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Model Documentation for Relations Between Continuous Real-Time and Discrete Water-Quality Constituents in Cheney Reservoir near Cheney, Kansas, 2001–2009

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U.S. Department of the Interior
U.S. Geological Survey

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By Mandy L. Stone, Jennifer L. Graham, and Jackline W. Gatotho

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.03281	foot (ft)
meter (m)	3.281	foot (ft)
mile (mi)	1.609	kilometer (km)
micrometer (µm)	0.001	millimeter (mm)
nanometer (nm)	0.000001	millimeter (mm)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
square meter (m^2)	10.76	square feet (ft^2)
	Volume	
milliliter (mL)	0.0338	ounce, fluid (oz)
	Flow rate	
milligram per liter (mg/L)	1	parts per million (ppm)
microgram per liter (µg/L)	1	parts per billion (ppb)
	Mass	
milligram (mg)	0.001	gram (g)
microgram (µg)	0.0.000001	gram (g)
ton per year (ton/yr)	0.9072	metric ton per year

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$°F=(1.8\times°C)+32$

Vertical coordinate information is referenced to the North American Vertical Datum of 1929 (NAVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Abbreviations

1Q	first quartile
3Q	third quartile
adjr2	adjusted R^2
cooksD	Cook's distance
Cp	Mallow's C_p
Df	degrees of freedom
dfits	change in fitted values
F-statistic	ratio of the mean square of the regression to the estimated variance
F Value	explained variance divided by unexplained variance
Max	maximum
Mean Sq	mean square
Min	minimum
Nvars	number of explanatory variables
press	prediction error sum of squares
Pr(F)	probability value of an F-test
Pr(>|t|)	probability of observing a test statistic that follows a Student's *t* distribution if the null hypothesis is supported
p-value	probability of observing a test statistic that is as extreme or more extreme than currently observed assuming that the null hypothesis is true
resids	residuals
Std. Error	standard error
Stderr	standard error
stnd.res	standardized residuals
stud.res	studentized residuals
Sum of Sq	sum of squares
t value	coefficient divided by its standard error
yhat	predicted values

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Abstract

Cheney Reservoir, located in south-central Kansas, is one of the primary water supplies for the city of Wichita, Kansas. The U.S. Geological Survey has operated a continuous real-time water-quality monitoring station in Cheney Reservoir since 2001; continuously measured physicochemical properties include specific conductance, pH, water temperature, dissolved oxygen, turbidity, fluorescence (wavelength range 650 to 700 nanometers; estimate of total chlorophyll), and reservoir elevation. Discrete water-quality samples were collected during 2001 through 2009 and analyzed for sediment, nutrients, taste-and-odor compounds, cyanotoxins, phytoplankton community composition, actinomycetes bacteria, and other water-quality measures. Regression models were developed to establish relations between discretely sampled constituent concentrations and continuously measured physicochemical properties to compute concentrations of constituents that are not easily measured in real time. The water-quality information in this report is important to the city of Wichita because it allows quantification and characterization of potential constituents of concern in Cheney Reservoir.

This report updates linear regression models published in 2006 that were based on data collected during 2001 through 2003. The update uses discrete and continuous data collected during May 2001 through December 2009. Updated models to compute dissolved solids, sodium, chloride, and suspended solids were similar to previously published models. However, several other updated models changed substantially from previously published models. In addition to updating relations that were previously developed, models also were developed for four new constituents, including magnesium, dissolved phosphorus, actinomycetes bacteria, and the cyanotoxin microcystin. In addition, a conversion factor of 0.74 was established to convert the Yellow Springs Instruments (YSI) model 6026 turbidity sensor measurements to the newer YSI model 6136 sensor at the Cheney Reservoir site.

Because a high percentage of geosmin and microcystin data were below analytical detection thresholds (censored data), multiple logistic regression was used to develop models that best explained the probability of geosmin and microcystin concentrations exceeding relevant thresholds. The geosmin and microcystin models are particularly important because geosmin is a taste-and-odor compound and microcystin is a cyanotoxin.

Introduction

The Bureau of Reclamation, U.S. Department of the Interior, constructed Cheney Reservoir (fig. 1) between 1962 and 1965. Cheney Reservoir, located in south-central Kansas, was constructed to provide a municipal water supply for the city of Wichita, Kansas, downstream flood control, wildlife habitat, and recreational areas. Water from Cheney Reservoir contributed between 51 and 69 percent of Wichita's water supply during 1995 through 2010 (Ziegler and others, 2010). Because of population growth and urban development, water-supply needs and reliance on Cheney Reservoir will continue to increase.

The U.S. Geological Survey, in cooperation with the city of Wichita, has continuously monitored water-quality in Cheney Reservoir (USGS site 07144790; fig. 1) since April 2001. Continuously monitored water-quality physicochemical properties that have been measured in Cheney Reservoir since 2001 include specific conductance, pH, water temperature, dissolved oxygen, turbidity, and fluorescence at a wavelength range from 650 to 700 nanometers. When measured at this wavelength, fluorescence may provide an estimate of total chlorophyll concentration. Discrete water-quality samples collected during 2001 through 2003 were used to develop regression models and establish relations between continuously monitored water-quality physicochemical properties and discretely monitored water-quality constituents (Christensen and others, 2006). Numerous discrete water-quality samples have been collected since the 2006 models were published and the relations between continuously monitored water-quality physicochemical properties and water-quality constituents need to be updated.

