



**2006**  
**SHELBYVILLE LAKE**  
**WATER QUALITY**  
**REPORT**



U.S. ARMY CORPS OF ENGINEERS, ST. LOUIS DISTRICT  
ENVIRONMENTAL QUALITY SECTION – WATER QUALITY

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## **WATER QUALITY MONITORING PROGRAM**

### **1.0 GENERAL OVERVIEW**

This report summarizes water quality activities of the St. Louis District for Fiscal Year 2006 in accordance with ER 1110-2-8154 Water Quality & Environmental management for Corps Civil Works Projects and ETL 1110-2-362 Environmental Engineering Initiatives for Water Management.

Water quality monitoring remains one of the Sections major responsibilities. The objective is to maintain a reasonable environmental monitoring program for the Mississippi River and the 5 lakes under the St. Louis District's control. The District's reservoirs consist of Mark Twain and Wappapello Lakes in Missouri, and Shelbyville, Carlyle and Rend Lakes in Illinois. Water quality sampling is conducted within the lakes and their tributaries to establish trend analysis and maintain water quality at or above state and federal regulations.

The main objective is to provide technical expertise of an environmental nature to all Corps elements requesting assistance in accordance with ER 1110-2-8154. This would include updating the water quality management priorities for the district's projects to ensure water quality meets the state and federal regulations, for protection of human health and the environment, and for the safety and economic welfare of those at Corps projects. Ongoing goals include ensuring that downstream water quality meets all state and federal regulations, is suitable for aquatic and human life, and continue to evaluate trend analysis in relation to baseline conditions at all projects.

Water quality data is provided to the Illinois Environmental Protection Agency (IEPA) to be used in the Illinois Integrated Water Quality Report which is required every two years by the Clean Water Act Sections 303(d) and 305(b). IEPA does not typically monitor the three Corps lakes in Illinois. However, IEPA has stated that since the Corps lakes are the 3 largest lakes in the state, it is critical that their quality be routinely assessed. The state indicated that having the federally collected water quality data available now and in the future is critical to the state of Illinois meeting their mission in complying with the Clean Water Act Sections 305(b) and 303(d).

The National Water Quality Inventory Report to Congress 305(b) report is the primary vehicle for informing Congress and the public about general water quality conditions in the United States. This document characterizes our water quality, identifies widespread water quality problems of national significance, and describes various programs implemented to restore and protect our waters.

Under Section 303(d) of the 1972 Clean Water Act, states, territories and authorized tribes are required to develop a list of water quality limited segments. These waters on the list do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these

jurisdictions establish priority rankings for water on the lists and develop action plans, called as Total Maximum Daily Loads (TMDL), to improve water quality.

Currently the Illinois Environmental Protection Agency (IEPA) has listed Shelbyville Lake impaired for Total Suspended Solids and aquatic plants. The lists of sources for these impairments are runoff, crop production, shore modifications, and recreational pollution. Continued monitoring of the lake and its tributaries is vital in assisting the future assessment of the lake for these and other possible impairments. The water quality monitoring program represents the single metric that encompasses the overall health of the watershed as it is a direct measure of how well the environmental stewardship programs are working.

## **1.1 INTRODUCTION**

Shelbyville Lake is within the Kaskaskia River basin in central Illinois. The lake serves as a heavy recreational usage lake. The land surrounding the lake is used predominately for agriculture. Surrounding communities have existing industrial/commercial operations and residents which discharge wastewater into municipal wastewater treatment plants which ultimately discharge treated water into the Kaskaskia River basin. Agricultural runoff and municipal wastewater treatment facilities are the primary potential source of pollution into the Shelbyville Lake watershed. Additional sources are marinas, recreational watercraft discharges and wildlife fecal material runoff.

Water quality monitoring was conducted during 2006 to assure the safe conditions for human recreation, wildlife and aquatic life was maintained and managed within the lake system. The 2006 water quality monitoring program began in March and continued through September. During each sampling period one site was selected for quality control duplication and denoted as SBV-15. The locations of the six sampling sites are depicted on the lake map in Figure 1.

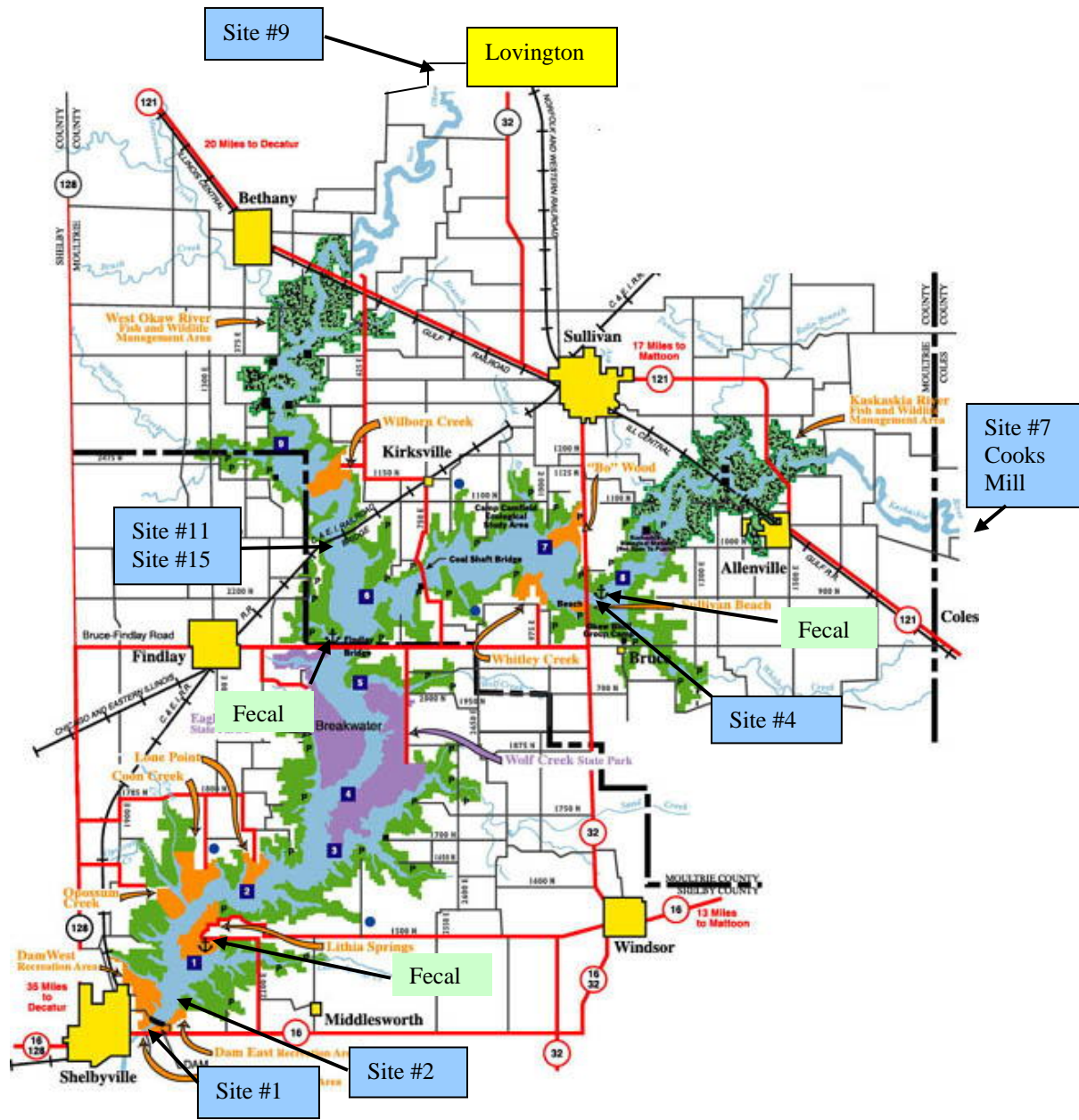


Figure 1  
Location of sample sites

## 2.0 WATER QUALITY ASSESSMENT CRITERIA

The water quality assessment criteria were based upon the State of Illinois regulatory limits for certain contaminants, which has been generally accepted criteria for sustaining adequate aquatic plant and animal growth. The samplings and analysis which were conducted at the Shelbyville Lake sites reflect the minimal set of parameters needed to analyze the current status of water quality for the Shelbyville Lake system.

The following parameters were analyzed in the Fiscal Year 2006 samplings at Shelbyville Lake: Total Organic Carbon (TOC), iron, manganese, ammonia-nitrogen, nitrate-nitrogen, orthophosphate, total phosphate, Total Suspended Solids (TSS), Total Volatile Suspended Solids (TVSS), fecal coliform, pH, temperature, dissolved oxygen, specific conductance, oxidation-reduction potential (ORP), chlorophyll, pheophytin-a, atrazine and alachlor,

The Illinois Environmental Protection Agency in Title 35, Subtitle, C, classifies water quality criteria based on end usage. Subpart B contains regulations for general use water, while subparts C and D delineate those for public and food processing water and secondary contact and indigenous aquatic life standards, respectively. These standards are used to determine the aquatic water quality of the lake. Table 2.1 provides a listing of the regulatory limits for the parameters analyzed where a limit has been established.

PARAMETER	LIMIT
Temperature	Rise of < 2.8°C above normal seasonal temp
Ammonia Nitrogen	< 15 mg/L
Nitrate Nitrogen	10 mg/L
Iron	2.0 mg/L
Manganese	1.0 mg/L
Phosphorous as Phosphate	0.05 mg/L
Fecal Coliform	< 500 colonies/100 ml
pH	Range: 6.5 to 9.0
DO	> 5.0 mg/L
Atrazine	0.003 mg/L (Drinking Water Standard)
Alachlor	0.002 mg/L (Drinking Water Standard)

Nitrogen is an essential component of proteins, genetic material, chlorophyll, and other key organic molecules. All organisms require nitrogen in order to survive. Nitrogen exists in several forms. These forms include gaseous nitrogen (N<sub>2</sub>), nitrites (NO<sub>2</sub>), nitrate (NO<sub>3</sub>), ammonia nitrogen (NH<sub>3</sub>-N), and ammonium (NH<sub>4</sub>). Ammonia can be toxic to fish and other aquatic organisms at certain levels. Unlike ammonia, ammonium (NH<sub>4</sub>) is not toxic to aquatic organisms and is readily available for uptake by plankton and macrophytes. Nitrogen levels have increased as human activities have accelerated the rate of fixed nitrogen being put into circulation. High nitrogen levels can cause eutrophication. Eutrophication increases biomass of

phytoplankton, decrease water transparency, and causes oxygen depletion. Ammonia nitrogen is monitored so that the effects on fish spawning, hatching, growth rate and pathologic changes in gills, liver and kidney tissue can be related to the detected levels of ammonia nitrogen. Nitrate-nitrogen degrades to nitrite or produces ammonia which has a detrimental effect on aquatic life and, therefore, has been monitored to assure levels are below the regulatory "safe" limit.

Phosphate has been analyzed as phosphorus and has been monitored due to the potential for uptake by nuisance algae. Levels of phosphate can indicate the potential for rapid growth of algae (algae bloom) which can cause serious oxygen depletion during the algae decay process. Phosphorous is typically the limiting nutrient in a water body. Therefore, addition of phosphorous to the ecosystem stimulates the growth of plants and algae. Phosphorous is delivered to lakes and streams by way of storm water runoff from agricultural fields, residential property, and construction sites. Other sources of phosphorous are anaerobic decomposition of organic matter, leaking sewer systems, waterfowl, and point source pollution. The general standard for phosphorous in lake water is 0.05mg/L. Dissolved phosphorous also called orthophosphorous is generally found in much smaller concentrations than total phosphorous and is readily available for uptake. For this reason dissolved phosphorous concentrations are variable and difficult to use as an indicator of nutrient availability.

The metals manganese and iron are nutrients for both plants and animals. Living organisms require trace amounts of metals. However, excessive amounts can be harmful to the organism. Heavy metals exist in surface waters in three forms, colloidal, particulate, and dissolved. Water chemistry determines the rate of adsorption and desorption of metals to and from sediment. Metals are desorbed from the sediment if the water experiences increases in salinity, decreases in redox potential, or decreases in pH. Metals in surface waters can be from natural or human sources. Currently human sources contribute more metals than natural sources. Metals levels in surface water may pose a health risk to humans and the environment.

Photosynthetic activity can be hindered by the levels of total suspended solids. Total suspended solids concentrations, which cause the photosynthetic activity to be reduced by more than 10% from the seasonably established norm, can have a detrimental effect on aquatic life. Soil particles, organic material, and other debris comprise suspended solids in the water column. Secchi disk measurements are inverse to suspended solid measurements. As the total suspended solids (TSS) increase, the secchi disk depth or water transparency decreases. Total suspended solids can be an important indicator of the type and degree of turbidity. TSS measurements represent a combination of organic (volatile) and inorganic (non-volatile) particles in the water. In order to more accurately determine the types and amounts of suspended solids, volatile suspended solids (VSS) are analyzed. VSS concentration represents the organic portion of the total suspended solids. Organic material often includes plankton and additional plant and animal debris that is present in water. Total volatile solids indicate the presence of organics in suspension and, therefore, show additional demand levels of oxygen.

Chlorophyll and pheophytin-a are monitored to provide indicators of algae growth and, therefore, potential oxygen depletion activity. Chlorophyll is measured in lakes to estimate the type and amount of algal productivity in the water column. Chlorophyll a is present in green algae, blue-green algae, and in diatoms. Chlorophyll a is often used to indicate the degree of

eutrophication. Chlorophyll b and c are used to estimate the extent of algal diversity and productivity. Chlorophyll b is common in green algae and is used as an auxiliary pigment for photosynthesis. Chlorophyll c is most common in diatom species and serves as an auxiliary pigment. Algal productivity and diversity can be determined by the concentrations of the individual pigments. For example high concentrations of chlorophyll a and b would indicate that green algae is abundant. High concentrations of chlorophyll a would indicate abundance of blue-green algae and concentrations of chlorophyll a and c would indicate diatoms are the dominant species. Chlorophyll production is currently being connected with hypoxia.

Fecal coliform bacteria is monitored for the protection of human health as it relates to full body contact of recreational waters. People can be exposed to disease-causing organisms, such as bacteria, viruses and protozoa in beach and recreational waters mainly through accidental ingestion of contaminated water or through skin contact. These organisms, called pathogens, usually come from the feces of humans and other warm-blooded animals. If taken into the body, pathogens can cause various illnesses and on rare occasions, even death. Waterborne illnesses include diseases resulting from bacteria infection such as cholera, salmonellosis, and gastroenteritis, viral infections such as hepatitis, gastroenteritis, and intestinal diseases, and protozoan infections such as amebic dysentery and giardiasis. The most commonly monitored recreational water indicator organisms are fecal coliform, *Escherichia coli*, (*E. coli*) and enterococci. Fecal coliform are bacteria that live in the intestinal tracts of warm-blooded animals. The standard for fecal coliform is less than 500 colonies per 100ml of sample water. Fecal coliform was originally recommended in 1968 by the Federal Water Pollution Control Administration (predecessor to EPA) as an effective water quality indicator organism for recreational waters. Recent studies indicate that fecal coliform show less correlation to illness than other indicator organisms such as *E. coli* and enterococci. The Environmental Protection Agency (EPA) currently recommends *E. coli* or enterococci as an indicator organism for fresh waters. Although *E. coli* and enterococci are more costly they may become the standard in the near future.

Atrazine and Alachlor herbicides are commonly used agricultural chemicals which can be readily transported by rainfall runoff. Both compounds are suspected of causing cancer and, therefore, were monitored for the protection of human and aquatic health. Organic compounds include many pesticides. A pesticide can be any substance that is intended to prevent, destroy, repel, or mitigate any pest. This includes insecticides, herbicides, fungicides, fumigants, algaecides and other substances. Herbicides which are pesticides used to kill vegetation are the most widely used and sampled. Ten of the most frequently used herbicides and detected in water are Atrazine, Metolachlor, Alachlor, 2,4-D, Trifluralin, Glyphosate, Dicamba, Cyanazine, Simazine, and 2,4,5-T. Two of the most widely used pesticides are Atrazine and Alachlor. Atrazine is a preemergence or postemergence herbicide use to control broadleaf weeds and annual grasses. Atrazine is most commonly detected in ground and surface water due to its wide use, and its ability to persist in soil and move in water. Alachlor is a Restricted Use Pesticide (RUP) due to the potential to contaminate groundwater. The drinking water standard for Atrazine is 0.003mg/L and 0.002 mg/L for Alachlor.

Temperature, dissolved oxygen and pH are monitored for the protection of aquatic life. Temperature is important because it controls several aspects of water quality. Cold water holds



more dissolved oxygen which is required by aquatic organisms. Plants grow more rapidly and use more oxygen in warmer water. Decomposition of organic matter which uses oxygen is accelerated in warmer water. Temperature can also determine the availability of toxic compounds such as ammonia. Since aquatic organisms are cold blooded, water temperature regulates their metabolism and ability to survive. The number and kinds of organisms that are found in streams or lakes is directly related to temperature. Certain organisms require a specific temperature range, such as trout, which require water temperatures below 20°C. Most aquatic organisms require a minimum concentration of dissolved oxygen to survive. In spring, surface waters of the lake mix with the water below through wind and thermal action. This mixing diminishes as the upper layer of water becomes warmer and less dense. Solar insolation during the summer months stratifies the lake into three zones. The upper warmer water zone is called the epilimnion and the lower cooler water zone is called the hypolimnion. The epilimnion and the hypolimnion zones are divided by a transition zone known as the metalimnion. The thermocline located within the metalimnion exhibits a rapid change in water temperature. During the summer months the hypolimnion may become anaerobic. In this anaerobic zone, chemical reduction of iron and manganese, or the production of methane and sulfides can occur. Iron rapidly oxidizes in aerobic environments, but manganese oxidizes slowly and can remain in the reduced state for long distances down stream even in aerobic environments. The degree of acidity of water is measured by a logarithmic scale ranging from 0 to 14 and is known as the pH scale. A reading of 7 indicates neutrality and readings below seven are acidic and above are alkaline. Most Illinois lakes range from 6 to 9 on the pH scale. The buffering capacity of water is the ability to neutralize acid better known as alkalinity. A high alkalinity concentration indicates an increased ability to neutralize pH and resist changes, whereas a low alkalinity concentration indicates that a water body is vulnerable to changes in pH.

