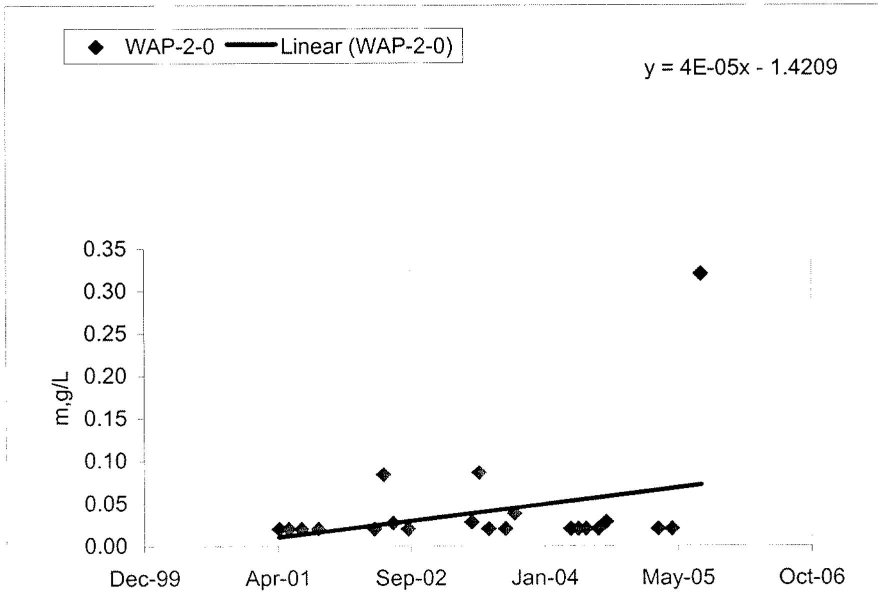


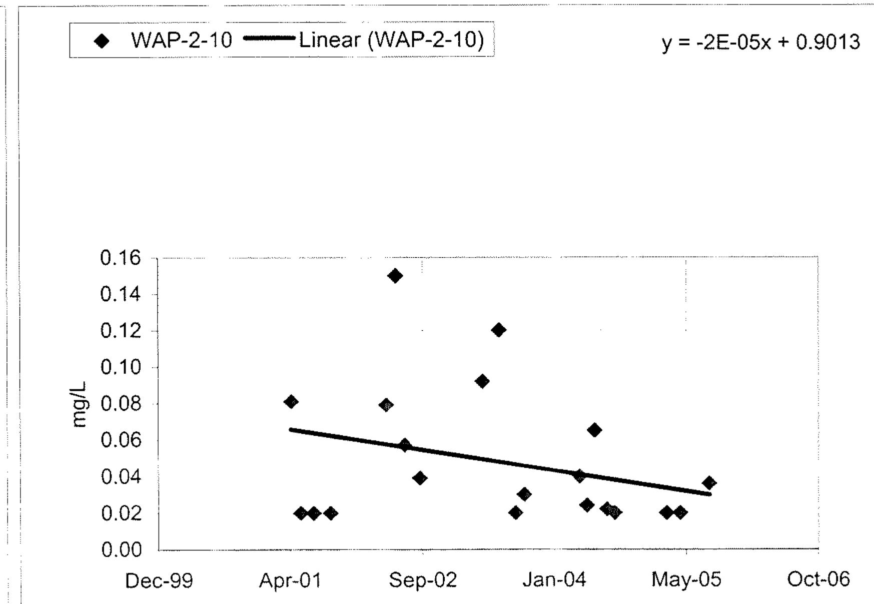


Nitrate

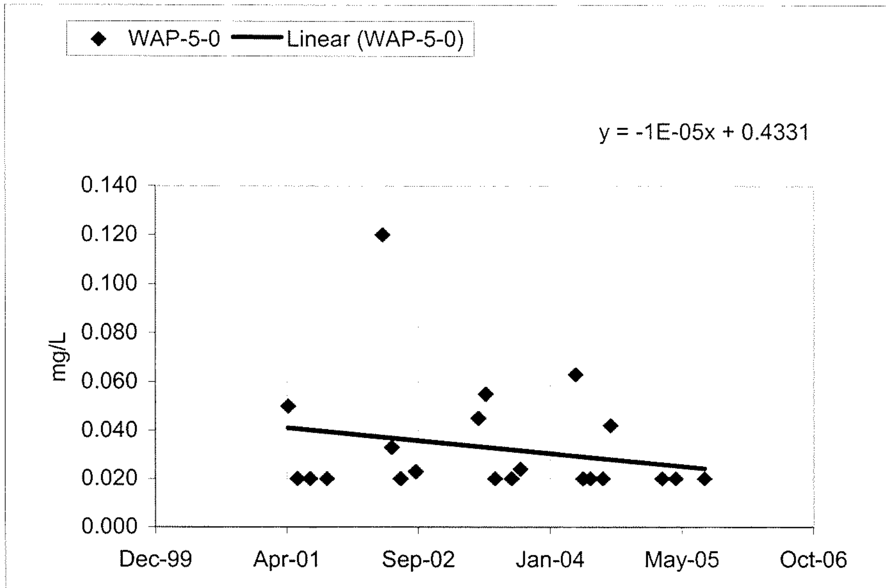

WAP-1
Linear (WAP-1)
y = 1E-05x - 0.4401
mg/L
0.2
0.2
0.1
0.1
0.1
0.1
0.1
0.0
0.0
0.0
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06


WAP-15-0
Linear (WAP-15-0)
y = -2E-05x + 0.9597
mg/L
0.2
0.2
0.1
0.1
0.1
0.1
0.1
0.0
0.0
0.0
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

