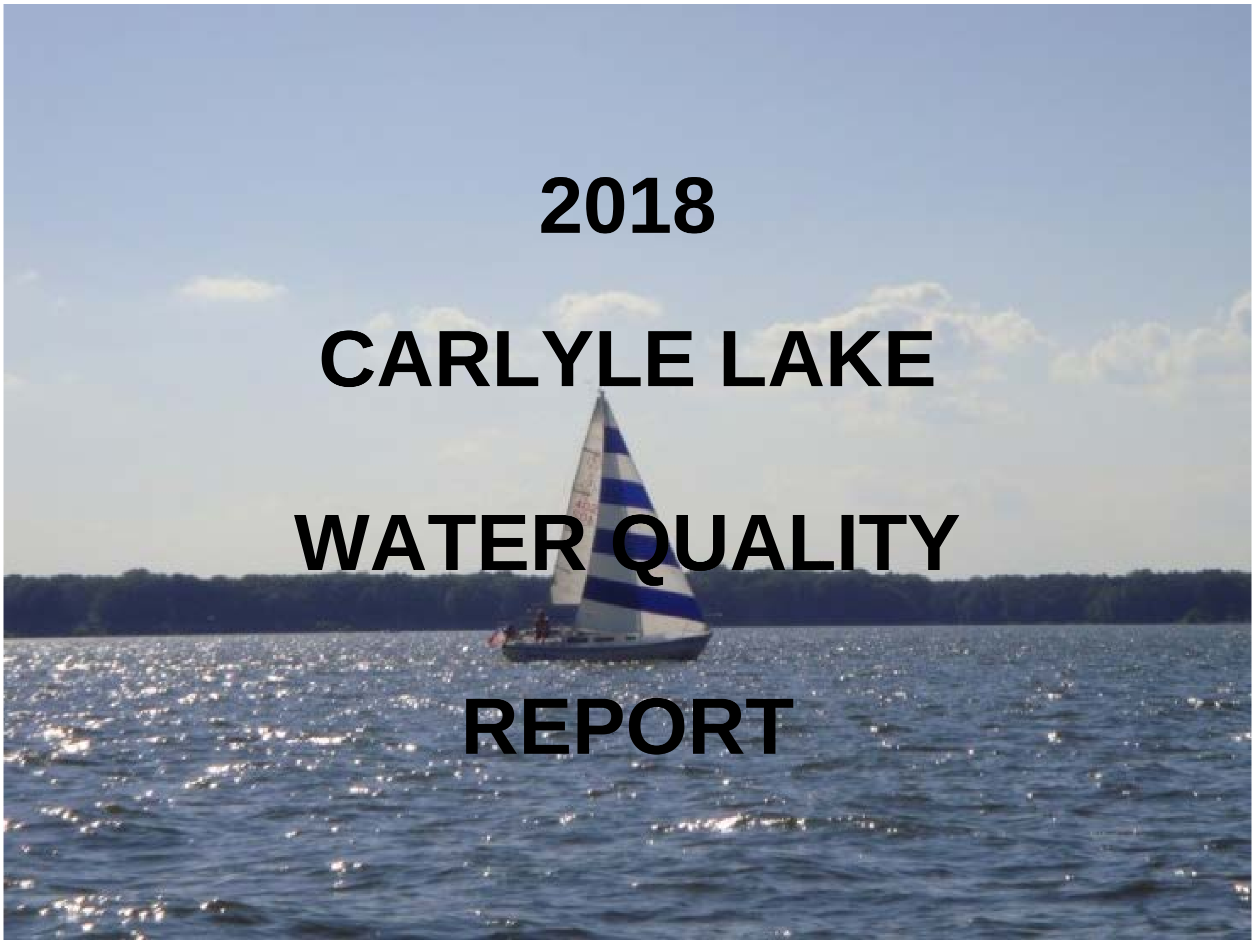

2018

CARLYLE LAKE

WATER QUALITY

REPORT

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

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Executive Summary

The purpose of this report is to provide an annual analysis of the water quality in the lake for the past year. Carlyle Lake is located in south central Illinois, approximately 50 miles east of St. Louis, Missouri. The lake is 12 miles long and is 1 to 3 miles wide and has approximately 26,000 acres of water surface at summer pool. The lake shoreline is 83 miles and there are approximately 11,000 acres of public land managed primarily by the Corps of Engineers. The lake is located on the Kaskaskia River at river mile 94.2 upstream from its confluence with the Mississippi River and approximately ½ mile upstream of the town of Carlyle.

Water quality sampling in 2018 revealed some minor issues at Carlyle Lake. The following parameters exceeded state standards during the 2018 sampling season: E. coli, phosphorus, pH, dissolved oxygen, and total suspended solids. The lake is a shallow reservoir susceptible to high winds. These conditions prevent the lake from stratifying permanently during the summer months. Historically, during low discharge during the heat of the summer fish kills have occurred in the old river channel below the dam due to low dissolved oxygen levels. Every year a remote sensor is installed on the discharge to allow project as well as water quality personnel to remotely monitor temperature and oxygen readings to avoid such fish kills by changing the release rate. Though the dissolved oxygen levels fell below 5 mg/L several times at the outflow, no fish kills were observed in 2018.

All sampling sites met the appropriate state standards during 2018 except E. coli, phosphorus, pH, dissolved oxygen, and total suspended solids. No beach bacteria samples exceeded the state standard. Phosphorous levels have exceeded the state standard on a routine basis. The project area has several pollution potentials, with agriculture being the major contributor, but at present time, no major form of degradation to the lake or streams is apparent. Constant water quality monitoring will continue to check future degradation of the watershed.

WATER QUALITY MONITORING PROGRAM

1.0 GENERAL OVERVIEW

This report summarizes water quality activities of the St. Louis District for Fiscal Year 2018 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. According to the U.S. Environmental Protection Agency (USEPA) high levels of nutrients and poor lakeshore habitat are some of the most significant problems in our nation's lakes. Shoreline vegetation provides shelter for aquatic wildlife, reduces sediment and nutrient movement. The biology of a lake is characterized by the diversity of its organisms. The number and kinds of plant and animal species present is a direct measure of a lake's well-being. Water quality at Carlyle Lake is directly assessed using stream and lake data from 5 site locations (see figure 1).

Water quality monitoring remains one of the Sections major responsibilities in the area of environmental stewardship. 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 to 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, and is suitable for aquatic and human life; and to 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) 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 Total Maximum Daily Loads (TMDL), to improve water quality.

The Illinois Environmental Protection Agency (IEPA), as of 2018, has listed Carlyle Lake impaired for Total Suspended Solids (TSS), Total Phosphorous, and mercury while the Kaskaskia River upstream from the Lake is impaired for dissolved oxygen, Atrazine, and mercury. The lists of sources for these impairments are contaminated sediments, crop production, and unknown sources. The entire Kaskaskia watershed is impaired by the above parameters as well as many others. 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

Carlyle Lake is within the Kaskaskia River Basin in central Illinois. The lake serves as a heavy recreational usage lake and supplies water to numerous communities. The land surrounding the lake is used predominately for agriculture. Surrounding communities have existing industrial/commercial operations as well as residential communities which discharge wastewater into municipal wastewater treatment plants that 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 Carlyle Lake watershed. Additional sources are marinas, recreational watercraft discharges and effluent from nearby subdivisions and a golf course.

Water quality monitoring was conducted during 2018 to assure safe conditions for human recreation, wildlife and aquatic life as maintained and managed within the lake system. Previous to 2009 five sampling events were conducted during the recreational season. In the initial phase of the sampling program during the 1970's and 80's six or seven sampling events were conducted. Four sampling events were conducted at five sites. The sampling sites include the following: Site 1 (Car-1) Spillway, Site 2 (Car-02) Lake side in front of Dam, Site 4 (Car-04) Keyesport, Site 13 (Car-13) Kaskaskia River at bridge on route 900, and Site 12 (Car-12) Cox Bridge. During the sampling period one site was selected for quality control duplication and denoted as CAR-15. The locations of the five sampling sites are depicted on the lake map in Figure 1. In 2014, it was decided to replace Car-9 at Vandalia with another site closer to the lake. Car-13 (Route 900N bridge over Kaskaskia River) was substituted for Car-9 at Vandalia. This tributary site was chosen to provide a site closer to the lake which included additional tributaries. This site provides a better opportunity to monitor water quality coming directly into Carlyle Lake from the Kaskaskia River and its tributaries.

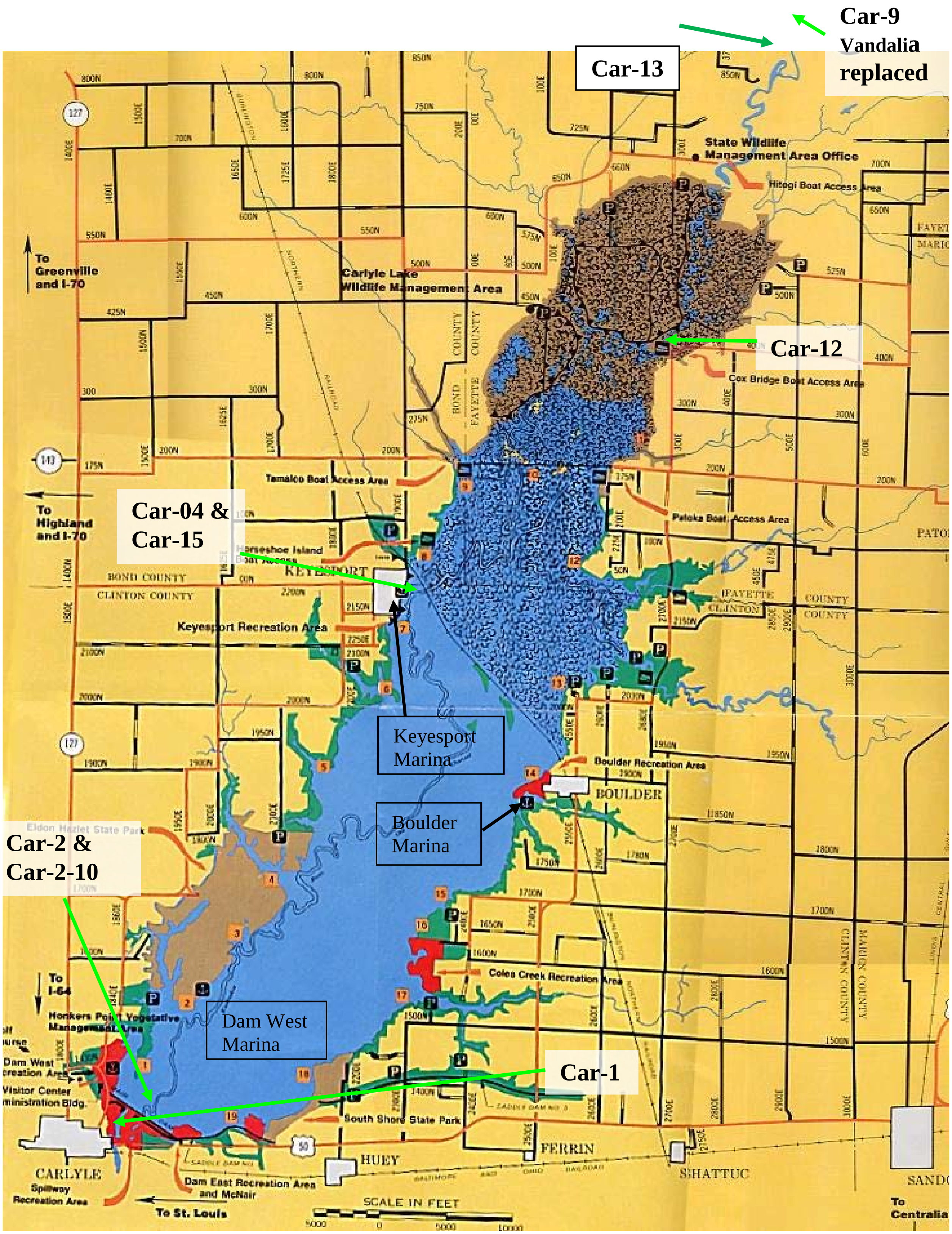


Figure 1. Location of sample sites.
In 2014 Car 13 replaced Car 9

2.0 WATER QUALITY ASSESSMENT CRITERIA

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

The following parameters were analyzed in the Fiscal Year 2018 sampling at Carlyle Lake: Total Organic Carbon (TOC), iron, manganese, ammonia-nitrogen, nitrate-nitrogen, orthophosphate, total phosphate, Total Suspended Solids (TSS), Total Volatile Suspended Solids (TVSS), Escherichia . coli (E. coli), pH, temperature, dissolved oxygen, specific conductance, oxidation-reduction potential (ORP), chlorophyll, pheophytin-a, atrazine, alachlor, chlorpyrifos, cyanazine, metolachlor, metribuzin, trifluralin, and pendmathalin.

2.1 WATER

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 where a limit has been established for the parameters analyzed.

TABLE 2.1

State of Illinois
Water Quality Standards

PARAMETER	LIMIT
Temperature	Rise of 2.8°C above normal seasonal temp
Ammonia Nitrogen	15 mg/L
Nitrate Nitrogen	10 mg/L
Total Iron	2.0 mg/L (2nd Contact & Aquatic Life)
Manganese	1.0 mg/L
Total Phosphate	0.05 mg/L Lakes; 0.61 mg/L Streams
E. Coli	Illinois standard is 235 E. coli per 100ml for single sample or 126 for geometric mean.
pH	Range: 6.5 to 9.0
DO	> 5.0 mg/L
Conductivity	1,667 *u*S/cm≈TDS of 1,000 mg/L
Total Suspended Solids (TSS)	116mg/L (Streams); >=12mg/L (Lakes)
Atrazine	0.003 mg/L[1]; 82ug/L[2]; 9ug/L[3]
Alachlor	0.002 mg/L (Drinking Water Standard)
Chlorpyrifos	10ug/L[1]
Cyanazine	370ug/L Acute; 30ug/L[3]
Metolachlor	1.7mg/L[2]
Metribuzin	200ug/L[1] 91ug/L HRL
Simazine	4.0ug/L [1]
Trifluralin	26ug/L Acute; 1.1ug/L[3]
Pendmethalin (PROWL)	70ug/L HBSL, 20ug/L[1]

[1] Drinking Water Standard
[2] Acute
[3] Chronic
Health Based Screening Level (HBSL)
Health Reference Level (HRL)

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_2), nitrites (NO_2), nitrate (NO_3), ammonia nitrogen (NH_3-N), and ammonium (NH_4). Ammonia can be toxic to fish and other aquatic organisms at certain levels. Unlike ammonia, ammonium (NH4) 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, decreases 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 (absent of oxygen) 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 ortho-phosphorous, 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. Metal 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 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 volatile suspended solids (VSS), that consist of organic material, and nonvolatile suspended solids (NVSS), which is comprised of inorganic mineral 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 suspended solids indicate the presence of organics in suspension; and, therefore, show additional demand levels of oxygen. Illinois does not currently have a standard for TVSS. However, literature suggests that NVSS above 15mg/L could highly impair recreational lake use. A NVSS of 3 to 7mg/L might cause slight impairment.

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 high 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 amoebic 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 235 colonies per 100ml per single sample water or geometric mean of 126 colonies per 100ml. 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. Since 2009 the St. Louis District has been using E. coli as the standard indicator.

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 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. Colder 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^{o}C. Most aquatic organisms require a minimum concentration of dissolved oxygen to survive (5 mg/l or above). In spring, surface waters of the lake mix with the water below by wind and thermal action. This mixing diminishes as the upper layer of water becomes warmer and less dense. Solar insulation 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. A rapid change in temperature within the metalimnion occurs and is referred to as a thermocline.   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 a neutral pH while readings below seven are acidic and above are alkaline. Most Illinois lakes range from 6 to 9 on the pH scale. If a body of water is alkaline, then it has the ability of act as buffer which can neutralize incoming acidic conditions. 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 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. Conversely, 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 of oxygen reduction activity. 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. Positive readings indicate increased oxidizing potential while negative readings indicate 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 (NH_3) requires an oxidating environment to convert it into nitrites (NO_2) and nitrates (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: (1) color of water, (2) amount of phytoplankton in the water column, and (3) amount of inorganic material in the water column. Secchi depth integrates the combined impacts of all three of these factors. Water transparency was measured using a Secchi disk. Secchi disk readings were taken at all lake sites.

2.2 Sediment

In accordance with EM-1110-2-1201, sediment samples should be taken to monitor and assess potential impacts to aquatic and human health. For potential ecological risk from inorganic contaminants, seven metals are typically of "most concern" with regards to fish and wildlife: Arsenic, Copper, Cadmium, Selenium, Mercury, Lead, and Zinc. Avian species are thought to be particularly sensitive to arsenic, which is considered a carcinogenic, mutagenic, and teratogenic contaminant in a variety of species in elevated doses over time. Avian species are also known to be particularly sensitive to lead in the environment with effects ranging from mortality, reduced growth and reproductive output, behavior changes, blood chemistry alterations, and lesions of major organs. Finally, the embryo stages in fish and avian species are known to be the most sensitive to selenium affecting reproductive success.

3.0 SUMMARY OF MONITORING RESULTS

3.1 Water Quality Summary

The monitoring program for Carlyle Lake during Fiscal Year 2018 revealed overall good water quality when compared to limits established by the IEPA for general use, secondary contact, and indigenous aquatic life. Water quality trends on a yearly basis are hard to determine when only conducting 3-4 sampling events. However, over the course of a 5 year period these 3-4 sampling events per year are adequate to determine trends in water quality. 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.

E. coli are sampled at the marinas to ensure that the marina areas are not being contaminated by boats with restroom facilities. E. coli levels at the marinas exceeded the Illinois standard of 235 mpn/100ml for a single sample at each of the three marinas on May 5 2018. The project office is notified as soon as any readings not meeting standards are received. E. coli beach data was received from the project office. No beach samples were above the Illinois standard.

Total iron and total manganese are sampled above the dam near the bottom of the channel (Car-2-10) and in the outflow (Car-1). As previously stated living organisms require trace amounts of metals, however excessive amounts can be harmful to the organism. Iron exceeded the state standard at the outflow on March 7 and near the bottom of the channel (2-10) on March 7 and July 10. Manganese was found to be above the state standard near the bottom of the channel on July 10.

Nitrogen and phosphates are sampled at all sites. In 2018 nitrogen levels recorded were well within the state water quality standards (ammonia nitrogen = 15mg/l, nitrate nitrogen = 10mg/l). As in the past several years, the 2018 phosphate results at all lake sites are above the 0.05 mg/L standard. The samples from the lake ranged from 0.153 mg/L to 1.86 mg/L. Because phosphorus in water is not considered directly toxic to humans and animals no drinking water standards have been established for phosphorus. However, phosphorus can cause health threats through the stimulation of toxic algal blooms and the resulting oxygen depletion. 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_3-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. In 2018 no algal blooms were reported.

Chlorophyll *a* was sampled at 3 sites, Car-2, Car-4, (Car-15 is a duplicate sample at site Car-4) and Car-12. Illinois does not currently have a standard for chlorophyll. 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 can lead to problems. 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. Chlorophyll is monitored to provide indicators of algae growth and therefore, potential oxygen depletion activity. Chlorophyll concentrations and cyanobacteria cell counts serve as proxies for the actual presence of algal toxins. Exposure to cyanobacteria or their toxins may produce allergic reactions such as skin rashes, eye irritations, respiratory symptoms, and in some cases more severe health effects. Microcystin is currently believed to be the most common cyanotoxin in lakes. While EPA does not currently have water quality criteria for algal toxins, the World Health Organization (WHO) has established recreational exposure guidelines for Chlorophyll *a*, cyanobacterial cell counts, and microcystin. Levels of chlorophyll 50 mg/cu m and greater are considered to create moderate risk according to the WHO. Carlyle lake was in the moderate to high risk of exposure category for chlorophyll. The 2018 data indicates a spike (maximum) in March at the Lake sites and elevated levels above 50 mg/cu m throughout the season (appendix B7). Cholorophyll-*a* fluctuations will occur naturally, but when there is an exponential increase like the above example on an already eutrophic lake, there is a higher potential for algal blooms and their negative effects. Continued monitoring is essential for the detection of these trends.

Atrazine and Alachlor are pesticides that were sampled at all sites. These chemicals are herbicides used to control weed growth. Cyanizine, Metolachlor, Trifluralin and Simazine are also analyzed as part of the pesticide screening. Sampling in 2018 did not indicate any elevated pesticide levels over the state standards. The Carlyle Lake watershed consists of approximately 75% cropland. 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 management practices when using these chemicals.

Total Suspended Solids (TSS) and Total Volatile Suspended Solids (TVSS) samples are collected at all sites. There were TSS exceedances at all lake sites and tributary site (CAR-13) during the 2018 season. 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 guidelines for identifying potential causes of impairment of aquatic life in lakes list a TSS above 12mg/L could impair recreational lake use and a TSS of 116mg/L may cause impairment of streams. Data indicates that sediment settles out as it travels down the lake. TSS concentrations at Carlyle Lake have been elevated for several years.

Total Organic Carbon (TOC) is collected at all sites. TOC levels for the 2018 sampling season range from 3.1 to 6 mg/L. TOC is an indicator of the organic character of water. The larger the carbon or organic content, the more oxygen is consumed. 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. Since Illinois does not have a standard for this parameter, observations of high or low are relative to the current sampling period.

Temperature and dissolved oxygen levels were taken at all sites during the scheduled sampling days. See Appendix C graphs C1-C3. Dissolved oxygen concentrations were recorded below the standard of 5 mg/L at all three marinas in September, during hot, dry, and low flow conditions. The remote sensor located at the outflow recorded multiple days where the dissolved oxygen levels fell below 5 mg/l. Of those occurrences, only one fell below 4 mg/L . See the 'remote sensor' paragraph below for a summary. During the scheduled sampling days measurements were taken at 1 meter intervals at the lake sites. During the summer months the lake may stratify and form a boundary layer 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. The four sampling events in 2018 showed no clear thermocline or oxycline.

pH is taken at all sites and at 1 meter intervals at lake sites. The pH standard was found to be above 9 on three occasions – May 10 at CAR-2 and July 10 at CAR-4 and Keyesport Marina. Variances in pH can be caused by increase runoff due to a rainfall event, unusual temperature extremes, or erosion from land disturbances. Another cause may be that photosynthetic organisms use 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 redox, but does have a standard of less than 1,667 uS/cm for conductivity. No samples exceeded this standard.

Secchi disk readings indicate that as the water travels down the lake it becomes clearer. This is the result of sediments dropping out of the water column as the water moves down stream toward the dam. The deepest secchi reading at site 2 (by the dam) was 28 inches on July 10, while the deepest secchi reading on the upper part of the lake at site 4 was 16 inches on July 10.

The remote sensor in the spillway was monitored and maintained throughout the year to allow the project and water quality personnel to remotely monitor temperature and oxygen readings to acquire data to inform operational actions in order 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 allows 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. See page C13 for the 2018 dissolved oxygen data. No fish kills were observed this year. The 2018 season produced similar dissolved oxygen levels to 2017 with the exception that levels did not drop below 5 mg/L after August 14. The sonde was serviced approximately once each month from May through September. Dissolved oxygen dropped below the 5mg/l standard in May, July, and August. During these events it is posited that the high air and water temperatures coupled with low flow conditions and low precipitation contributed to the low dissolved oxygen conditions.

3.2 Sediment Summary

Sediment sampling was conducted at sites CAR-2 and CAR-4 on July 10, 2018. Ideally sediment sampling would be conducted every 5 years if funding is available, but was last conducted in 2007. Discrete sediment samples were collected using a ponar dredge. The following parameters were analyzed for: pesticides (same suite as water samples), arsenic, barium, boron, cadmium, chromium, copper, iron, manganese, lead, mercury, nickel, selenium, silver, zinc, total organic carbon, kjeldahl nitrogen, nitrate nitrogen, and total phosphorus. Illinois does not have human health standards for sediment, therefore test results were compared to background levels referenced in Illinois Title 35, 742, appendix A, table G. As with any environmental sampling, results only apply to the specific locations where the sample was taken from. A more comprehensive sampling design may lead to different overall results. Although, these samples represent only a snapshot in space and time of sediment in Carlyle Lake, the data is useful in establishing baselines for future assessments. All pesticides tested for were below the detection limits.

In Table 3.2 the 2018 sediment results are compared to samples taken in 2007. For this comparison, all results labeled ND were below detection limits (not detected). All red text indicates the result exceeds the reference background level.

Table 3.2 Sediment Comparison

Site #	Parameter	2018 Result	2007 Result	Units
CAR-2	Alachlor	ND	ND	UG/KG
CAR-4	Alachlor	18.2	92	UG/KG
CAR-2	Arsenic	3.12	6	MG/KG
CAR-4	Arsenic	5.72	6	MG/KG
CAR-2	Atrazine	ND	ND	UG/KG
CAR-4	Atrazine	18.2	92	UG/KG
CAR-2	Barium	33.6	178	MG/KG
CAR-4	Barium	205	178	MG/KG
CAR-2	Boron	3.85	23	MG/KG
CAR-4	Boron	12.2	28	MG/KG
CAR-2	Cadmium	0.257	1.2	MG/KG

CAR-4	Cadmium	0.580	1.3	MG/KG
CAR-2	Chlorpyrifos	ND	ND	UG/KG
CAR-4	Chlorpyrifos	18.2	92	UG/KG
CAR-2	Chromium	5.97	25.8	MG/KG
CAR-4	Chromium	32.0	30	MG/KG
CAR-2	Copper	3.45	16	MG/KG
CAR-4	Copper	20.5	16	MG/KG
CAR-2	Cyanazine	ND	ND	UG/KG
CAR-4	Cyanazine	18.2	92	UG/KG
CAR-2	Iron	8460	21700	MG/KG
CAR-4	Iron	30000	22700	MG/KG
CAR-2	Kjeldahl nitrogen	227	1820	MG/KG
CAR-4	Kjeldahl nitrogen	2690	1340	MG/KG
CAR-2	Lead	4.75	12	MG/KG
CAR-4	Lead	17.8	11	MG/KG
CAR-2	Manganese	532	1480	MG/KG
CAR-4	Manganese	1430	932	MG/KG
CAR-2	Mercury	0.109	0.53	MG/KG
CAR-4	Mercury	0.210	0.46	MG/KG
CAR-2	Metolachlor	ND	ND	UG/KG
CAR-4	Metolachlor	18.2	92	UG/KG
CAR-2	Metribuzin	ND	ND	UG/KG
CAR-4	Metribuzin	18.2	92	UG/KG
CAR-2	Nickel	3.72	17	MG/KG
CAR-4	Nickel	22.2	20	MG/KG
CAR-2	Nitrate-N	2.72	14.7	MG/KG
CAR-4	Nitrate-N	9.92	13.2	MG/KG
CAR-2	Pendimethalin	ND	ND	UG/KG
CAR-4	Pendimethalin	18.2	92	UG/KG
CAR-2	Phosphorus, total	803	1300	MG/KG
CAR-4	Phosphorus, total	818	830	MG/KG
CAR-2	Selenium	0.642	12	MG/KG
CAR-4	Selenium	1.26	13	MG/KG
CAR-2	Silver	0.642	1.2	MG/KG
CAR-4	Silver	1.26	1.3	MG/KG
CAR-2	Total Organic Carbon	600	13800	MG/KG
CAR-4	Total Organic Carbon	1400	17300	MG/KG
CAR-2	Trifluralin	ND	ND	UG/KG
CAR-4	Trifluralin	18.2	92	UG/KG
CAR-2	Zinc	13.0	65	MG/KG
CAR-4	Zinc	92.0	71	MG/KG

Metals were compared to the background soil concentrations listed in Illinois Title 35. The general trend for all metals is down as water flows downstream. The sample site CAR-4 exhibits much higher levels than CAR-2. Arsenic, barium, chromium, copper, iron, manganese, and nickel all were found to be above background levels at site CAR-4, but below background levels at CAR-2. Boron, cadmium, mercury, selenium and silver were all either below detection limits or had estimated values that were below background levels. Lead and zinc were below background levels and were significantly higher at CAR-4 than at CAR-2.