Conductivity is a measure of a water's ability to conduct an electrical current. The ability to carry a current is often driven by the dissolved materials present in a water column. These materials can include dissolved ions and other materials in the water and thus are directly proportional to the concentration of total dissolved solids (TDS) present in the water column. Typically TDS concentrations represent 50-60% of the conductivity measurements. Conductivity is also affected by water temperature. The warmer the water, the higher the conductivity. Conductivity in streams and rivers is affected by the geology of the area. Streams running through granite areas tend to have lower conductivity due to granite being composed of inert material, materials that do not ionize or dissolve into ionic compounds in water. On the other hand streams that run through areas of limestone or clay soils tend to have higher conductivity readings because of the presence of materials that ionize. Conductivity is useful as a general measure of water quality. A stream tends to have a relatively constant range of conductivity that once established can be used as a baseline. Significant changes either high or low might indicate a source of pollution has been introduced into the water. The pollution source could be a treatment plant which raises the conductivity or an oil spill which would lower the conductivity.

Redox or Oxidation-Reduction Potential (ORP) is a measurement to oxidize materials. Oxidation involves an exchange of electrons between 2 atoms. The atom that loses an electron is oxidized and the one that gains an electron is reduced. ORP sensors measure the electrochemical potential between the solution and a reference electrode. Readings are expressed in millivolts

with positive readings indicating increased oxidizing potential and negative readings being increased reduction. The ORP probe is essentially a millivolt meter, measuring the voltage across 2 electrodes with the water in between. ORP values are used much like pH values to determine water quality. While pH readings characterize the state of a system relative to the receiving or donating hydrogen ions (base or acid), ORP readings characterize the relative state of losing or gaining electrons. The conversion of ammonia ( $\text{NH}_3$ ) requires an oxidating environment to convert it into nitrites ( $\text{NO}_2$ ) and nitrates ( $\text{NO}_3$ ). Ammonia levels as low as 0.002mg/L can be harmful to fish. Generally ORP readings above 400mV are harmful to aquatic life. However, ORP is a non-specific measurement which is a reflection of a combination of effects of all the dissolved materials in the water. Therefore, the measurement of ORP in relatively clean water has only limited utility unless a predominant redox-active material is known to be present.

Water clarity is intuitively used by the public to judge water quality. Secchi depth has been used for many years as a limnological characterization tool for characterizing water clarity. Secchi depth is a measure of light penetration into a waterbody and is a function of the absorption and scattering of light in the water. There are three characteristics of water which affect the penetration of light. The three factors are the color of water, amount of phytoplankton in the water column, and amount of inorganic material in the water column. Secchi depth integrates the combined impacts of all the factors which influence water clarity. Water transparency was measured using a Secchi disk. Secchi disk readings were taken at all lake sites.

### **3.0 SUMMARY OF MONITORING RESULTS**

The seasonal change brought on gradual lake stratification during the summer months. Fecal coli are sampled at the marinas to ensure that the marina areas are not being contaminated by boats with restroom facilities. Bacteria levels for all the marinas were below the Illinois standard of 500 colonies/100ml of sample water for the sampling period, April through September.

Total iron and total manganese are sampled above the dam near the bottom of the channel (SBV-2-10) and in the spillway area (SBV-1). As was previously stated living organisms require trace amounts of metals, however excessive amounts can be harmful to the organism. Iron exceeded the Illinois Standard of 1.0mg/L on June 29 at Site SBV-2-10 and manganese exceeded the 0.05mg/L drinking water and ground water standard on June 29 at sites SBV-1 and SBV-2-10. Iron cycling is a function of oxidation-reduction processes. Elevated levels of iron near the bottom of a lake is not immediately detrimental to the overall lake system. Iron oxidizes relatively rapidly (minutes to hours); therefore any iron released through the spillway will be oxidized in a short period of time.

Nitrogen and phosphates are sampled at all sites. The 2006 phosphate results at all sites are above the 0.05 mg/L standard. Because phosphorous in water is not considered directly toxic to humans and animals no drinking water standards have been established for phosphorous. However, phosphorous can cause health threats through the stimulation of toxic algal blooms and the resulting oxygen depletion. However, nitrates can pose a threat to human and animal health. Nitrate in water is toxic at high levels and has been linked to toxic effects of livestock and to

blue baby disease (methemoglobinemia) in infants. The Maximum Contaminant Level (MCL) for nitrate-N in drinking water is 10mg/L to protect babies 3 to 6 months of age. The Illinois Water Quality Standard for ammonia nitrogen (NH<sub>3</sub>-N) is 15mg/L. The increased levels of phosphate in combination with nitrogen and other lake conditions, such as temperature, pH and stagnant lake conditions, can lead to increased algae growth. Eutrophication is currently the most widespread water quality problem in the U.S. and many other countries. Restoration of eutrophic waters requires the reduction of nonpoint inputs of phosphorous and nitrogen. The resulting detrimental effects of algae toxins and oxygen depletion could result in health problems for fish and other aquatic species as well as land animals utilizing the water supply. There were no signs of any of these effects throughout 2006.

Chlorophyll *a* was sampled at 4 sites, SBV-2, SBV-4, SBV-11, and SBV-15. Chlorophyll *a* is a green pigment found in plants. Chlorophyll *a* concentrations are an indicator of phytoplankton abundance and biomass. They can be an effective measure of trophic status, and used as a measure of water quality. High levels often indicate poor water quality and low levels suggest good conditions. However, elevated levels are not necessarily bad. It is the long term persistence of elevated levels that is the problem. It is natural for chlorophyll *a* levels to fluctuate over time. Chlorophyll *a* tends to be higher after storm events and during the summer months when water temperatures and light levels are elevated. Chlorophyll can reduce the clarity of the water and the amount of oxygen available to other organisms. Illinois does not currently have a standard for chlorophyll. The data indicates a normal increase in chlorophyll levels during the warmer summer months, which is not a concern.

Atrazine and Alachlor are pesticides that were sampled at all sites. These chemicals are herbicides used to control weed growth. Atrazine exceeded the 3.0ug/L standard at SBV-7 on April 18 and had elevated levels at SBV-11 on June 29. The SBV-11 is located on the Okaw River arm near the C. & E. I. railroad bridge, and SBV-7 is located on the Kaskaskia River near Cooks Mill. The Shelbyville Lake watershed consists largely of cropland. The spike in Atrazine on April 18 was preceded by a rainfall event a few days before. These substances can enter water bodies as a result of drift during spraying, surface runoff, and leaching through soil. In order to eliminate pesticide contamination of waters it is important for the public to be educated and institute best manage practices when using these chemicals.

Total Suspended Solids (TSS) and Total Volatile Suspended Solids (TVSS) samples are collected at all sites. Solids can affect water quality by increasing temperature through the absorption of sunlight by the particles in the water, which also effects the clarity of the water. This can then effect the amount of oxygen in the water. Illinois does not currently have a standard for TSS or TVSS.

Total Organic Carbon (TOC) is collected at all sites. TOC is an indicator of the organic character of water. The larger the carbon or organic content, the more oxygen is consumed. The highest values for TOC occurred in September. This may be a result of plant material, which had grown all summer and begins to decay. Illinois does not currently have a standard for TOC.

Temperature and dissolved oxygen levels were taken at all sites. Measurements were taken at 1 meter intervals at the lake sites. During the summer months the lake stratifies and a

boundary is formed between the upper warmer water and the lower cooler water. This transition area is known as the thermocline, the area where the temperature drops significantly. Oxygen levels can also change drastically as a function of depth. This area where the oxygen level significantly drops is called the oxycline. The depth of the thermocline and oxycline can have an effect on the aquatic organisms. Occasionally the thermocline and oxycline are at or near the same depth.

pH is taken at all sites and at 1 meter intervals at lake sites. All sites were within the 6 to 9 pH range. Variances in pH can be caused by a rainfall event. Another cause may be that photosynthesis uses up dissolved carbon dioxide, which acts like carbonic acid ( $H_2CO_3$ ) in water.  $CO_2$  removal in effect reduces the acidity of the water thus the pH increases.

Conductivity and redox are taken at all sites and at 1 meter intervals at lake sites. Illinois does not currently have a standard for conductivity or redox. A faulty probe on one of the sondes gave erratic readings for redox during the May sampling event.

The monitoring program for Shelbyville Lake during Fiscal Year 2006 revealed good water quality when compared to limits established by the Illinois Environmental Protection Agency (IEPA) for general use, secondary contact, and indigenous aquatic life. Agricultural nutrient runoffs were primary concerns for the lake's water quality. Better land management practices, erosion control and buffering zones are methods used to reduce such contaminants from entering the lake. The St. Louis District personnel have been working continuously with lake personnel, area communities and other agencies in the implementation of educational programs and implementation planning to bring about the use of better management techniques to improve the lake's water quality.

A remote sensor was installed in the spillway to allow project as well as water quality personnel to monitor temperature and oxygen readings to avoid fish kills. During low flow, water is discharged through the sluice gates from the bottom of the lake. This water is low in oxygen and can create a low oxygen area below the dam. The sensor will allow the project to track oxygen levels below the dam and make appropriate adjustments to avoid a possible fish kill. Normally allowing water to spill through the tainter gates will alleviate low oxygen levels below the dam.

In addition to the regular water quality sampling EC-HQ conducted a water quality investigation on a bore hole that was discovered in the dam west area. Preliminary investigation indicated that city water was recharging the hole. The source of the water is still under investigation.

#### **4.0 PLANNED 2007 STUDIES**

The Shelbyville Lake water quality monitoring will continue in Fiscal Year 2007. A total of five sampling events will be conducted between February and September in 2007. Shelbyville Lake provides water supplies to many communities and is a high usage recreational lake. The monitoring of water quality is imperative to assure the water quality is within acceptable limits

for the designated usage.

The sampling plan will involve an intensive trend analysis of the contaminants entering Shelbyville Lake. The sampling sites include the following: Site 1 SBV-1 Spillway, Site 2 SBV-02 Lake side in front of Dam, Site 4 SBV-04 Kaskaskia River arm near Sullivan Marina, Site 7, SBV-7, at Cooks Mill, Site 9 SBV-9, at Hwy 32 at Lovington, and Site 11 SBV-11, Okaw River Arm near the C. & E. I. railroad bridge. This combination of sites effectively represents the incoming contaminants and their effects on the lake.

# **APPENDIX A**

## **DATA**

## LAB DATA

SITE	DEPTH (m)	DATE	TIME	TOC (mg/L)	Total Fe (mg/L)	Total Mn (mg/L)	NH <sub>3</sub> N (mg/L)	NO <sub>3</sub> - NO <sub>2</sub> (mg/L)	Ortho Phosphate (mg/L)	Total Phos (mg/L)	Total Suspended Solids (mg/L)	Total Volatile Suspended Solids (mg/L)
SVL-1	0	4/18/2006	0929	<5	0.31	0.02	0.26	7.90	0.03	0.13	12	3
SVL-1	0	5/23/2006	1347	<5	0.25	0.02	0.12	6.10	<0.01	0.06	8	<2
SVL-1	0	6/29/2006	1035	<5	0.27	0.20	0.35	4.70	0.01	0.05	6	<1.7
SVL-1	0	7/26/2006		10.0	0.10	0.06	0.10	4.60	<0.01	0.04	4	2
SVL-1	0	8/29/2006	0955	<5	0.08	0.03	0.04	2.90	<0.01	0.04	5	2
SVL-2	0	4/18/2006	1034	<5			0.24	8.20	0.02	0.11	9	4
SVL-2	0	5/23/2006	1040	<5			0.05	6.10	<0.01	0.06	7	3
SVL-2	0	6/29/2006	1116	5.2			0.05	5.60	<0.01	0.03	5	3
SVL-2	0	7/26/2006		<5			0.04	4.70	<0.01	0.03	3	1
SVL-2	0	8/29/2006	1146	5.2			0.03	3.20	<0.01	0.03	4	3
SVL-2-10	10	4/18/2006	1038	<5	0.23	0.03	0.40	7.70	0.06	0.10	14	3
SVL-2-10	10	5/23/2006	1047	<5	0.17	0.01	0.15	6.00	<0.01	0.04	5	<1.7
SVL-2-10	10	6/29/2006	1121	<5	8.50	0.47	0.07	5.20	0.05	0.46	912	37
SVL-2-10	10	7/26/2006		5.3	0.10	0.03	0.03	4.70	<0.01	0.04	5	2
SVL-2-10	10	8/29/2006	1153	7.7	0.05	0.04	0.03	3.00	<0.01	0.02	5	3
SVL-4	0	4/18/2006	1211	<5			0.14	11.90	0.08	0.32	63	9
SVL-4	0	5/23/2006	1230	<5			0.05	11.30	<0.01	0.13	21	4
SVL-4	0	6/29/2006	1430	<5			0.04	4.80	0.01	0.17	48	9
SVL-4	0	7/26/2006		6.5			0.04	2.50	<0.01	0.09	14	6
SVL-4	0	8/29/2006	1402	12.9			0.19	0.05	0.29	0.51	26	10
SVL-7	0	4/18/2006	1100	5.3			0.16	9.90	0.17	0.44	35	5
SVL-7	0	5/23/2006	1242	<5			0.04	11.10	0.05	0.13	24	2
SVL-7	0	6/29/2006	1245	<5			0.04	6.30	0.08	0.24	45	4
SVL-7	0	7/26/2006		<5			0.03	3.10	0.10	0.32	47	7
SVL-7	0	8/29/2006	1143	13.3			0.04	0.99	0.20	0.41	48	5

## LAB DATA

SITE	DEPTH (m)	DATE	STIME	TOC (mg/L)	Total Fe (mg/L)	Total Mn (mg/L)	NH <sub>3</sub> N (mg/L)	NO <sub>3</sub> - NO <sub>2</sub> (mg/L)	Ortho Phosphate (mg/L)	Total Phos (mg/L)	Total Suspended Solids (mg/L)	Total Volatile Suspended Solids (mg/L)
SVL-9	0	4/18/2006	1140	<5			0.10	14.90	0.06	0.13	12	<2
SVL-9	0	5/23/2006	1156	<5			0.06	10.70	<0.01	0.03	4	<1.3
SVL-9	0	6/29/2006	1321	<5			0.06	8.90	0.04	0.16	40	4
SVL-9	0	7/26/2006		<5			0.06	6.00	0.09	0.17	19	2
SVL-9	0	8/29/2006	1244	11.6			0.06	4.10	0.19	0.36	41	5
SVL-11	0	4/18/2006	1130	<5			0.17	12.40	0.13	0.27	18	3
SVL-11	0	5/23/2006	1203	<5			0.04	7.50	<0.01	0.08	15	6
SVL-11	0	6/29/2006	1401	<5			0.03	5.00	<0.01	0.08	15	5
SVL-11	0	7/26/2006		7.2			0.09	0.81	0.04	0.46	33	9
SVL-11	0	8/29/2006	1312	5.9			0.12	1.00	<0.01	0.14	17	6
SVL-15	0	4/18/2006	1137	<5			0.15	12.20	0.13	0.28	25	4
SVL-15	0	5/23/2006	1208	<5			0.04	7.70	<0.01	0.08	15	6
SVL-15	0	6/29/2006	1410	<5			0.11	5.00	<0.01	0.06	15	5
SVL-15	0	7/26/2006		5.1			0.04	2.60	<0.01	0.09	14	6
SVL-15	0	8/29/2006	1317	8.0			0.11	0.69	0.01	0.15	16	5



### LAB DATA

SITE	DEPT H (m)	DATE	STIME	Chlorophyll (mg/m <sup>3</sup> )	Pheophytin (mg/m <sup>3</sup> )	Atrazine (ug/L)	Alachlor (ug/L)
SVL-1	0	4/18/2006	0929		<	1.1 <	1.1
SVL-1	0	5/23/2006	1347		<	1.1 <	1.1
SVL-1	0	6/29/2006	1035		<	1.1 <	1.1
SVL-1	0	7/26/2006			J	0.8 <	1.0
SVL-1	0	8/29/2006	0955		J	0.7 <	1.1
SVL-2	0	4/18/2006	1034	21.8	5.2 <	1.0 <	1.0
SVL-2	0	5/23/2006	1040	11.1	<5 <	1.0 <	1.0
SVL-2	0	6/29/2006	1116	5.4	<5 <	1.1 <	1.1
SVL-2	0	7/26/2006		5.5	<5 J	0.8 <	1.0
SVL-2	0	8/29/2006	1146	11.0	<5 J	0.7 <	1.0
SVL-2-10	10	4/18/2006	1038				
SVL-2-10	10	5/23/2006	1047				
SVL-2-10	10	6/29/2006	1121				
SVL-2-10	10	7/26/2006					
SVL-2-10	10	8/29/2006	1153				
SVL-4	0	4/18/2006	1211	8.2	8.4 <	1.0 <	1.0
SVL-4	0	5/23/2006	1230	30.9	<5 J	0.9 <	1.0
SVL-4	0	6/29/2006	1430	38.5	11.6 J	1.1 <	1.1
SVL-4	0	7/26/2006		29.1	5.7 J	0.9 <	1.0
SVL-4	0	8/29/2006	1402	85.3	15.8 <	1.0 <	1.0
SVL-7	0	4/18/2006	1100			4.9 <	1.0
SVL-7	0	5/23/2006	1242		<	1.1 <	1.1
SVL-7	0	6/29/2006	1245		<	1.1 <	1.1
SVL-7	0	7/26/2006					
SVL-7	0	8/29/2006	1143		<	1.0 <	1.0

### LAB DATA

SITE	DEPT H (m)	DATE	STIME	Chlorophyll (mg/m <sup>3</sup> )	Pheophytin (mg/m <sup>3</sup> )	Atrazine (ug/L)	Alachlor (ug/L)
SVL-9	0	4/18/2006	1140			< 1.0	< 1.0
SVL-9	0	5/23/2006	1156			< 1.0	< 1.0
SVL-9	0	6/29/2006	1321			< 1.1	< 1.1
SVL-9	0	7/26/2006				< 1.0	< 1.0
SVL-9	0	8/29/2006	1244			< 1.0	< 1.0
						<	1.0
SVL-11	0	4/18/2006	1130	<5	<5	< 1.0	< 1.0
SVL-11	0	5/23/2006	1203	34.5	7.6	J 0.7	< 1.0
SVL-11	0	6/29/2006	1401	16.2	<5	2.4	< 1.1
SVL-11	0	7/26/2006		54.5	16.5	< 1.0	< 1.0
SVL-11	0	8/29/2006	1312	42.3	10.8	J 0.6	< 1.0
						<	1.0
SVL-15	0	4/18/2006	1137	<5	<5	< 1.0	< 1.0
SVL-15	0	5/23/2006	1208	33.6	5.6		
SVL-15	0	6/29/2006	1410	21.4	<5	1.7	< 1.1
SVL-15	0	7/26/2006		26.4	<5	1.1	< 1.0
SVL-15	0	8/29/2006	1317	49.9	13.3	< 1.1	< 1.1