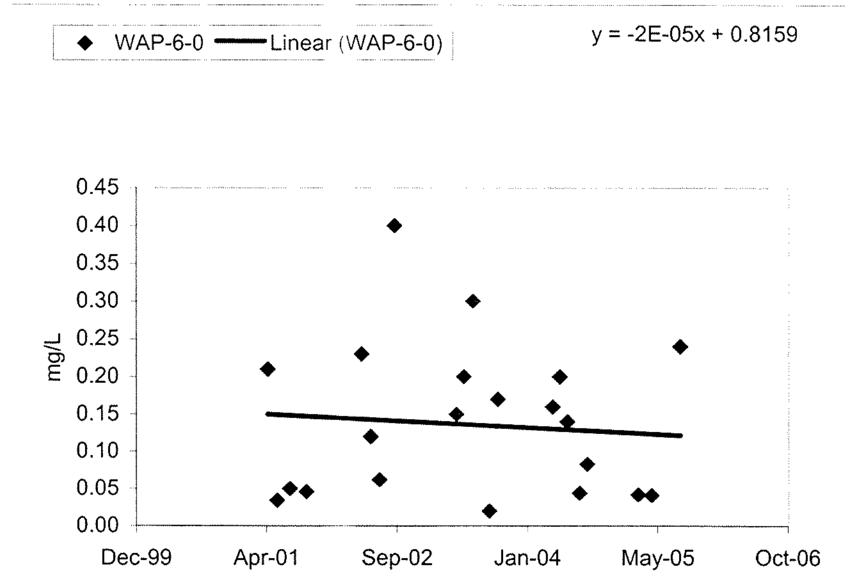

WAP-2-0
Linear (WAP-2-0)
y = 4E-05x - 1.4209
m,g/L
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06


WAP-2-10
Linear (WAP-2-10)
y = -2E-05x + 0.9013
mg/L
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

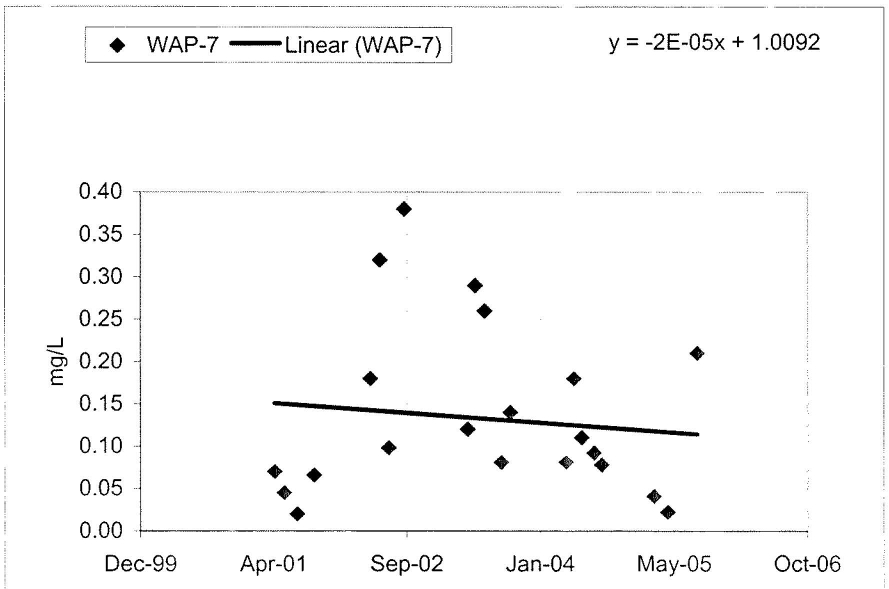
Nitrate



WAP-5-0
Linear (WAP-5-0)
y = -1E-05x + 0.4331
mg/L
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

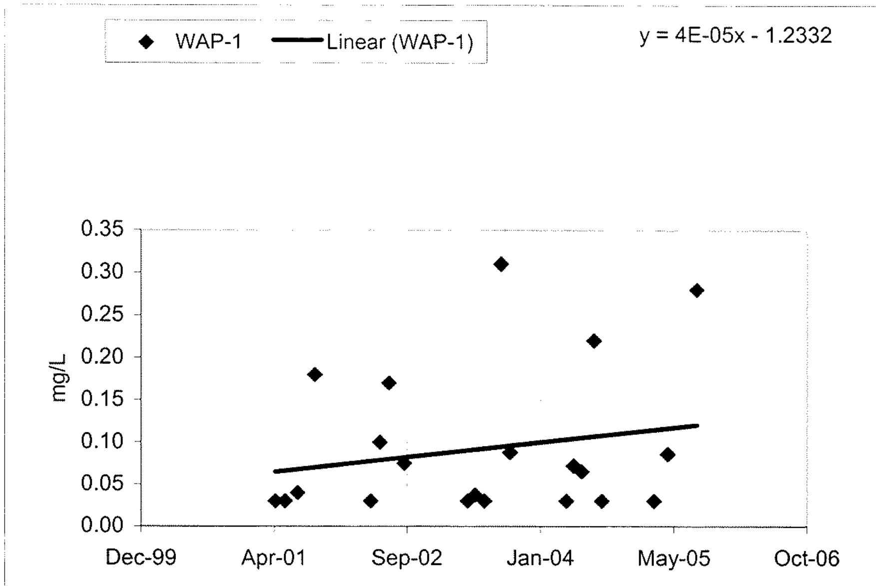


WAP-6-0
Linear (WAP-6-0)
y = -2E-05x + 0.8159
mg/L
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

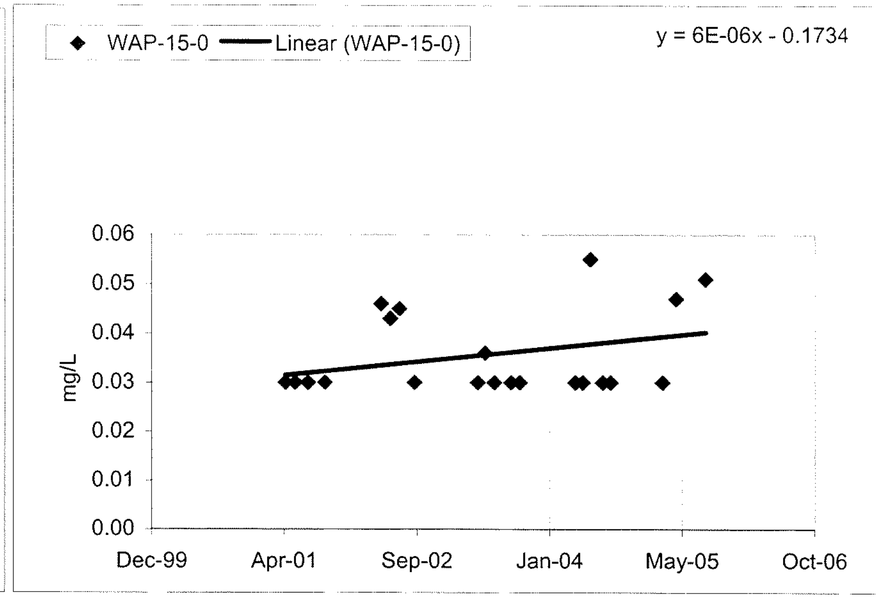


WAP-7
Linear (WAP-7)
y = -2E-05x + 1.0092
mg/L
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