Nutrients nitrate-nitrogen and total phosphorus were analyzed for in 2018. There are no nutrient level comparison standards in the above references. Nitrate-N was below detection levels at site CAR-2. All nutrient levels were higher at CAR-4 than CAR-2.

Total organic carbon (TOC) was also analyzed for in 2018. TOC at site CAR-2 was found to be below the detection limit of 600 mg/kg, therefore TOC at CAR-4 was significantly higher at 1400 mg/kg. As with all the other sediment parameters, TOC was found to be higher at the upper end of the lake at CAR-4.

In 2015 a study was conducted (Pearce et al) at Carlyle Lake to investigate the internal nutrient dynamics to ascertain the potential for sedimentary nutrients to stimulate harmful algal blooms, '*Characterizing nutrient distributions and fluxes in a eutrophic reservoir, Midwestern United States'*. The findings of this study are compared with the limited sediment sampling conducted by the Corps in 2018. The 2018 Corps results contrast with this study in regard to the concentrations of phosphorus in the upper part of the lake versus the lower part. In general Pearce's study found that phosphorus increased from the north to the south, while 2018 Corps results were the opposite. Conversely, Pearce's study found that nitrate levels were higher at the north end than the south, which aligns with 2018 Corps results. In Pearce's study there were 61 sample locations versus 2 Corps sample locations. Given this difference in number of samples and spatial representation, the two sets of results are not of equal comparison.

4.0 <u>PLANNED 2019 STUDIES</u>

The Carlyle Lake water quality monitoring will continue in Fiscal Year 2019 in much the same way as 2018 with a total of 4 sampling events. Water quality personnel will continue to maintain and remotely monitor the dissolved oxygen and temperature sensor at the outflow. Carlyle 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 sites include the following: Site 1 (Car-1) Spillway, Site 2 (Car-02) Lake side in front of Dam, Site 4 (Car-04) Keyesport, Site 13 (Car-13) Kaskaskia River at bridge on route 900, and Site 12 (Car-12) Cox Bridge. This combination of sites effectively represents the incoming contaminants and their effects on the lake.

APPENDIX A

DATA

LAB DATA

LAB DATA

Site #	Collection Date	Parameter	Flag	Reported Result	MDL	PQL	Units
CAR-1	3/7/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	5/10/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	7/10/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	9/5/2018	Alachlor	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	5/10/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	7/10/2018	Alachlor	<	0.250	0.250	0.250	UG/L
	9/5/2018	Alachlor	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	5/10/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	7/10/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	9/5/2018	Alachlor	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	5/10/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	7/10/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	9/5/2018	Alachlor	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Alachlor	<	0.250	0.250	0.250	UG/L
	5/10/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	7/10/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	9/5/2018	Alachlor	<	0.222	0.222	0.222	UG/L
CAR-4	3/7/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	5/10/2018	Alachlor	<	0.222	0.222	0.222	UG/L
	7/10/2018	Alachlor	<	0.200	0.200	0.200	UG/L
	9/5/2018	Alachlor	<	0.222	0.222	0.222	UG/L
CAR-1	3/7/2018	Atrazine		0.244	0.222	0.222	UG/L
	5/10/2018	Atrazine	<	0.200	0.200	0.200	UG/L
	7/10/2018	Atrazine		0.867	0.222	0.222	UG/L
	9/5/2018	Atrazine		0.611	0.222	0.222	UG/L
CAR-12	3/7/2018	Atrazine		0.460	0.200	0.200	UG/L
	5/10/2018	Atrazine		0.256	0.222	0.222	UG/L
	7/10/2018	Atrazine	<	0.250	0.250	0.250	UG/L
	9/5/2018	Atrazine	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Atrazine		0.500	0.222	0.222	UG/L
	5/10/2018	Atrazine		0.233	0.222	0.222	UG/L
	7/10/2018	Atrazine		0.420	0.200	0.200	UG/L
	9/5/2018	Atrazine	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Atrazine		0.260	0.200	0.200	UG/L
	5/10/2018	Atrazine		0.430	0.200	0.200	UG/L
	7/10/2018	Atrazine		0.380	0.200	0.200	UG/L
	9/5/2018	Atrazine	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Atrazine		0.338	0.250	0.250	UG/L
	5/10/2018	Atrazine	<	0.200	0.200	0.200	UG/L
	7/10/2018	Atrazine		0.967	0.222	0.222	UG/L

	9/5/2018	Atrazine		0.667	0.222	0.222	UG/L
CAR-4	3/7/2018	Atrazine		0.278	0.222	0.222	UG/L
	5/10/2018	Atrazine		0.556	0.222	0.222	UG/L
	7/10/2018	Atrazine		0.410	0.200	0.200	UG/L
	9/5/2018	Atrazine	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Chlorophyll-a	<	150	150	150	MG/CU.M.
	5/10/2018	Chlorophyll-a		73.5	1.00	1.00	MG/CU.M.
	7/10/2018	Chlorophyll-a		62.4	1.00	1.00	MG/CU.M.
	9/5/2018	Chlorophyll-a		109	1.00	1.00	MG/CU.M.
CAR-15	3/7/2018	Chlorophyll-a	<	150	150	150	MG/CU.M.
	5/10/2018	Chlorophyll-a		81.2	1.00	1.00	MG/CU.M.
	7/10/2018	Chlorophyll-a		68.4	1.00	1.00	MG/CU.M.
	9/5/2018	Chlorophyll-a		82.0	1.00	1.00	MG/CU.M.
CAR-2	3/7/2018	Chlorophyll-a	<	200	200	200	MG/CU.M.
	5/10/2018	Chlorophyll-a		110	1.00	1.00	MG/CU.M.
	7/10/2018	Chlorophyll-a		39.5	1.00	1.00	MG/CU.M.
	9/5/2018	Chlorophyll-a		47.8	1.00	1.00	MG/CU.M.
CAR-4	3/7/2018	Chlorophyll-a	<	100	100	100	MG/CU.M.
	5/10/2018	Chlorophyll-a		82.6	1.00	1.00	MG/CU.M.
	7/10/2018	Chlorophyll-a		65.8	1.00	1.00	MG/CU.M.
	9/5/2018	Chlorophyll-a		66.6	1.00	1.00	MG/CU.M.
CAR-1	3/7/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	5/10/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	7/10/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	9/5/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	5/10/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	7/10/2018	Chlorpyrifos	<	0.250	0.250	0.250	UG/L
	9/5/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	5/10/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	7/10/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	9/5/2018	Chlorpyrifos	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	5/10/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	7/10/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	9/5/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Chlorpyrifos	<	0.250	0.250	0.250	UG/L
	5/10/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	7/10/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	9/5/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
CAR-4	3/7/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	5/10/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
	7/10/2018	Chlorpyrifos	<	0.200	0.200	0.200	UG/L
	9/5/2018	Chlorpyrifos	<	0.222	0.222	0.222	UG/L
CAR-1	3/7/2018	Cyanazine	<	0.222	0.222	0.222	UG/L

	5/10/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	7/10/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	9/5/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	5/10/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	7/10/2018	Cyanazine	<	0.250	0.250	0.250	UG/L
	9/5/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	5/10/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	7/10/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	9/5/2018	Cyanazine	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	5/10/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	7/10/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	9/5/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Cyanazine	<	0.250	0.250	0.250	UG/L
	5/10/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	7/10/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	9/5/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
CAR-4	3/7/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	5/10/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
	7/10/2018	Cyanazine	<	0.200	0.200	0.200	UG/L
	9/5/2018	Cyanazine	<	0.222	0.222	0.222	UG/L
CAR-BL MARINA	7/10/2018	E. Coliform		50.0	1.00	1.00	COL/100 ML
	5/10/2018	E. Coliform		375	1.00	1.00	COL/100 ML
	9/5/2018	E. Coliform		100	1.00	1.00	COL/100 ML
CAR-DW MARINA	7/10/2018	E. Coliform		200	1.00	1.00	COL/100 ML
	5/10/2018	E. Coliform		575	1.00	1.00	COL/100 ML
	9/5/2018	E. Coliform		175	1.00	1.00	COL/100 ML
CAR-KP MARINA	7/10/2018	E. Coliform		145	1.00	1.00	COL/100 ML
	5/10/2018	E. Coliform		475	1.00	1.00	COL/100 ML
	9/5/2018	E. Coliform		125	1.00	1.00	COL/100 ML
CAR-1	3/7/2018	Iron		3.20	0.0500	0.100	MG/L
	5/10/2018	Iron		0.991	0.0500	0.100	MG/L
	7/10/2018	Iron		0.402	0.0500	0.100	MG/L
	9/5/2018	Iron		0.413	0.0500	0.100	MG/L
CAR-2-10	3/7/2018	Iron		3.56	0.0500	0.100	MG/L
	5/10/2018	Iron		1.50	0.0500	0.100	MG/L
	7/10/2018	Iron		4.39	0.0500	0.100	MG/L
	9/5/2018	Iron		0.829	0.0500	0.100	MG/L

CAR-1	3/7/2018	Manganese		0.137	0.00500	0.0100	MG/L
	5/10/2018	Manganese		0.107	0.00500	0.0100	MG/L
	7/10/2018	Manganese		0.202	0.00500	0.0100	MG/L
	9/5/2018	Manganese		0.154	0.00500	0.0100	MG/L
CAR-2-10	3/7/2018	Manganese		0.140	0.00500	0.0100	MG/L
	5/10/2018	Manganese		0.132	0.00500	0.0100	MG/L
	7/10/2018	Manganese		1.11	0.00500	0.0100	MG/L
	9/5/2018	Manganese		0.281	0.00500	0.0100	MG/L
CAR-1	3/7/2018	Metolachlor	<	0.222	0.222	0.222	UG/L
	5/10/2018	Metolachlor	<	0.200	0.200	0.200	UG/L
	7/10/2018	Metolachlor		1.60	0.222	0.222	UG/L
	9/5/2018	Metolachlor		0.433	0.222	0.222	UG/L
CAR-12	3/7/2018	Metolachlor	<	0.200	0.200	0.200	UG/L
	5/10/2018	Metolachlor		0.233	0.222	0.222	UG/L
	7/10/2018	Metolachlor		0.325	0.250	0.250	UG/L
	9/5/2018	Metolachlor	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Metolachlor	<	0.222	0.222	0.222	UG/L
	5/10/2018	Metolachlor		0.222	0.222	0.222	UG/L
	7/10/2018	Metolachlor		0.780	0.200	0.200	UG/L
	9/5/2018	Metolachlor		0.313	0.250	0.250	UG/L
CAR-15	3/7/2018	Metolachlor	<	0.200	0.200	0.200	UG/L
	5/10/2018	Metolachlor		0.310	0.200	0.200	UG/L
	7/10/2018	Metolachlor		1.01	0.200	0.200	UG/L
	9/5/2018	Metolachlor	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Metolachlor	<	0.250	0.250	0.250	UG/L
	5/10/2018	Metolachlor	<	0.200	0.200	0.200	UG/L
	7/10/2018	Metolachlor		1.78	0.222	0.222	UG/L
	9/5/2018	Metolachlor		0.478	0.222	0.222	UG/L
CAR-4	3/7/2018	Metolachlor	<	0.222	0.222	0.222	UG/L
	5/10/2018	Metolachlor		0.378	0.222	0.222	UG/L
	7/10/2018	Metolachlor		1.07	0.200	0.200	UG/L
	9/5/2018	Metolachlor	<	0.222	0.222	0.222	UG/L
CAR-1	3/7/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	9/5/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	5/10/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Metribuzin	<	0.250	0.250	0.250	UG/L
	9/5/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Metribuzin	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	5/10/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Metribuzin	<	0.200	0.200	0.200	UG/L

	9/5/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Metribuzin	<	0.250	0.250	0.250	UG/L
	5/10/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	9/5/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
CAR-4	3/7/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Metribuzin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Metribuzin	<	0.222	0.222	0.222	UG/L
CAR-1	3/7/2018	Nitrate-N		0.632	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		1.39	0.0380	0.0400	MG/L
	7/10/2018	Nitrate-N		0.0310	0.0190	0.0200	MG/L
	9/5/2018	Nitrate-N		0.166	0.0190	0.0200	MG/L
CAR-12	3/7/2018	Nitrate-N		0.619	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		4.79	0.0950	0.100	MG/L
	7/10/2018	Nitrate-N		2.78	0.0380	0.0400	MG/L
	9/5/2018	Nitrate-N		0.117	0.0190	0.0200	MG/L
CAR-13	3/7/2018	Nitrate-N		0.704	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		4.43	0.0950	0.100	MG/L
	7/10/2018	Nitrate-N		2.37	0.0380	0.0400	MG/L
	9/5/2018	Nitrate-N		1.76	0.0190	0.0200	MG/L
CAR-15	3/7/2018	Nitrate-N		0.697	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		3.38	0.0380	0.0400	MG/L
	7/10/2018	Nitrate-N	<	0.0190	0.0190	0.0200	MG/L
	9/5/2018	Nitrate-N	<	0.0190	0.0190	0.0200	MG/L
CAR-2	3/7/2018	Nitrate-N		0.404	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		1.23	0.0380	0.0400	MG/L
	7/10/2018	Nitrate-N	<	0.0190	0.0190	0.0200	MG/L
	9/5/2018	Nitrate-N		0.106	0.0190	0.0200	MG/L
CAR-2-10	3/7/2018	Nitrate-N		0.414	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		1.37	0.0380	0.0400	MG/L
	7/10/2018	Nitrate-N		0.0270	0.0190	0.0200	MG/L
	9/5/2018	Nitrate-N		0.154	0.0190	0.0200	MG/L
CAR-4	3/7/2018	Nitrate-N		0.687	0.0380	0.0400	MG/L
	5/10/2018	Nitrate-N		3.23	0.0380	0.0400	MG/L
	7/10/2018	Nitrate-N	<	0.0190	0.0190	0.0200	MG/L
	9/5/2018	Nitrate-N		0.258	0.0190	0.0200	MG/L
CAR-1	3/7/2018	Nitrogen, ammonia		0.207	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia		0.154	0.0200	0.0300	MG/L
	7/10/2018	Nitrogen, ammonia		0.244	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia		0.0427	0.0200	0.0300	MG/L
CAR-12	3/7/2018	Nitrogen, ammonia		0.237	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia		0.0328	0.0200	0.0300	MG/L
	7/10/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
CAR-13	3/7/2018	Nitrogen, ammonia		0.197	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia		0.256	0.0200	0.0300	MG/L

	7/10/2018	Nitrogen, ammonia	J	0.0245	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
CAR-15	3/7/2018	Nitrogen, ammonia		0.163	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia	J	0.0229	0.0200	0.0300	MG/L
	7/10/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
CAR-2	3/7/2018	Nitrogen, ammonia		0.223	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia		0.0391	0.0200	0.0300	MG/L
	7/10/2018	Nitrogen, ammonia		0.0356	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
CAR-2-10	3/7/2018	Nitrogen, ammonia		0.221	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia		0.331	0.0200	0.0300	MG/L
	7/10/2018	Nitrogen, ammonia		0.435	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia		0.0924	0.0200	0.0300	MG/L
CAR-4	3/7/2018	Nitrogen, ammonia		0.188	0.0200	0.0300	MG/L
	5/10/2018	Nitrogen, ammonia		0.0332	0.0200	0.0300	MG/L
	7/10/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
	9/5/2018	Nitrogen, ammonia	<	0.0200	0.0200	0.0300	MG/L
CAR-1	3/7/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	9/5/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	5/10/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Pendimethalin	<	0.250	0.250	0.250	UG/L
	9/5/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Pendimethalin	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	5/10/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Pendimethalin	<	0.250	0.250	0.250	UG/L
	5/10/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	9/5/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
CAR-4	3/7/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Pendimethalin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Pendimethalin	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Pheophytin-a	<	150	150	150	MG/CU.M.
	5/10/2018	Pheophytin-a		10.3	1.00	1.00	MG/CU.M.
	7/10/2018	Pheophytin-a		7.60	1.00	1.00	MG/CU.M.
	9/5/2018	Pheophytin-a		30.6	1.00	1.00	MG/CU.M.
CAR-15	3/7/2018	Pheophytin-a	<	150	150	150	MG/CU.M.

	5/10/2018	Pheophytin-a		15.5	1.00	1.00	MG/CU.M.
	7/10/2018	Pheophytin-a		8.20	1.00	1.00	MG/CU.M.
	9/5/2018	Pheophytin-a		23.2	1.00	1.00	MG/CU.M.
CAR-2	3/7/2018	Pheophytin-a	<	200	200	200	MG/CU.M.
	5/10/2018	Pheophytin-a		12.4	1.00	1.00	MG/CU.M.
	7/10/2018	Pheophytin-a		9.50	1.00	1.00	MG/CU.M.
	9/5/2018	Pheophytin-a		10.2	1.00	1.00	MG/CU.M.
CAR-4	3/7/2018	Pheophytin-a	<	100	100	100	MG/CU.M.
	5/10/2018	Pheophytin-a		16.1	1.00	1.00	MG/CU.M.
	7/10/2018	Pheophytin-a		9.00	1.00	1.00	MG/CU.M.
	9/5/2018	Pheophytin-a		12.3	1.00	1.00	MG/CU.M.
CAR-1	3/7/2018	Phosphorus, ortho-		0.106	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-		0.0345	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.362	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.428	0.00800	0.0100	MG/L
CAR-12	3/7/2018	Phosphorus, ortho-		0.0309	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-	<	0.00800	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.0543	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.0356	0.00800	0.0100	MG/L
CAR-13	3/7/2018	Phosphorus, ortho-		0.0194	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-	<	0.00800	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.0259	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.0164	0.00800	0.0100	MG/L
CAR-15	3/7/2018	Phosphorus, ortho-		0.120	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-		0.0267	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.173	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.214	0.00800	0.0100	MG/L
CAR-2	3/7/2018	Phosphorus, ortho-		0.0655	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-	J	0.00840	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.310	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.423	0.00800	0.0100	MG/L
CAR-2-10	3/7/2018	Phosphorus, ortho-		0.0684	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-		0.0686	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.424	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.448	0.00800	0.0100	MG/L
CAR-4	3/7/2018	Phosphorus, ortho-		0.132	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, ortho-		0.0424	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, ortho-		0.171	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, ortho-		0.222	0.00800	0.0100	MG/L
CAR-1	3/7/2018	Phosphorus, total		0.395	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		0.235	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.462	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.472	0.00800	0.0100	MG/L
CAR-12	3/7/2018	Phosphorus, total		0.303	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		0.209	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.228	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.272	0.00800	0.0100	MG/L

CAR-13	3/7/2018	Phosphorus, total		0.321	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		0.230	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.445	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.397	0.00800	0.0100	MG/L
CAR-15	3/7/2018	Phosphorus, total		0.452	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		1.86	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.351	0.008	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.653	0.00800	0.0100	MG/L
CAR-2	3/7/2018	Phosphorus, total		0.382	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		0.153	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.437	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.494	0.00800	0.0100	MG/L
CAR-2-10	3/7/2018	Phosphorus, total		0.386	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		0.243	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.675	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.539	0.00800	0.0100	MG/L
CAR-4	3/7/2018	Phosphorus, total		0.482	0.00800	0.0100	MG/L
	5/10/2018	Phosphorus, total		0.346	0.00800	0.0100	MG/L
	7/10/2018	Phosphorus, total		0.351	0.00800	0.0100	MG/L
	9/5/2018	Phosphorus, total		0.423	0.00800	0.0100	MG/L
CAR-1	3/7/2018	Solids, total suspended		40.0	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		30.9	2.86	2.86	MG/L
	7/10/2018	Solids, total suspended		11.6	4.00	4.00	MG/L
	9/5/2018	Solids, total suspended		11.2	4.00	4.00	MG/L
CAR-12	3/7/2018	Solids, total suspended		104	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		83.0	5.00	5.00	MG/L
	7/10/2018	Solids, total suspended		40.4	4.00	4.00	MG/L
	9/5/2018	Solids, total suspended		27.6	4.00	4.00	MG/L
CAR-13	3/7/2018	Solids, total suspended		119	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		95.5	5.00	5.00	MG/L
	7/10/2018	Solids, total suspended		114	4.00	4.00	MG/L
	9/5/2018	Solids, total suspended		71.6	4.00	4.00	MG/L
CAR-15	3/7/2018	Solids, total suspended		79.5	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		80.5	5.00	5.00	MG/L
	7/10/2018	Solids, total suspended		20.0	4.00	4.00	MG/L
	9/5/2018	Solids, total suspended		38.4	4.00	4.00	MG/L
CAR-2	3/7/2018	Solids, total suspended		38.5	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		25.2	4.00	4.00	MG/L
	7/10/2018	Solids, total suspended		11.3	2.50	2.50	MG/L
	9/5/2018	Solids, total suspended		9.60	4.00	4.00	MG/L
CAR-2-10	3/7/2018	Solids, total suspended		44.5	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		46.0	4.00	4.00	MG/L
	7/10/2018	Solids, total suspended		74.0	4.00	4.00	MG/L
	9/5/2018	Solids, total suspended		22.0	4.00	4.00	MG/L
CAR-4	3/7/2018	Solids, total suspended		82.0	5.00	5.00	MG/L
	5/10/2018	Solids, total suspended		74.7	6.67	6.67	MG/L
	7/10/2018	Solids, total suspended		25.2	4.00	4.00	MG/L

	9/5/2018	Solids, total suspended		38.8	4.00	4.00	MG/L
CAR-1	3/7/2018	Solids, Volaltile Suspended		6.00	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		7.71	2.86	2.86	MG/L
	7/10/2018	Solids, Volaltile Suspended	<	4.00	4.00	4.00	MG/L
	9/5/2018	Solids, Volaltile Suspended	<	4.00	4.00	4.00	MG/L
CAR-12	3/7/2018	Solids, Volaltile Suspended		7.00	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		10.0	5.00	5.00	MG/L
	7/10/2018	Solids, Volaltile Suspended		6.80	4.00	4.00	MG/L
	9/5/2018	Solids, Volaltile Suspended		9.20	4.00	4.00	MG/L
CAR-13	3/7/2018	Solids, Volaltile Suspended		8.00	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		11.5	5.00	5.00	MG/L
	7/10/2018	Solids, Volaltile Suspended		12.0	4.00	4.00	MG/L
	9/5/2018	Solids, Volaltile Suspended		15.6	4.00	4.00	MG/L
CAR-15	3/7/2018	Solids, Volaltile Suspended		8.50	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		17.5	5.00	5.00	MG/L
	7/10/2018	Solids, Volaltile Suspended		8.00	4.00	4.00	MG/L
	9/5/2018	Solids, Volaltile Suspended		5.60	4.00	4.00	MG/L
CAR-2	3/7/2018	Solids, Volaltile Suspended		5.50	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		10.0	4.00	4.00	MG/L
	7/10/2018	Solids, Volaltile Suspended		5.25	2.50	2.50	MG/L
	9/5/2018	Solids, Volaltile Suspended	<	4.00	4.00	4.00	MG/L
CAR-2-10	3/7/2018	Solids, Volaltile Suspended		6.50	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		7.60	4.00	4.00	MG/L
	7/10/2018	Solids, Volaltile Suspended		11.2	4.00	4.00	MG/L
	9/5/2018	Solids, Volaltile Suspended	<	4.00	4.00	4.00	MG/L
CAR-4	3/7/2018	Solids, Volaltile Suspended		8.50	5.00	5.00	MG/L
	5/10/2018	Solids, Volaltile Suspended		17.3	6.67	6.67	MG/L

	7/10/2018	Solids, Volaltile Suspended		8.40	4.00	4.00	MG/L
	9/5/2018	Solids, Volaltile Suspended		6.80	4.00	4.00	MG/L
CAR-1	3/7/2018	Total Organic Carbon		3.50	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	5.40	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		4.70	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		4.30	0.500	1.00	MG/L
CAR-12	3/7/2018	Total Organic Carbon		3.10	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	5.00	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		3.40	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		4.40	0.500	1.00	MG/L
CAR-13	3/7/2018	Total Organic Carbon		3.20	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	5.10	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		3.50	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		5.20	0.500	1.00	MG/L
CAR-15	3/7/2018	Total Organic Carbon		3.50	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	4.90	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		5.90	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		5.10	0.500	1.00	MG/L
CAR-2	3/7/2018	Total Organic Carbon		3.90	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	6.00	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		5.00	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		4.80	0.500	1.00	MG/L
CAR-2-10	3/7/2018	Total Organic Carbon		3.70	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	5.20	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		4.90	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		4.80	0.500	1.00	MG/L
CAR-4	3/7/2018	Total Organic Carbon		3.90	0.500	1.00	MG/L
	5/10/2018	Total Organic Carbon	B	5.10	0.500	1.00	MG/L
	7/10/2018	Total Organic Carbon		5.90	0.500	1.00	MG/L
	9/5/2018	Total Organic Carbon		5.30	0.500	1.00	MG/L
CAR-1	3/7/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	9/5/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
CAR-12	3/7/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	5/10/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Trifluralin	<	0.250	0.250	0.250	UG/L
	9/5/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
CAR-13	3/7/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Trifluralin	<	0.250	0.250	0.250	UG/L
CAR-15	3/7/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	5/10/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Trifluralin	<	0.200	0.200	0.200	UG/L

	9/5/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
CAR-2	3/7/2018	Trifluralin	<	0.250	0.250	0.250	UG/L
	5/10/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	7/10/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	9/5/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
CAR-4	3/7/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	5/10/2018	Trifluralin	<	0.222	0.222	0.222	UG/L
	7/10/2018	Trifluralin	<	0.200	0.200	0.200	UG/L
	9/5/2018	Trifluralin	<	0.222	0.222	0.222	UG/L

ND – Indicates compound was analyzed for but not detected.
J – Indicates an estimated value
B – Indicates the analyte was found in the blank as well as the sample and possible blank contamination.