<b>SITE</b>	<b>DEPTH (m)</b>	<b>DATE</b>	<b>STIME</b>	<b>FECALCOL (colonies /100ml)</b>
LS MARINA	0	5/23/2006	1030	8
LS MARINA	0	6/29/2006	1040	6
LS-MARINA	0	7/26/2006		2
LS MARINA	0	8/29/2006	1130	56
FIN MARINA	0	5/23/2006	1158	2
FIN MARINA	0	6/29/2006	1350	2
FIN-MARINA	0	7/26/2006		<2
FIN MARINA	0	8/29/2006	1251	20
SUL MARINA	0	7/26/2006		2
SUL MARINA	0	8/29/2006	1425	64

## FIELD DATA

Site	Date	Depth (m)	H2OTemp (°C)	Redox (mV)	Cond (uS/cm)	pH	D.O.%	D.O.(mg/L)	Time	Seechi (in.)
1	4/18/06	0.5	14.96	397	485	8.42	117	11.78	929	
1	5/23/06	0.4	16.85	375	431.9	8.02	106.9	10.1	1347	
1	6/29/06	0.9	18.32	20	421	7.38	104.3	9.79	1035	
1	7/25/06	0.6	25.75	305	433	8.15	109	8.79	707	
1	8/29/06	0.5	26.47	102	374	7.73	94.2	7.57	955	
2	4/18/06	0.3	15.37	379	483	8.49	124.5	12.36	1034	31
2	4/18/06	1.0	15.05	378	482	8.51	118.7	11.85	1034	
2	4/18/06	2.0	15.02	377	484	8.51	116.1	11.61	1035	
2	4/18/06	3.0	15.00	377	484	8.51	114.7	11.47	1036	
2	4/18/06	4.0	14.99	377	484.9	8.51	113.9	11.38	1037	
2	4/18/06	5.0	14.99	379	485	8.50	113.4	11.35	1037	
2	4/18/06	6.0	14.97	379	485	8.49	112.8	11.28	1038	
2	4/18/06	7.0	14.93	379	485	8.52	112.2	11.23	1038	
2	4/18/06	8.0	14.53	377	485	8.50	107.5	10.85	1037	
2	4/18/06	9.0	12.37	380	491.5	8.16	86.7	9.14	1040	
2	4/18/06	10.0	11.72	393	496	8.42	83.0	8.72	1041	
2	4/18/06	11.0	11.44	394	490	8.02	78.2	8.46	1042	
2	4/18/06	12.0	11.29	392	490	8.01	76.3	8.29	1042	
2	4/18/06	13.0	11.13	393	490	7.95	72.2	7.85	1043	
2	4/18/06	14.0	11.06	394	490	7.95	70.0	7.58	1044	
2	5/23/06	0.2	19.12	-38.6	18	7.57	150	13.86	1040	45
2	5/23/06	1.0	18.57	-31.7	200	7.94	149	13.98		
2	5/23/06	2.0	18.45	-31.7	253	8.05	142.5	13.36		
2	5/23/06	3.0	18.37	-30.2	257	8.11	140	13.09		
2	5/23/06	4.0	17.74	-29	265	8.12	128	12.19		
2	5/23/06	5.0	17.36	-28.5	263	8.10	116.8	11.18		
2	5/23/06	6.0	17.17	-27.6	280	8.06	112.7	10.70		
2	5/23/06	7.0	16.80	-28.4	469	8.09	98.0	9.38		
2	5/23/06	8.0	16.45	-28.3	467	8.06	88.0	8.45		
2	5/23/06	9.0	16.21	-30	483	8.05	78.6	7.76		
2	5/23/06	10.0	16.04	-32	483	8.03	73.0	7.12		
2	5/23/06	11.0	15.87	-33	487	7.97	64.9	7.35		
2	5/23/06	12.0	15.65	-34	489	7.97	54.8	5.36		

## FIELD DATA

Site	Date	Depth(m)	H2OTemp(°C)	Redox (mV)	Cond (uS/cm)	pH	D.O. %	D.O.(mg/L)	Time	Seechi (in.)
2	5/23/06	13.0	15.56	-37	490	7.96	49.8	4.85		
2	6/29/06	0.5	27.0	306	425	8.48	126	9.84	1116	54
2	6/29/06	1.5	26.2	305	424	8.53	116	9.24		
2	6/29/06	2.5	26.1	305	425	8.52	115	9.14		
2	6/29/06	3.5	26.0	309	427	8.45	114	9.06		
2	6/29/06	4.5	25.8	316	433	8.26	111	8.88		
2	6/29/06	5.5	24.7	330	445	7.81	98.1	7.99		
2	6/29/06	6.5	23.5	335	451	7.66	85.4	7.10		
2	6/29/06	7.5	22.1	116	453	7.60	70.6	6.08		
2	7/25/06	0.5	26.92	315	426	8.30	125	9.78	913	78
2	7/25/06	1.5	26.42	314	426	8.34	124	9.78		
2	7/25/06	2.5	26.86	311	426	8.38	124	9.73		
2	7/25/06	3.5	26.7	315	426	8.34	123	9.67		
2	7/25/06	4.5	26.5	324	433	7.95	120	9.44		
2	7/25/06	5.5	25.9	330	437	7.80	112	8.98		
2	7/25/06	6.5	25.1	376	444	7.73	102	8.31		
2	7/25/06	7.5	23.8	249	451	7.70	87.1	7.3		
2	7/25/06	8.5	22.8	132	455	7.68	78.5	6.59		
2	7/25/06	9.5	21.8	136	459	7.66	67.6	5.83		
2	7/25/06	10.5	20.0	143	465	7.65	52.8	4.67		
2	7/25/06	11.5	18.6	150	467	7.62	41.4	3.84		
2	7/25/06	12.5	17.3	140	470	7.59	32.0	3.01		
2	8/29/06	0.9	26.70	404	396	8.53	100	8.52	1146	42
2	8/29/06	1.0	26.71	386	396	8.54	100	7.84		
2	8/29/06	2.0	26.72	388	396	8.54	100	7.84		
2	8/29/06	3.0	26.72	387	396	8.55	100	7.84		
2	8/29/06	4.0	26.72	388	395	8.54	100	7.83		
2	8/29/06	5.0	26.72	387	395	8.56	100	8.83		
2	8/29/06	6.0	26.70	387	395	8.56	99	7.82		
2	8/29/06	7.0	26.70	387	395	8.57	99	7.82		
2	8/29/06	8.0	26.52	388	399	8.40	97	7.67		
2	8/29/06	9.0	26.26	396	404	8.20	95	7.54		

## FIELD DATA

Site	Date	Depth(m)	H2OTemp(°C)	Redox (mV)	Cond (uS/cm)	pH	D.O.%	D.O.(mg/L)	Time	Seechi (in.)
4	4/18/06	0.2	16.94	381	629	8.14	91.7	8.80	1211	5
4	4/18/06	1.0	16.86	377	631	8.21	91.6	8.79		
4	4/18/06	2.0	16.74	236	665	7.44	4.3	0.38	1214	
4	5/23/06	0.2	21.66	-36	25	8.01	155	13.99	1230	12
4	5/23/06	1.0	18.77	-33	390	7.93	157	14.70		
4	5/23/06	2.0	17.96	-42	727	7.89	116	11.00		
4	6/29/06	0.5	27.24	290	551	8.39	128.0	10.00	1430	13
4	6/29/06	1.5	26.10	297	565	8.17	114.0	9.08		
4	6/29/06	2.0	26.10	239	568	7.51	114.0	9.08		
4	7/24/06	0.5	27.3	281	427	8.70	131	10.1		11
4	7/24/06	1.5	27.2	286	437	8.61	128	10.0		
4	8/29/06	0.5	26.72	351	474	12.08	154	8.46	1402	9
4	8/29/06	1.0	26.54	353	480	11.79	150	8.35		
4	8/29/06	2.0	26.49	357	485	11.75	149	8.16		
7	4/18/06	1.2	15.03	96.7	432	8.24	84.3	8.49	1100	
7	5/23/06	0.7	17.34	373	678	7.9	96.5	9.0	1242	
7	6/29/06	0.7	23.69	-3.8	626	7.28	86.5	7.32	1245	
7	7/25/06	0.1	27.00	304	591	8.19	125	9.54		
7	8/29/06		24.28	90	546	7.55	76.2	6.30	1143	
9	4/18/06	0.4	11.78	103.1	537	8.14	105.4	11.53	1140	
9	5/23/06	0.6	15.04	383	655.9	7.81	94.1	9.22	1156	
9	6/29/06	0.6	21.87	-5.5	605	7.51	96.4	8.42	1321	
9	7/25/06	0.1	24.9	353	690	7.89	100	8.14	1503	
9	8/29/06		21.67	62	476	7.48	84.6	7.43	1244	
11	4/18/06	0.2	17.77	381	460.9	8.10	88.2	8.32	1130	10
11	4/18/06	1.0	17.77	377	462	8.19	88.1	8.31	1131	

## FIELD DATA

Site	Date	Depth(m)	H2OTemp(oC)	Redox (mV)	Cond (uS/cm)	pH	D.O. %	D.O.(mg/L)	Time	Secchi (in.)
11	4/18/06	2.0	17.76	375	460	8.20	87.9	8.29	1132	
11	4/18/06	3.0	17.69	375	452	8.21	88.2	8.34	1132	
11	4/18/06	4.0	17.51	377	447	8.18	85.1	8.06	1133	
11	4/18/06	5.0	17.41	379	446	8.03	76.3	7.26	1134	
11	4/18/06	6.0	16.99	382	437	7.86	63.5	6.10	1135	
11	4/18/06	7.0	15.65	388	412	7.76	49.1	4.80	1136	
11	5/23/06	0.2	19.31	-42.2	23	7.55	175	16.23	1203	19
11	5/23/06	1.0	18.72	-39	28	7.39	178.7	16.56		
11	5/23/06	2.0	18.59	-37	294	7.30	178	16.83		
11	5/23/06	3.0	17.04	-38.8	304	7.24	130	12.57		
11	5/23/06	4.0	17.02	-40.6	307	7.25	122.6	11.80		
11	5/23/06	5.0	16.85	-40	310	7.24	119	11.40		
11	5/23/06	6.0	16.73	-41	315	7.23	108	10.53		
11	5/23/06	7.0	16.67	-42	331	7.27	96.3	9.26		
11	6/29/06	0.5	28.03	260	455	8.67	139	10.67	1401	53
11	6/29/06	1.5	26.84	267	456	8.52	127	9.82		
11	6/29/06	2.5	25.8	277	458	8.40	110	8.83		
11	6/29/06	3.5	25.6	281	458	8.34	108	8.71		
11	6/29/06	4.5	25.4	288	460	8.23	106	8.57		
11	6/29/06	5.5	24.4	232	481	7.73	93.0	7.65		
11	6/29/06	6.5	23.7	121	491	7.61	86.1	7.16		
11	6/29/06	7.4	23.5	79	492	7.57	84.1	7.07		
11	7/24/06	0.5	27.5	300	398	8.60	133	10.3		27
11	7/24/06	1.5	27.5	300	397	8.59	133	10.3		
11	7/24/06	2.5	27.5	302	396	8.55	132	10.2		
11	7/24/06	3.5	27.4	303	395	8.48	132	10.2		
11	7/24/06	4.5	27.3	311	396	8.2	130	10.1		
11	7/24/06	5.5	27.3	312	396	8.1	130	10.1		
11	7/24/06	6.5	27.3	309	397	8.1	130	10.1		

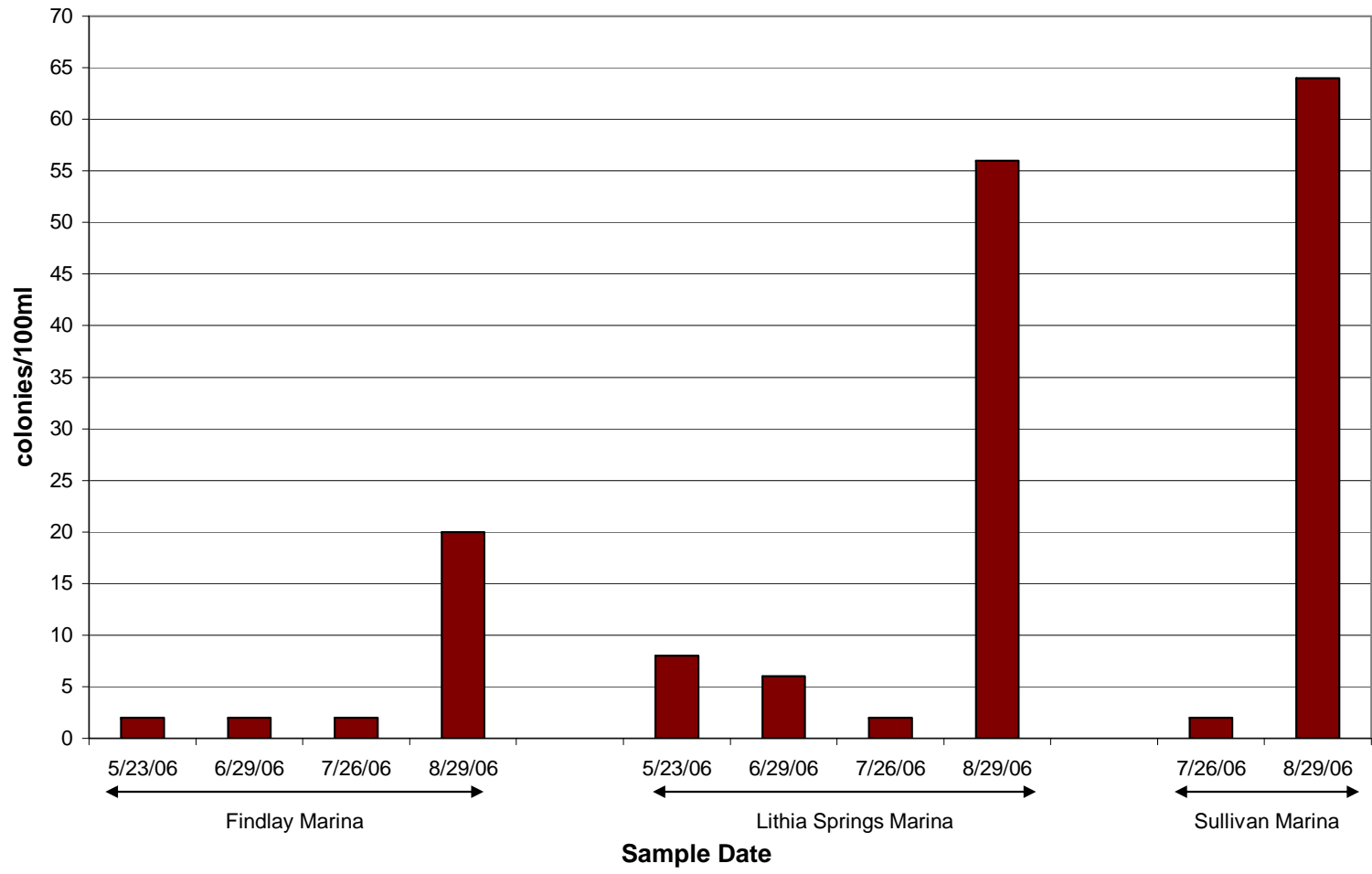
Site	Date	Depth(m)	H2OTemp(oC)	Redox (mV)	Cond (uS/cm)	pH	D.O.%	D.O.(mg/L)	Time	Seechi (in.)
11	7/24/06	7.5	27.3	300	299	8.07	129	10.0		
11	7/24/06	8.5	26.9	64	407	7.77	124	9.7		
11	8/29/06	0.3	26.47	364	372	8.32	149	11.74	1312	12
11	8/29/06	1.0	26.51	362	371	8.34	149	11.76		
11	8/29/06	2.0	26.52	361	371	8.36	150	11.79		
11	8/29/06	3.0	26.52	361	371	8.38	150	11.78		
11	8/29/06	4.0	26.52	362	371	8.33	150	11.78		
11	8/29/06	5.0	26.51	362	370	8.32	149	11.77		
11	8/29/06	6.0	26.51	362	370	8.32	149	11.72		
11	8/29/06	7.0	26.51	363	371	8.31	150	11.78		
11	8/29/06	8.0	26.51	363	372	8.30	150	11.78		