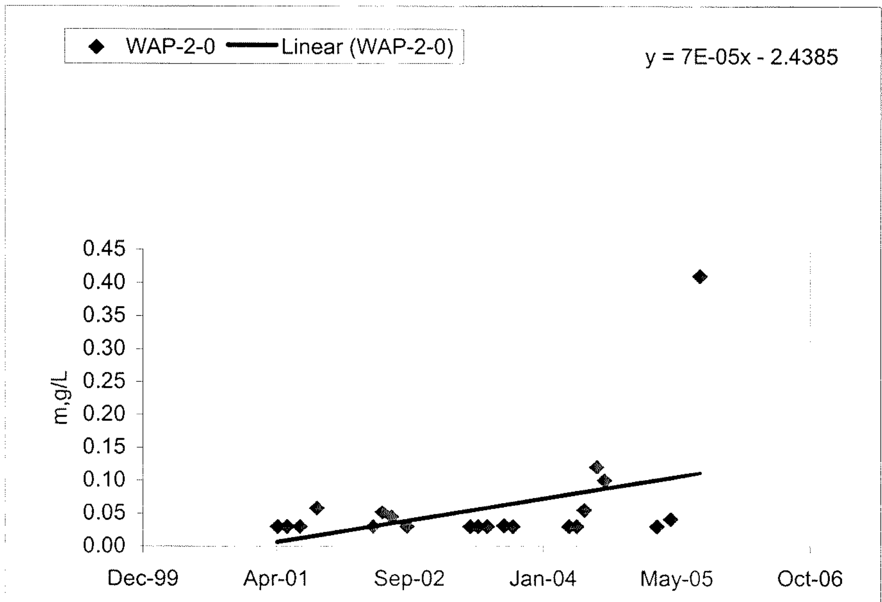
Ammonia



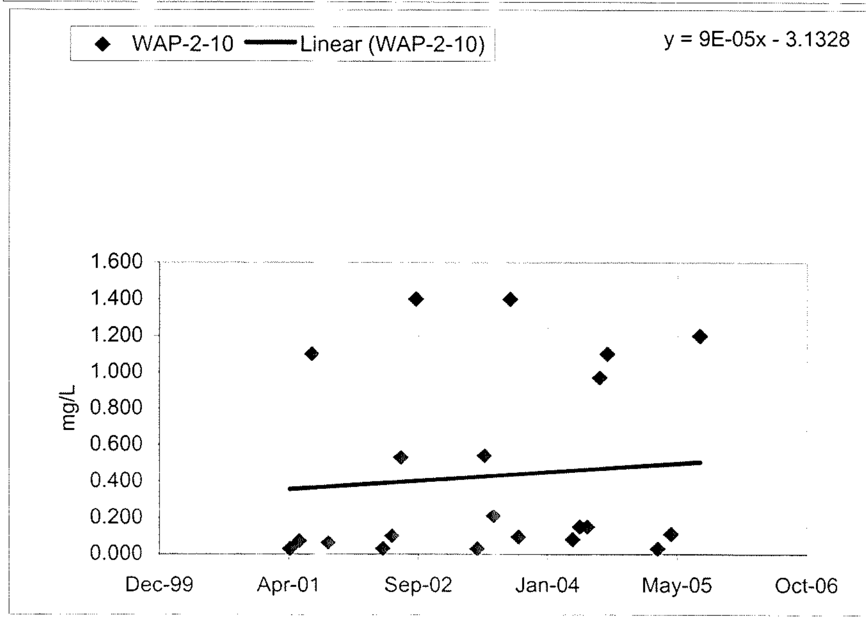
WAP-1
Linear (WAP-1)
y = 4E-05x - 1.2332
mg/L
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06



WAP-15-0
Linear (WAP-15-0)
y = 6E-06x - 0.1734
mg/L
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

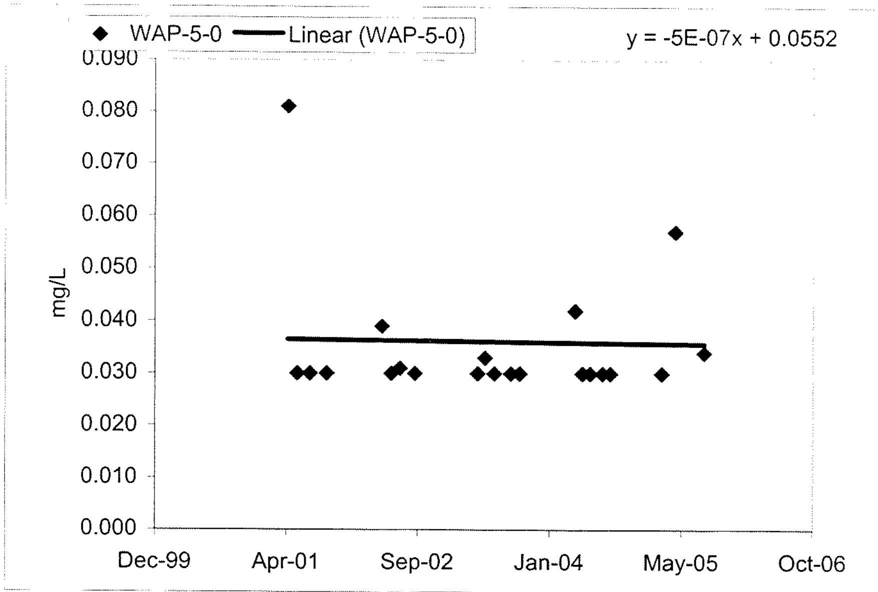


WAP-2-0
Linear (WAP-2-0)
y = 7E-05x - 2.4385
m,g/L
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