FIELD DATA

Site	Date	Depth (m)	Water Temp (ºC)	Redox (mv)	Cond (uS)	DO %	DO mg/l	pH	Time	Seechi (in)	Total Depth (ft)
CAR-1	3/7/2018	0.87	45.9	188.5	272	107.6	12.8	7.55	9:00		
	5/10/2018	0.54	67.9	265.3	349	102	9.27	8.39	8:53		
	7/10/2018	0.77	82.7	287.2	312	96.3	7.51	8.22	8:58		
	9/5/2018	0.66	80.3	336.8	313	88.9	7.1	8.26	9:10		
CAR-2	3/7/2018	0.03	46	167.8	265	86.9	10.3	7.36	10:37	8	22
CAR-2		0.95	45.9	156.6	265	86.6	10.3	7.59	10:40		
CAR-2		2.08	45.9	157	265	86.4	10.3	7.57	10:41		
CAR-2		2.98	45.9	156.9	265	86.4	10.3	7.56	10:41		
CAR-2		4.04	45.9	155.4	265	86.4	10.3	7.58	10:41		
CAR-2		4.93	45.9	150.2	265	86.1	10.3	7.64	10:42		
CAR-2	5/10/2018	0.14	69.4	189	335	153.8	13.8	9.19	9:45	17	21
CAR-2		1.10	68.8	201.9	343	124	11.2	8.86	9:45		
CAR-2		2.11	68.3	218.9	346	106.1	9.61	8.49	9:46		
CAR-2		3.11	67.7	222	349	96.9	8.83	8.37	9:46		
CAR-2		4.07	67.8	222.5	349	97.2	8.85	8.42	9:48		
CAR-2		5.14	65.5	230.8	358	59.3	5.54	7.9	9:49		
CAR-2	7/10/2018	-0.01	84.6	298.4	307	89.3	6.84	8.91	10:12	28	22
CAR-2		1.02	83.1	291.4	308	69.5	5.4	8.81	10:13		
CAR-2		2.16	82.4	297.7	312	38.1	2.98	8.4	10:13		
CAR-2		3.20	82.1	304.1	315	23.8	1.87	8.13	10:14		
CAR-2		4.42	82	307.8	316	19	1.5	7.92	10:15		
CAR-2		4.96	82	306.8	317	15.4	1.21	7.88	10:15		
CAR-2		6.12	82	304.8	318	12.9	1.01	7.87	10:16		
CAR-2	9/5/2018	1.00	80.4	60.9	312	72.8	5.81	8.26	10:41	23	12
CAR-2		2.02	80.3	63.5	312	66.2	5.29	8.17	10:40		
CAR-2		3.02	80.2	66.4	314	56.6	4.52	8.08	10:40		
CAR-2		4.30	80.2	66.3	315	49.2	3.93	8.09	10:39		
CAR-4	3/7/2018	0.13	44.2	141.2	268	92.7	11.3	7.73	11:57	5	25
CAR-4		0.96	44.2	147	268	92.6	11.3	7.64	11:58		
CAR-4		2.04	44.2	152.3	269	92.6	11.3	7.56	11:58		
CAR-4		3.01	44.2	152.7	268	92.3	11.3	7.56	11:59		
CAR-4		4.02	44.2	151.8	268	92.4	11.3	7.58	12:00		
CAR-4		5.07	44.2	152	268	92.4	11.3	7.57	12:00		
CAR-4		5.86	44.2	152.2	268	92.5	11.3	7.56	12:00		
CAR-4	5/10/2018	0.01	74.8	173.4	463	145.3	12.3	8.76	10:51	9	16
CAR-4		1.27	69.2	188.7	472	89.8	8.06	8.31	10:51		
CAR-4		2.11	68.9	203.7	473	88.9	8	8.07	10:52		
CAR-4		3.05	68.4	207.3	476	87.8	7.94	8.03	10:52		
CAR-4		4.09	68.2	208.7	477	85.6	7.76	8.03	10:53		
CAR-4		4.75	68.1	210.6	477	84.2	7.63	8.02	10:53		
CAR-4	7/10/2018	0.05	89.7	236.6	263	173.3	12.6	9.39	11:39	16	23
CAR-4		1.08	85.4	248.3	269	102.7	7.81	8.93	11:40		

CAR-4		2.04	83.6	267.4	265	71.8	5.55	8.43	11:40		
CAR-4		3.07	83.3	271.7	263	68.6	5.32	8.32	11:41		
CAR-4		4.06	82.9	274.1	264	61.4	4.77	8.19	11:41		
CAR-4		5.01	82.8	275.1	264	57.1	4.45	8.15	11:42		
CAR-4		6.07	82.7	246.8	269	52.5	4.09	7.79	11:43		
CAR-4	9/5/2018	1.01	84.9	39.8	264	82.7	6.31	8.21	11:52	12	21
CAR-4		2.07	84	36.8	272	64.1	4.94	7.96	11:51		
CAR-4		3.00	83.8	36.1	278	61.4	4.74	7.93	11:51		
CAR-4		4.00	83.7	37.3	272	62.4	4.82	7.97	11:51		
CAR-4		5.13	83.7	-0.1	270	57.3	4.42	8.05	11:47		
CAR-4		6.16	83.6	-14.7	265	54.3	4.2	8.09	11:47		
CAR-12	3/7/2018	0.82	42.7	142.2	419	97.5	12.1	7.65	14:00		
	5/10/2018	0.47	67.2	195.7	471	98.1	8.99	8.16	12:40		
	7/10/2018	0.96	82.6	347.5	518	119.3	9.31	8.55	13:21		
	9/5/2018	1.10	81.6	40.9	474	58.9	4.65	7.84	13:50		
		2.04	81.4	62.5	474	54.6	4.31	7.85	13:49		
		2.97	81.3	60.7	475	51.5	4.07	7.87	13:49		
		4.05	81.4	53.5	474	53.5	4.22	7.95	13:49		
		5.09	81.3	43.1	475	49.4	3.91	7.98	13:48		
		6.06	81.3	35.2	475	50.4	3.98	8.04	13:48		
		6.86	81.3	23.6	476	50.2	3.96	8.16	13:47		
CAR-13	3/7/2018	0.04	42.4	172.5	425	94.3	11.8	7.58	13:16		
		1.12	42.4	161.2	425	93.3	11.7	7.8	13:18		
	5/10/2018	0.05	67.8	211.4	450	97.1	8.84	7.98	11:59		
		1.13	67.8	221.1	450	97	8.83	7.79	12:00		
		1.29	67.8	219.8	450	96.9	8.82	7.81	12:00		
		2.45	67.8	220.6	450	96.8	8.81	7.79	12:00		
	7/10/2018	1.03	83.5	383.5	377	96.6	7.47	8.63	12:35		
	9/5/2018	0.92	82.4	63.8	454	125	9.78	8.54	12:57		

SEDIMENT

Collection Date	Site #	Parameter	Flag	Reported Result	MDL	PQL	Units
7/10/2018	CAR-15	Alachlor	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Alachlor	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Alachlor	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Arsenic		7.27	0.724	1.45	MG/KG
7/10/2018	CAR-2	Arsenic		3.12	0.385	0.771	MG/KG
7/10/2018	CAR-4	Arsenic		5.72	0.756	1.51	MG/KG
7/10/2018	CAR-15	Atrazine	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Atrazine	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Atrazine	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Barium		196	2.41	4.83	MG/KG
7/10/2018	CAR-2	Barium		33.6	1.28	2.57	MG/KG
7/10/2018	CAR-4	Barium		205	2.52	5.04	MG/KG
7/10/2018	CAR-15	Boron	J	8.54	7.24	14.5	MG/KG
7/10/2018	CAR-2	Boron	<	3.85	3.85	7.71	MG/KG
7/10/2018	CAR-4	Boron	J	12.2	7.56	15.1	MG/KG
7/10/2018	CAR-15	Cadmium	J	0.531	0.483	0.966	MG/KG
7/10/2018	CAR-2	Cadmium	<	0.257	0.257	0.514	MG/KG
7/10/2018	CAR-4	Cadmium	J	0.580	0.504	1.01	MG/KG
7/10/2018	CAR-15	Chlorpyrifos	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Chlorpyrifos	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Chlorpyrifos	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Chromium		28.8	1.21	2.41	MG/KG
7/10/2018	CAR-2	Chromium		5.97	0.642	1.28	MG/KG
7/10/2018	CAR-4	Chromium		32.0	1.26	2.52	MG/KG
7/10/2018	CAR-15	Copper		20.3	2.41	4.83	MG/KG
7/10/2018	CAR-2	Copper		3.45	1.28	2.57	MG/KG
7/10/2018	CAR-4	Copper		20.5	2.52	5.04	MG/KG
7/10/2018	CAR-15	Cyanazine	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Cyanazine	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Cyanazine	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Iron		28300	60.3	121	MG/KG
7/10/2018	CAR-2	Iron		8460	32.1	64.2	MG/KG
7/10/2018	CAR-4	Iron		30000	63.0	126	MG/KG
7/10/2018	CAR-15	Kjeldahl nitrogen		2080	471	496	MG/KG
7/10/2018	CAR-2	Kjeldahl nitrogen		227	24.8	26.1	MG/KG
7/10/2018	CAR-4	Kjeldahl nitrogen		2690	554	583	MG/KG
7/10/2018	CAR-15	Lead		17.8	0.724	1.45	MG/KG
7/10/2018	CAR-2	Lead		4.75	0.385	0.771	MG/KG
7/10/2018	CAR-4	Lead		17.8	0.756	1.51	MG/KG
7/10/2018	CAR-15	Manganese		1400	6.03	12.1	MG/KG
7/10/2018	CAR-2	Manganese		532	3.21	6.42	MG/KG
7/10/2018	CAR-4	Manganese		1430	6.30	12.6	MG/KG

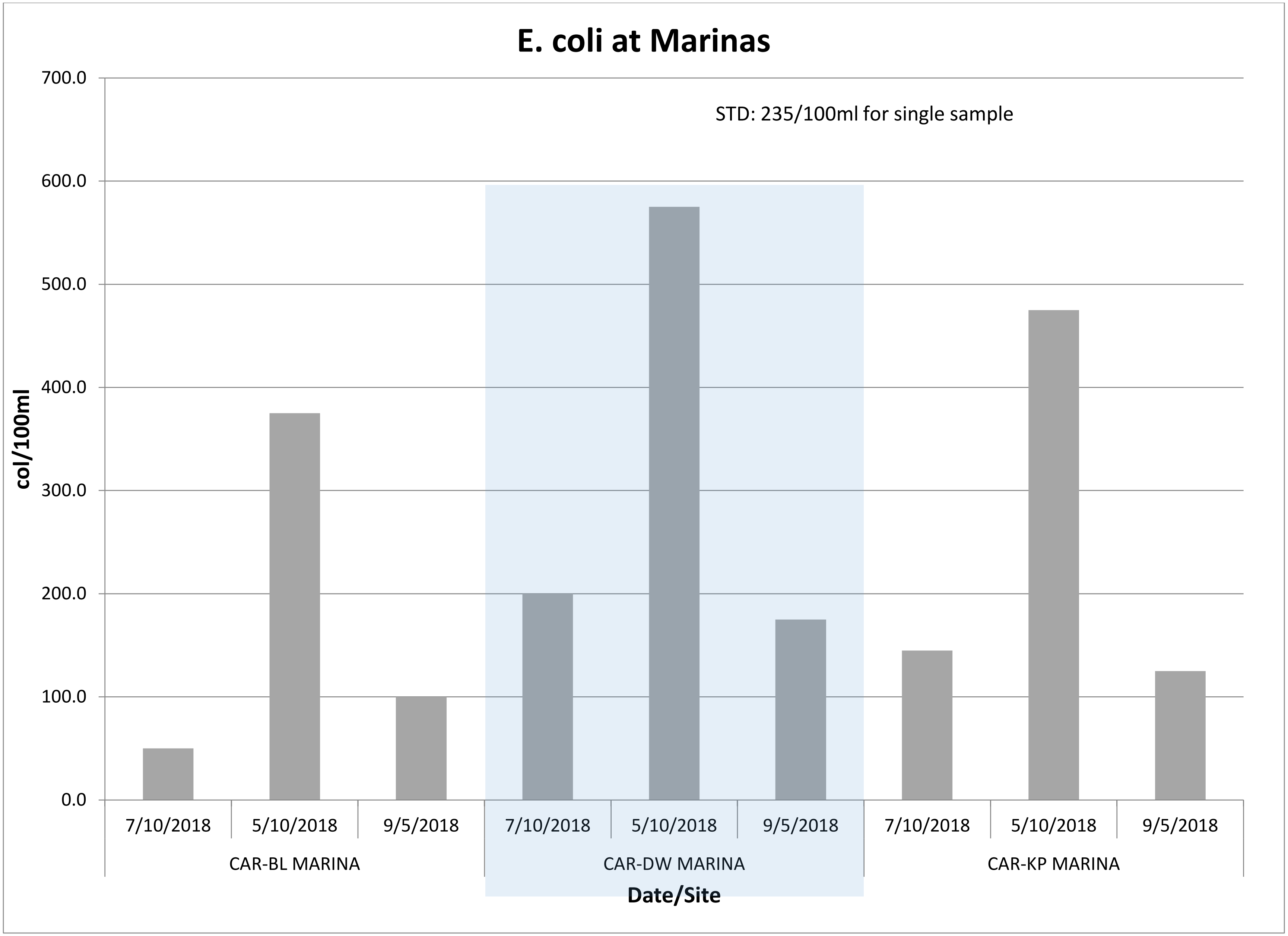
7/10/2018	CAR-15	Mercury	<	0.204	0.204	0.511	MG/KG
7/10/2018	CAR-2	Mercury	<	0.109	0.109	0.272	MG/KG
7/10/2018	CAR-4	Mercury	<	0.210	0.210	0.526	MG/KG
7/10/2018	CAR-15	Metolachlor	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Metolachlor	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Metolachlor	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Metribuzin	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Metribuzin	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Metribuzin	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Nickel		22.2	3.62	7.24	MG/KG
7/10/2018	CAR-2	Nickel	J	3.72	1.93	3.85	MG/KG
7/10/2018	CAR-4	Nickel		22.2	3.78	7.56	MG/KG
7/10/2018	CAR-15	Nitrate-N		6.38	4.73	4.73	MG/KG
7/10/2018	CAR-2	Nitrate-N	<	2.72	2.72	2.72	MG/KG
7/10/2018	CAR-4	Nitrate-N		9.92	5.36	5.36	MG/KG
7/10/2018	CAR-15	Pendimethalin	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Pendimethalin	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Pendimethalin	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Phosphorus, total		183	17.3	21.6	MG/KG
7/10/2018	CAR-2	Phosphorus, total		803	9.45	11.8	MG/KG
7/10/2018	CAR-4	Phosphorus, total		818	7.40	9.24	MG/KG
7/10/2018	CAR-15	Selenium	<	1.21	1.21	2.41	MG/KG
7/10/2018	CAR-2	Selenium	<	0.642	0.642	1.28	MG/KG
7/10/2018	CAR-4	Selenium	<	1.26	1.26	2.52	MG/KG
7/10/2018	CAR-15	Silver	<	1.21	1.21	2.41	MG/KG
7/10/2018	CAR-2	Silver	<	0.642	0.642	1.28	MG/KG
7/10/2018	CAR-4	Silver	<	1.26	1.26	2.52	MG/KG
7/10/2018	CAR-15	Solids, total		40.3	0.100	0.100	%
7/10/2018	CAR-2	Solids, total		73.6	0.100	0.100	%
7/10/2018	CAR-4	Solids, total		37.3	0.100	0.100	%
7/10/2018	CAR-15	Total Organic Carbon		8700	600	1000	MG/KG
7/10/2018	CAR-2	Total Organic Carbon	<	600	600	1000	MG/KG
7/10/2018	CAR-4	Total Organic Carbon		1400	600	1000	MG/KG
7/10/2018	CAR-15	Trifluralin	<	16.6	16.6	16.6	UG/KG
7/10/2018	CAR-2	Trifluralin	<	9.10	9.10	9.10	UG/KG
7/10/2018	CAR-4	Trifluralin	<	18.2	18.2	18.2	UG/KG
7/10/2018	CAR-15	Zinc		87.4	1.21	2.41	MG/KG
7/10/2018	CAR-2	Zinc		13.0	0.642	1.28	MG/KG
7/10/2018	CAR-4	Zinc		92.0	1.26	2.52	MG/KG

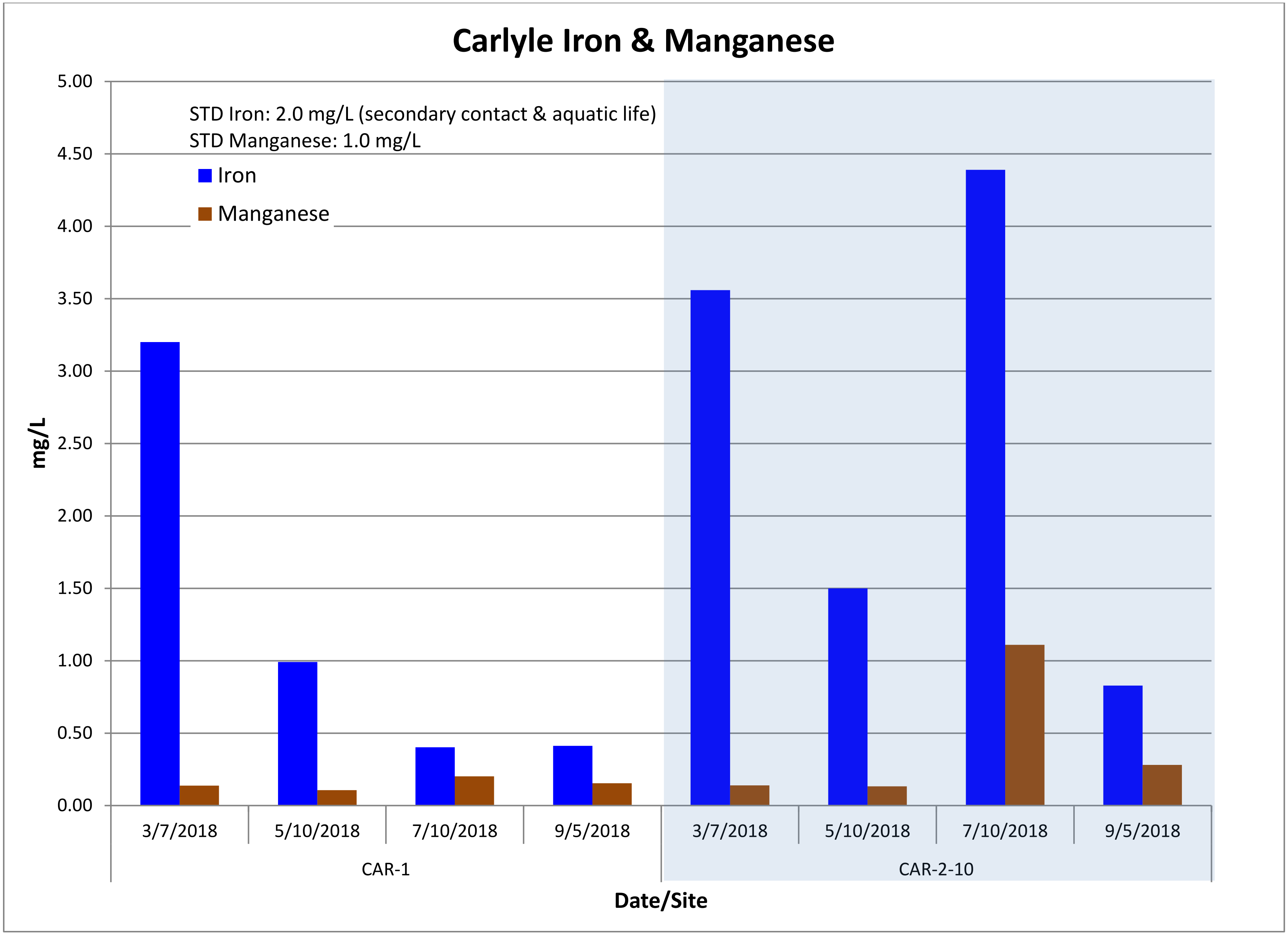
ND – Indicates compound was analyzed for but not detected.
J – Indicates an estimated value.