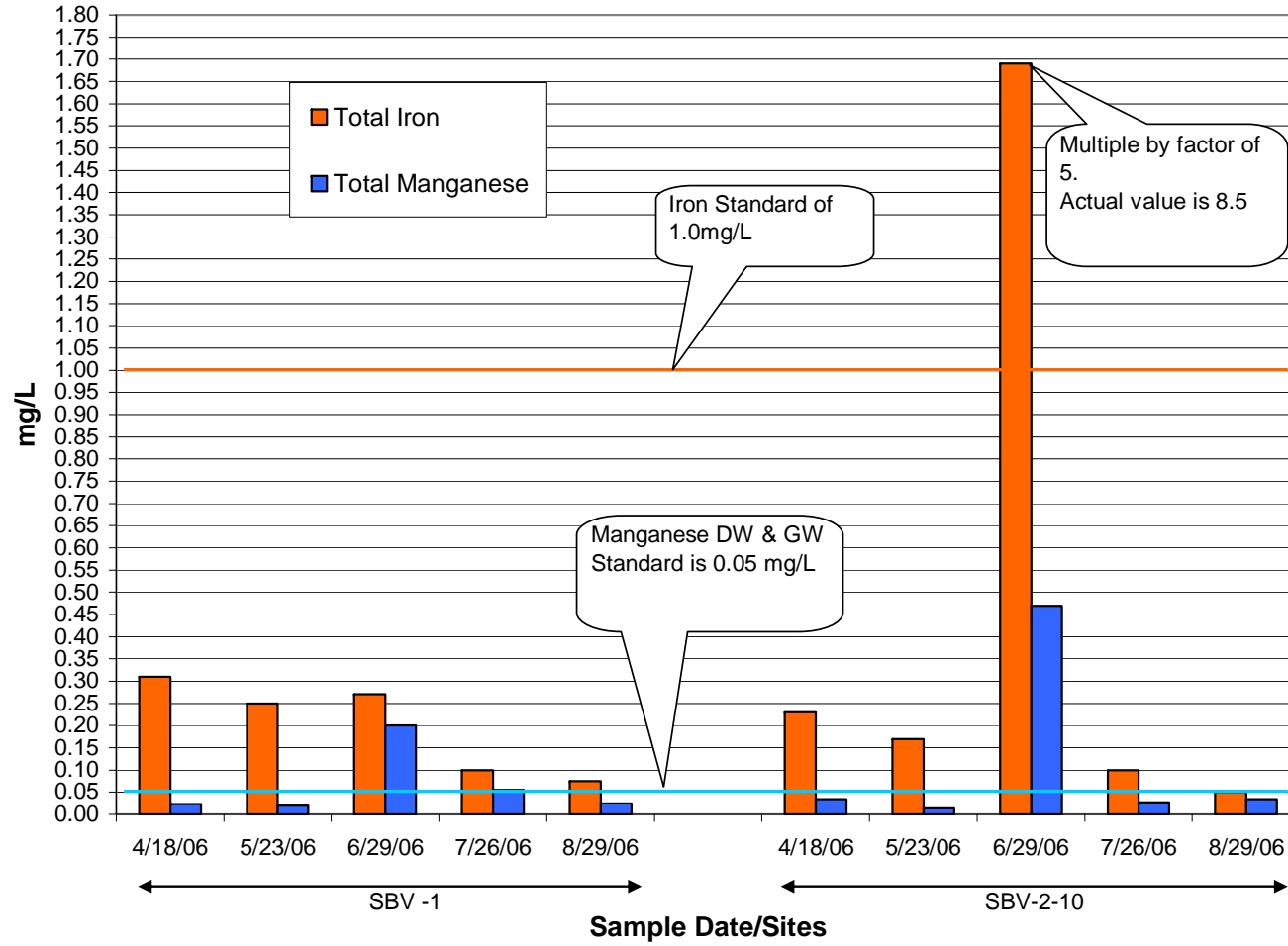
## **APPENDIX B**

### **LAB DATA GRAPHS**

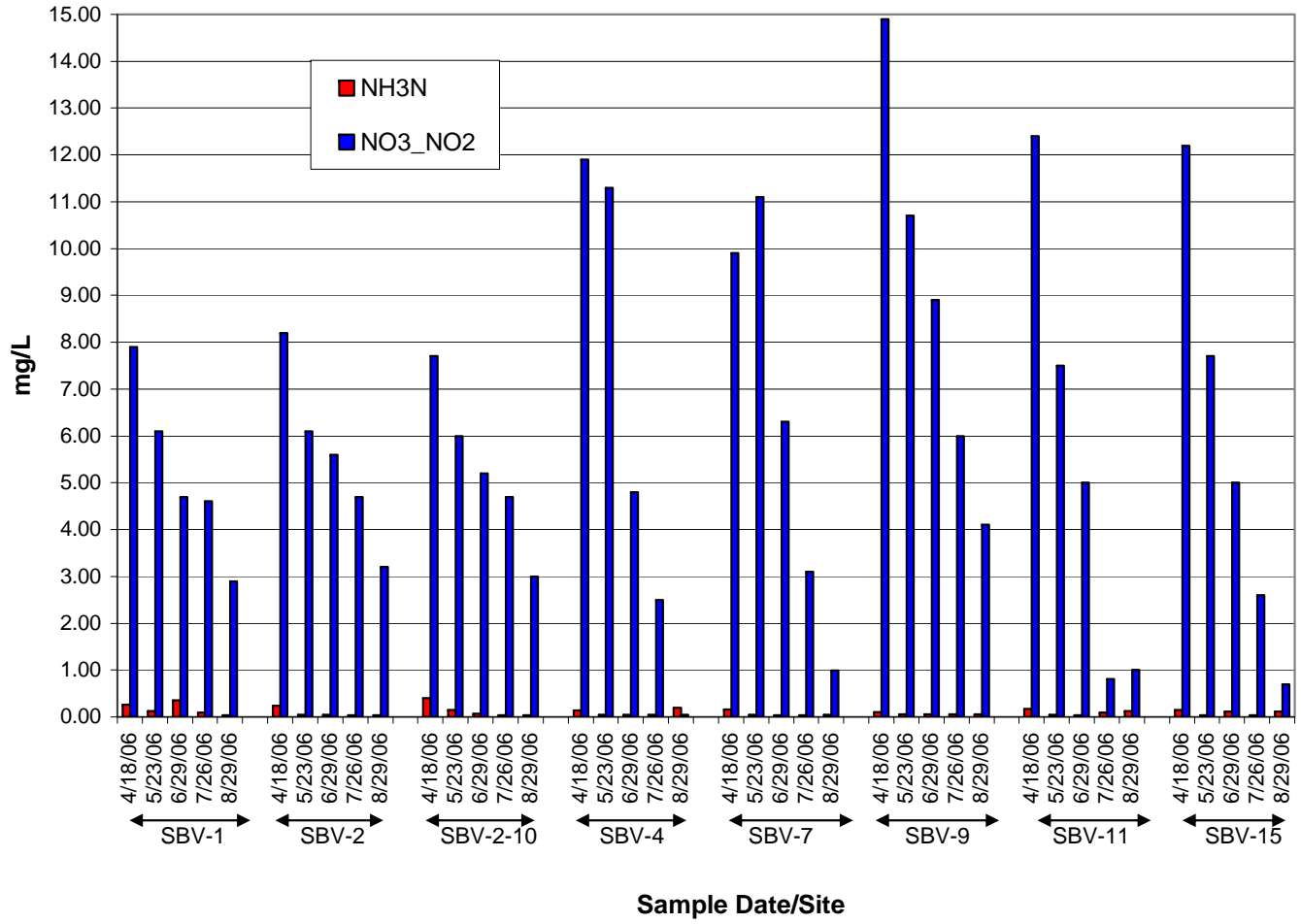
### Fecal Coliform



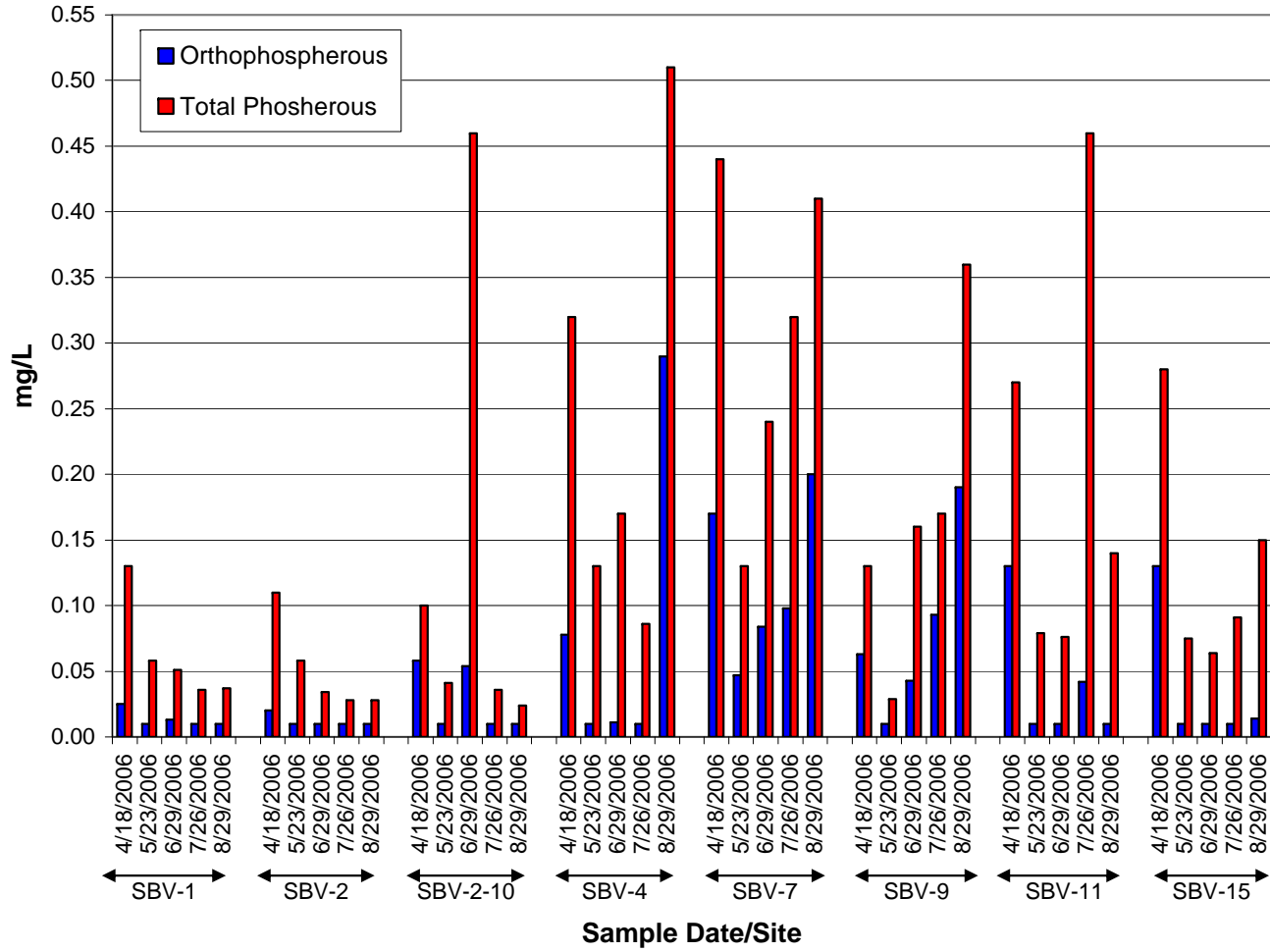
### Metals



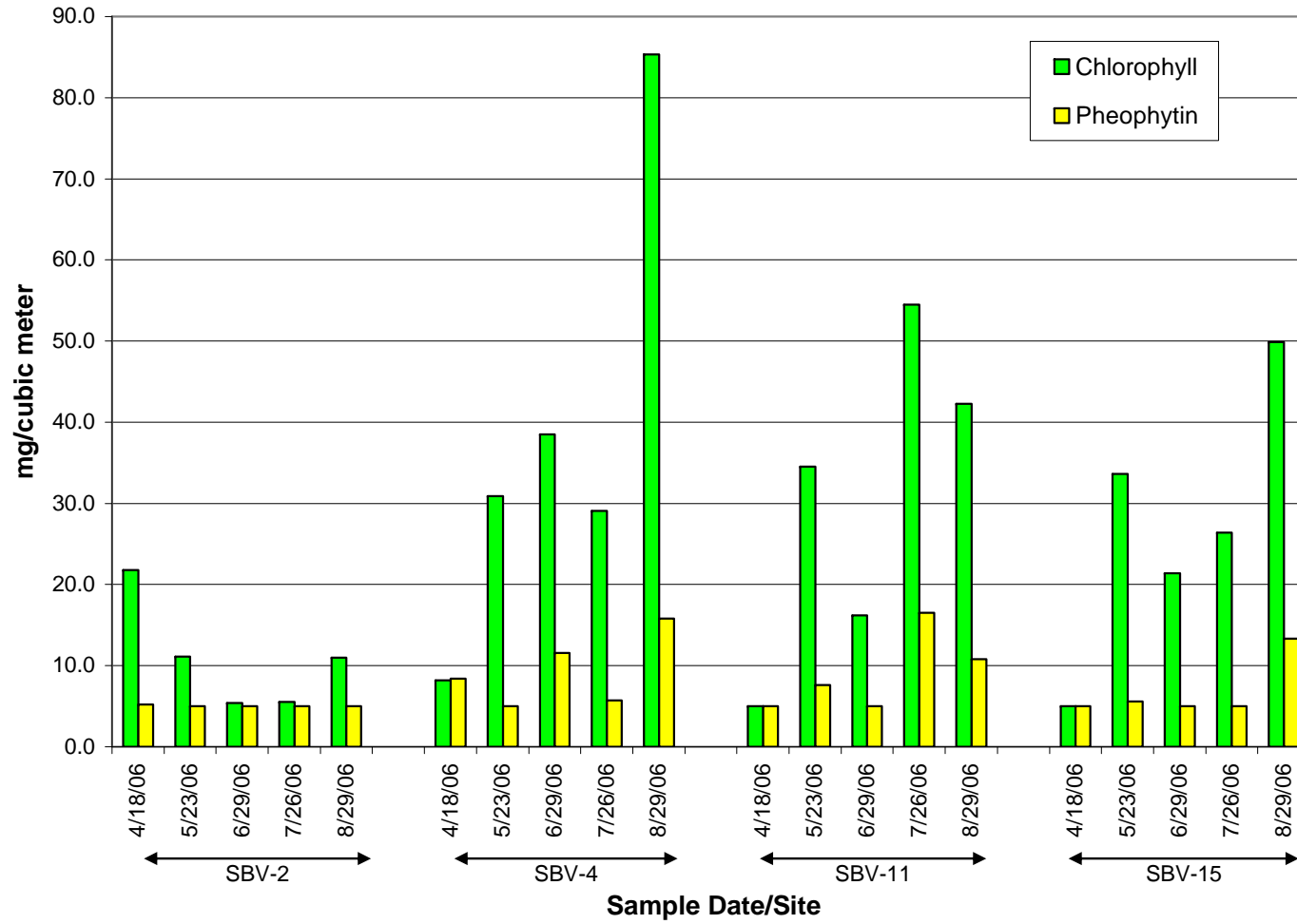
### Nitrogen



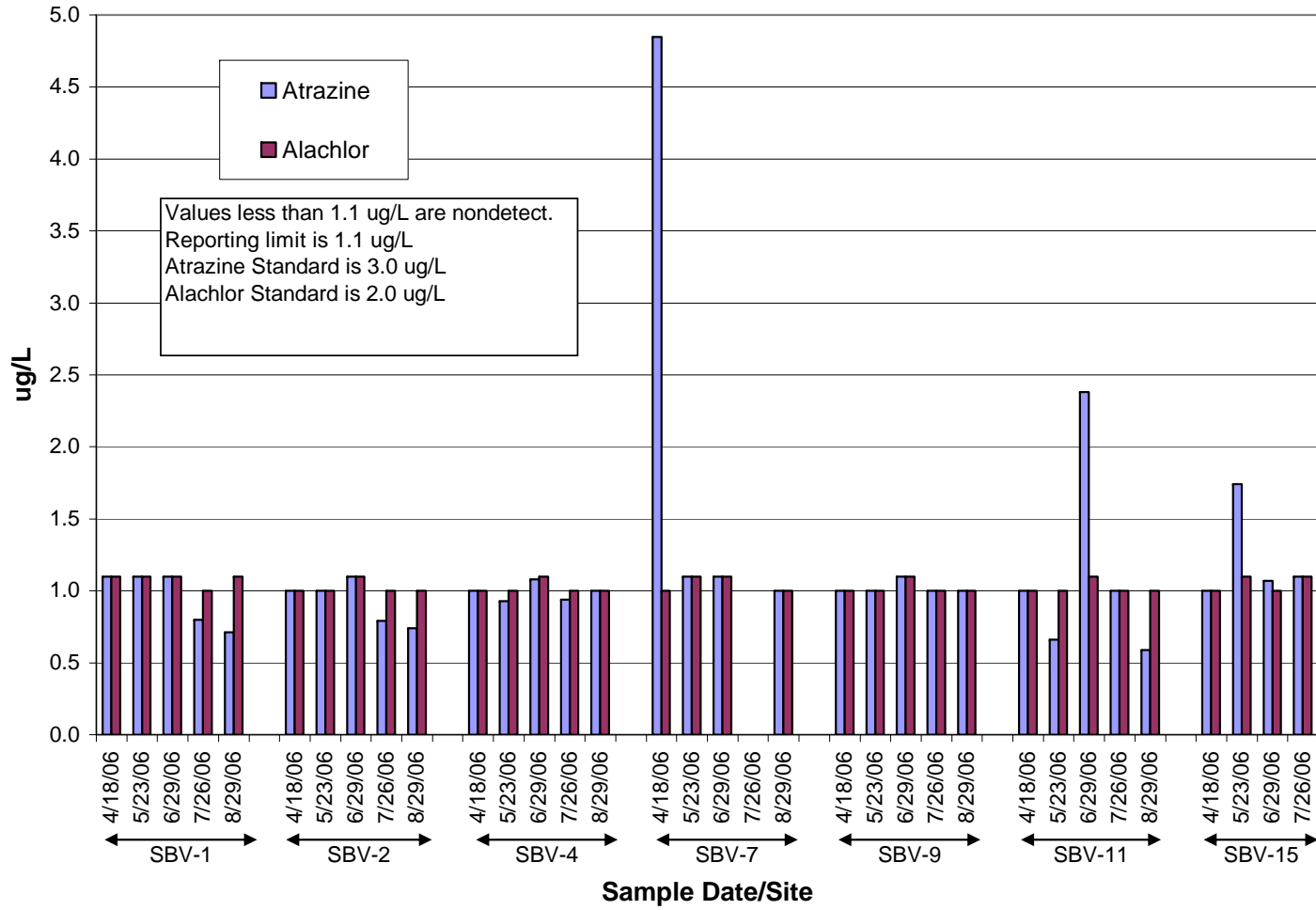
### Phosphorous



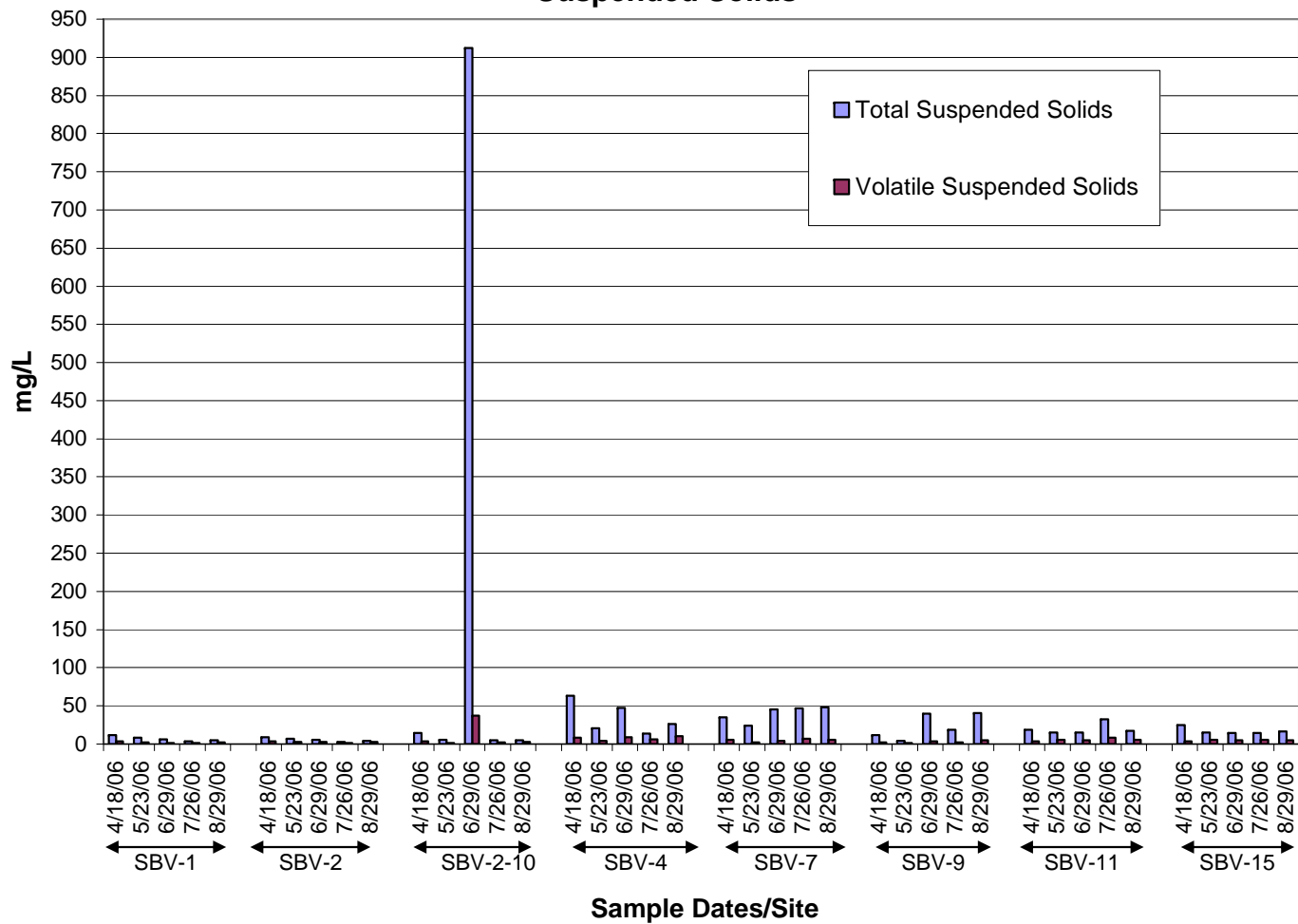