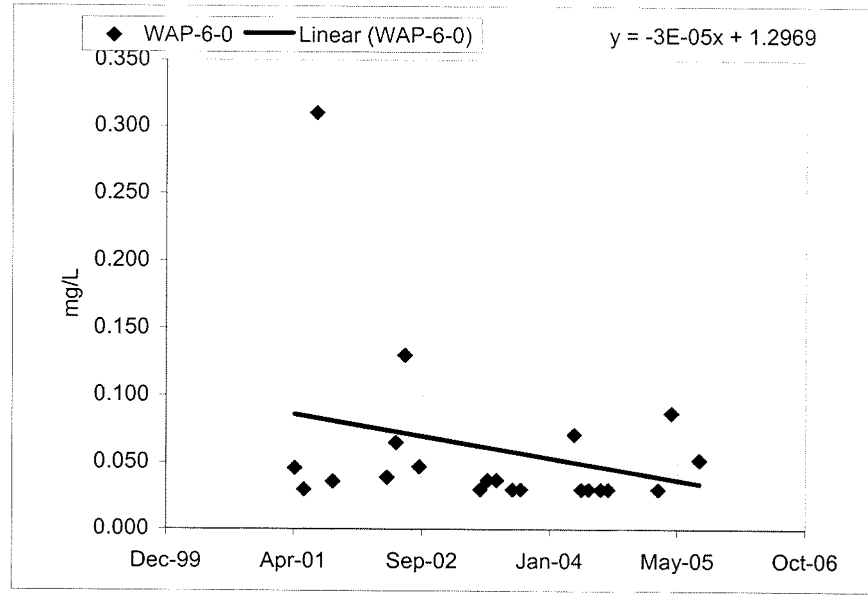


WAP-2-10
Linear (WAP-2-10)
y = 9E-05x - 3.1328
mg/L
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

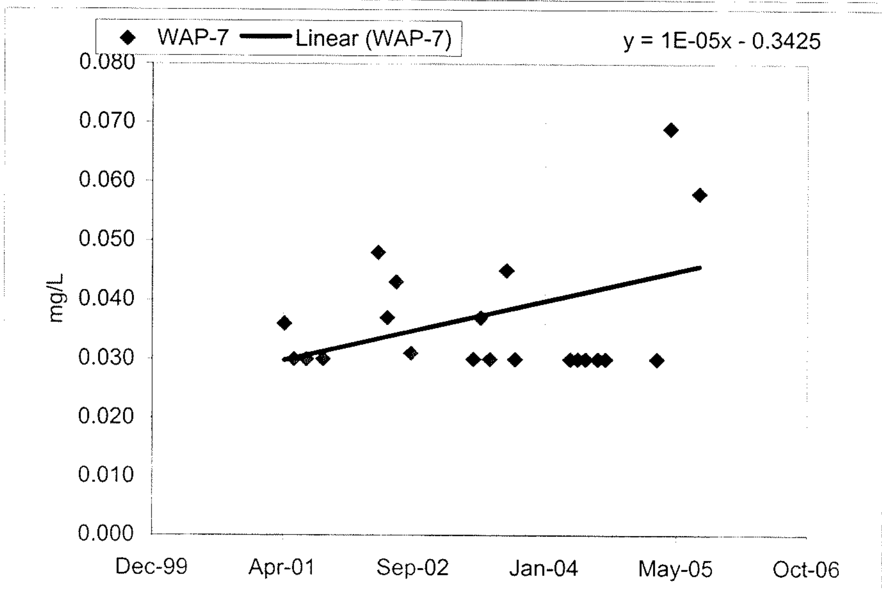
Ammonia



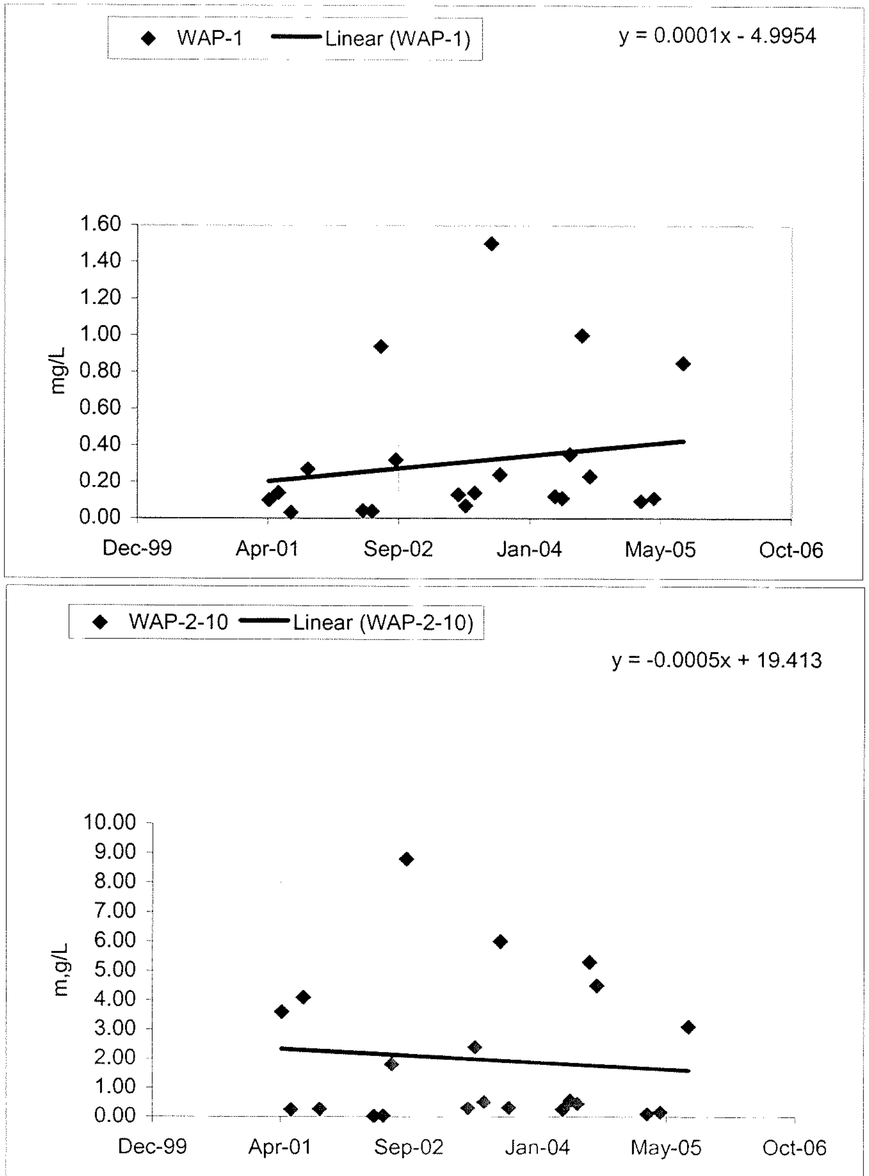
WAP-5-0
Linear (WAP-5-0)
y = -5E-07x + 0.0552
mg/L
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06