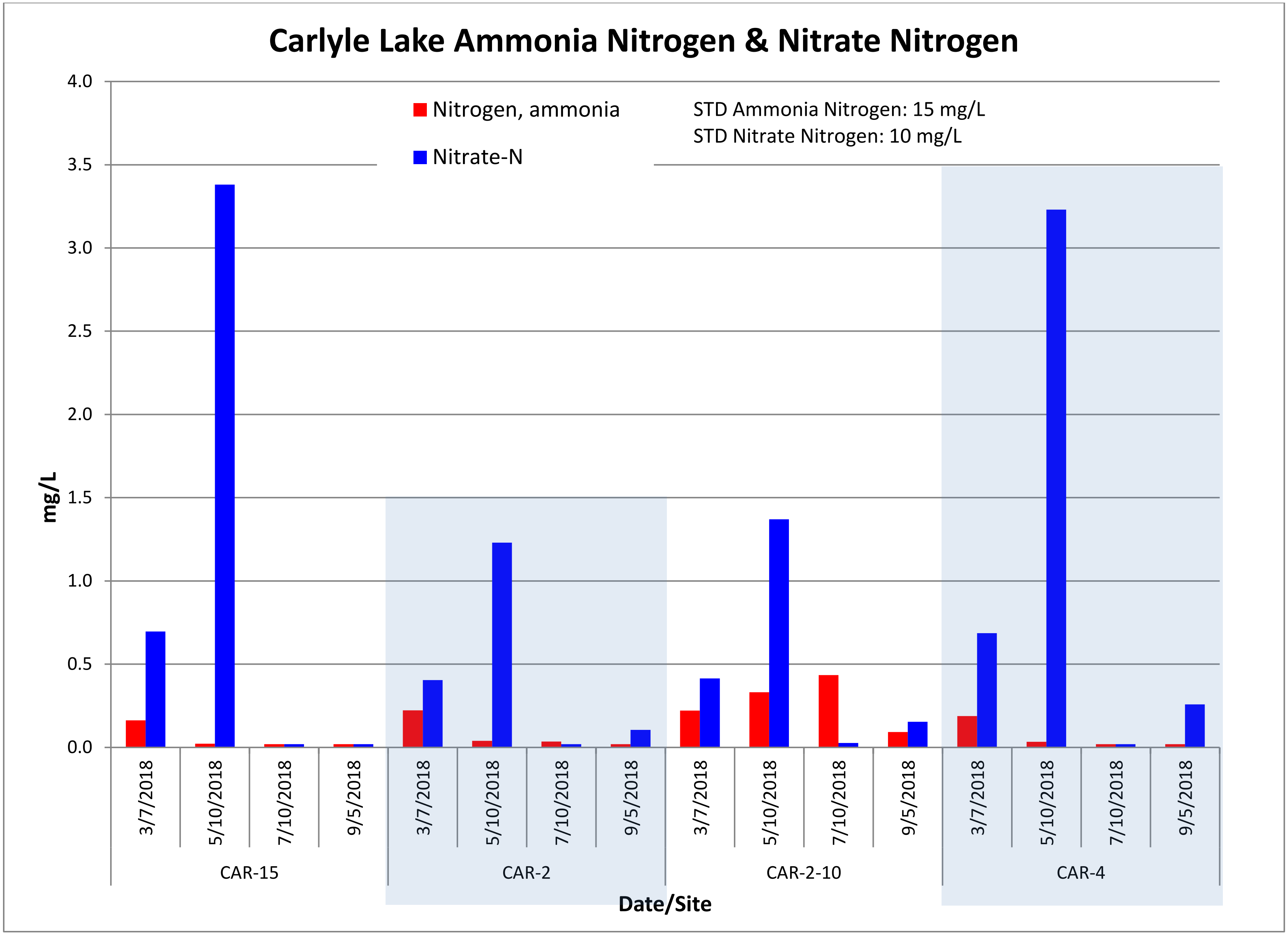
APPENDIX B

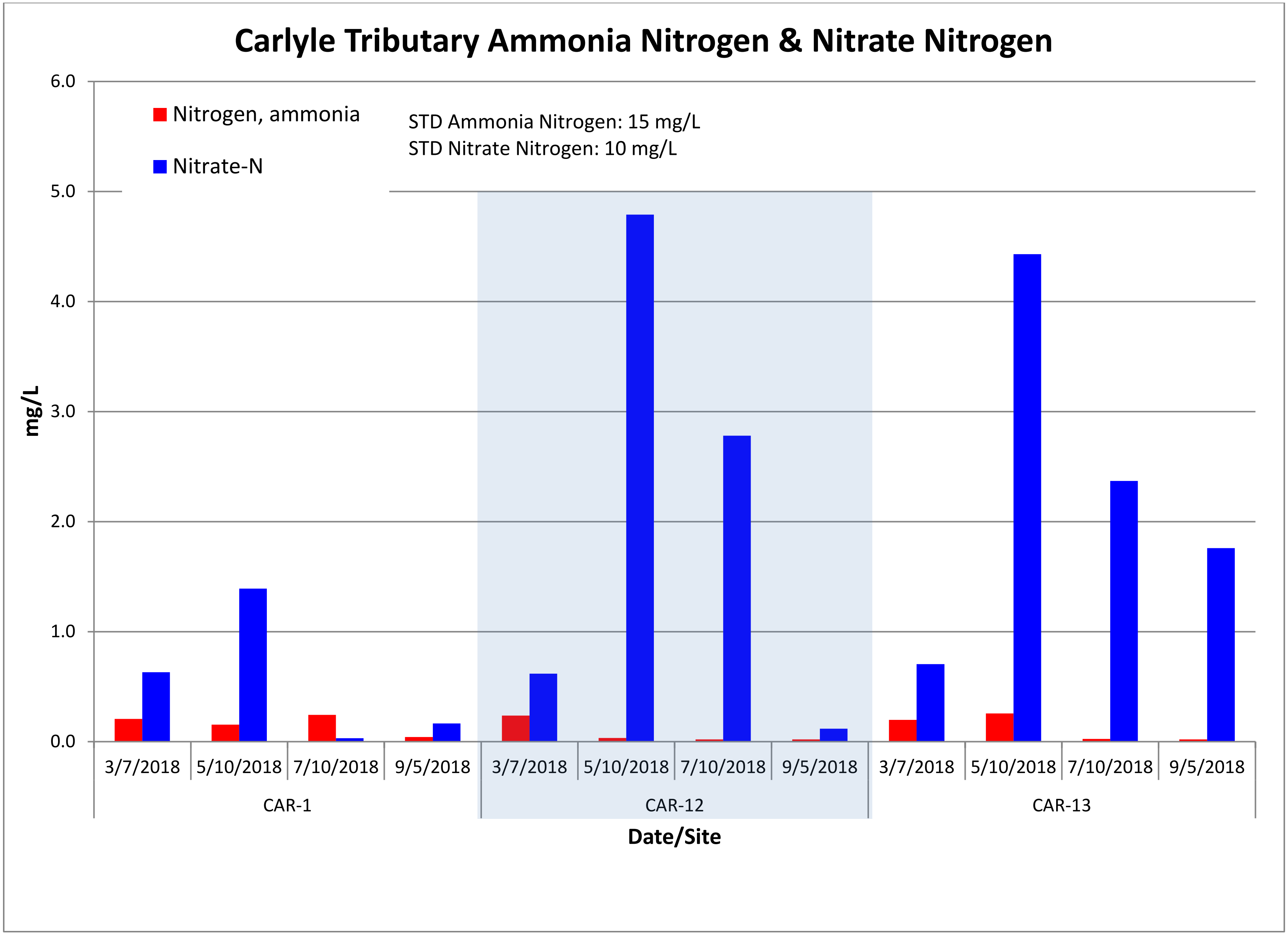
GRAPHS

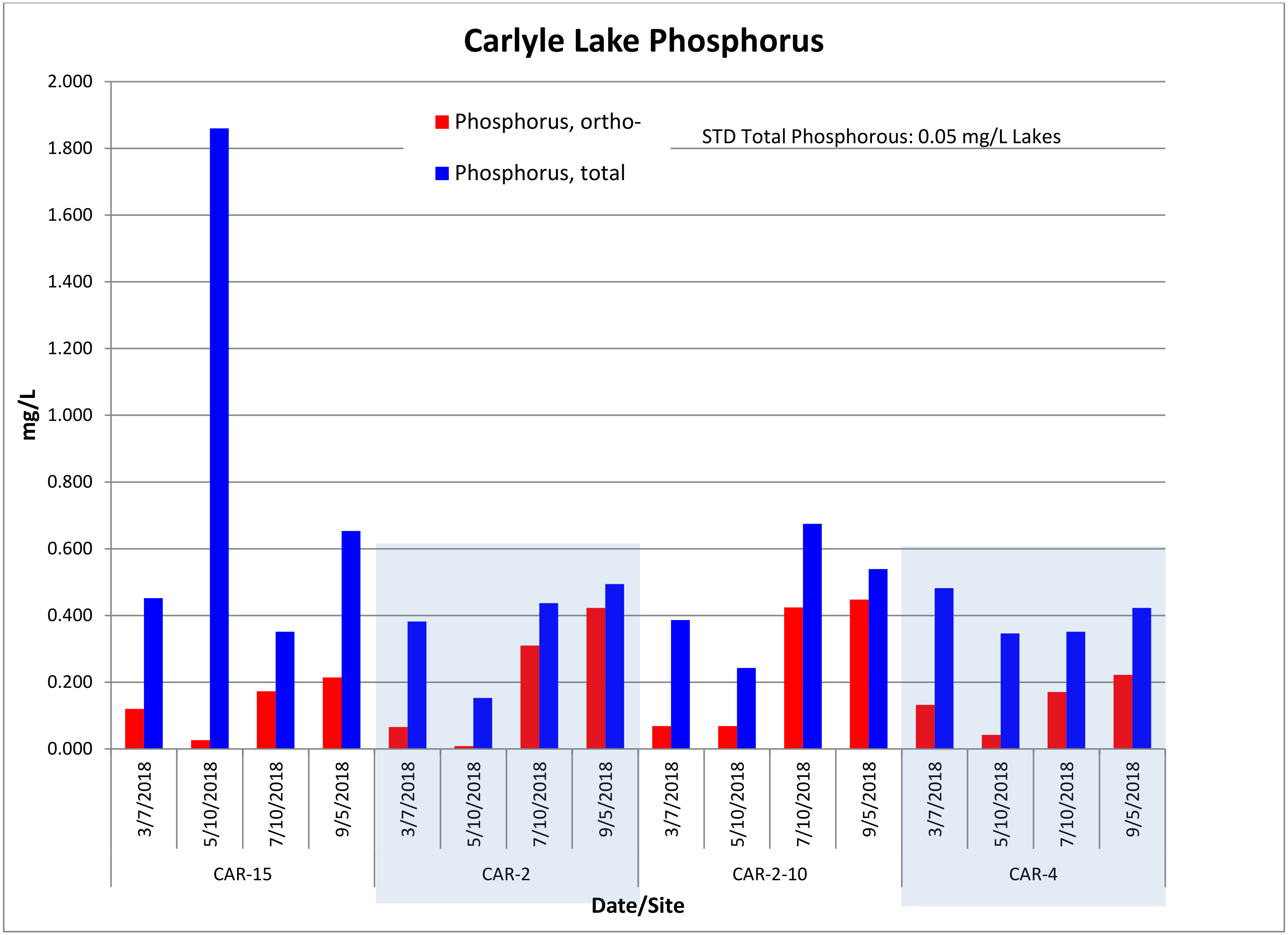
LABORATORY


E. coli at Marinas
STD: 235/100ml for single sample
col/100ml
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
7/10/2018
5/10/2018
9/5/2018
7/10/2018
5/10/2018
9/5/2018
7/10/2018
5/10/2018
9/5/2018
CAR-BL MARINA
CAR-DW MARINA
CAR-KP MARINA
Date/Site

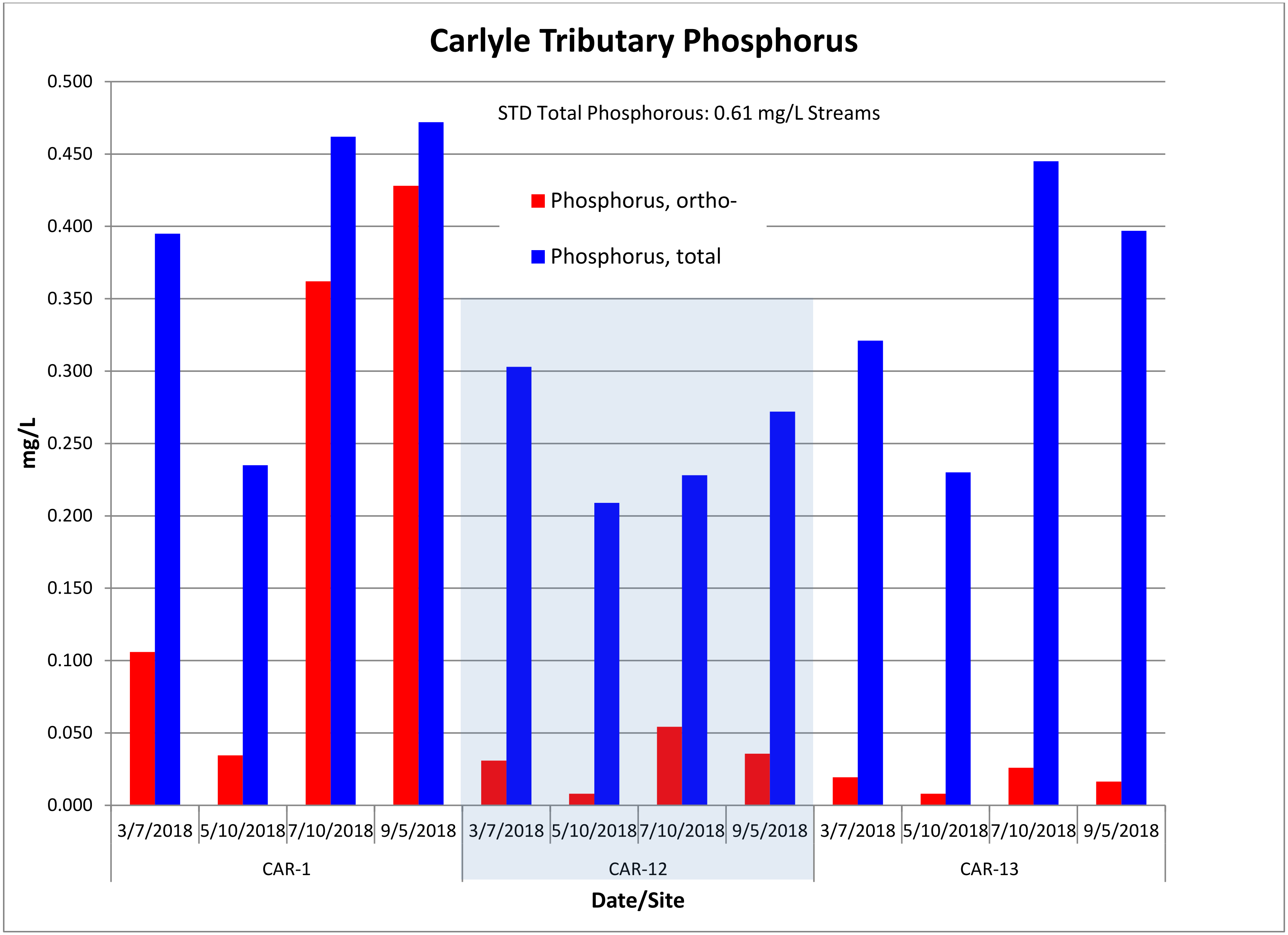

Carlyle Iron & Manganese
STD Iron: 2.0 mg/L (secondary contact & aquatic life)
STD Manganese: 1.0 mg/L
Iron
Manganese
mg/L
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-2-10
Date/Site

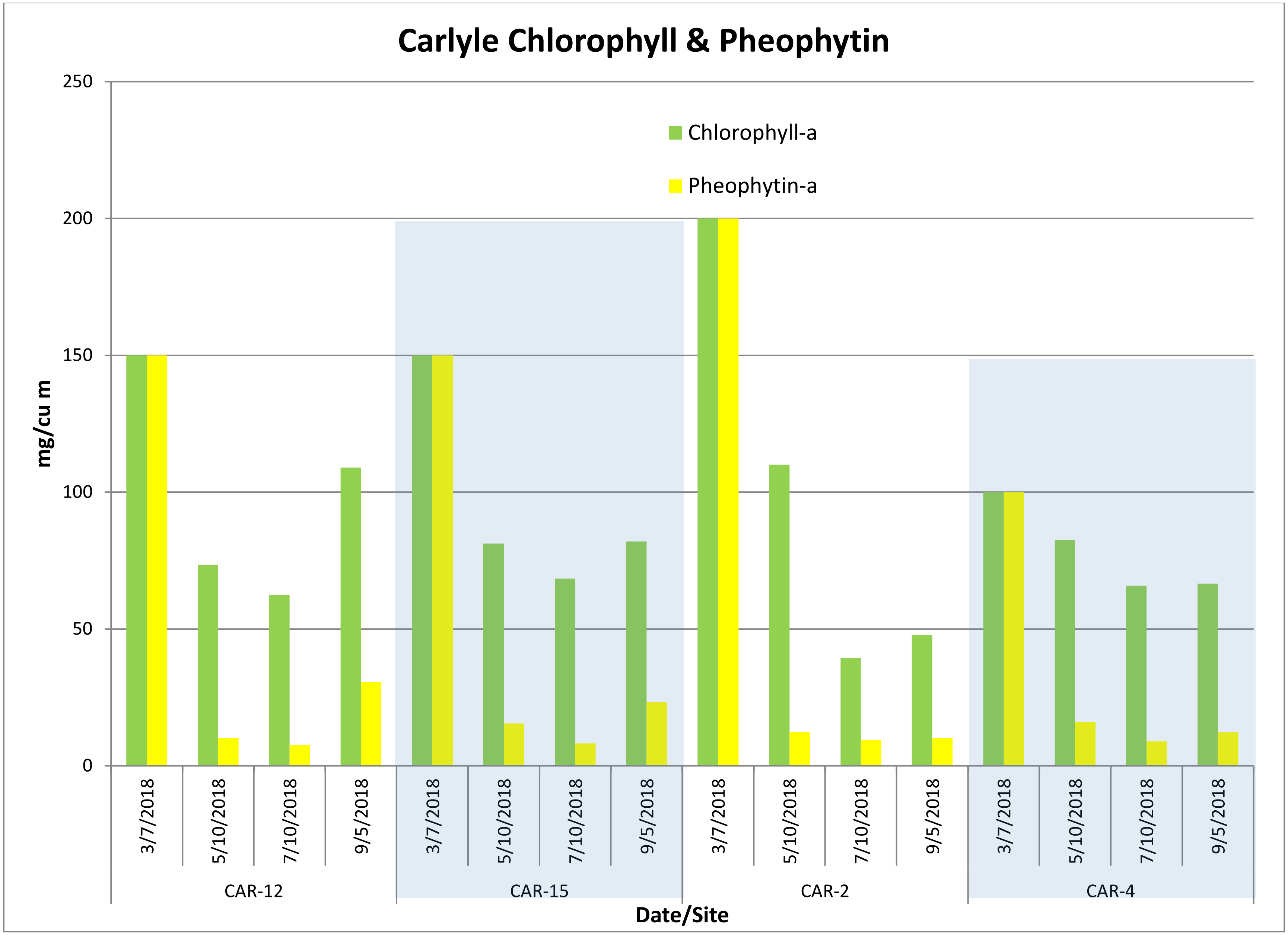

Carlyle Lake Ammonia Nitrogen & Nitrate Nitrogen
Nitrogen, ammonia
Nitrate-N
STD Ammonia Nitrogen: 15 mg/L
STD Nitrate Nitrogen: 10 mg/L
mg/L
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-15
CAR-2
CAR-2-10
CAR-4
Date/Site

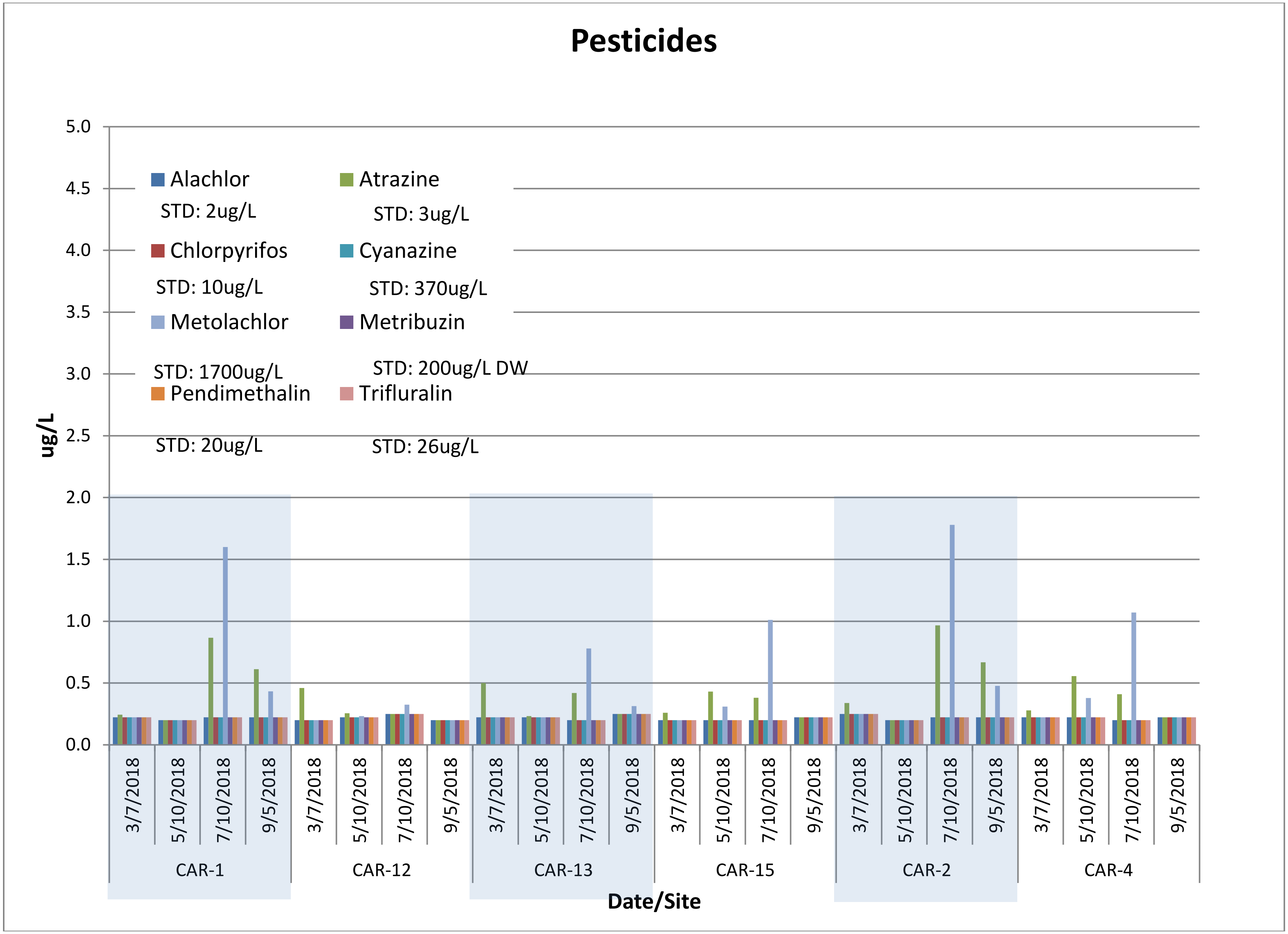

Carlyle Tributary Ammonia Nitrogen & Nitrate Nitrogen
Nitrogen, ammonia
Nitrate-N
STD Ammonia Nitrogen: 15 mg/L
STD Nitrate Nitrogen: 10 mg/L
mg/L
6.0
5.0
4.0
3.0
2.0
1.0
0.0
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
Date/Site

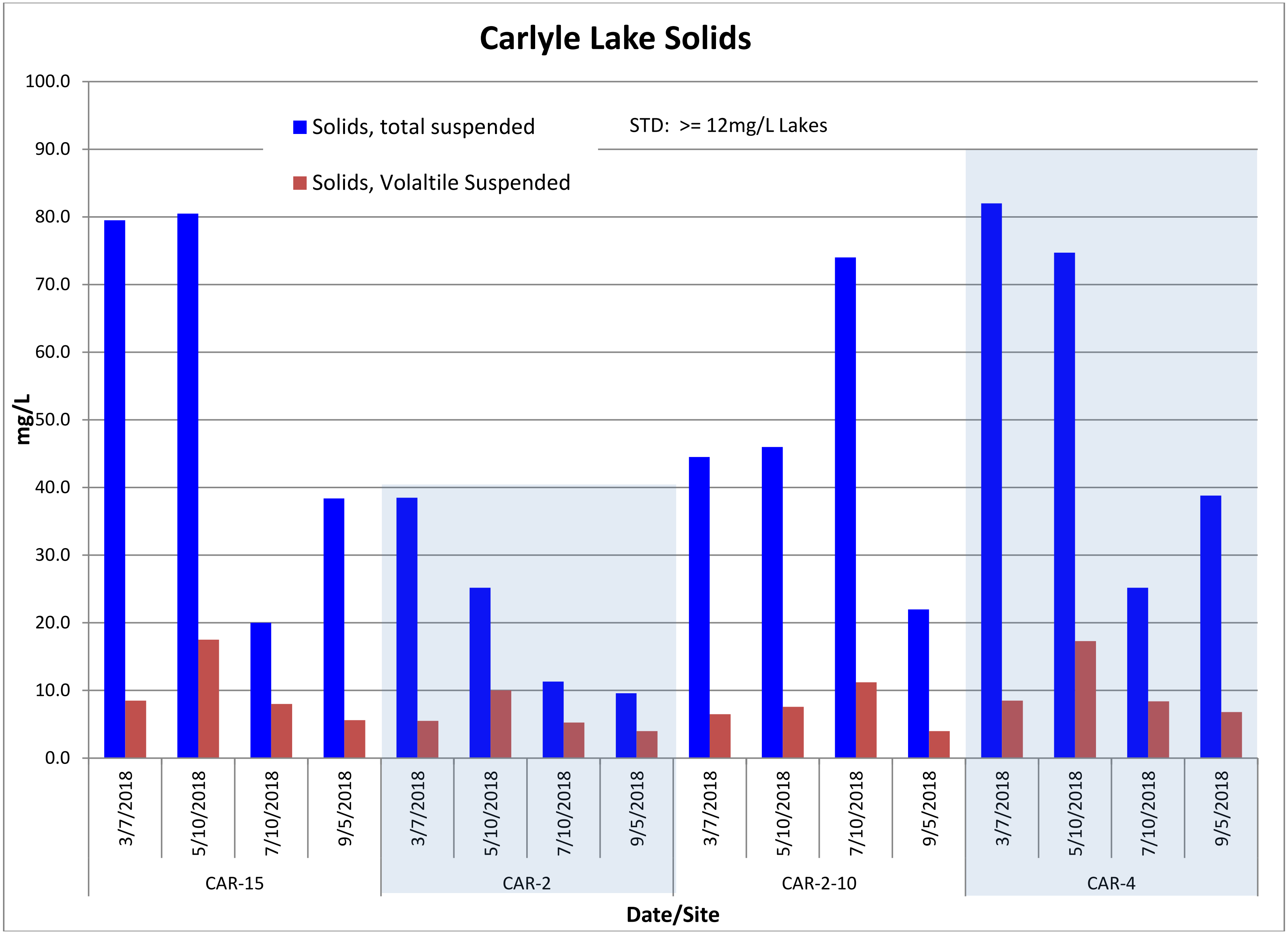


Carlyle Lake Phosphorus
Phosphorus, ortho-
Phosphorus, total
STD Total Phosphorous: 0.05 mg/L Lakes
mg/L
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-15
CAR-2
CAR-2-10
CAR-4
Date/Site

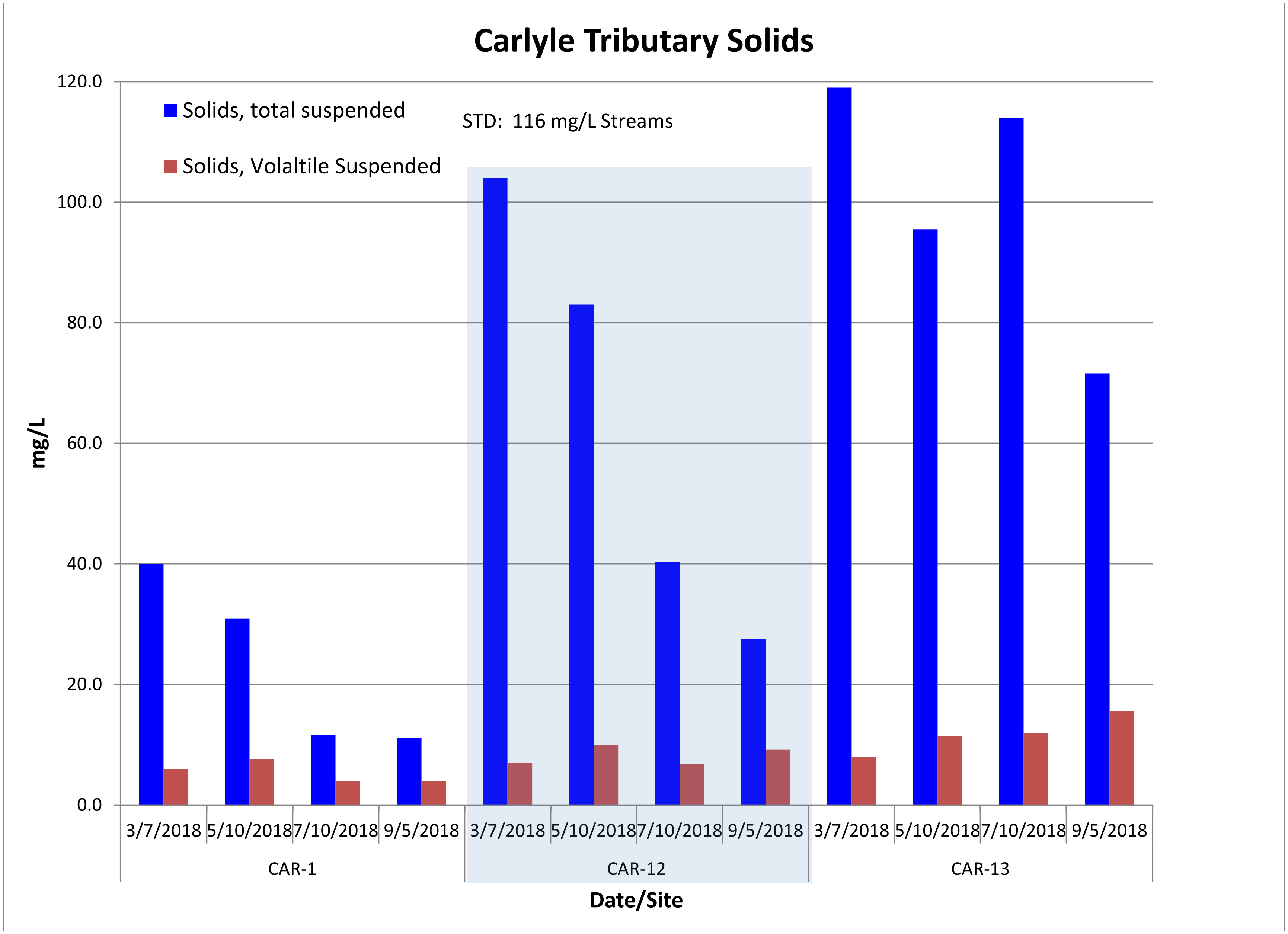

Carlyle Tributary Phosphorus
STD Total Phosphorous: 0.61 mg/L Streams
Phosphorus, ortho-
Phosphorus, total
mg/L
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
Date/Site


Carlyle Chlorophyll & Pheophytin
250
200
150
100
50
0
mg/cu m
Chlorophyll-a
Pheophytin-a
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-12
CAR-15
CAR-2
CAR-4
Date/Site