### Chlorophyll & Pheophytin



### Pesticides

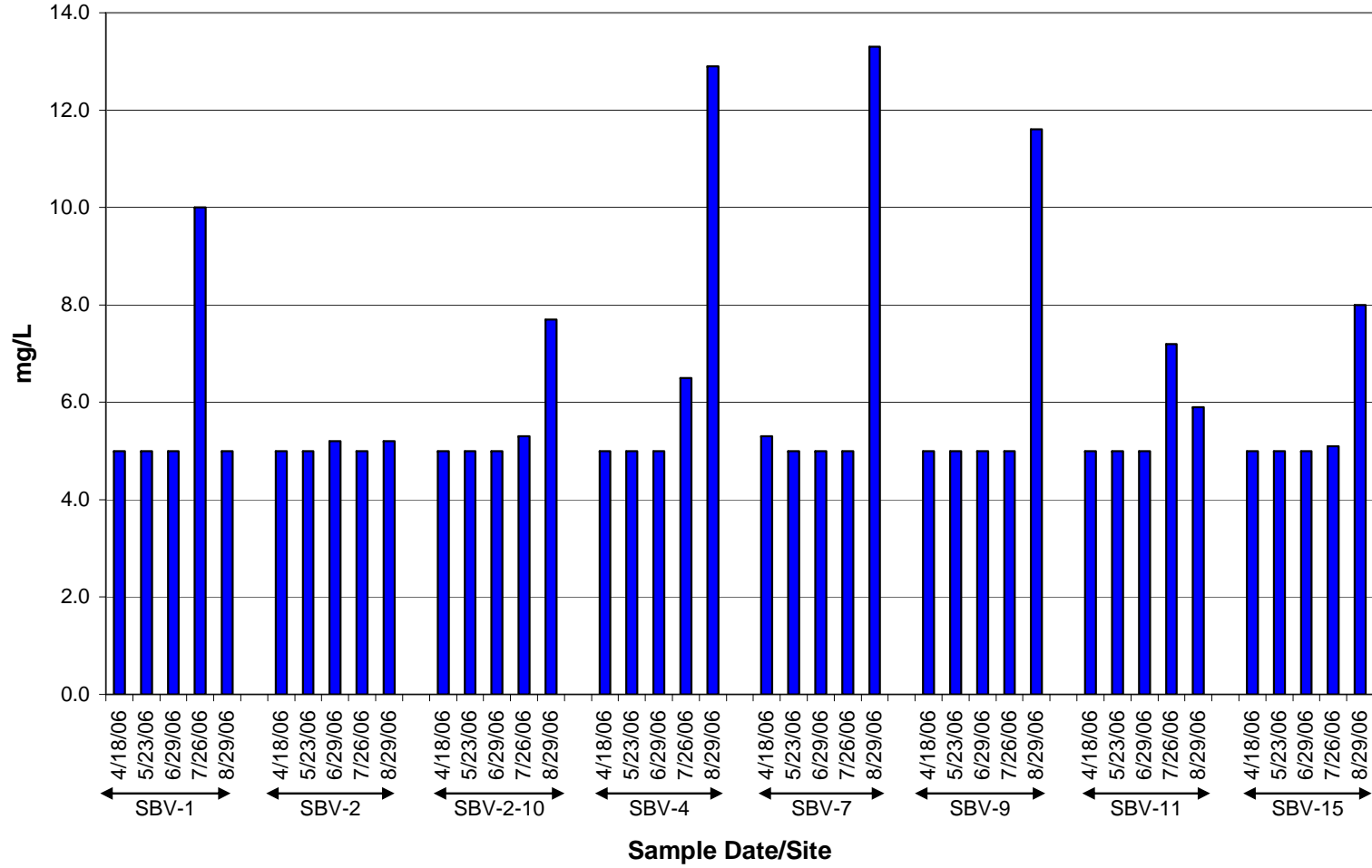


### Suspended Solids





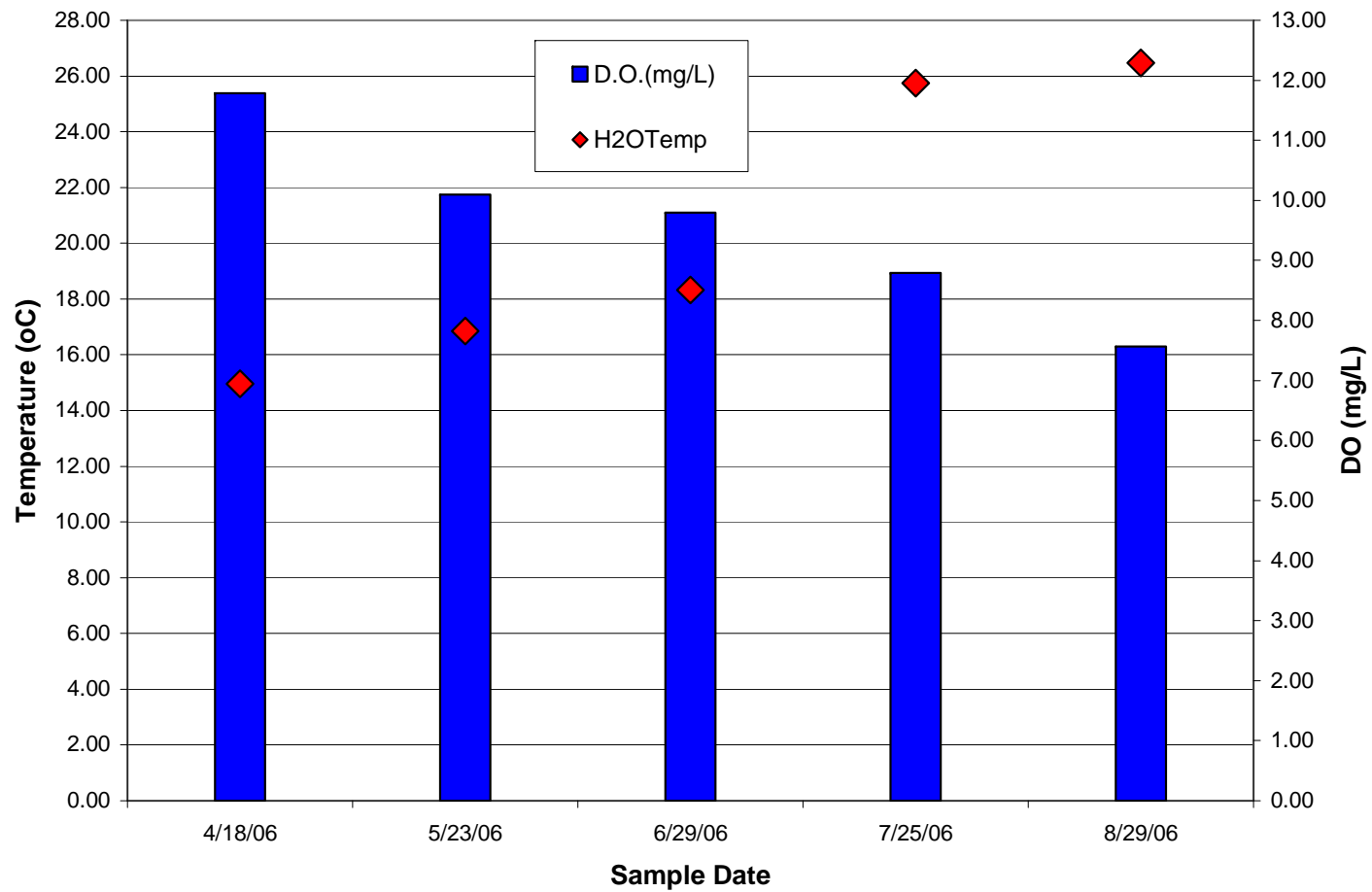
### Total Organic Carbon



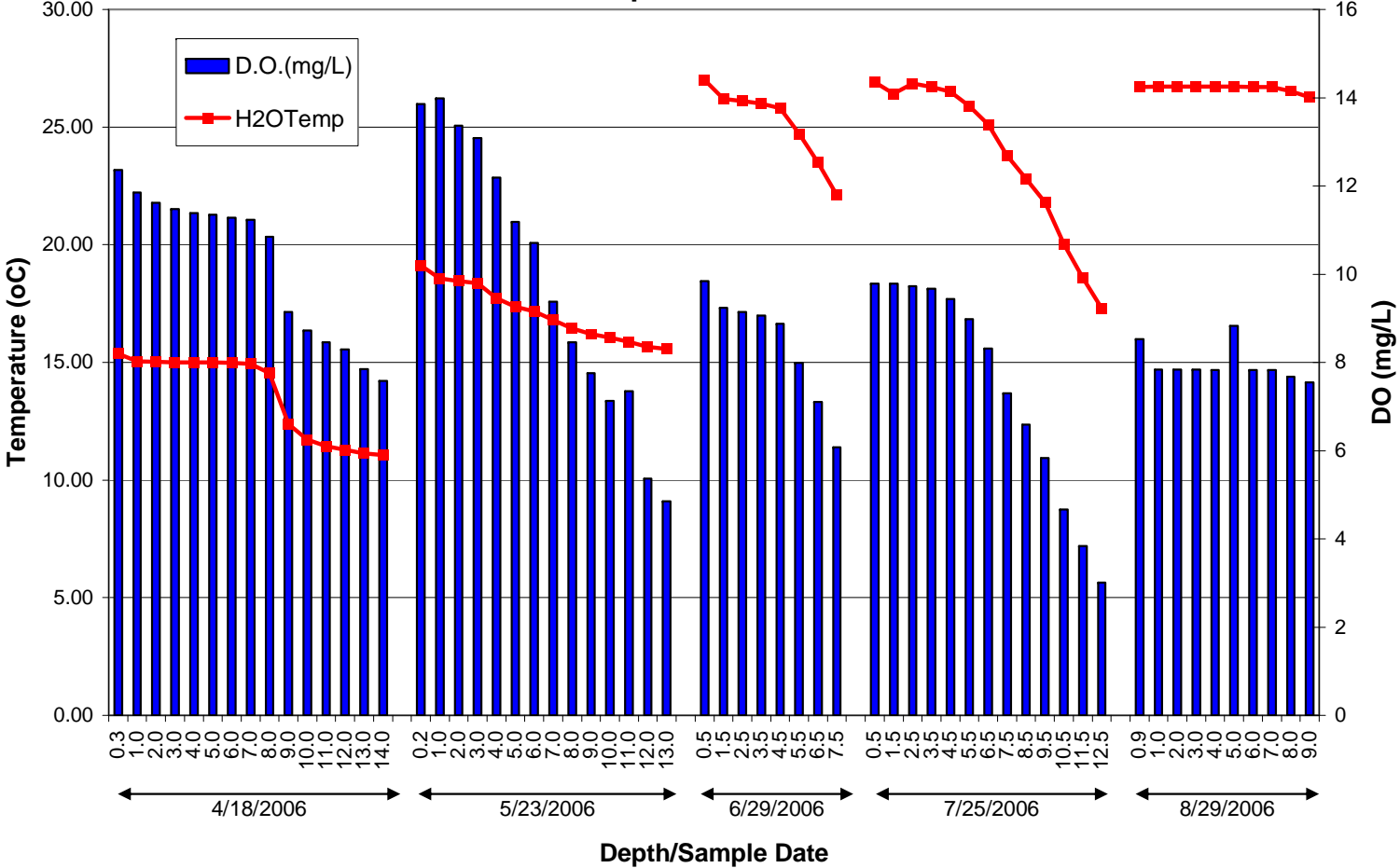
## **APPENDIX C**

### **FIELD DATA GRAPHS**

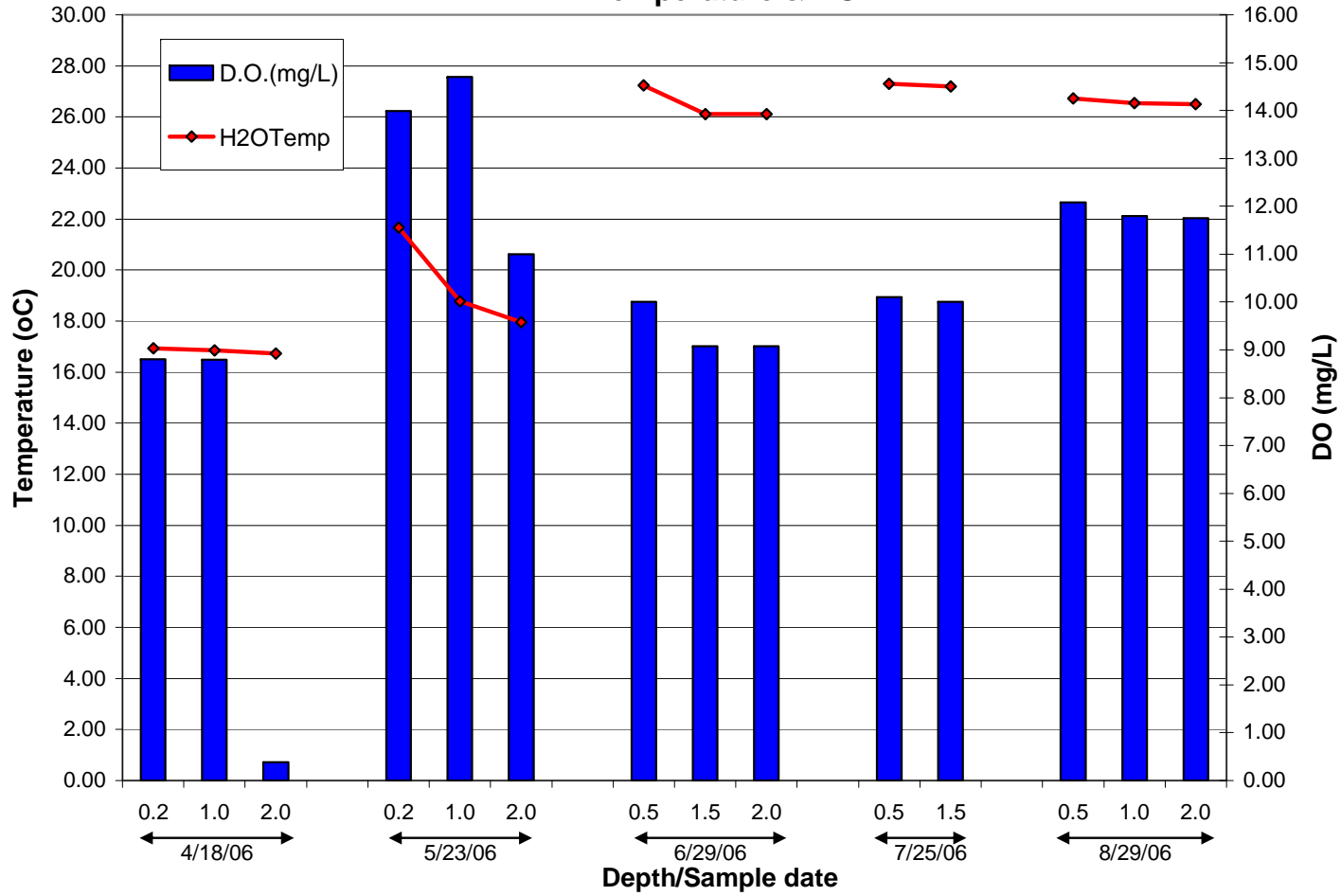
### Site 1 Spillway Temperature & DO



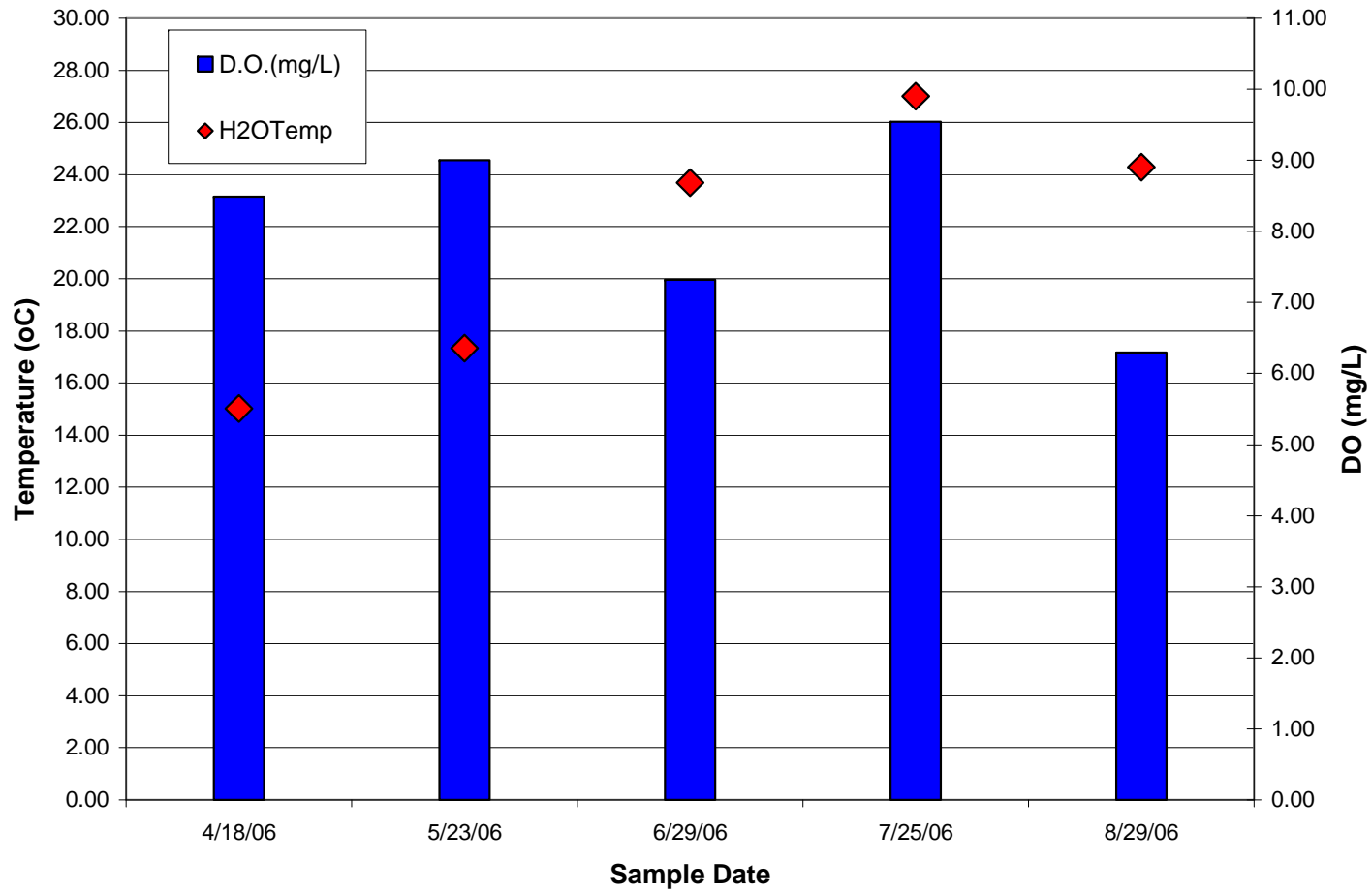
### Site 2 Lake Side of Dam Temperature & DO