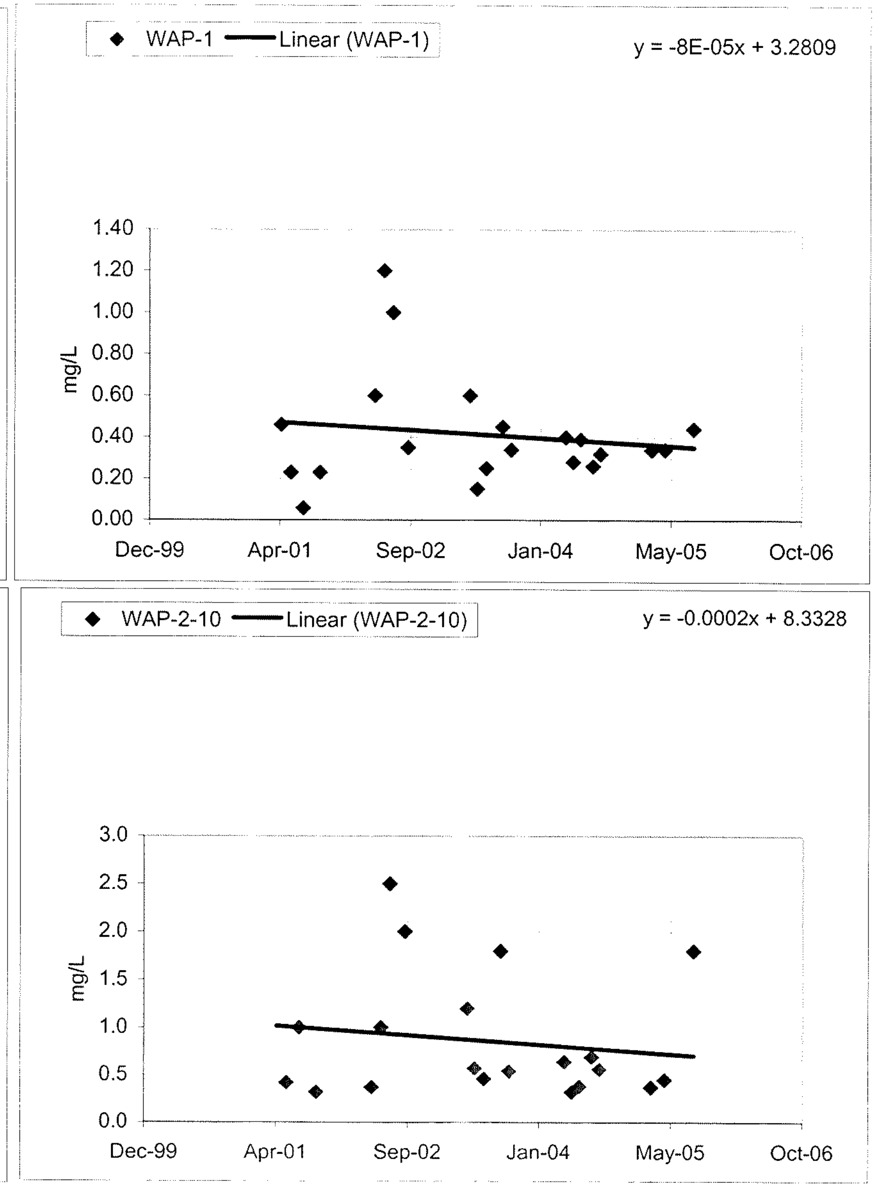
WAP-6-0
Linear (WAP-6-0)
y = -3E-05x + 1.2969
mg/L
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06



WAP-7
Linear (WAP-7)
y = 1E-05x - 0.3425
mg/L
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