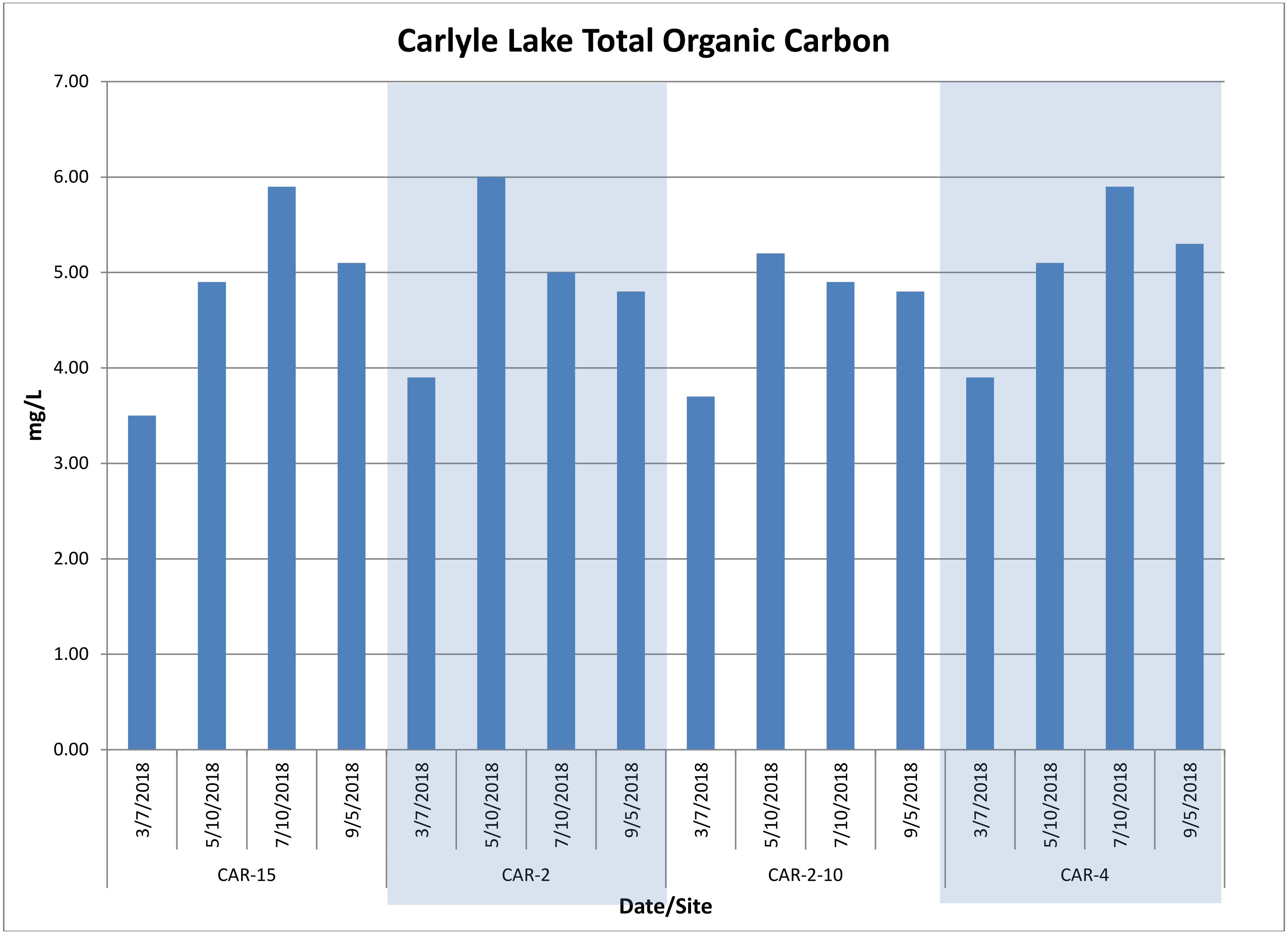

Pesticides
Alachlor
STD: 2ug/L
Atrazine
STD: 3ug/L
Chlorpyrifos
STD: 10ug/L
Cyanazine
STD: 370ug/L
Metolachlor
STD: 1700ug/L
Metribuzin
STD: 200ug/L DW
Pendimethalin
STD: 20ug/L
Trifluralin
STD: 26ug/L
ug/L
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
CAR-15
CAR-2
CAR-4
Date/Site

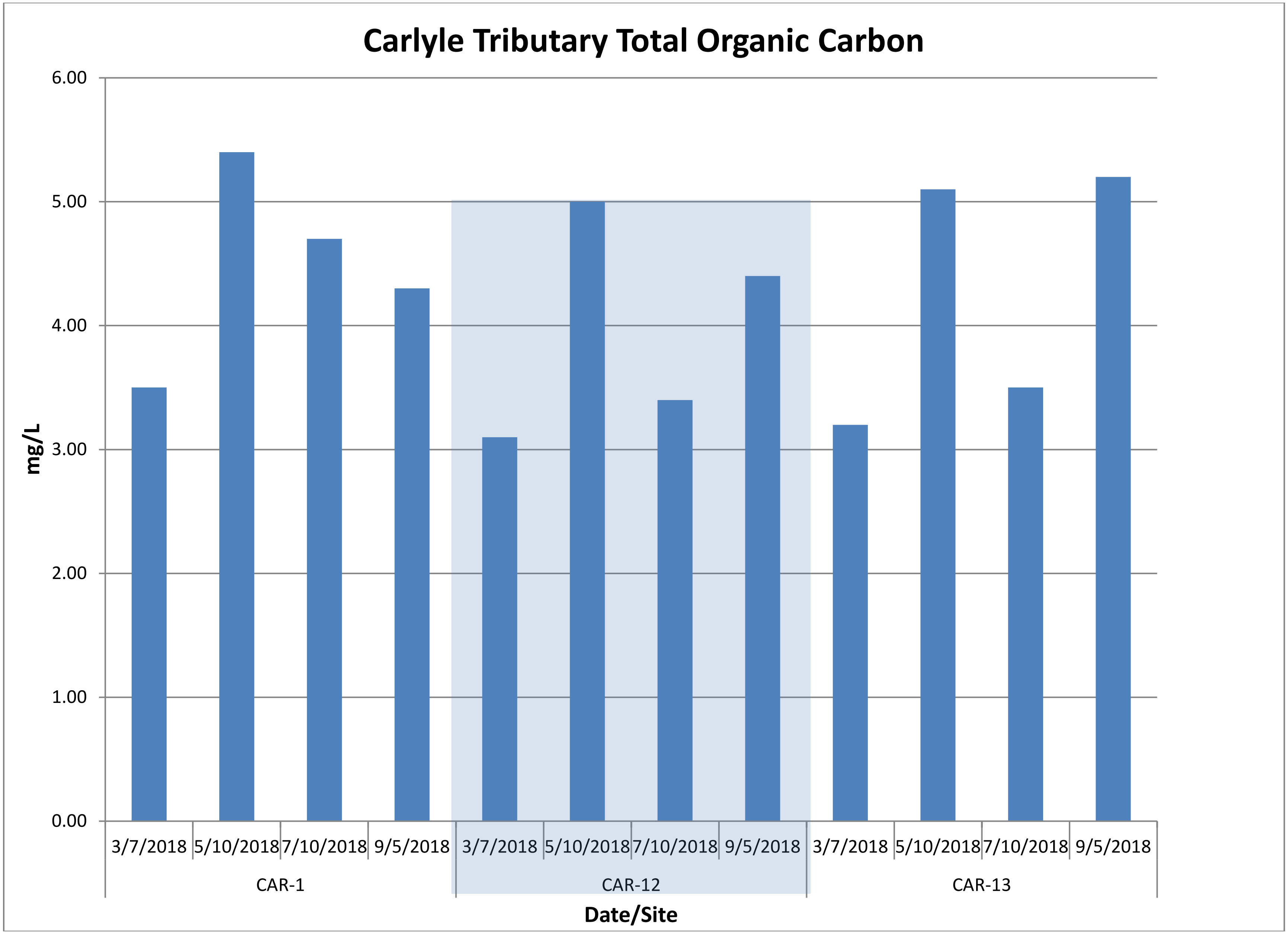


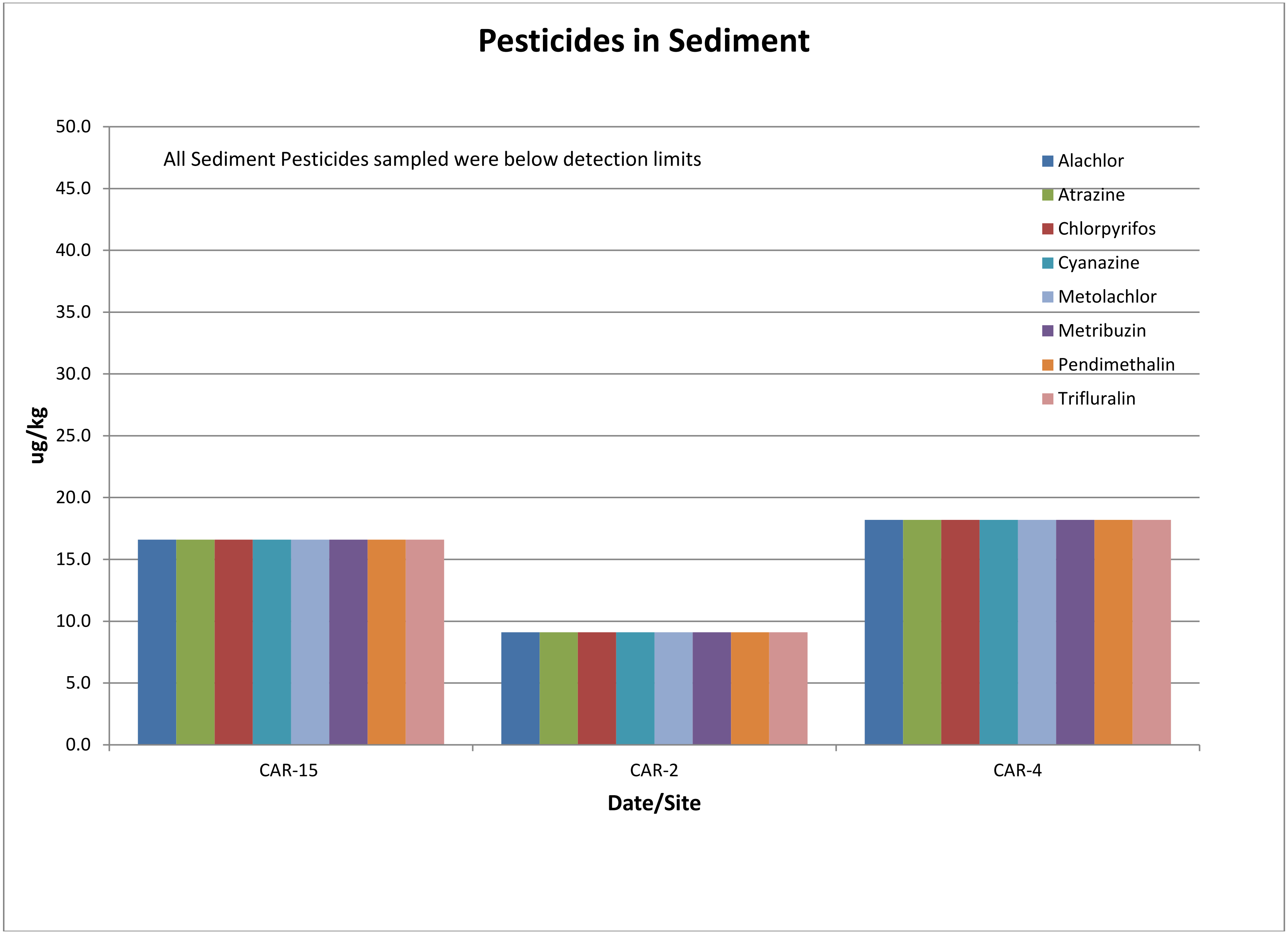
Carlyle Lake Solids
Solids, total suspended
Solids, Volaltile Suspended
STD: >= 12mg/L Lakes
mg/L
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-15
CAR-2
CAR-2-10
CAR-4
Date/Site

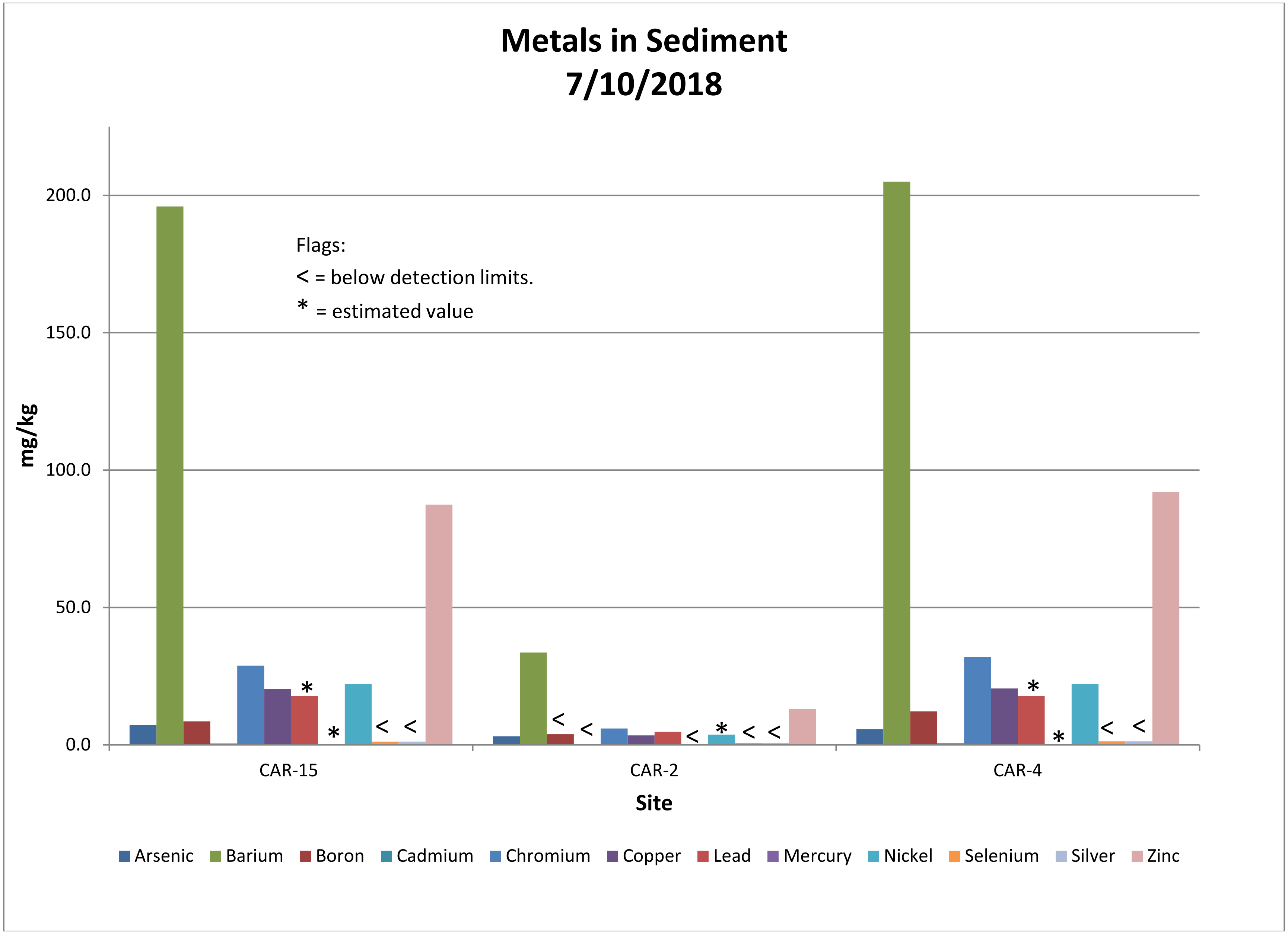


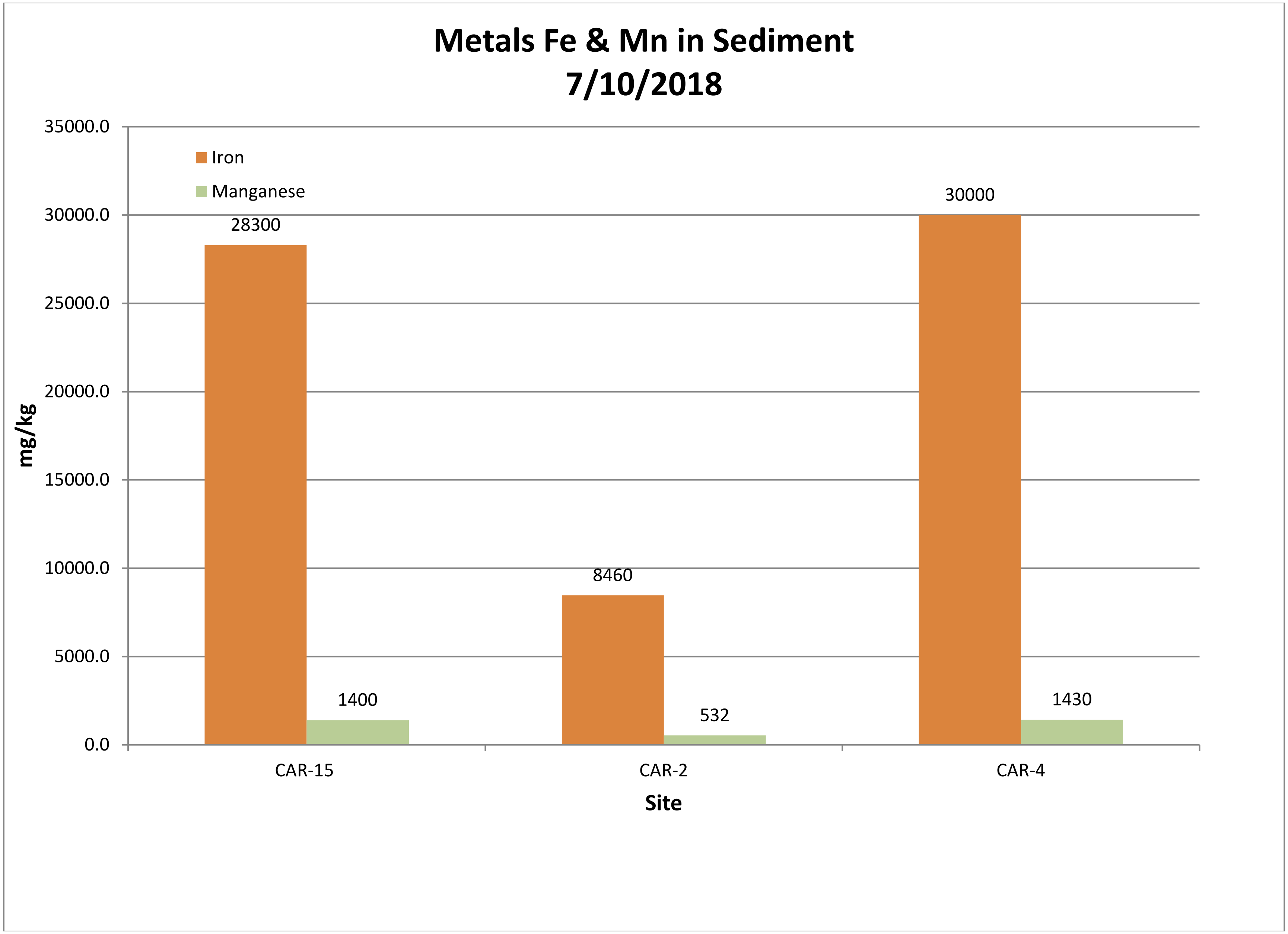
Carlyle Tributary Solids
120.0
100.0
80.0
60.0
40.0
20.0
0.0
mg/L
Solids, total suspended
Solids, Volaltile Suspended
STD: 116 mg/L Streams
3/7/2018
5/10/2018
7/10/2018
9/5/2018
3/7/2018
5/10/2018
7/10/2018
9/5/2018
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
Date/Site

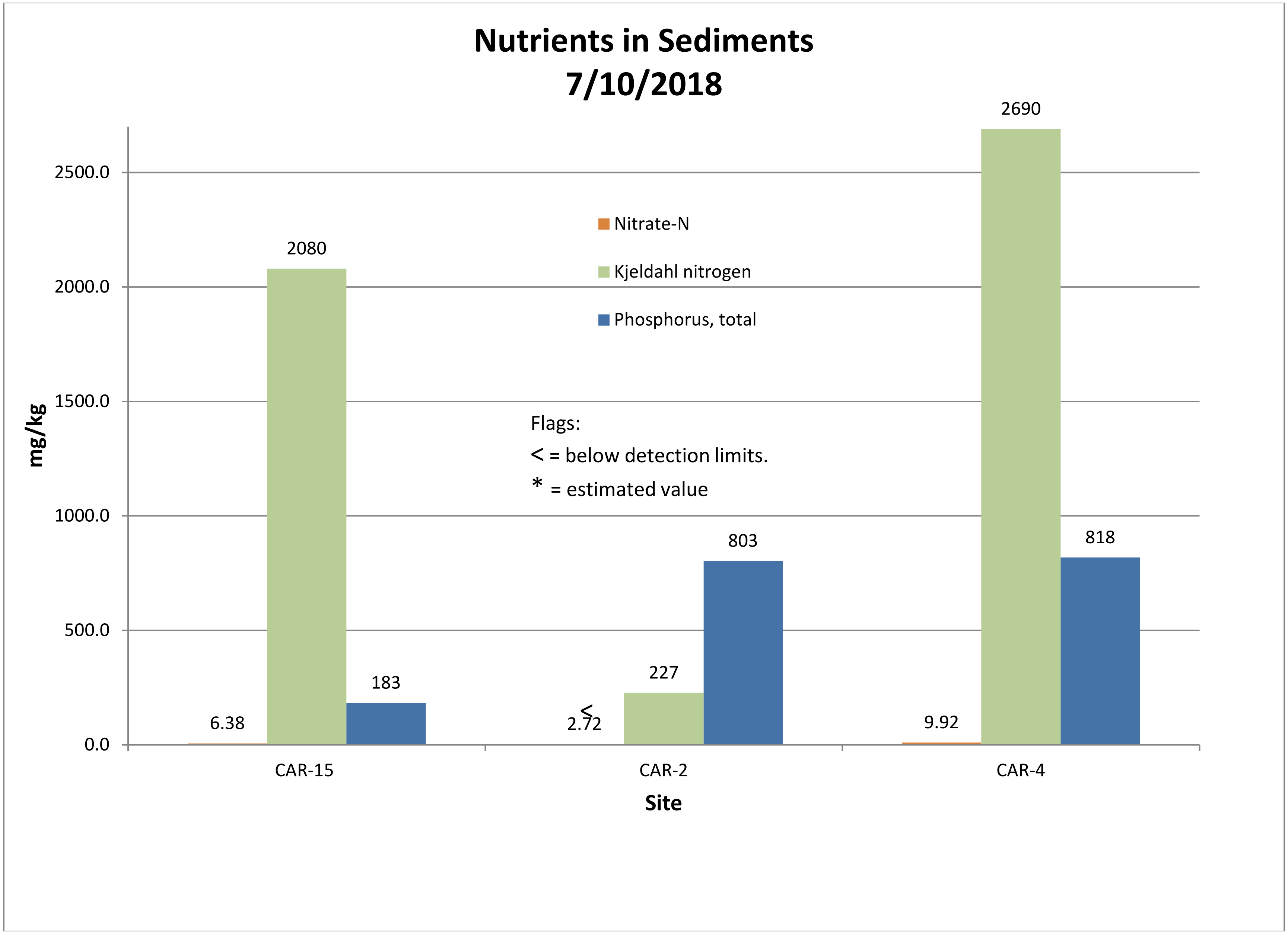

Carlyle Lake Total Organic Carbon
mg/L
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-15
CAR-2
CAR-2-10
CAR-4
Date/Site

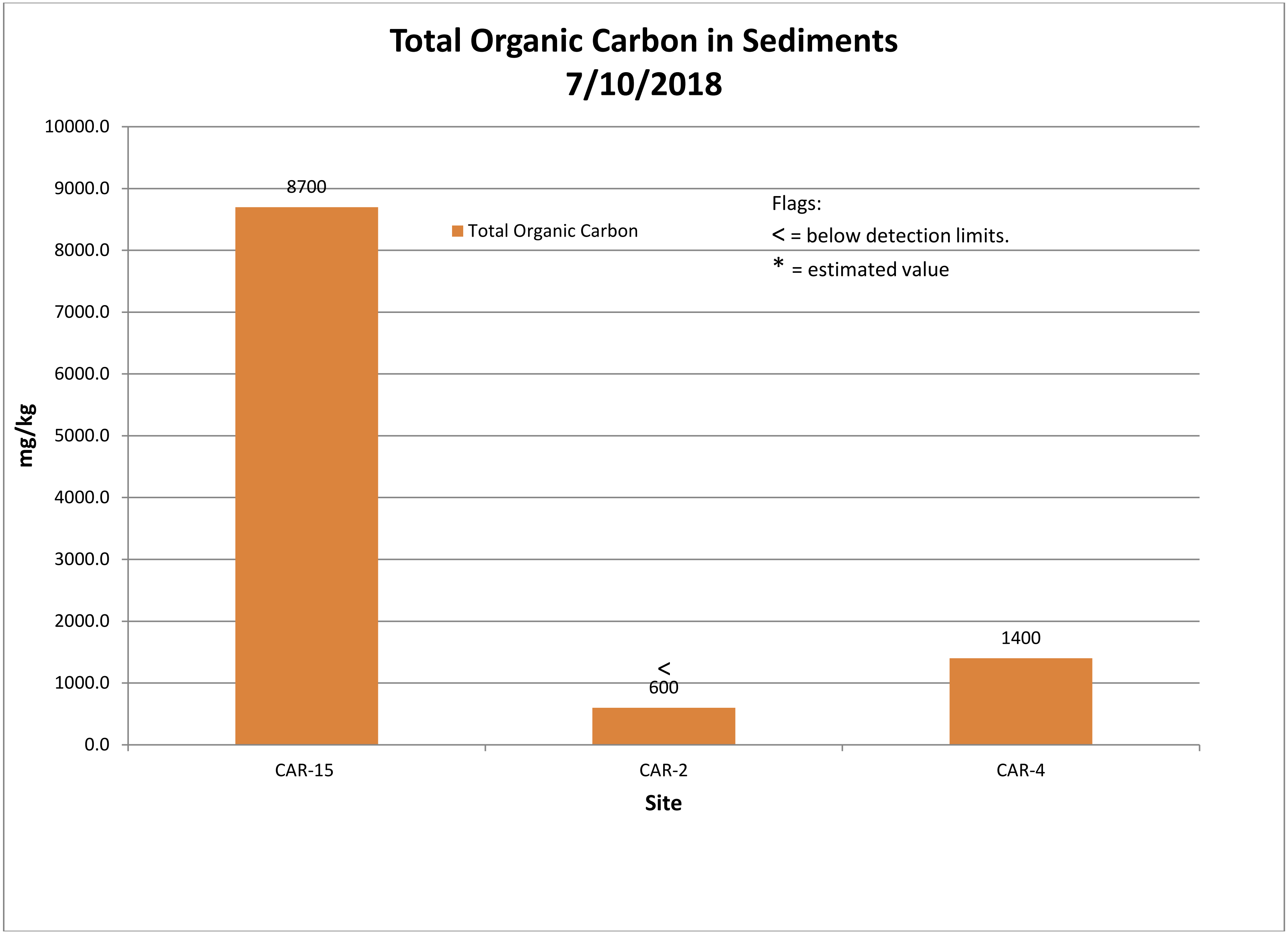

Carlyle Tributary Total Organic Carbon
6.00
5.00
4.00
3.00
2.00
1.00
0.00
mg/L
3/7/2018
5/10/2018
7/10/2018
9/5/2018
3/7/2018
5/10/2018
7/10/2018
9/5/2018
3/7/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
Date/Site