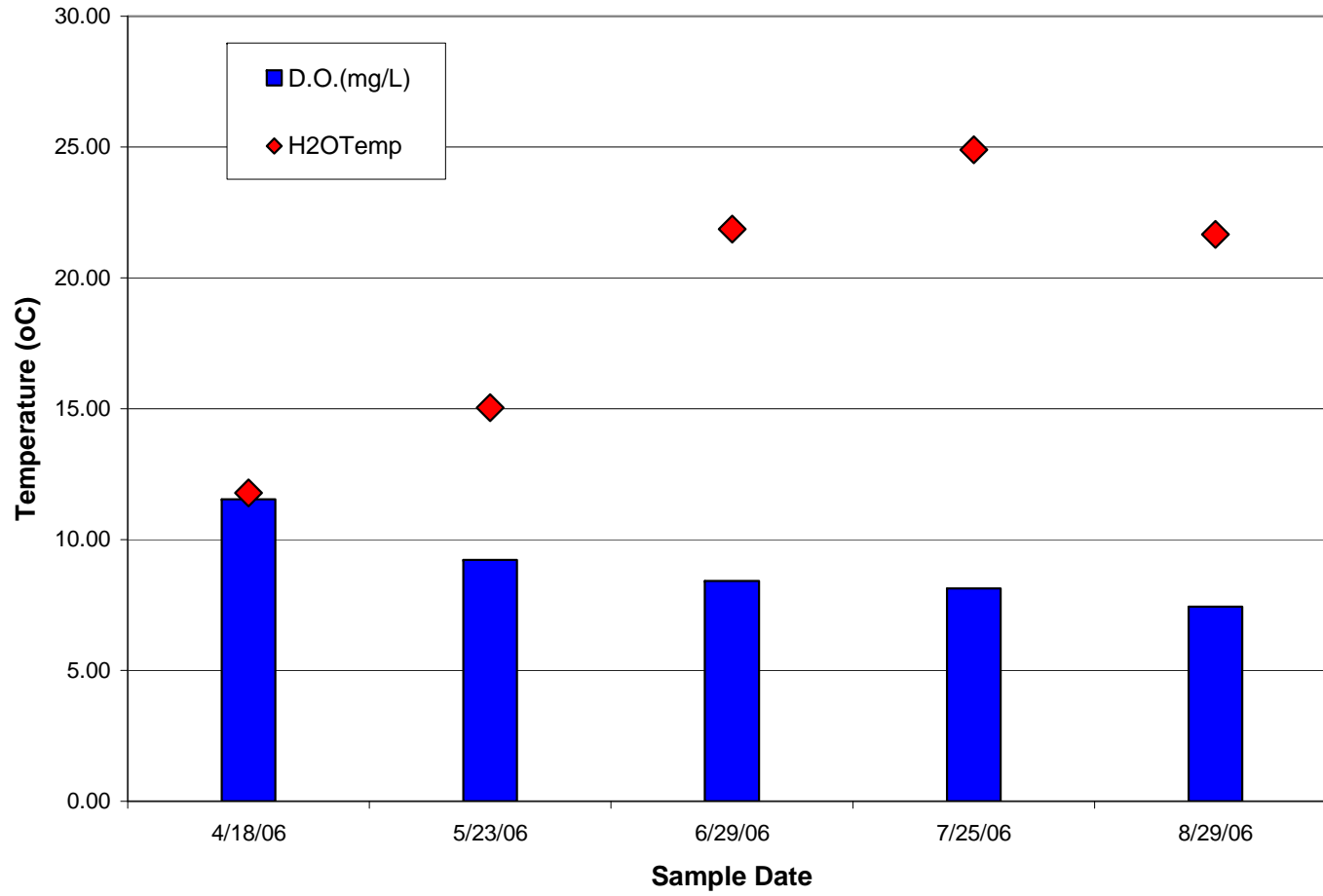
### Site 4 Kaskaskia Arm Temperature & DO