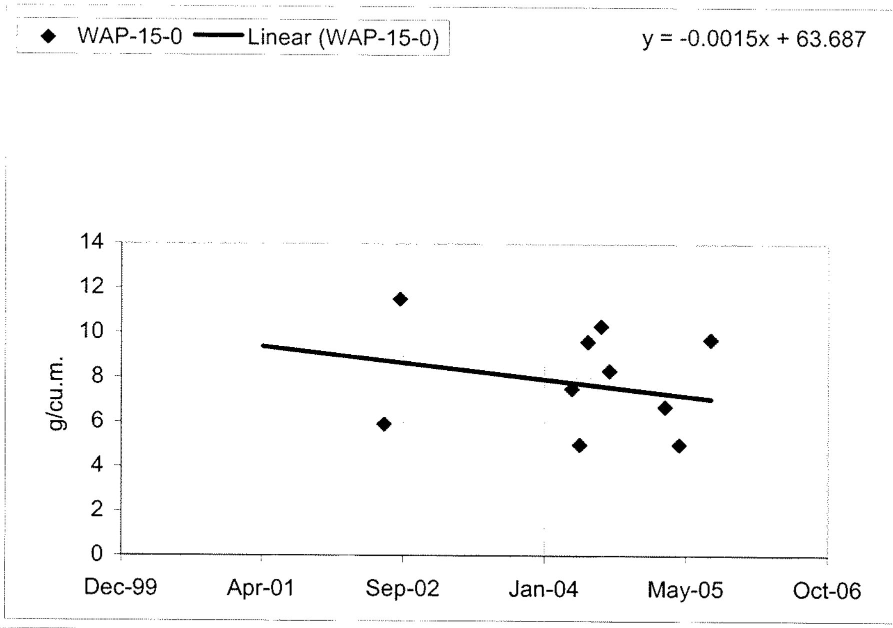


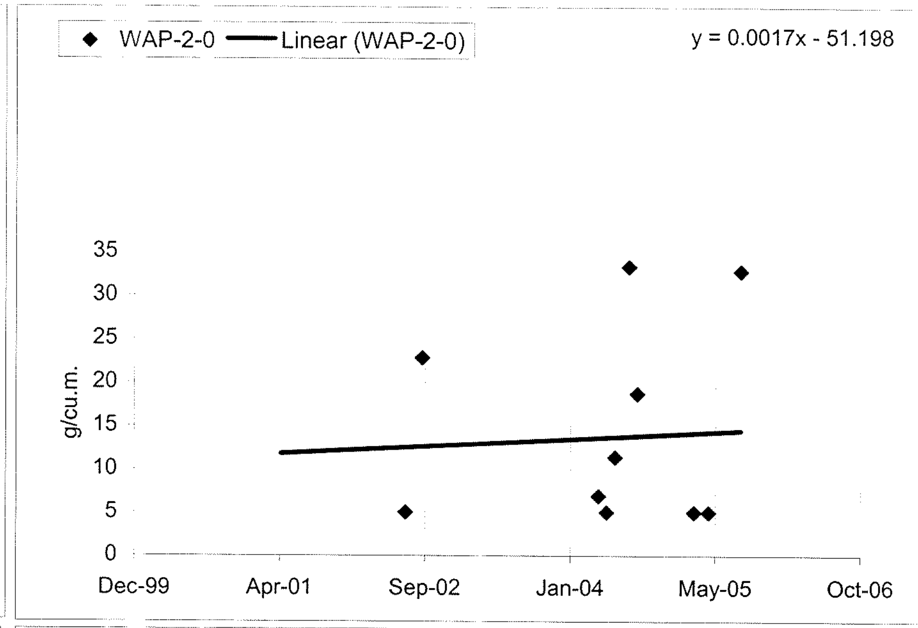
Total Manganese

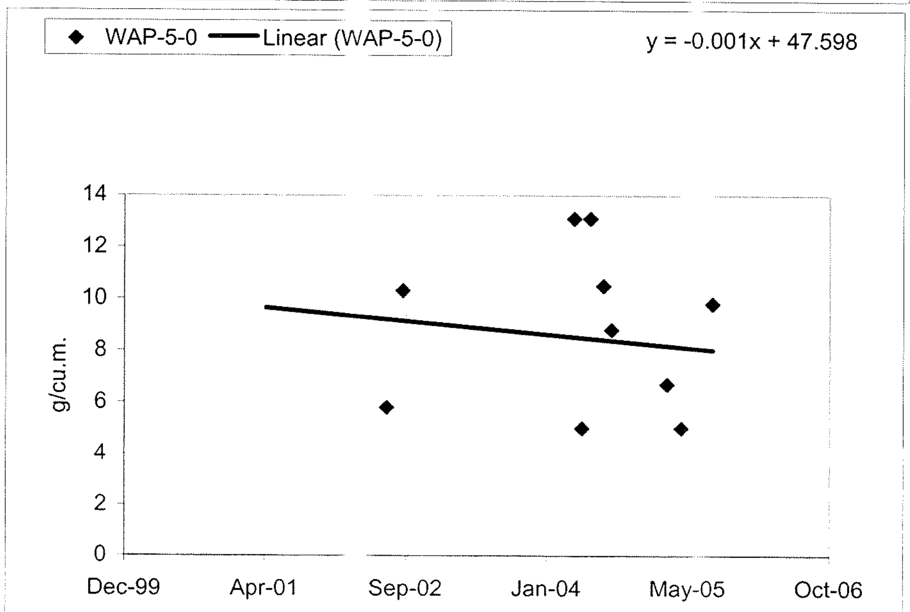


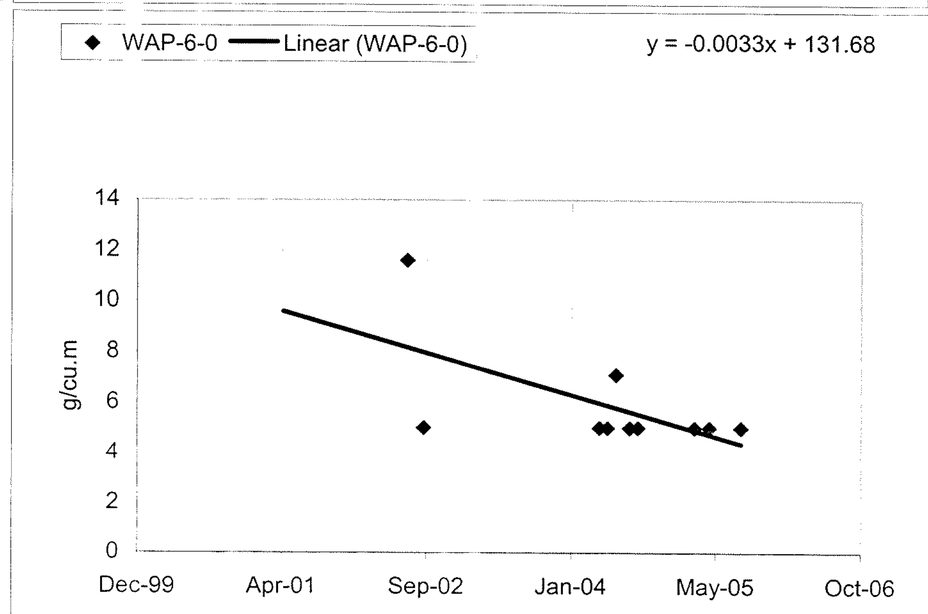
Total Iron

Chlorophyll

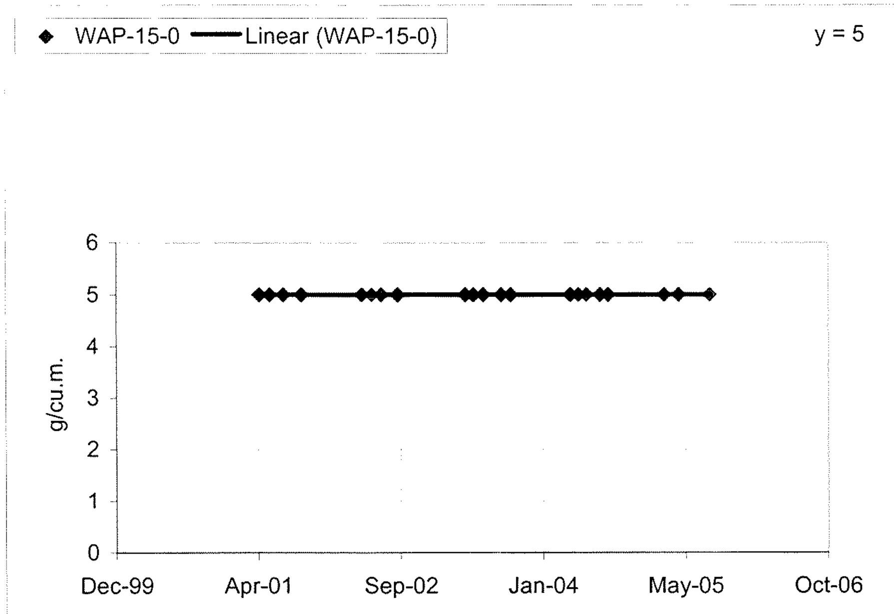




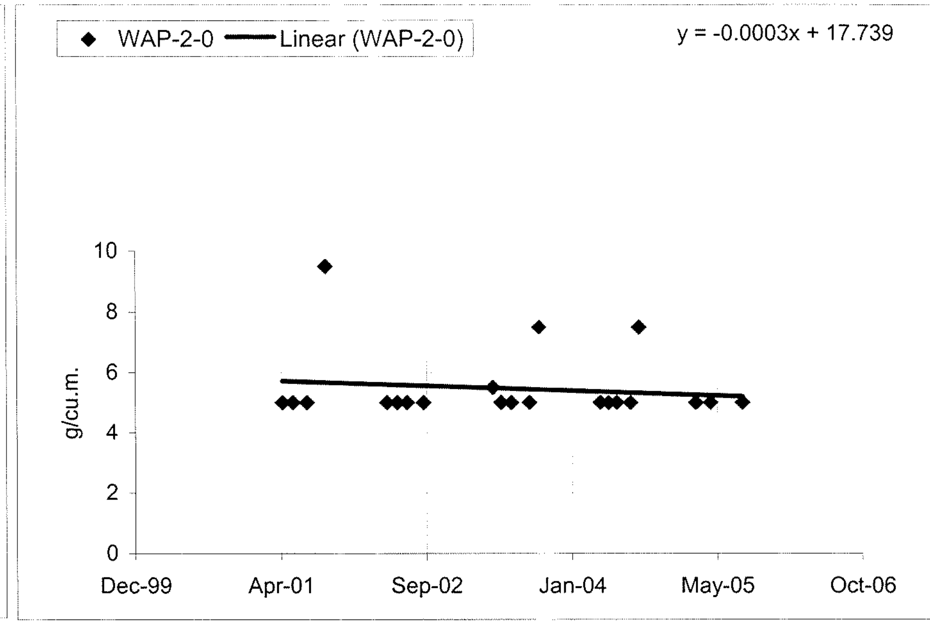