Pesticides in Sediment
All Sediment Pesticides sampled were below detection limits
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
ug/kg
Alachlor
Atrazine
Chlorpyrifos
Cyanazine
Metolachlor
Metribuzin
Pendimethalin
Trifluralin
CAR-15
CAR-2
CAR-4
Date/Site


Metals in Sediment
7/10/2018
Flags:
< = below detection limits.
* = estimated value
mg/kg
200.0
150.0
100.0
50.0
0.0
CAR-15
CAR-2
CAR-4
Site
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Zinc


Metals Fe & Mn in Sediment
7/10/2018
35000.0
30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
mg/kg
Iron
Manganese
28300
1400
8460
532
30000
1430
CAR-15
CAR-2
CAR-4
Site

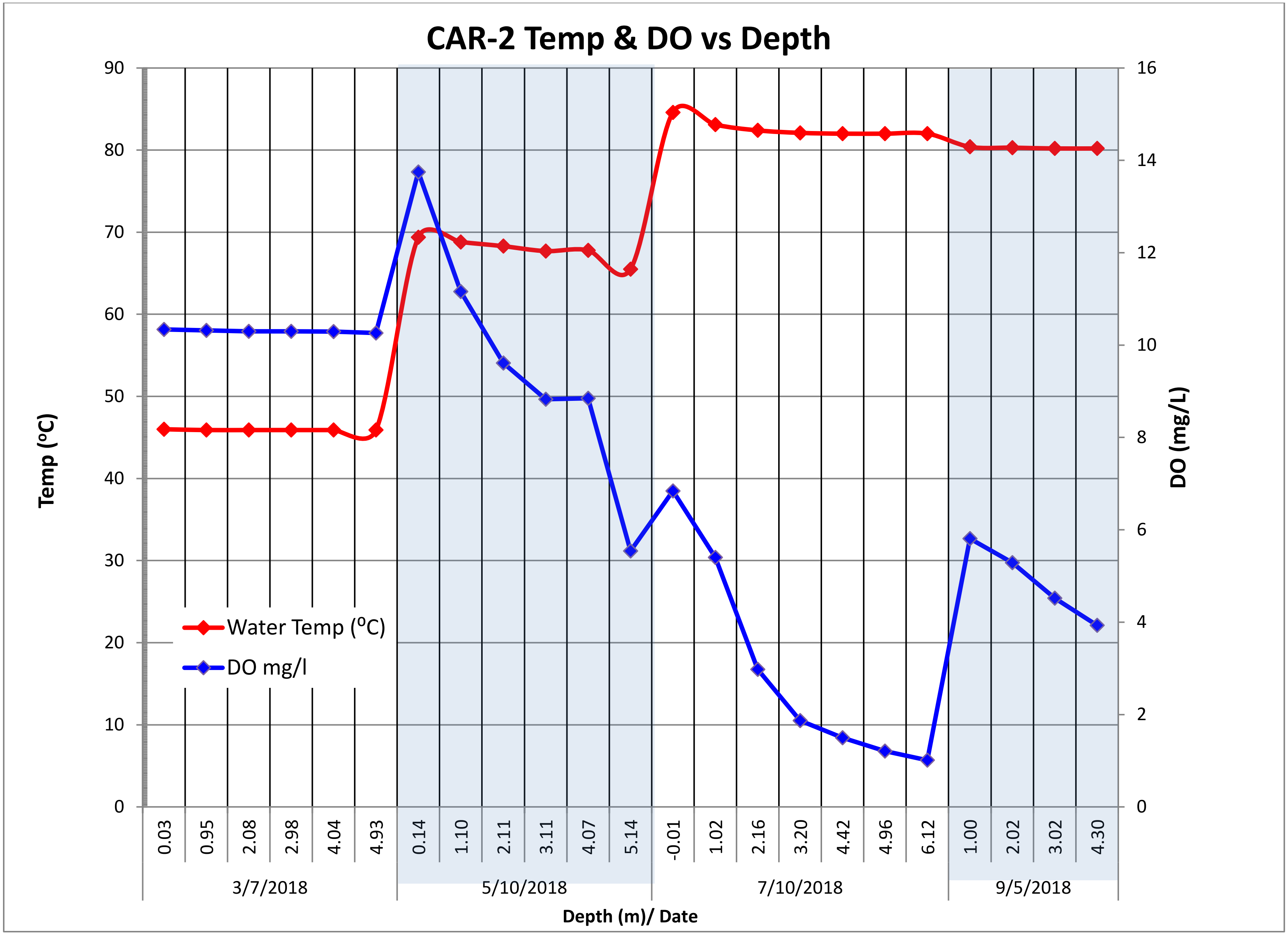

Nutrients in Sediments
7/10/2018
2500.0
2000.0
1500.0
1000.0
500.0
0.0
mg/kg
Nitrate-N
Kjeldahl nitrogen
Phosphorus, total
Flags:
< = below detection limits.
* = estimated value
2080
183
6.38
<
2.72
227
803
2690
818
9.92
CAR-15
CAR-2
CAR-4
Site


Total Organic Carbon in Sediments
7/10/2018
mg/kg
10000.0
9000.0
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
8700
<
600
1400
Total Organic Carbon
Flags:
< = below detection limits.
* = estimated value
CAR-15
CAR-2
CAR-4
Site

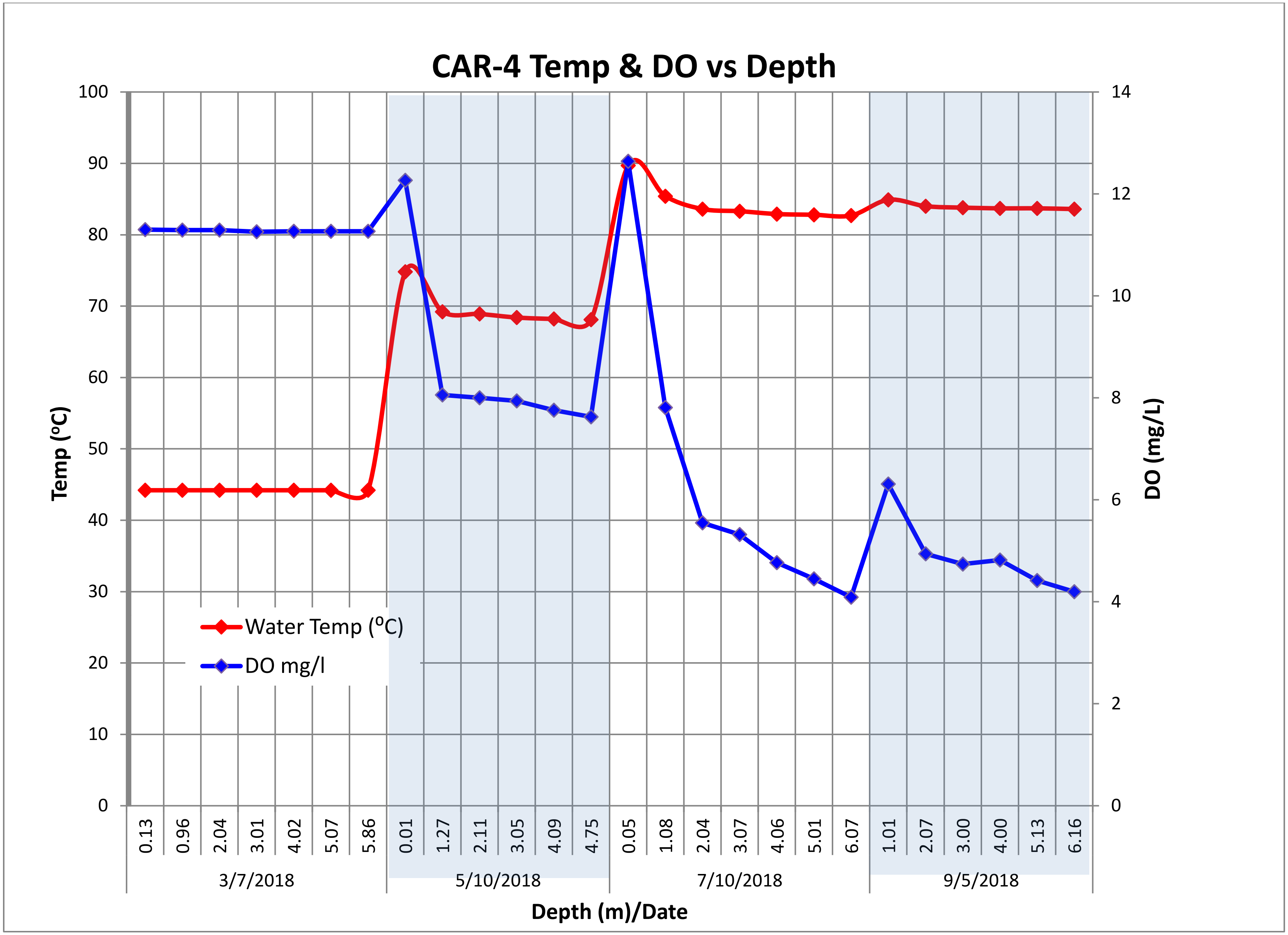
APPENDIX C

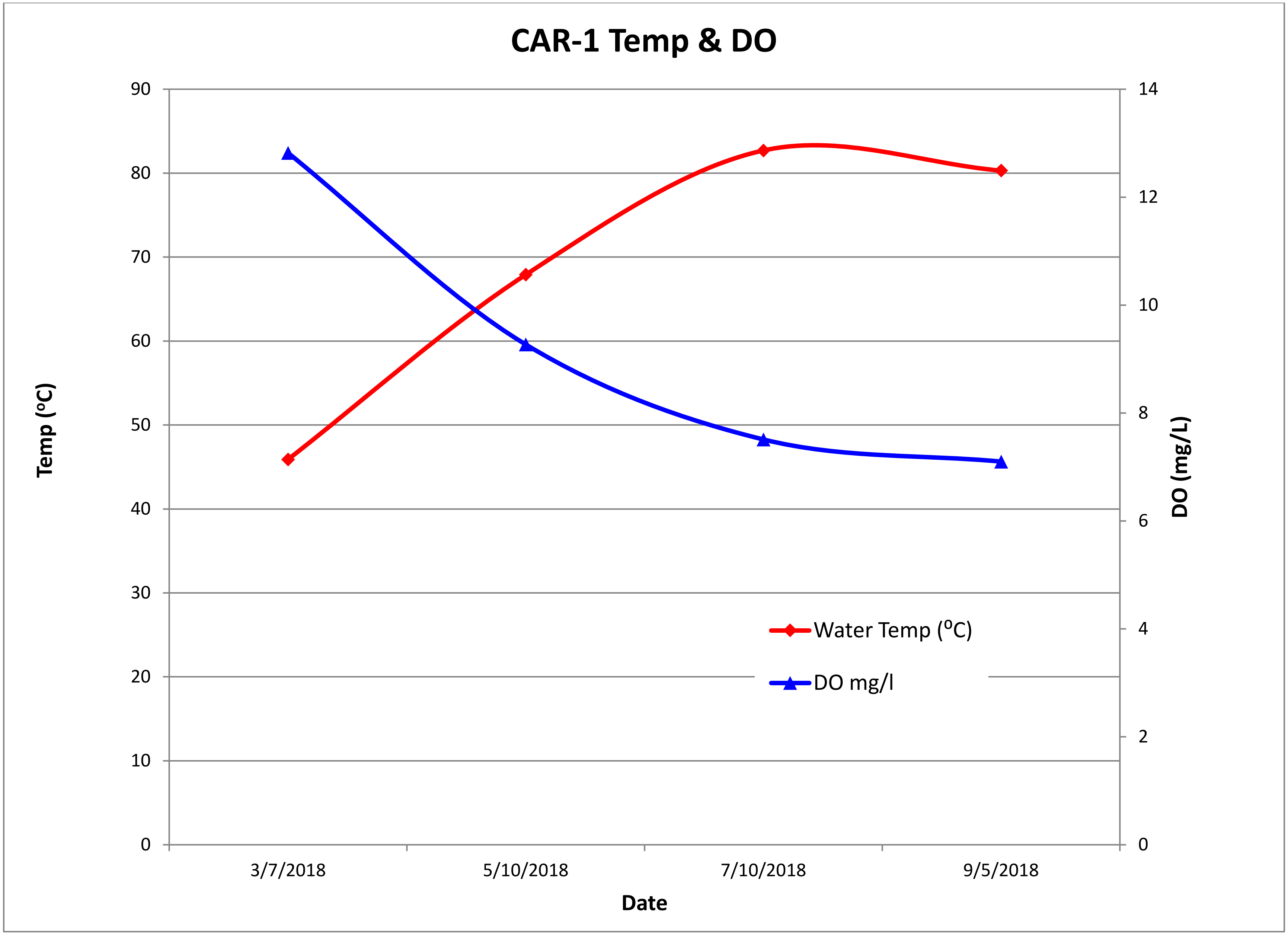
GRAPHS

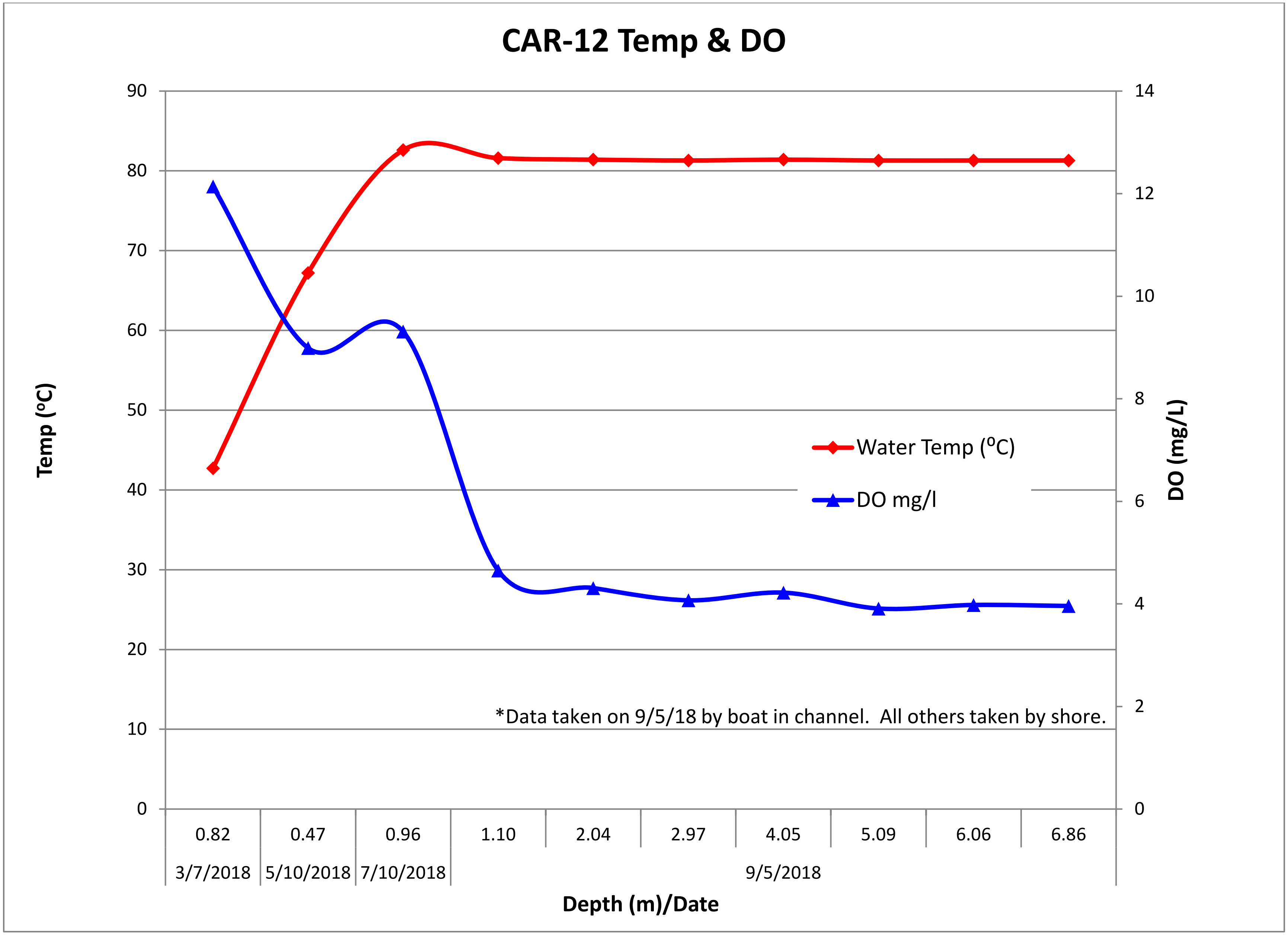
FIELD

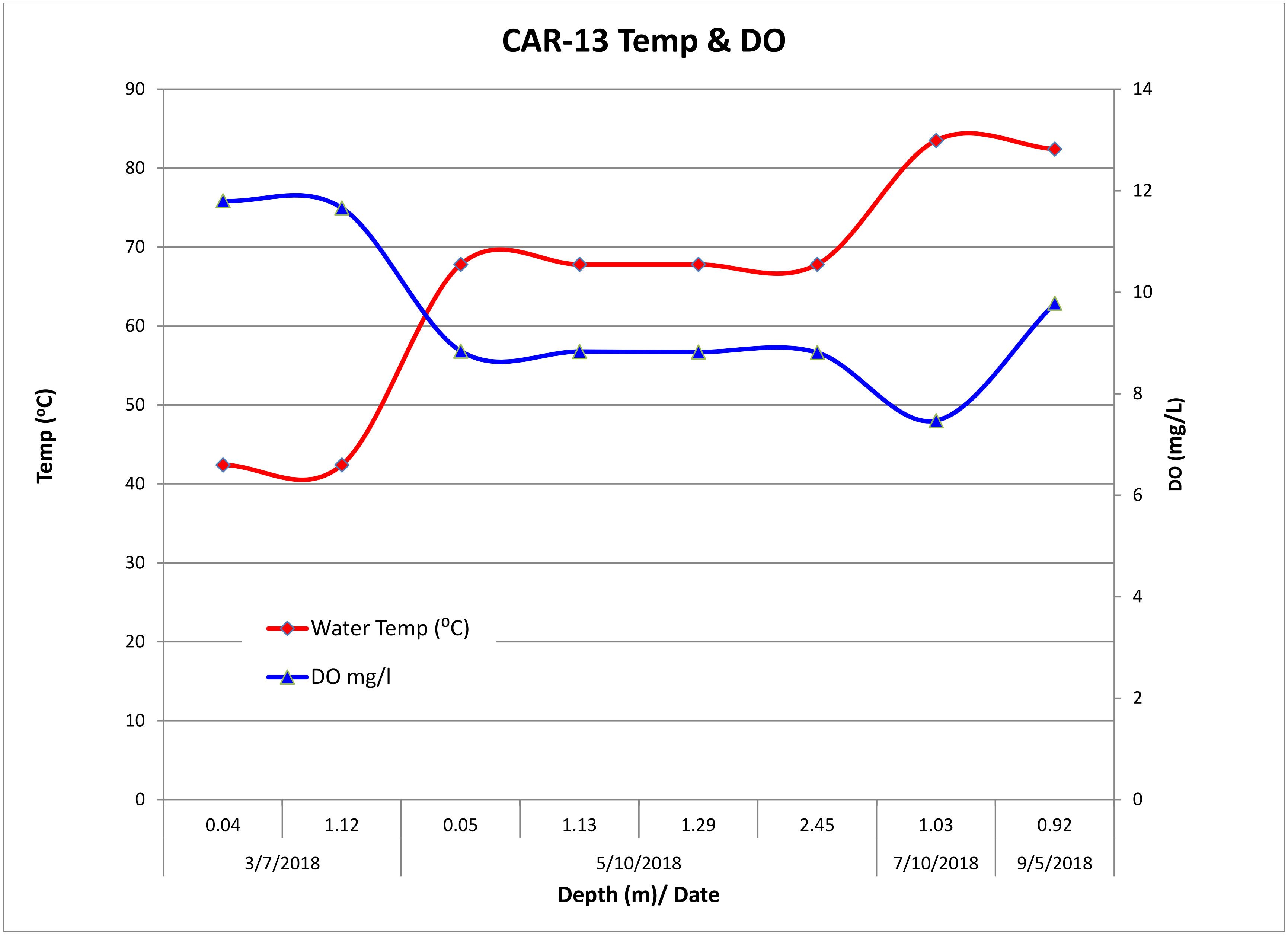


CAR-2 Temp & DO vs Depth
Temp (°C)
DO (mg/L)
90
80
70
60
50
40
30
20
10
0
16
14
12
10
8
6
4
2
0
Water Temp (°C)
DO mg/l
0.03
0.95
2.08
2.98
4.04
4.93
0.14
1.10
2.11
3.11
4.07
5.14
-0.01
1.02
2.16
3.20
4.42
4.96
6.12
1.00
2.02
3.02
4.30
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth (m)/ Date

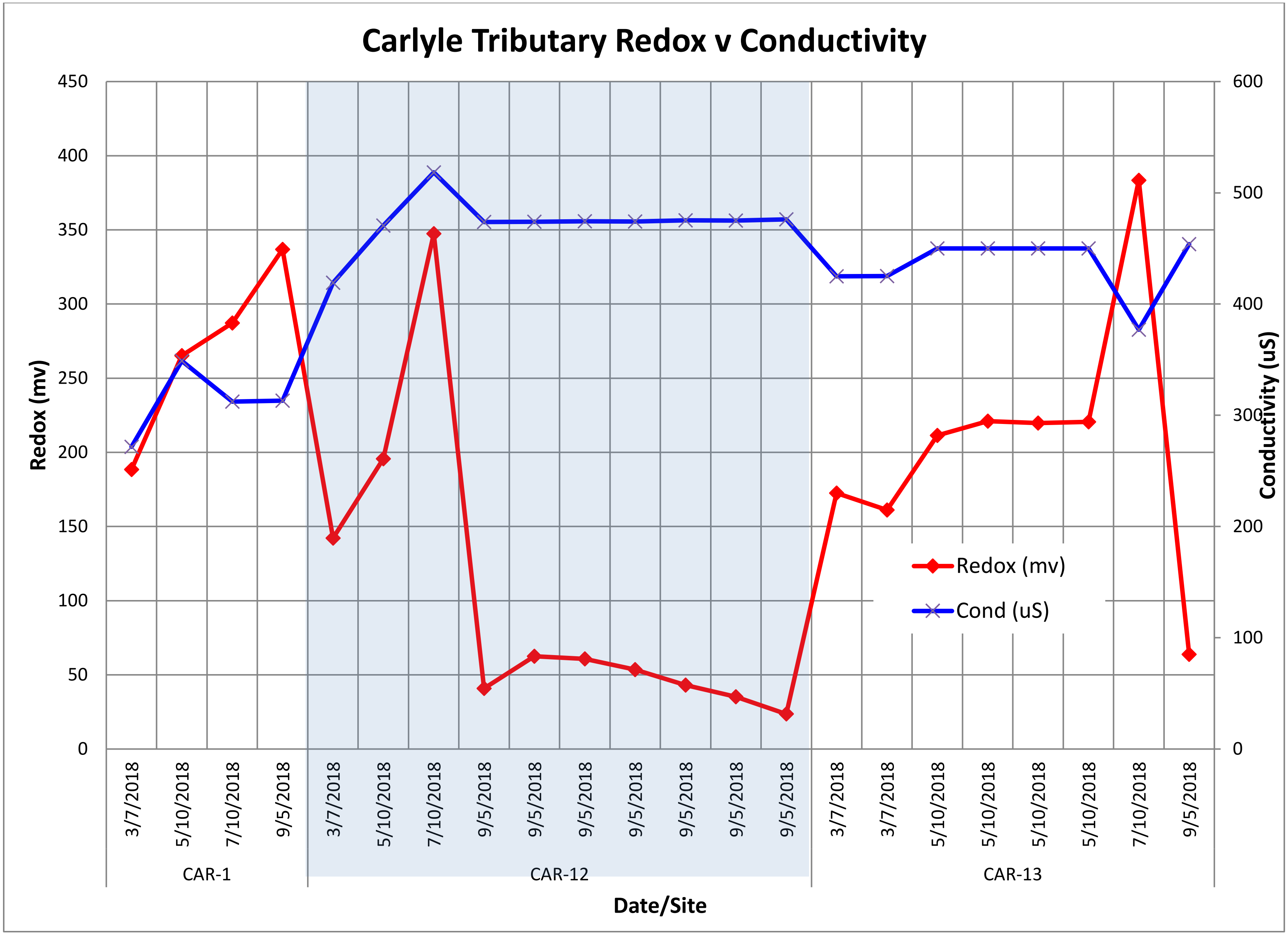

CAR-4 Temp & DO vs Depth
Temp (°C)
100
90
80
70
60
50
40
30
20
10
0
DO (mg/L)
14
12
10
8
6
4
2
0
Water Temp (°C)
DO mg/l
0.13
0.96
2.04
3.01
4.02
5.07
5.86
0.01
1.27
2.11
3.05
4.09
4.75
0.05
1.08
2.04
3.07
4.06
5.01
6.07
1.01
2.07
3.00
4.00
5.13
6.16
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth (m)/Date