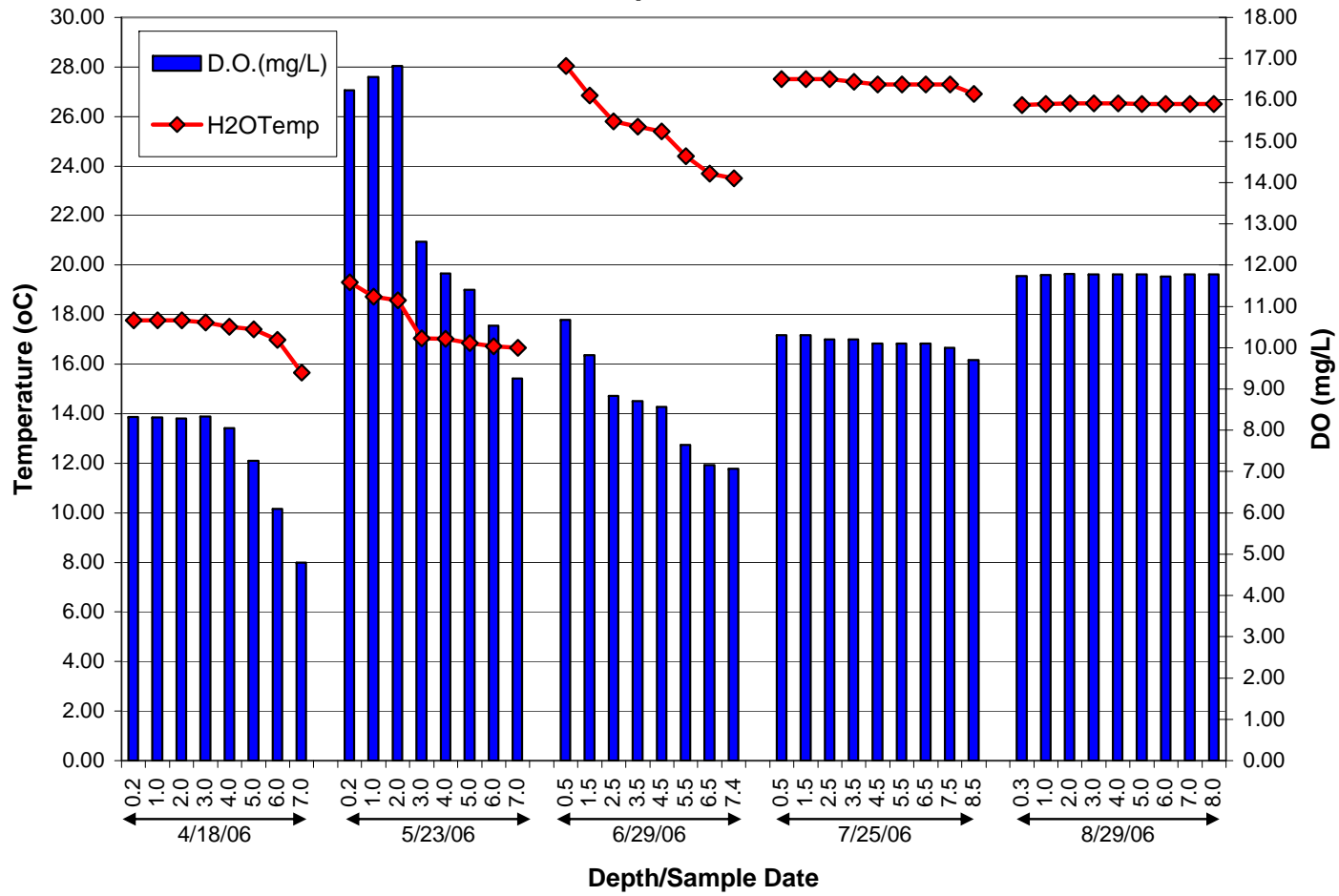
### Site 7 Cooks Mill Temperature & DO



### Site 9 Hwy 32 Bridge Temperature & DO

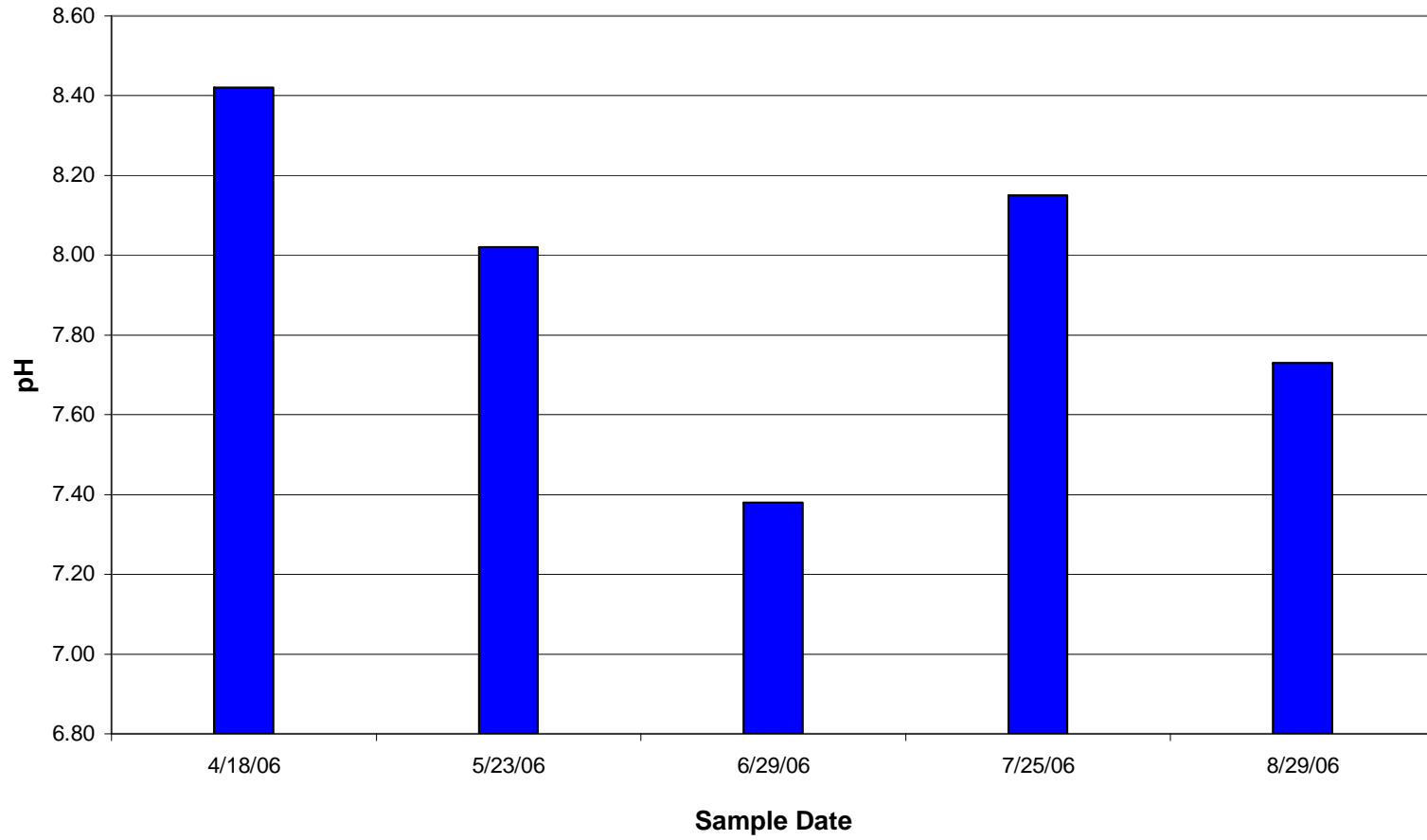


### Site 11 West Okaw at C. & E. I. RR Bridge Temperature & DO

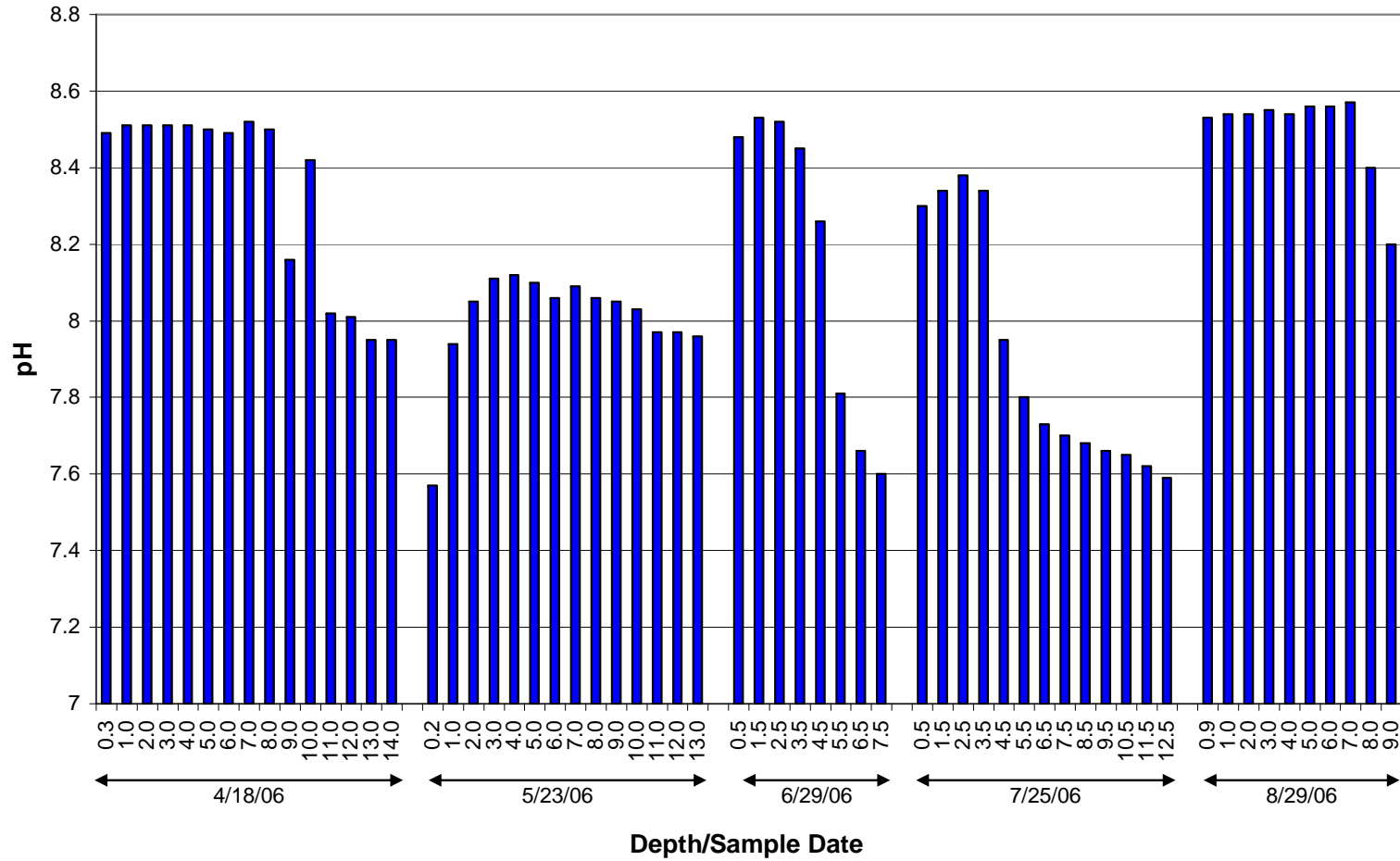




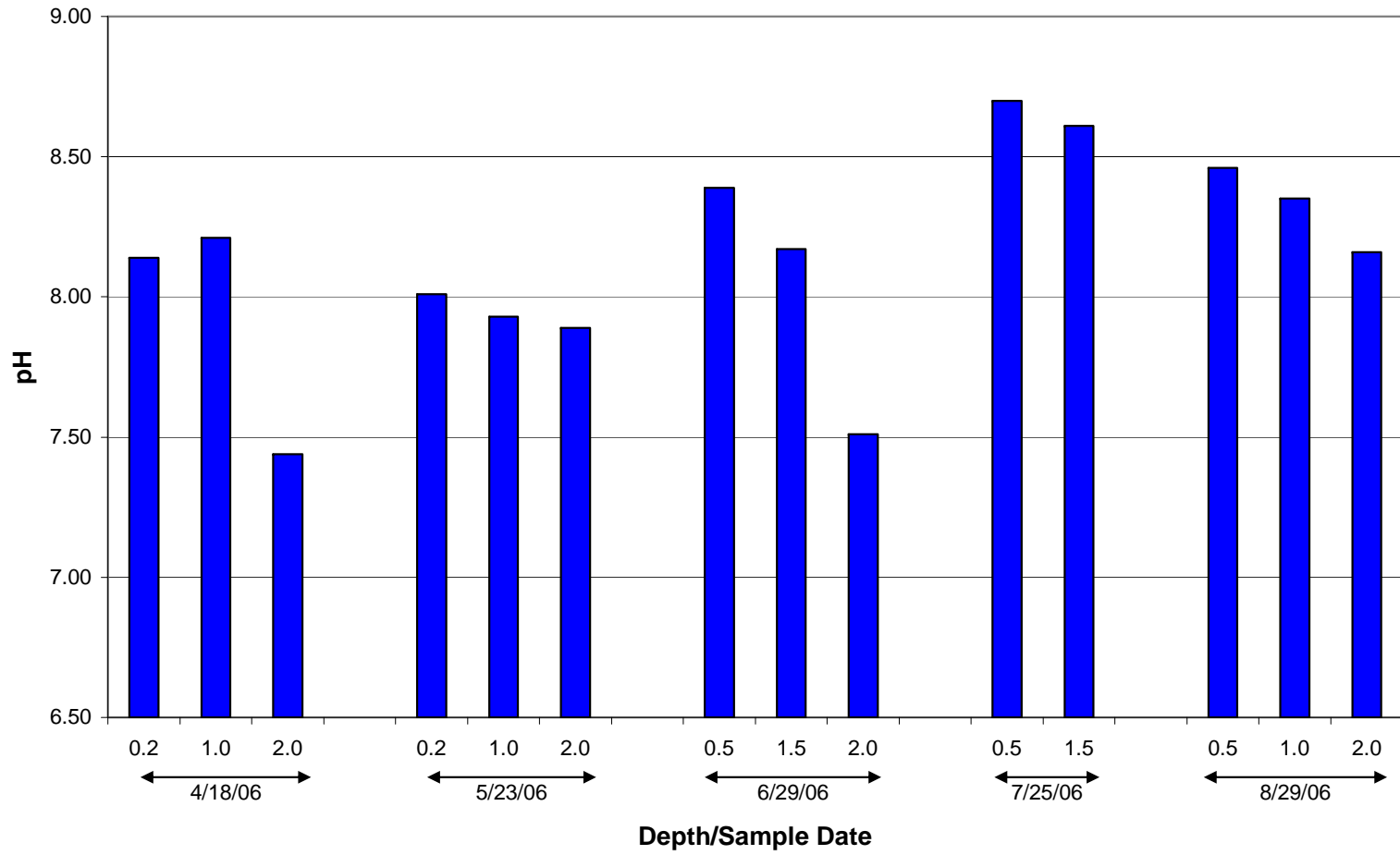
**Site 1 Spillway  
pH**



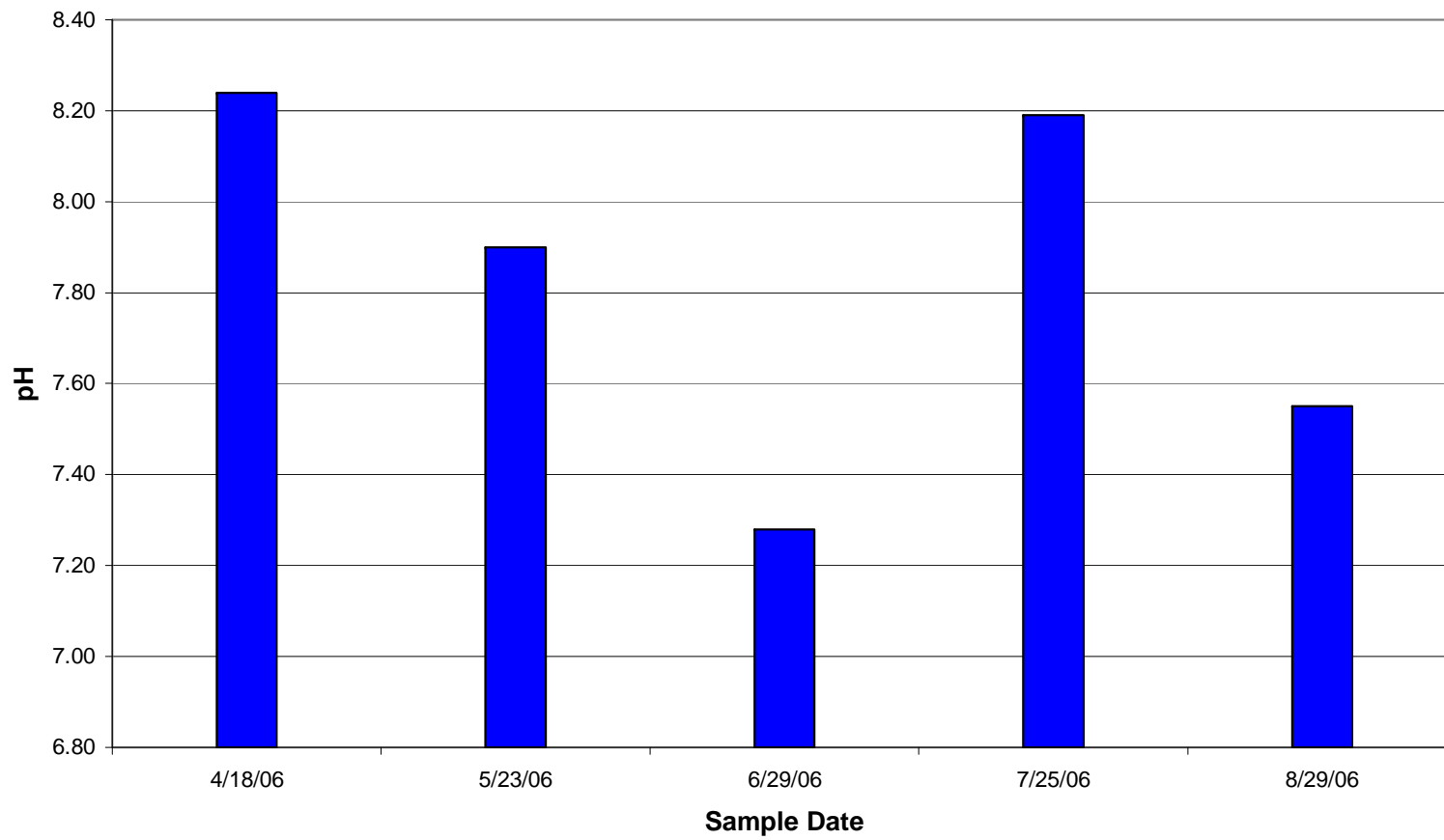
### Site 2 Lake Dam Side pH



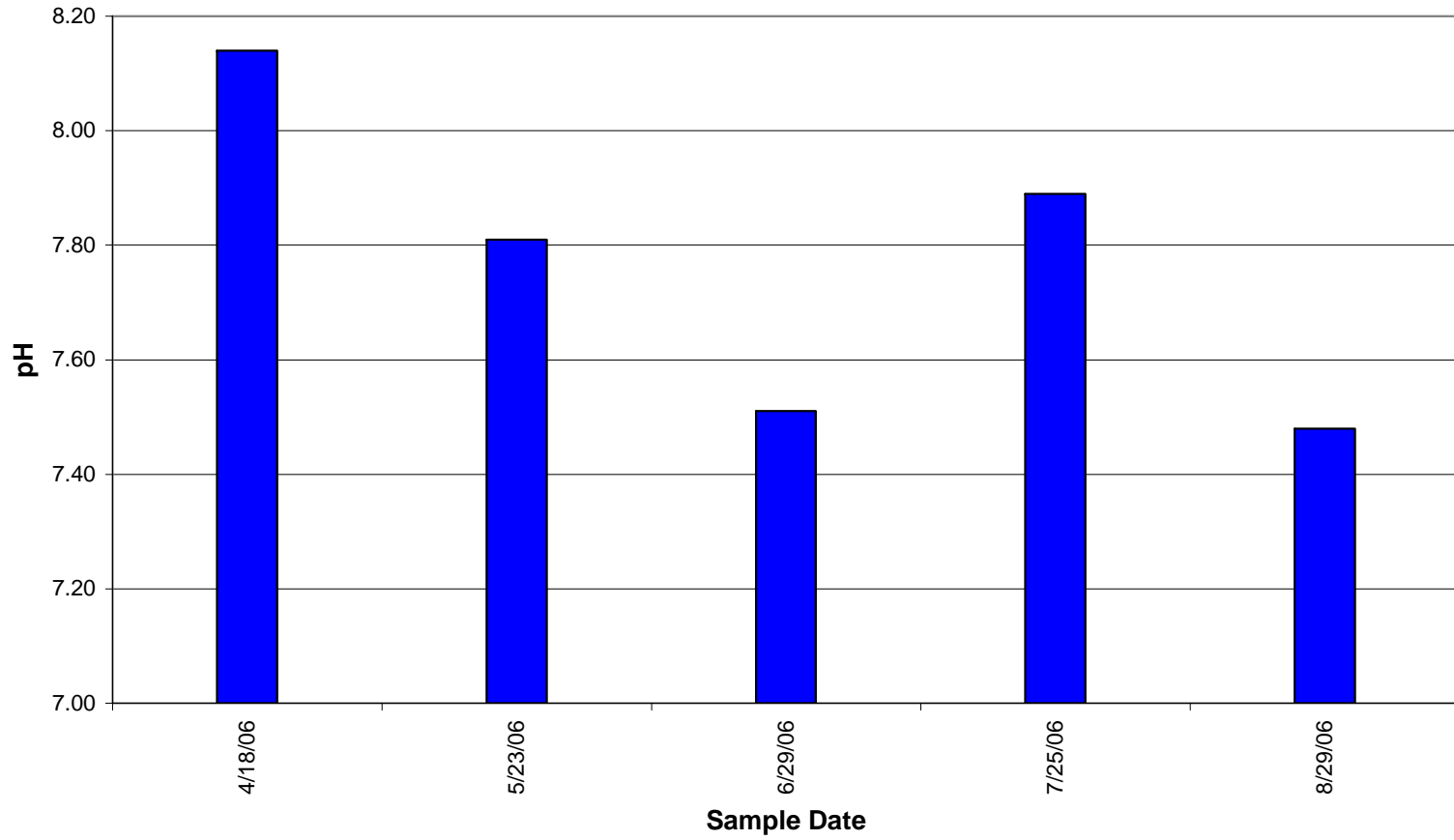
**Site 4 Kaskaskia Arm  
pH**



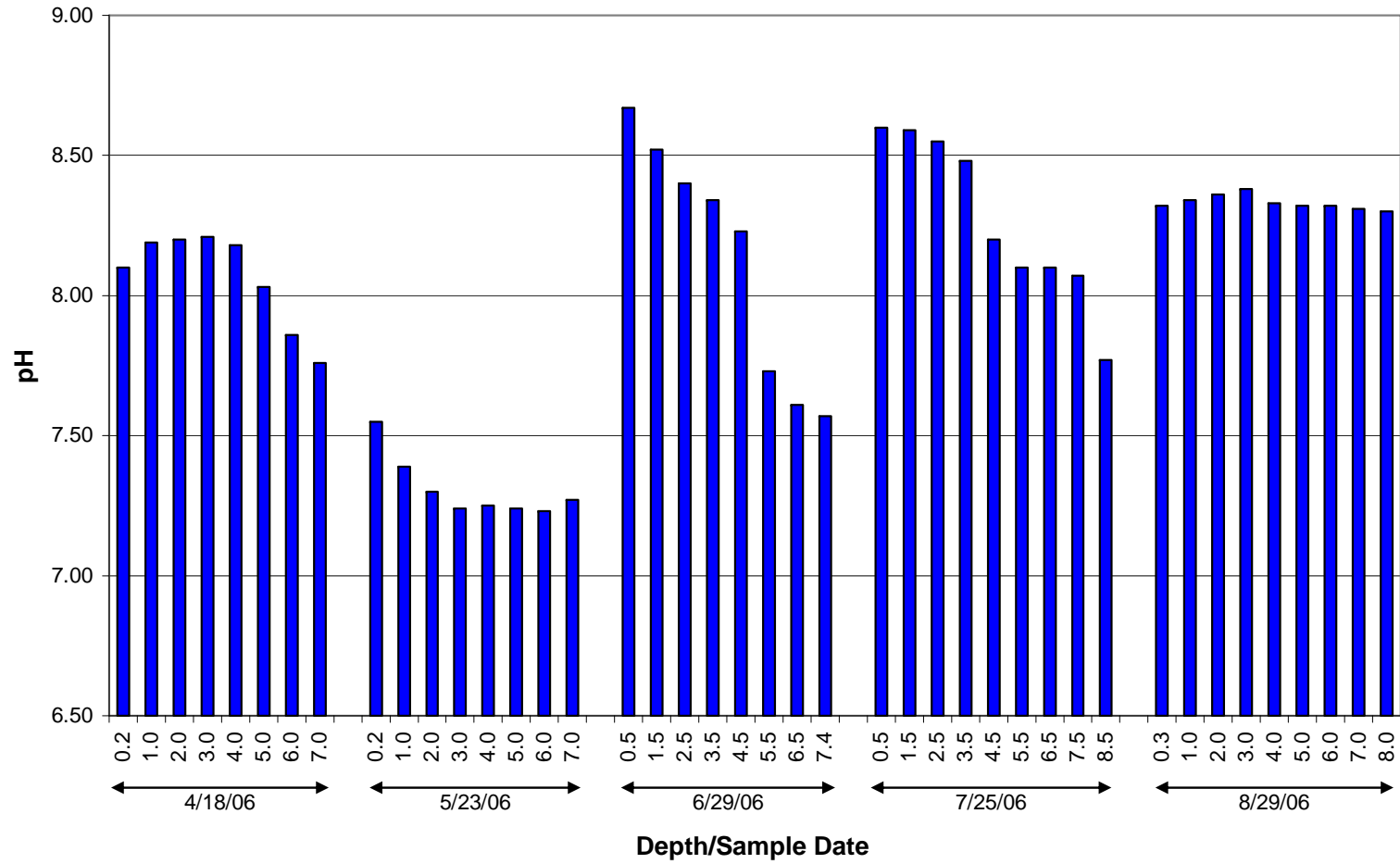
**Site 7 Cooks Mill  
pH**



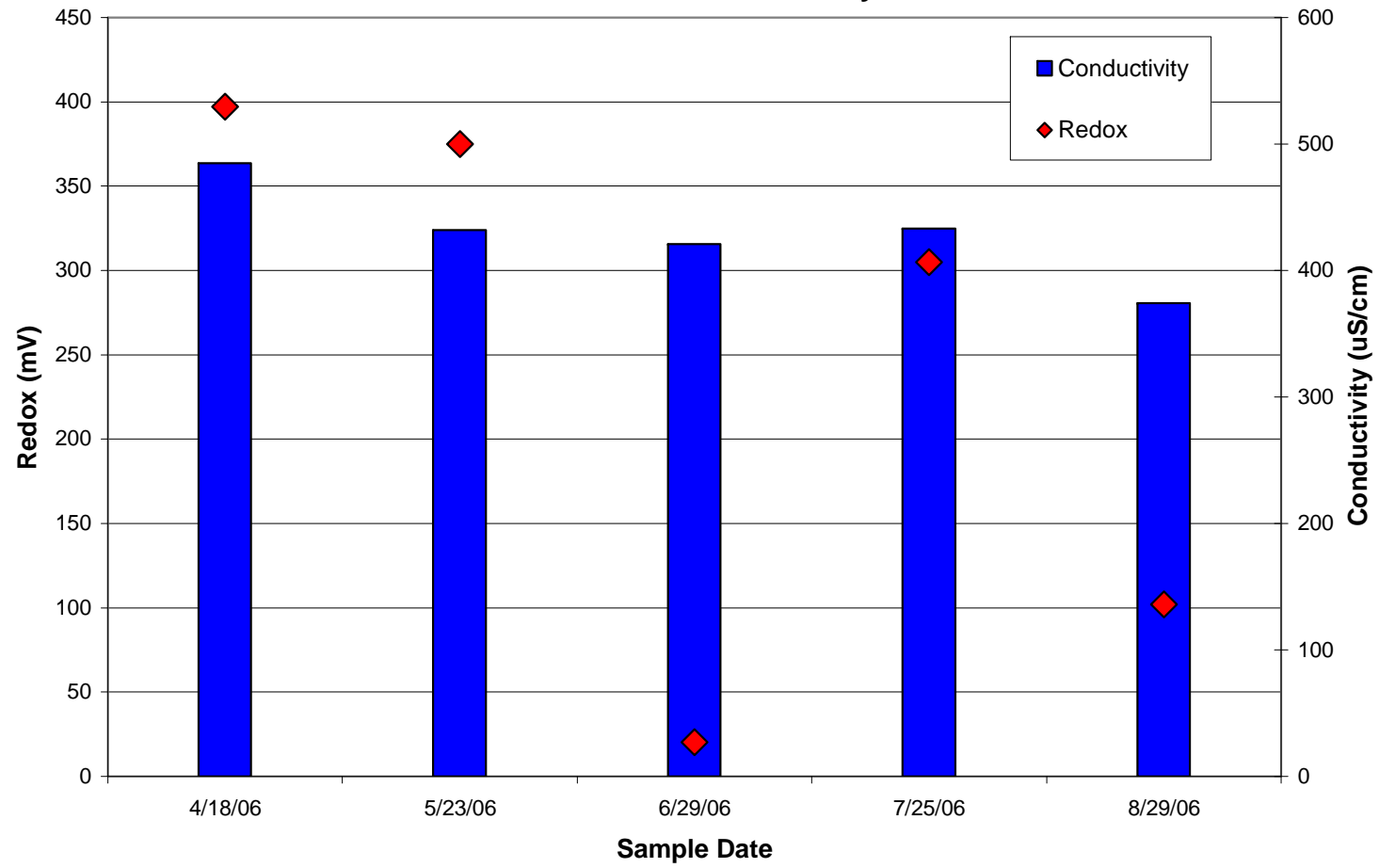