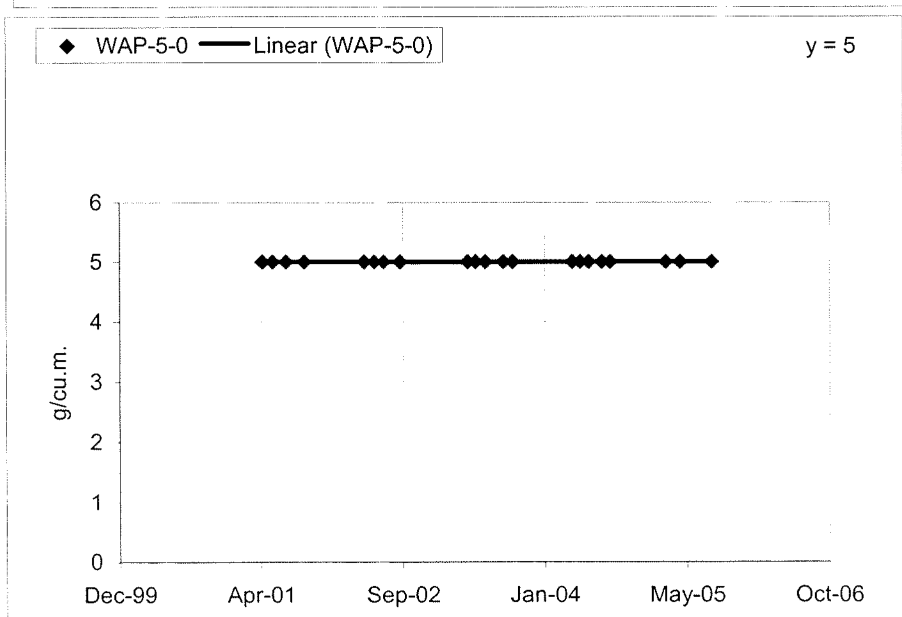
Pheophytin



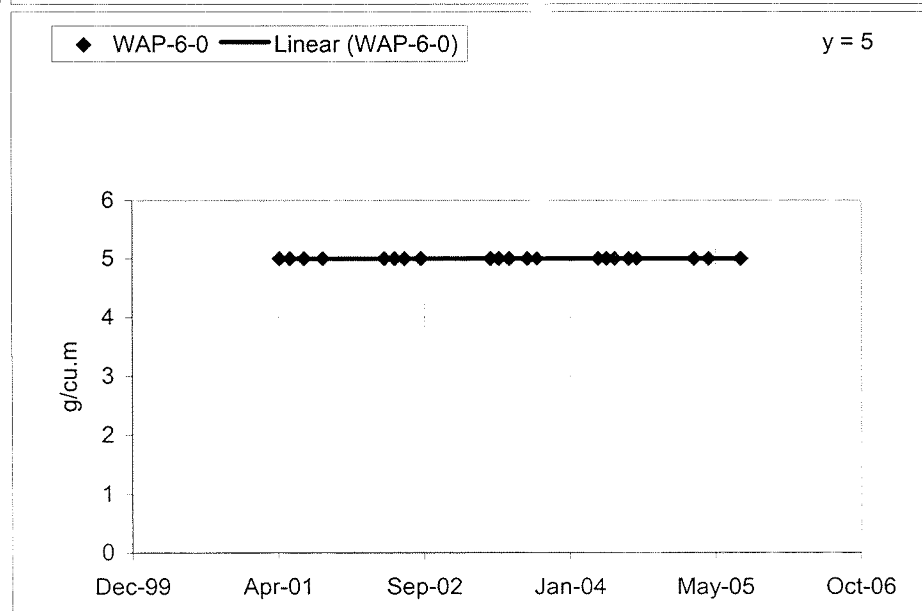
WAP-15-0
Linear (WAP-15-0)
y = 5
g/cu.m.
0
1
2
3
4
5
6
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06



WAP-2-0
Linear (WAP-2-0)
y = -0.0003x + 17.739
g/cu.m.
0
2
4
6
8
10
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