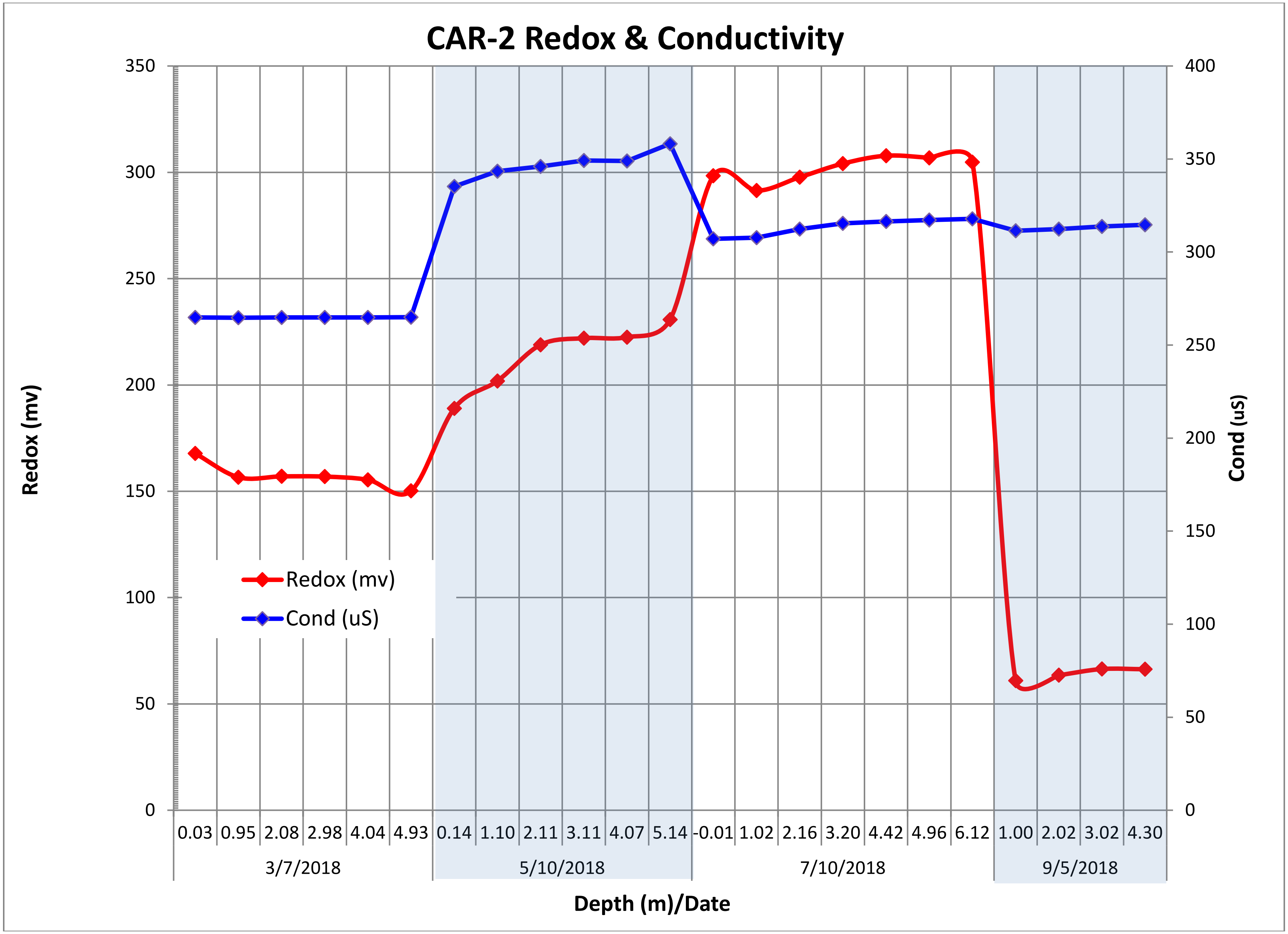

CAR-1 Temp & DO
Temp (oC)
DO (mg/L)
Date
90
80
70
60
50
40
30
20
10
0
14
12
10
8
6
4
2
0
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Water Temp (oC)
DO mg/l


CAR-12 Temp & DO
Temp (°C)
DO (mg/L)
Water Temp (°C)
DO mg/l
*Data taken on 9/5/18 by boat in channel. All others taken by shore.
0.82
0.47
0.96
1.10
2.04
2.97
4.05
5.09
6.06
6.86
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth (m)/Date

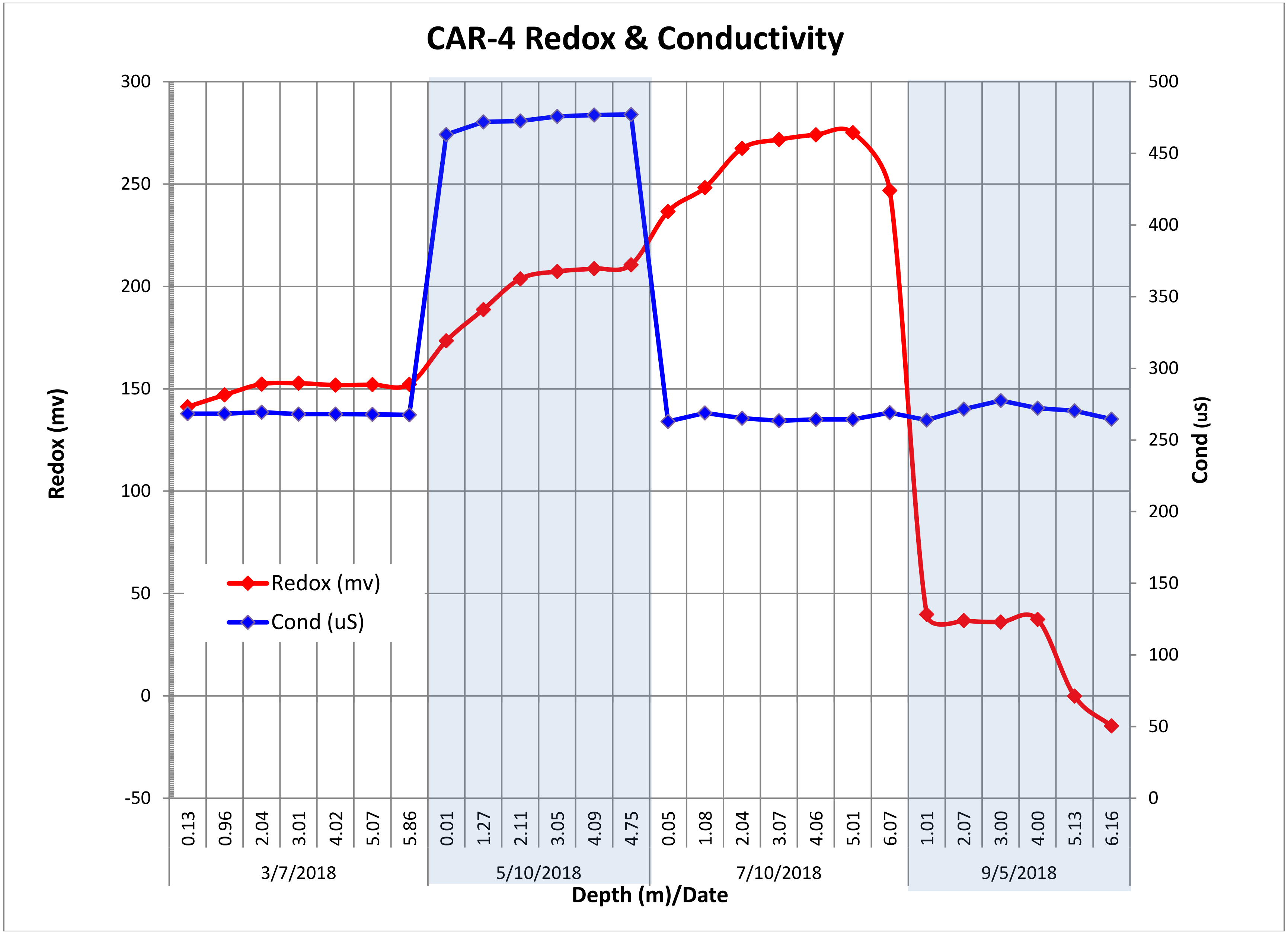


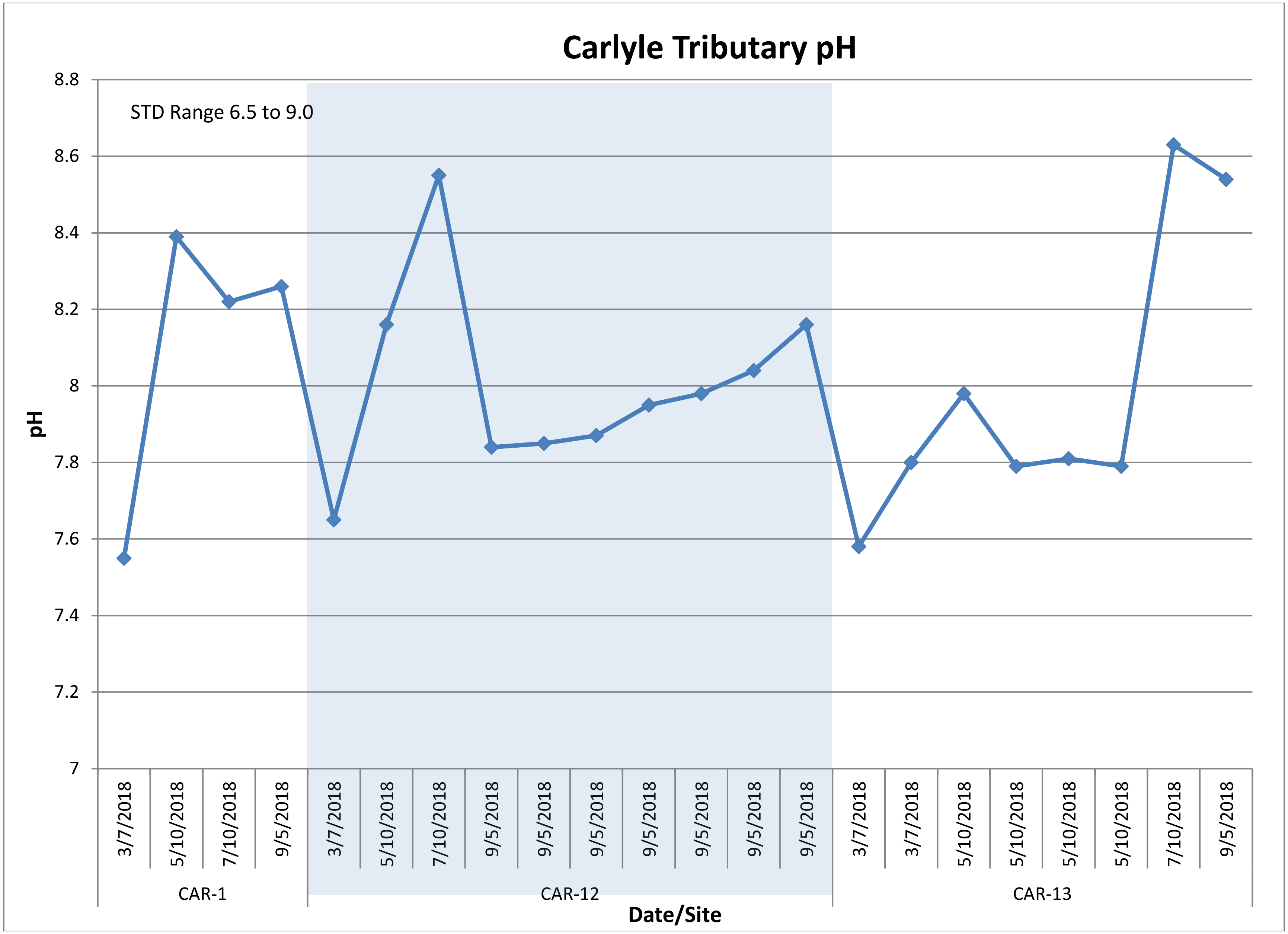
CAR-13 Temp & DO
Temp (ºC)
DO (mg/L)
90
80
70
60
50
40
30
20
10
0
14
12
10
8
6
4
2
0
Water Temp (ºC)
DO mg/l
0.04
1.12
0.05
1.13
1.29
2.45
1.03
0.92
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth (m)/ Date

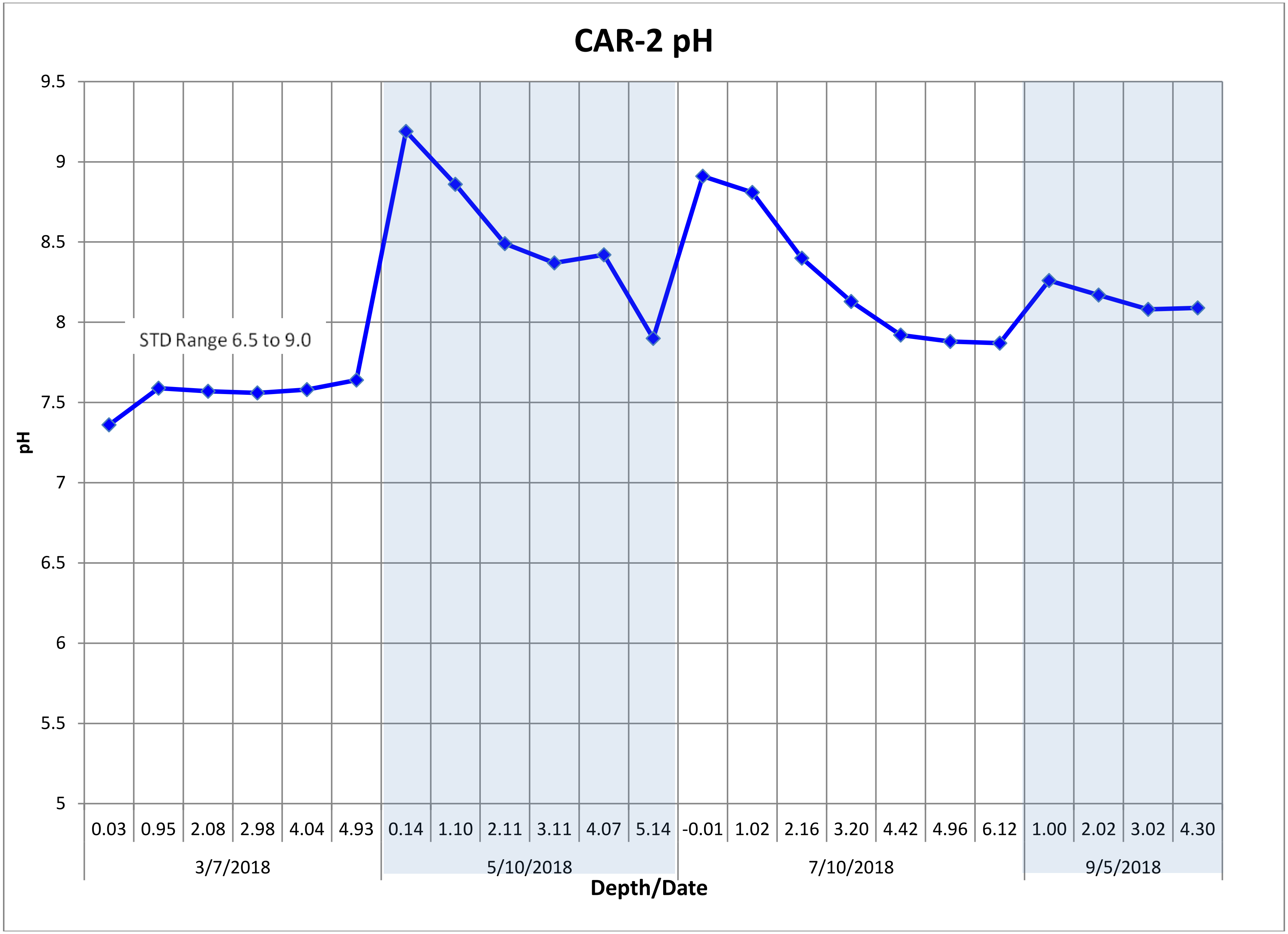

Carlyle Tributary Redox v Conductivity
Redox (mv)
Conductivity (uS)
450
400
350
300
250
200
150
100
50
0
600
500
400
300
200
100
0
Redox (mv)
Cond (uS)
3/7/2018
5/10/2018
7/10/2018
9/5/2018
3/7/2018
5/10/2018
7/10/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
3/7/2018
3/7/2018
5/10/2018
5/10/2018
5/10/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
Date/Site

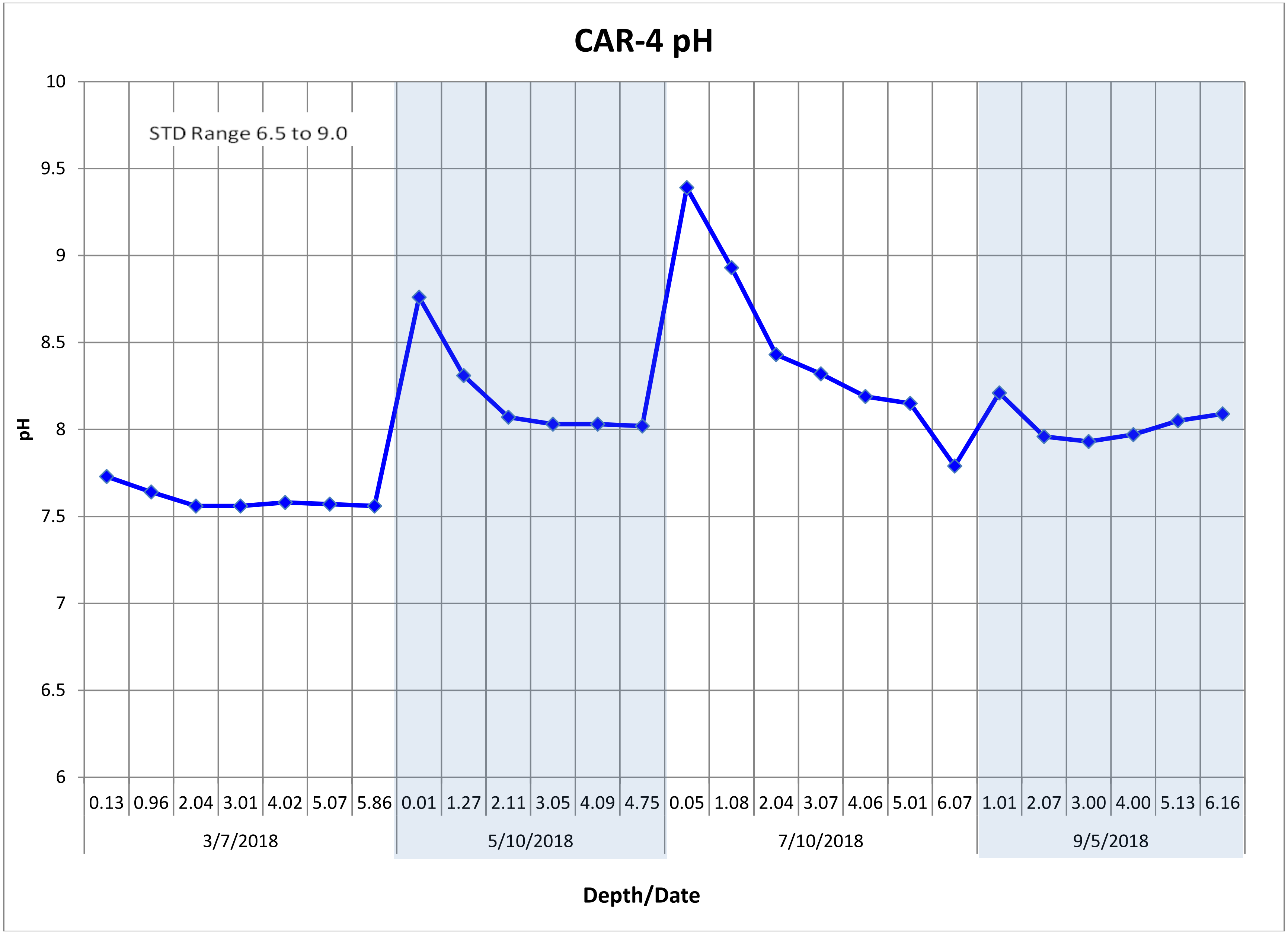


CAR-2 Redox & Conductivity
Redox (mv)
Cond (uS)
Depth (m)/Date
Redox (mv)
Cond (uS)
0
50
100
150
200
250
300
350
400
0.03
0.95
2.08
2.98
4.04
4.93
0.14
1.10
2.11
3.11
4.07
5.14
-0.01
1.02
2.16
3.20
4.42
4.96
6.12
1.00
2.02
3.02
4.30
3/7/2018
5/10/2018
7/10/2018
9/5/2018

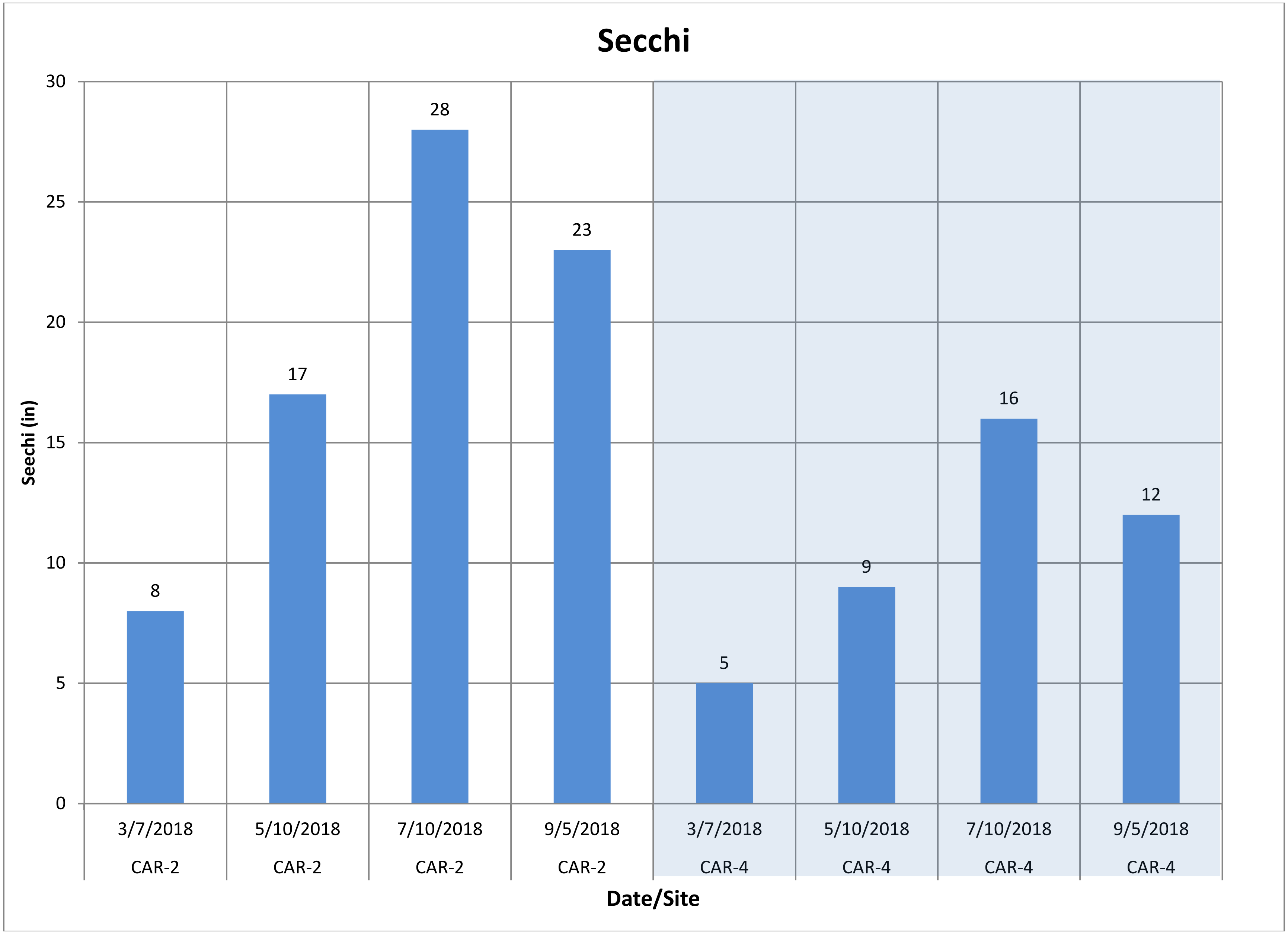

CAR-4 Redox & Conductivity
Redox (mv)
Cond (uS)
300
250
200
150
100
50
0
-50
500
450
400
350
300
250
200
150
100
50
0
0.13
0.96
2.04
3.01
4.02
5.07
5.86
0.01
1.27
2.11
3.05
4.09
4.75
0.05
1.08
2.04
3.07
4.06
5.01
6.07
1.01
2.07
3.00
4.00
5.13
6.16
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth (m)/Date
Redox (mv)
Cond (uS)