Site 9 Hwy 32 Bridge  
pH



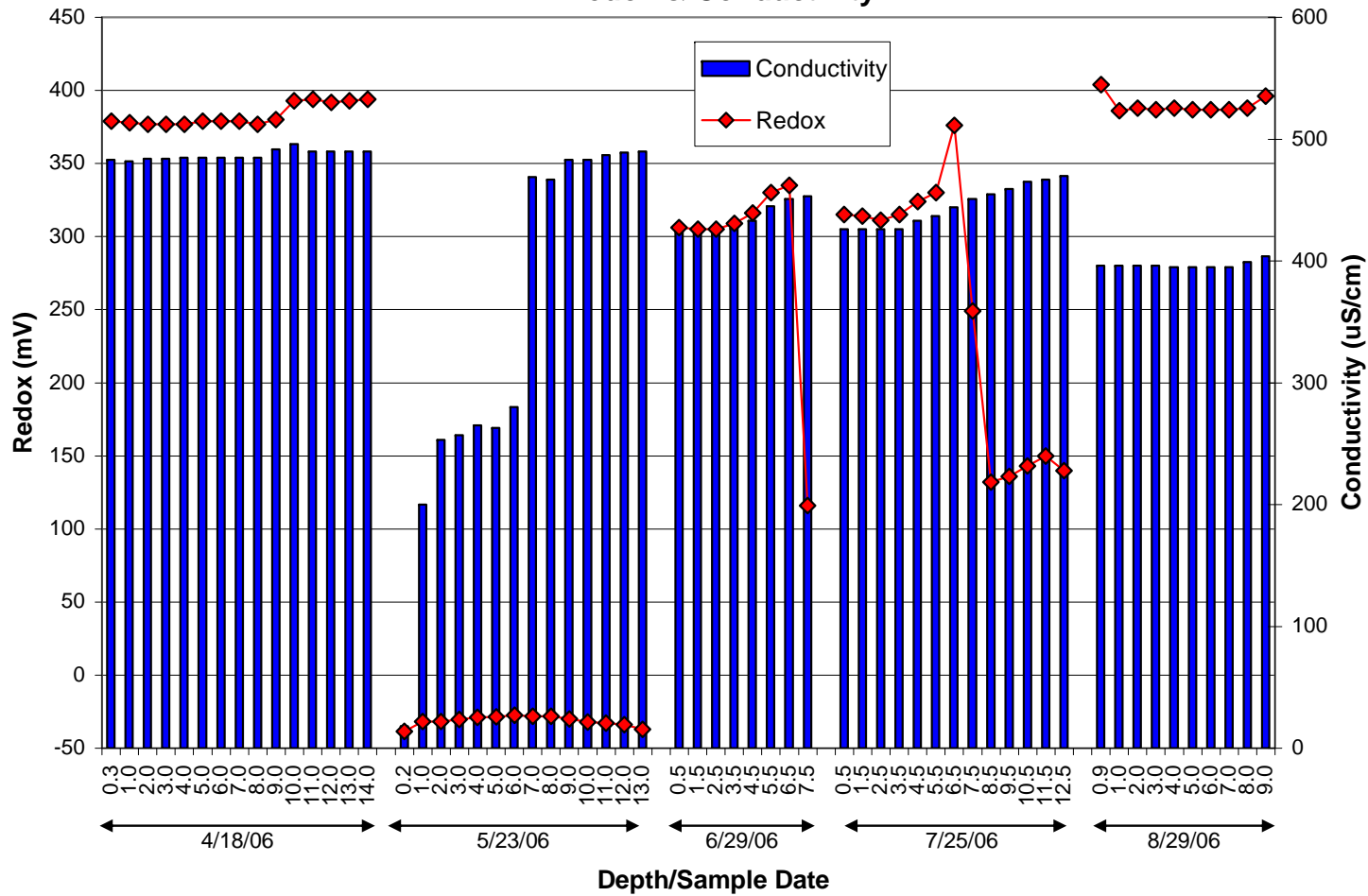
**Site 11 Okaw Arm at C. & E. I. RR Bridge  
pH**



### Site 1 Spillway Redox & Conductivity

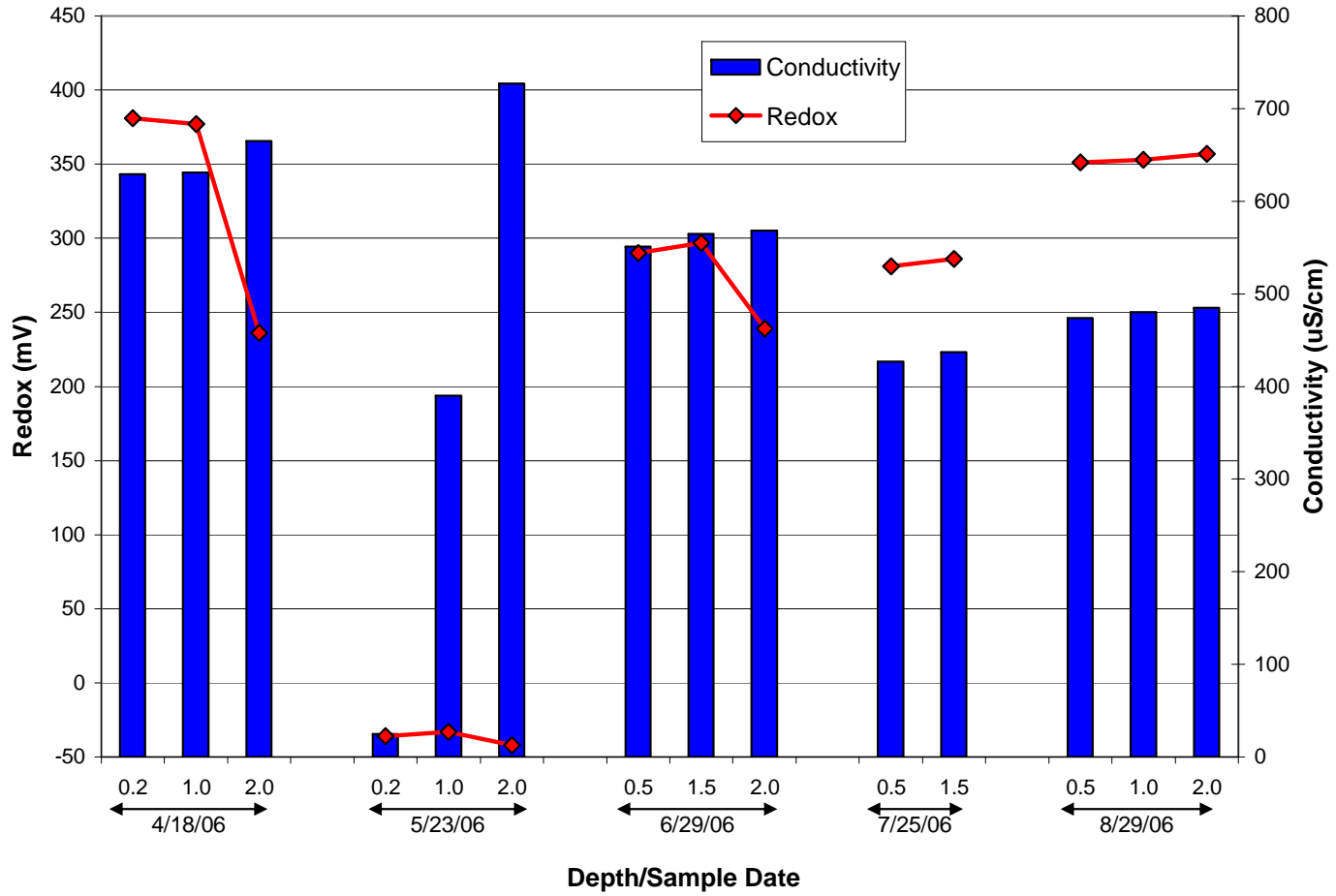


### Site 2 Lake Side of Dam Redox & Conductivity

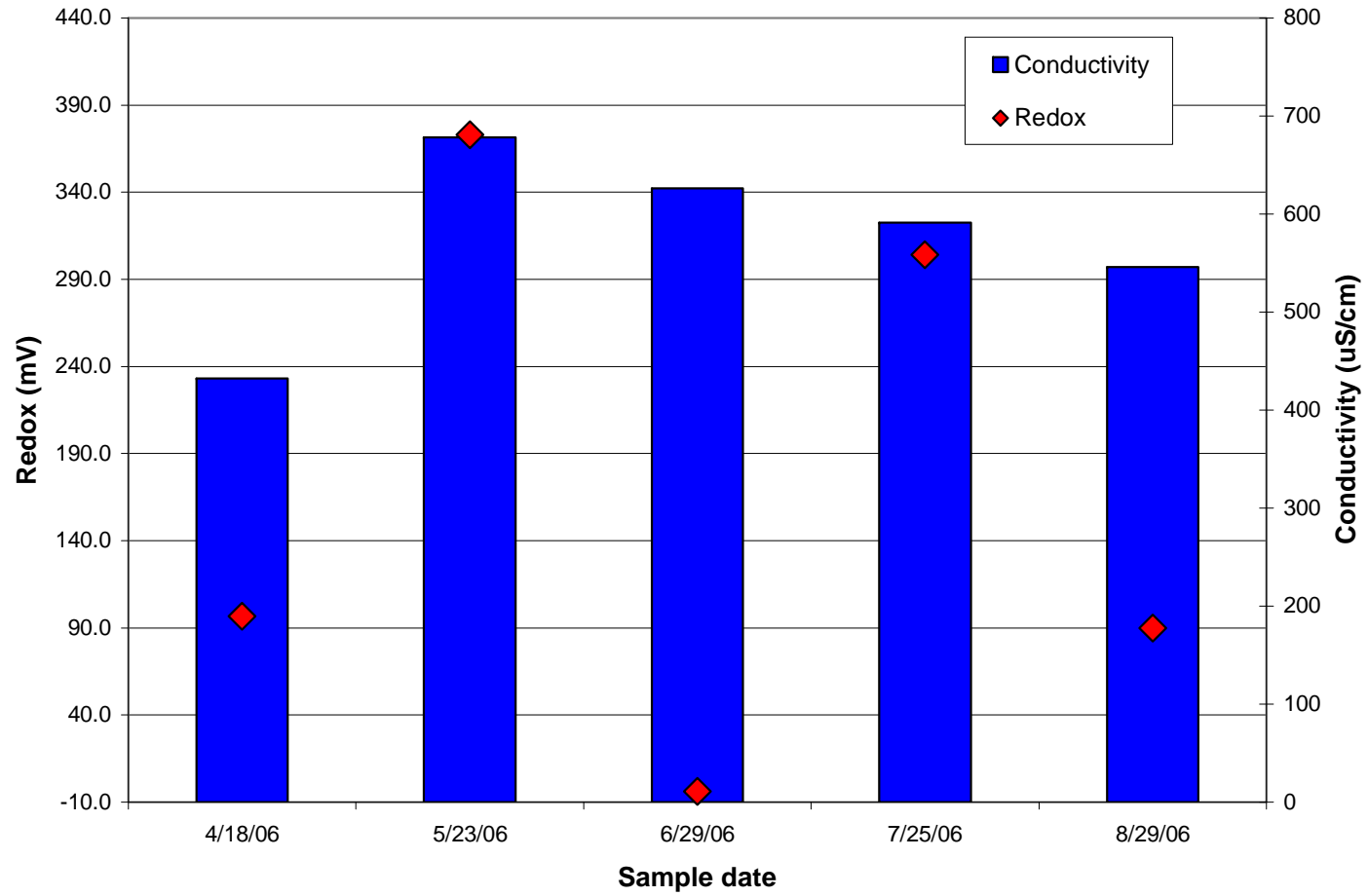




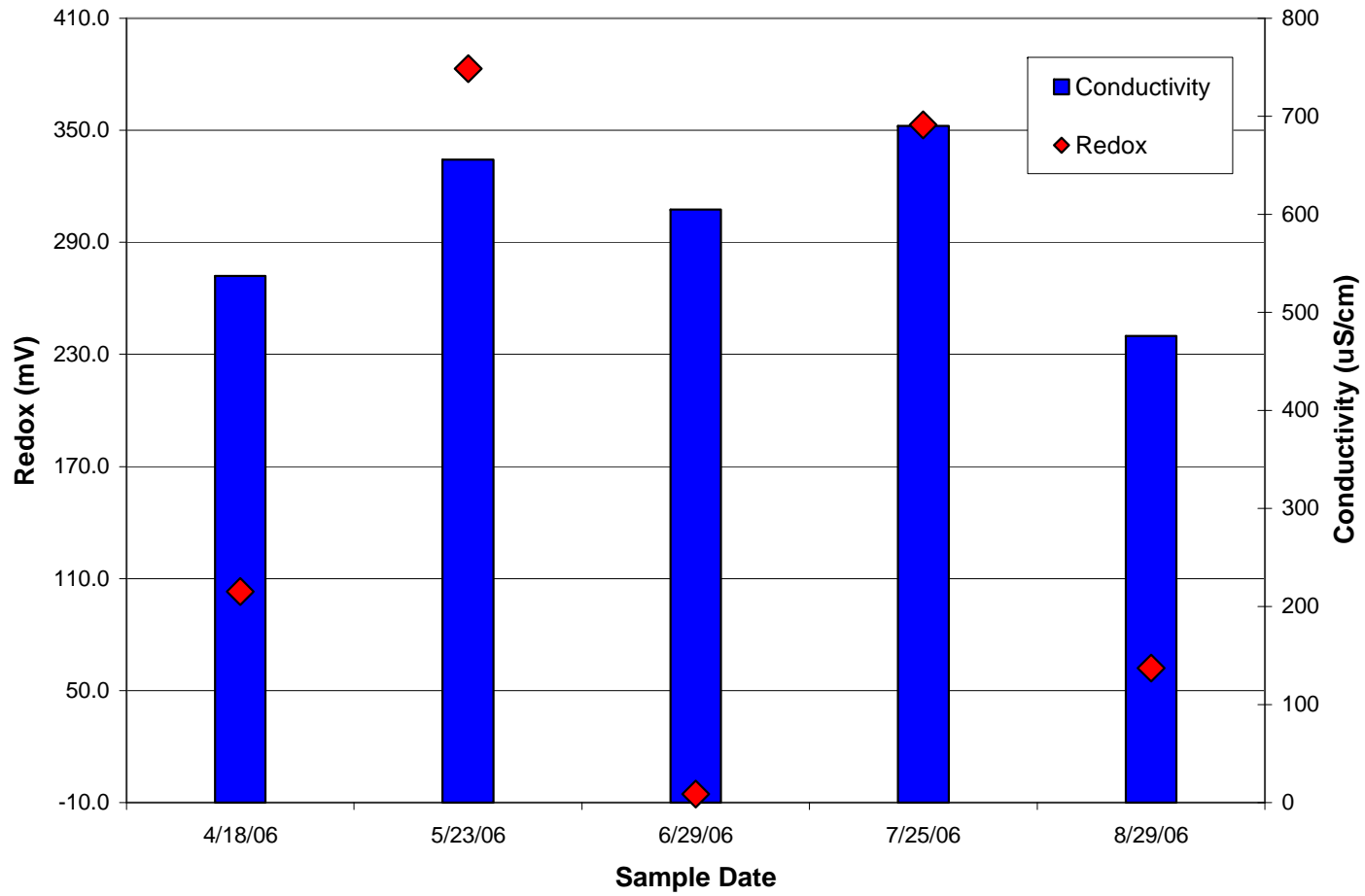
### Site 4 Kaskaskia Arm Redox & Conductivity



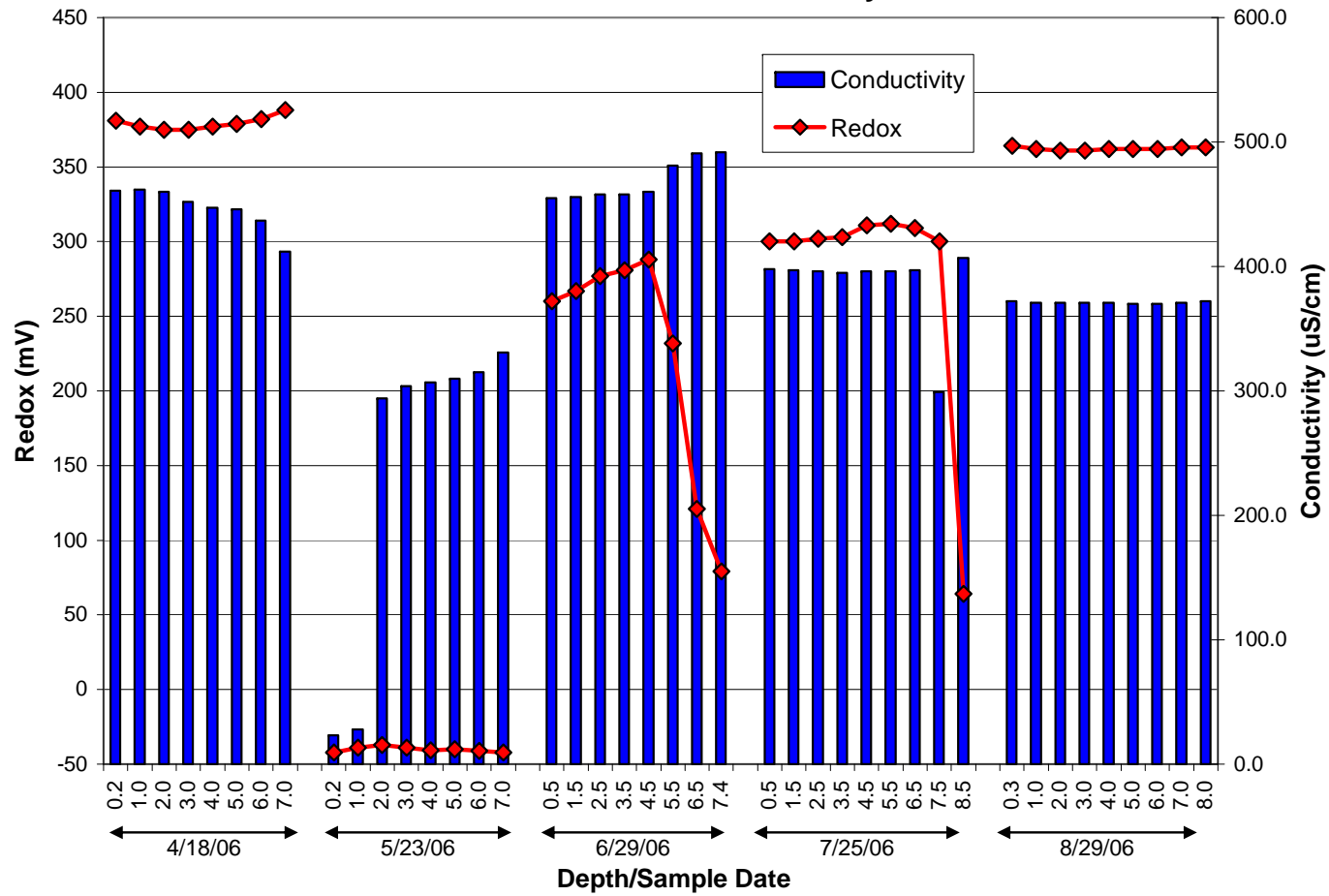
### Site 7 Cooks Mill Redox & Conductivity



### Site 9 Hwy 32 Bridge Redox & Conductivity



### Site 11 Okaw Arm at C. & E. I. RR Bridge Redox & Conductivity



# Secchi