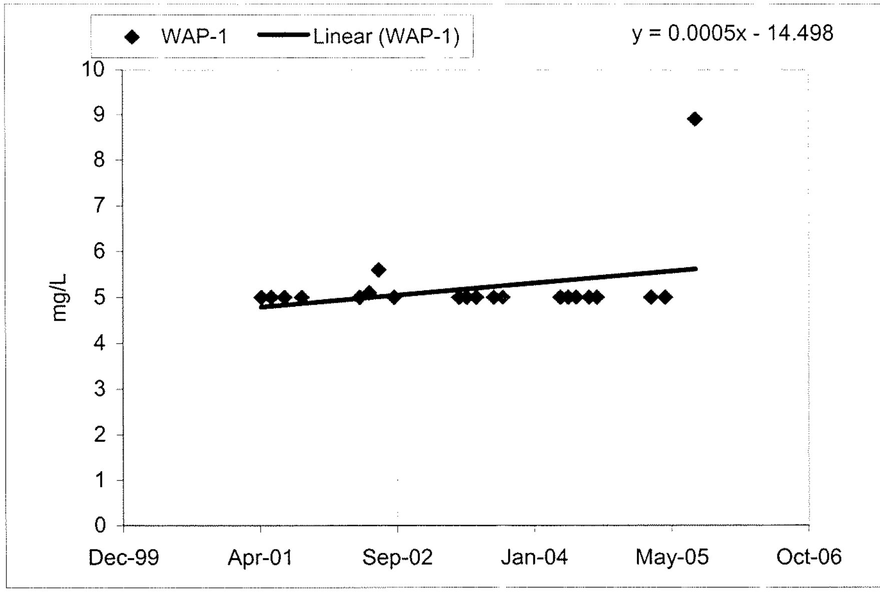


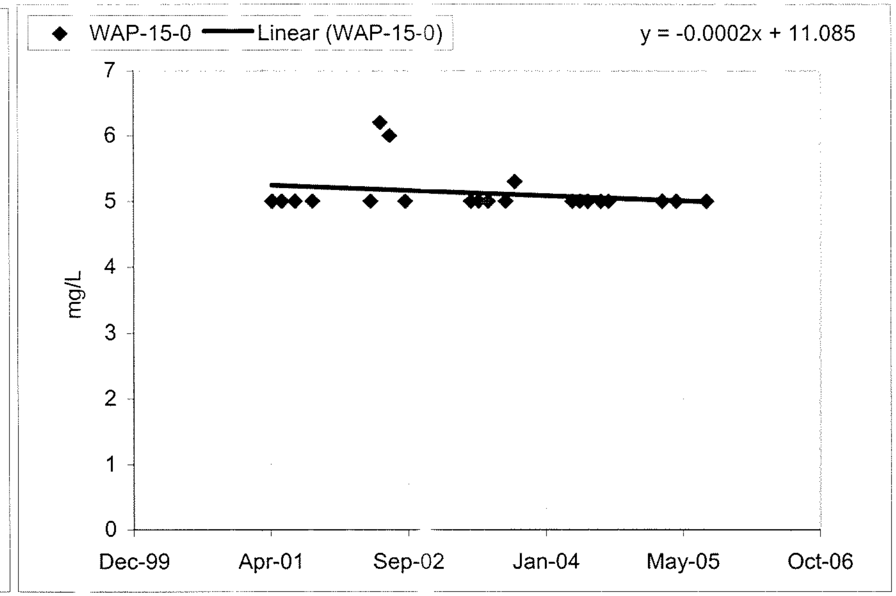
WAP-5-0
Linear (WAP-5-0)
y = 5
g/cu.m.
0
1
2
3
4
5
6
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

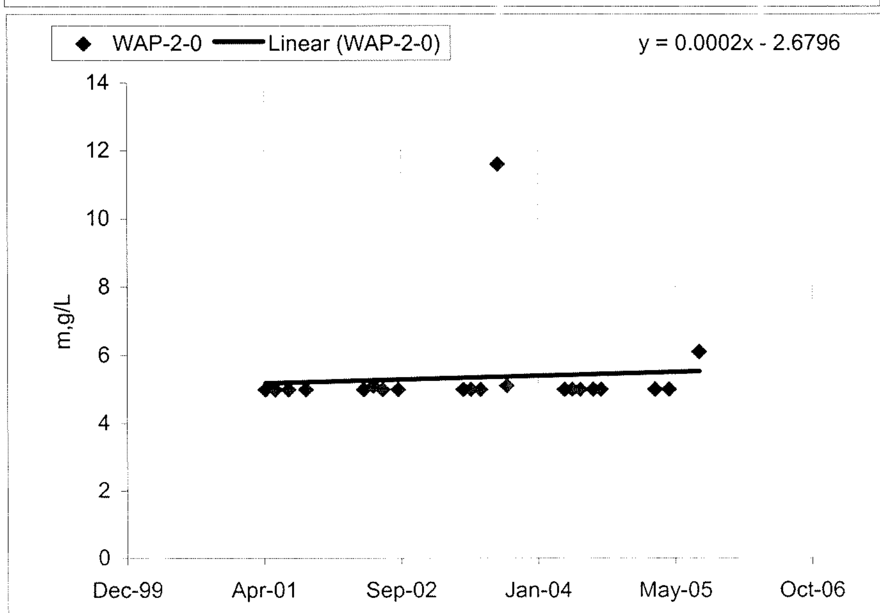


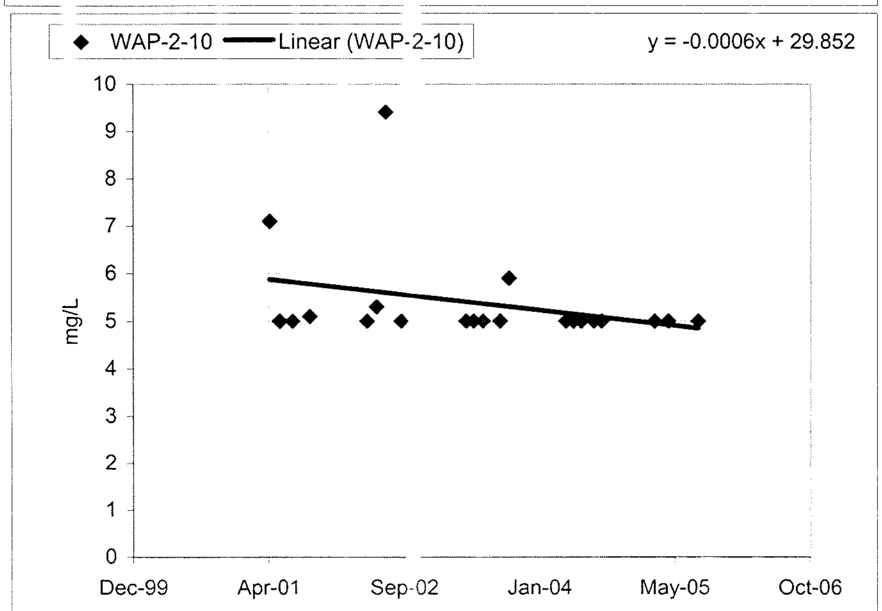
WAP-6-0
Linear (WAP-6-0)
y = 5
g/cu.m
0
1
2
3
4
5
6
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06

Total Organics Carbon (TOC)









Total Organics Carbon (TOC)