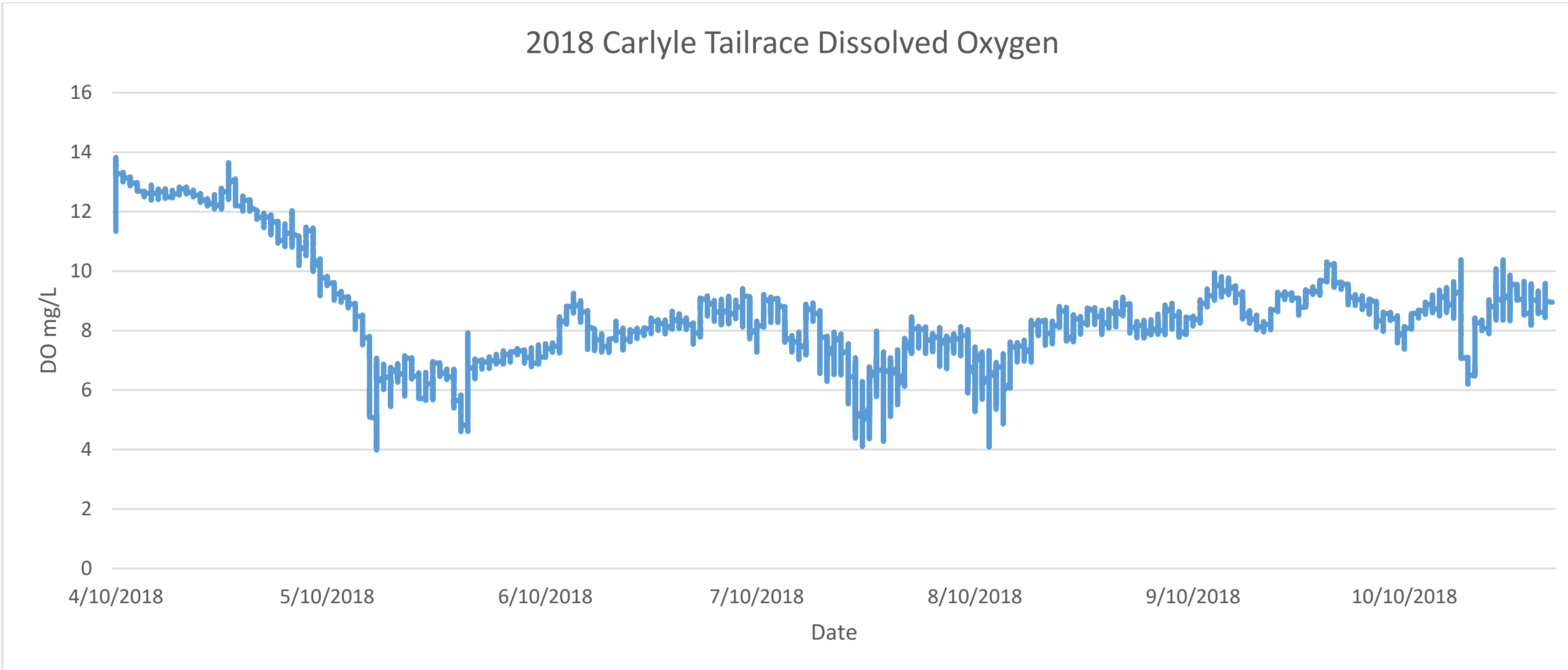

Carlyle Tributary pH
STD Range 6.5 to 9.0
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
pH
3/7/2018
5/10/2018
7/10/2018
9/5/2018
3/7/2018
5/10/2018
7/10/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
9/5/2018
3/7/2018
3/7/2018
5/10/2018
5/10/2018
5/10/2018
5/10/2018
7/10/2018
9/5/2018
CAR-1
CAR-12
CAR-13
Date/Site


CAR-2 pH
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
pH
STD Range 6.5 to 9.0
0.03
0.95
2.08
2.98
4.04
4.93
0.14
1.10
2.11
3.11
4.07
5.14
-0.01
1.02
2.16
3.20
4.42
4.96
6.12
1.00
2.02
3.02
4.30
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth/Date



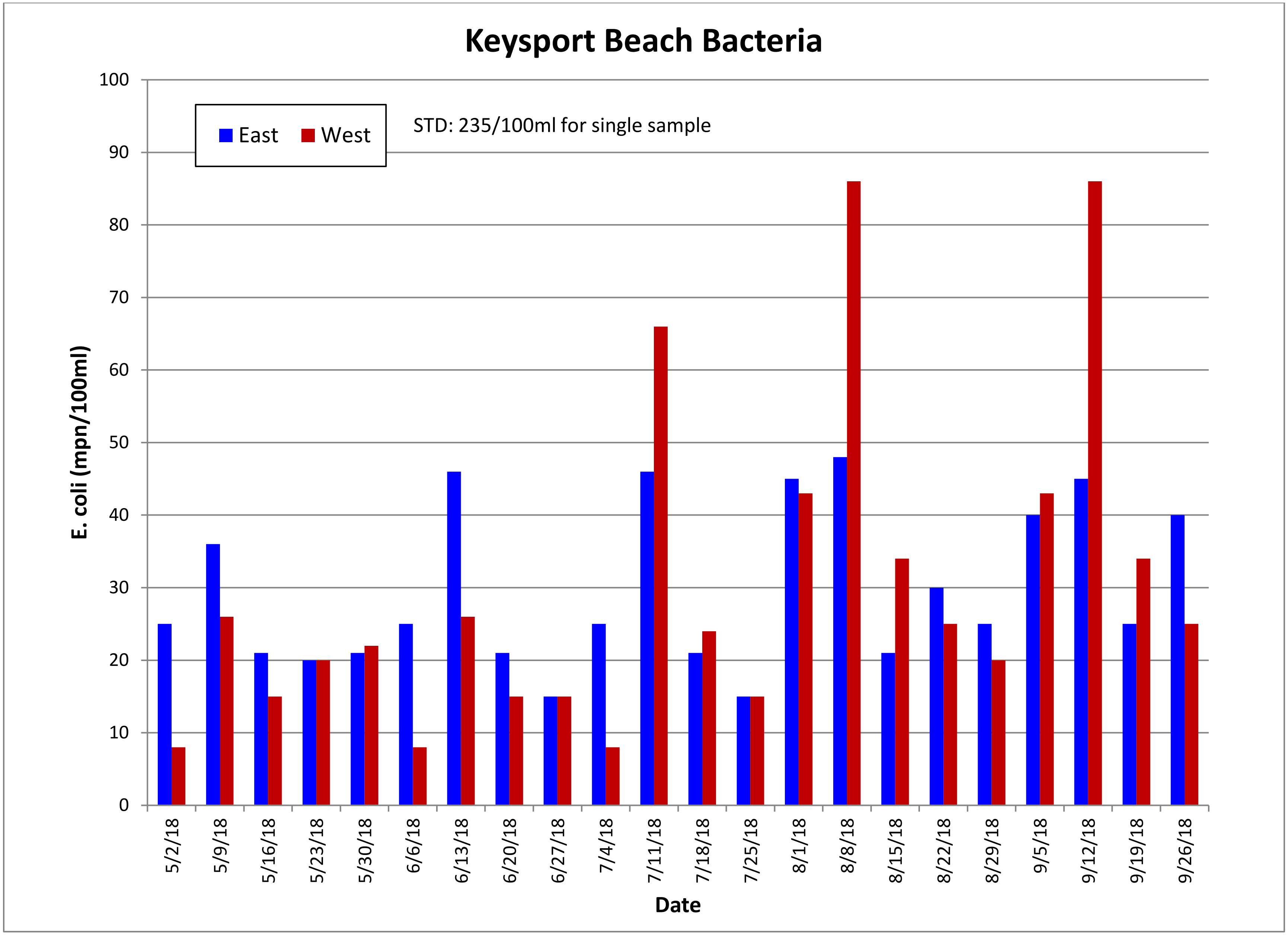
CAR-4 pH
STD Range 6.5 to 9.0
pH
10
9.5
9
8.5
8
7.5
7
6.5
6
0.13
0.96
2.04
3.01
4.02
5.07
5.86
0.01
1.27
2.11
3.05
4.09
4.75
0.05
1.08
2.04
3.07
4.06
5.01
6.07
1.01
2.07
3.00
4.00
5.13
6.16
3/7/2018
5/10/2018
7/10/2018
9/5/2018
Depth/Date

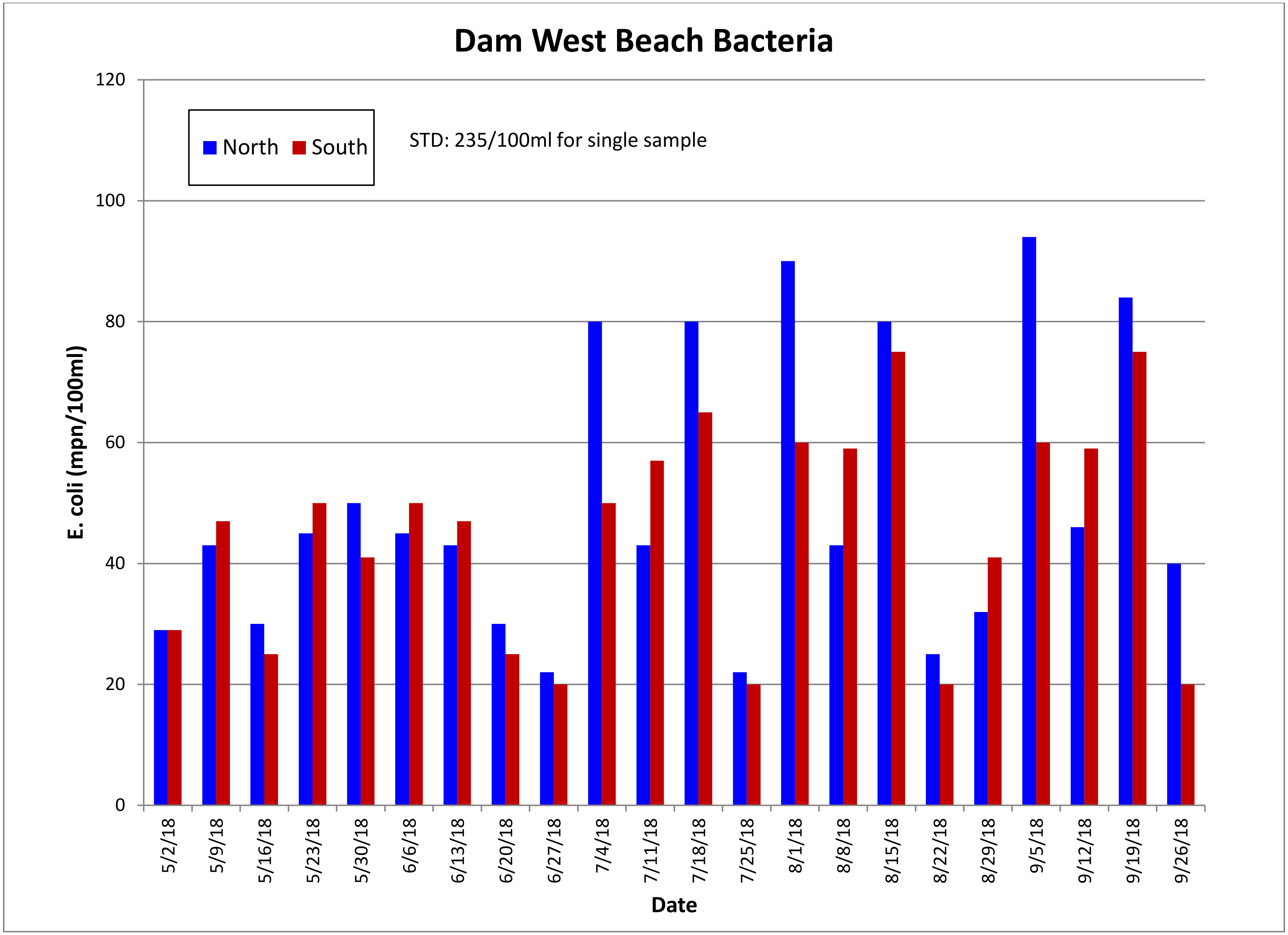

Secchi
Seechi (in)
30
25
20
15
10
5
0
8
17
28
23
5
9
16
12
3/7/2018
CAR-2
5/10/2018
CAR-2
7/10/2018
CAR-2
9/5/2018
CAR-2
3/7/2018
CAR-4
5/10/2018
CAR-4
7/10/2018
CAR-4
9/5/2018
CAR-4
Date/Site

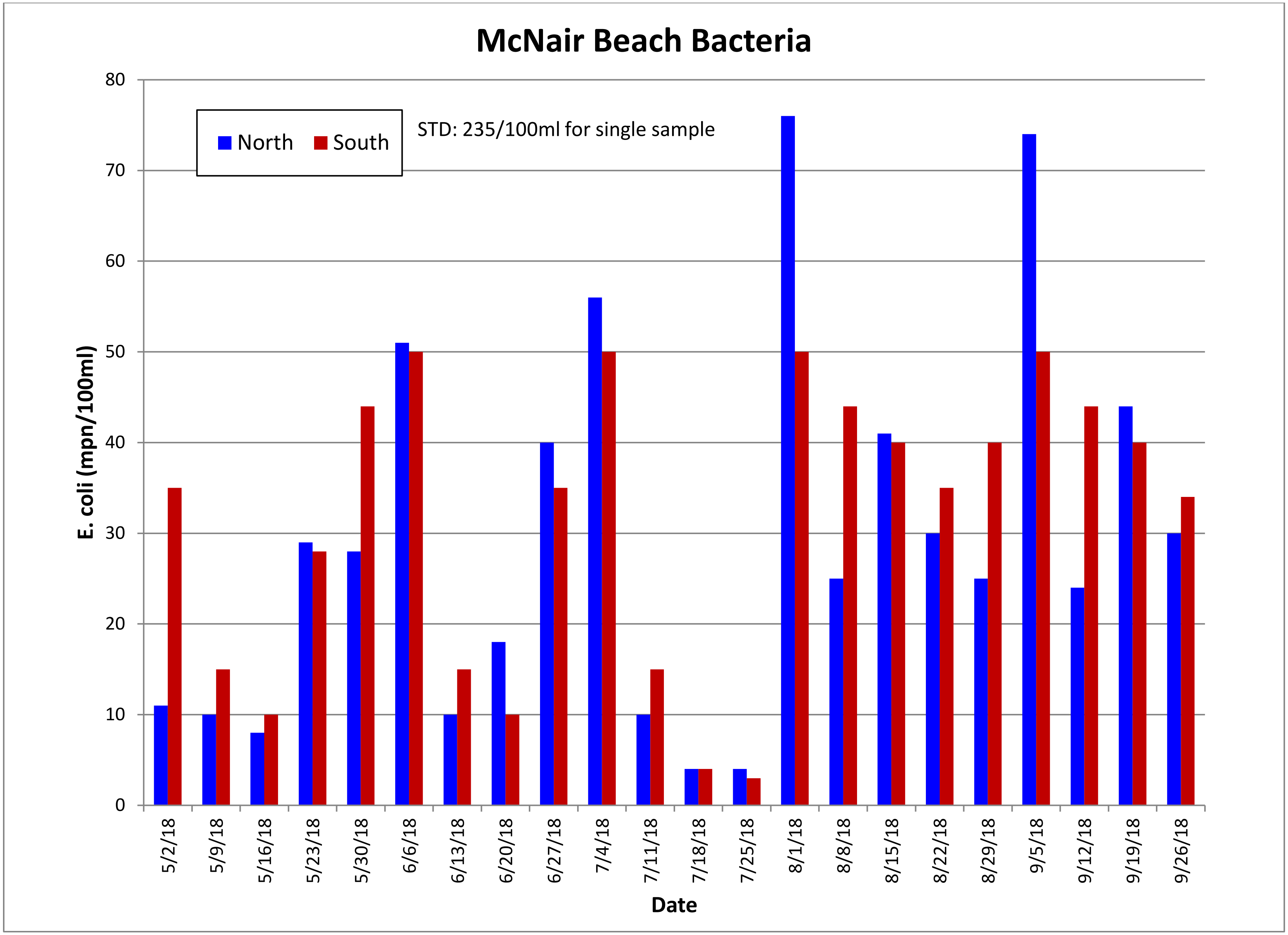

2018 Carlyle Tailrace Dissolved Oxygen
DO mg/L
16
14
12
10
8
6
4
2
0
4/10/2018
5/10/2018
6/10/2018
7/10/2018
8/10/2018
9/10/2018
10/10/2018
Date

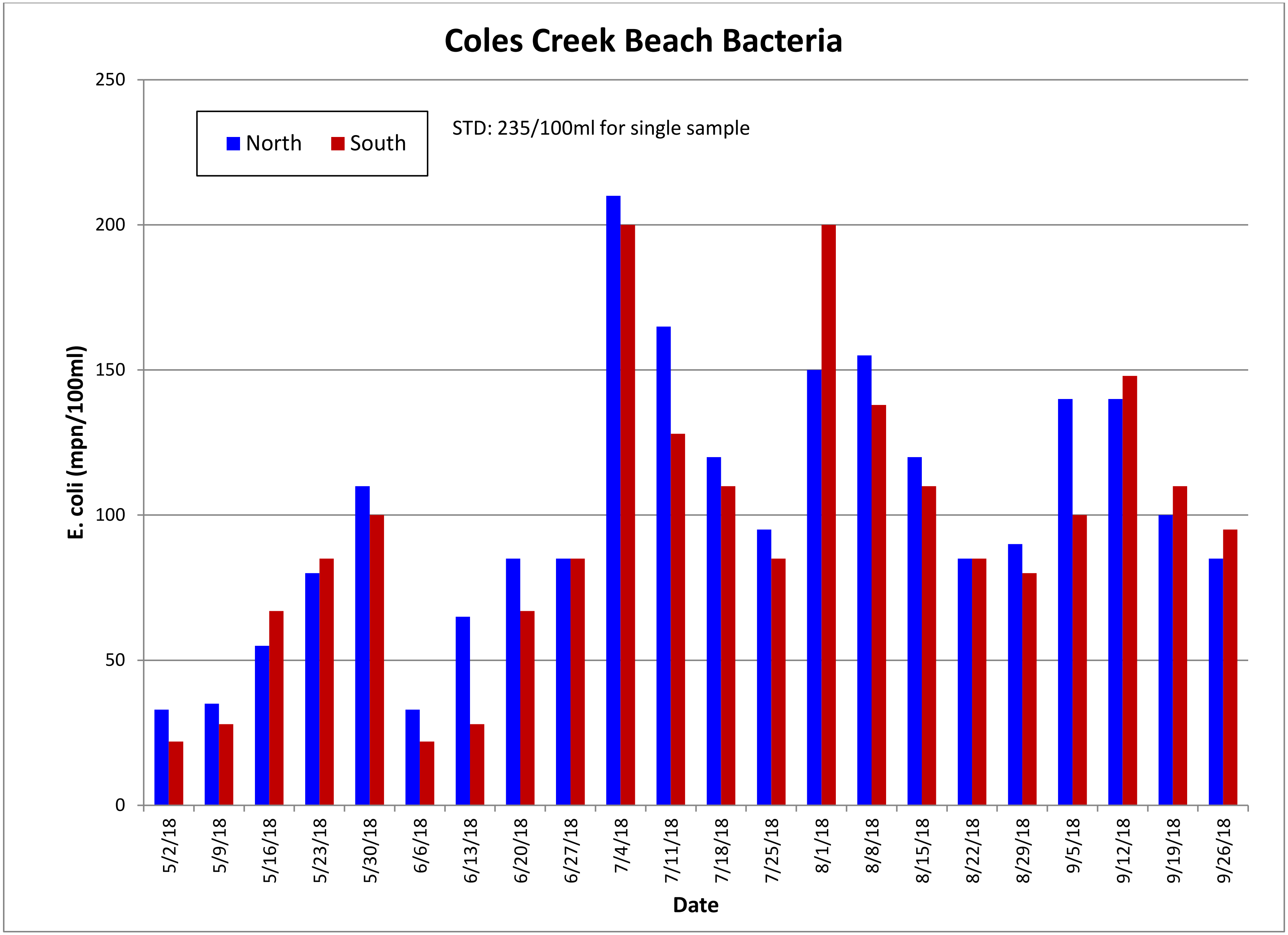
APPENDIX D

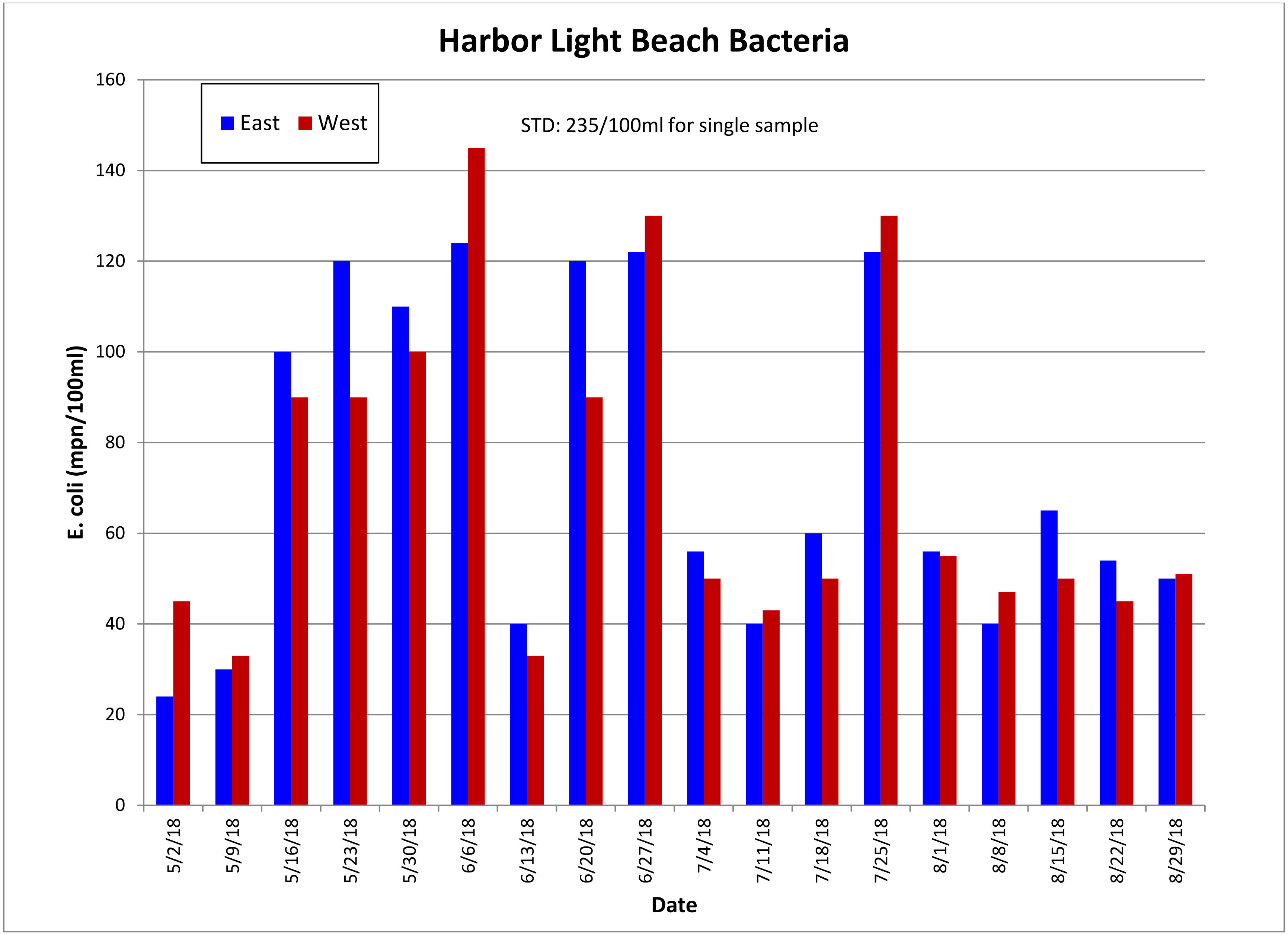
BEACH GRAPHS AND DATA


Keysport Beach Bacteria
100
90
80
70
60
50
40
30
20
10
0
E. coli (mpn/100ml)
East
West
STD: 235/100ml for single sample
5/2/18
5/9/18
5/16/18
5/23/18
5/30/18
6/6/18
6/13/18
6/20/18
6/27/18
7/4/18
7/11/18
7/18/18
7/25/18
8/1/18
8/8/18
8/15/18
8/22/18
8/29/18
9/5/18
9/12/18
9/19/18
9/26/18
Date


Dam West Beach Bacteria
North
South
STD: 235/100ml for single sample
E. coli (mpn/100ml)
120
100
80
60
40
20
0
5/2/18
5/9/18
5/16/18
5/23/18
5/30/18
6/6/18
6/13/18
6/20/18
6/27/18
7/4/18
7/11/18
7/18/18
7/25/18
8/1/18
8/8/18
8/15/18
8/22/18
8/29/18
9/5/18
9/12/18
9/19/18
9/26/18
Date


McNair Beach Bacteria
North
South
STD: 235/100ml for single sample
E. coli (mpn/100ml)
80
70
60
50
40
30
20
10
0
5/2/18
5/9/18
5/16/18
5/23/18
5/30/18
6/6/18
6/13/18
6/20/18
6/27/18
7/4/18
7/11/18
7/18/18
7/25/18
8/1/18
8/8/18
8/15/18
8/22/18
8/29/18
9/5/18
9/12/18
9/19/18
9/26/18
Date


Coles Creek Beach Bacteria
North
South
STD: 235/100ml for single sample
E. coli (mpn/100ml)
250
200
150
100
50
0
5/2/18
5/9/18
5/16/18
5/23/18
5/30/18
6/6/18
6/13/18
6/20/18
6/27/18
7/4/18
7/11/18
7/18/18
7/25/18
8/1/18
8/8/18
8/15/18
8/22/18
8/29/18
9/5/18
9/12/18
9/19/18
9/26/18
Date


Harbor Light Beach Bacteria
East
West
STD: 235/100ml for single sample
E. coli (mpn/100ml)
160
140
120
100
80
60
40
20
0
5/2/18
5/9/18
5/16/18
5/23/18
5/30/18
6/6/18
6/13/18
6/20/18
6/27/18
7/4/18
7/11/18
7/18/18
7/25/18
8/1/18
8/8/18
8/15/18
8/22/18
8/29/18
Date

Carlyle Beach Data 2018

Beach E. coli (mpn/100ml) MPN = most probable number

Date	Keysport		Harbor Light		Dam West		McNair		Coles Creek	
	East	West	East	West	North	South	North	South	North	South
5/2/18	25	8	24	45	29	29	11	35	33	22
5/9/18	36	26	30	33	43	47	10	15	35	28
5/16/18	21	15	100	90	30	25	8	10	55	67
5/23/18	20	20	120	90	45	50	29	28	80	85
5/30/18	21	22	110	100	50	41	28	44	110	100
6/6/18	25	8	124	145	45	50	51	50	33	22
6/13/18	46	26	40	33	43	47	10	15	65	28
6/20/18	21	15	120	90	30	25	18	10	85	67
6/27/18	15	15	122	130	22	20	40	35	85	85
7/4/18	25	8	56	50	80	50	56	50	210	200
7/11/18	46	66	40	43	43	57	10	15	165	128
7/18/18	21	24	60	50	80	65	4	4	120	110
7/25/18	15	15	122	130	22	20	4	3	95	85
8/1/18	45	43	56	55	90	60	76	50	150	200
8/8/18	48	86	40	47	43	59	25	44	155	138
8/15/18	21	34	65	50	80	75	41	40	120	110
8/22/18	30	25	54	45	25	20	30	35	85	85
8/29/18	25	20	50	51	32	41	25	40	90	80
9/5/18	40	43	50	55	94	60	74	50	140	100
9/12/18	45	86	45	47	46	59	24	44	140	148
9/19/18	25	34	65	58	84	75	44	40	100	110
9/26/18	40	25	59	45	40	20	30	34	85	95