Purpose and Scope

The purpose of this report is to update and document regression models that establish relations between continuous and discrete water-quality data collected from Cheney Reservoir near Cheney, Kansas (USGS station 07144790; fig. 1). Linear regression models for 12 water-quality constituents, including suspended solids and sediment, dissolved solids and major ions, nutrient species, chlorophyll-*a*, taste-and-odor compounds, and taste-and-odor cyanotoxin producers, originally were published by Christensen and others (2006) using data collected during 2001 through 2003. In this report, the linear regression models published in 2006 are updated using data collected through 2009, and additional models are developed for magnesium, dissolved phosphorus, actinomycetes bacteria, and the cyanotoxin microcystin. Because the necessary assumptions for using linear approaches were not met with geosmin, a taste-and-odor coupound, and microcystin data, new logistic regression models are developed for these constituents to estimate the probability of concentrations to exceed relevant thresholds. These models are useful for evaluating how computed concentrations of water-quality constituents compare with water-quality criteria, characterizing changes in water-quality conditions through time, characterizing potentially harmful cyanobacterial bloom events, and indicating changes in water-quality conditions that may affect drinking-water treatment processes. The water-quality information in this report is important to the city of Wichita because it allows quantification and characterization of potential constituents of concern in Cheney Reservoir.

Description of Study Area

The Cheney Reservoir watershed is located in south-central Kansas (fig. 1) and has a contributing drainage area of 933 square miles (mi^2). Land use in the Cheney Reservoir watershed predominately is rural (fig. 1); less than 1 percent of the land use in the watershed is classified as urban. All agricultural crops, including wheat, comprise about 51 percent of land use. About 26 percent of the Cheney Reservoir watershed is grassland and about 18 percent is conservation reserve program (CRP) land (Peterson and others, 2005).

Cheney Reservoir (fig. 1) is a eutrophic impoundment constructed by the Bureau of Reclamation, U.S. Department of the Interior, between 1962 and 1965 to provide downstream flood control, wildlife habitat, recreation, and a municipal water supply for the city of Wichita, Kansas. The North Fork Ninnescah River is the largest tributary to Cheney Reservoir and contributes about 70 percent of the inflow (Christensen and others, 2006). Cheney Reservoir has a mean depth of 16 feet (ft), a maximum depth of 43 ft, and a surface area of about 12 mi^2. Thermal and chemical stratification rarely occur in Cheney Reservoir primarily because of the relatively shallow depths and persistent winds (Smith and others, 2002).

The city of Wichita's population in 2011 was 384,445 people (State of Kansas, 2012). The city of Wichita currently (2013) takes about 60 percent of its water supply from Cheney Reservoir (Shelly Bloesser, city of Wichita, written commun., June 6, 2012). Objectionable tastes and odors have been a problem in the finished drinking water from Cheney Reservoir since 1990. Cheney Reservoir is listed as an impaired waterway under section 303(d) of the 1972 Clean Water Act. Siltation is listed as an impairment to water supply and eutrophication and pH are listed as impairments to aquatic life in Cheney Reservoir (Kansas Department of Health and Environment, 2012).

Methods

Continuous and discrete water-quality data were collected at one site in Cheney Reservoir (fig. 1; USGS station 07144790, Cheney Re nr Cheney, Kansas) located near the city of Wichita's drinking-water intake by the dam. Water quality has been measured continuously at this site since April 2001; discrete water-quality samples have been routinely collected since May 2001. Continuous and discrete water-quality data collected by the USGS at the Cheney Reservoir site from May 2001 through December 2009 were used to develop site-specific regression models.

Continuous Water-Quality Monitoring

The reservoir site was equipped with a YSI 6600 Extended Deployment System water-quality monitor that measured specific conductance, pH, water temperature, dissolved oxygen (YSI Clark cell or optical dissolved oxygen sensors), turbidity [YSI model 6026 (YSI_{6026}) and 6136 (YSI_{6136}) turbidity sensors], and fluorescence (YSI model 6025 sensor; wavelength range 650 to 700 nanometers; estimate of total chlorophyll). The YSI Clark cell dissolved-oxygen sensor was used from April 2001 through January 2007 and was replaced by the YSI optical dissolved-oxygen sensor in February 2007. YSI_{6026} turbidity sensors were used from April 2001 through December 2010 and YSI_{6136} turbidity sensors were added in September 2006. Reservoir elevation was measured using a Design Analysis H-350 nonsubmersible pressure transducer and H-355 gas system. The monitor and pressure transducer were maintained in accordance with standard USGS procedures (Wilde and Radke, 1998; Wagner and others, 2006; Sauer and Turnipseed, 2010). Continuous water-quality data were recorded hourly and are available on the USGS website at *http://waterdata.usgs.gov/ks/nwis*.

Sensor maxima were not exceeded for any of the physicochemical properties measured, with the exception of one fluorescence measurement [409 micrograms per liter (µg/L); sensor maxima = 400 µg/L] on August 11, 2003. Continuous

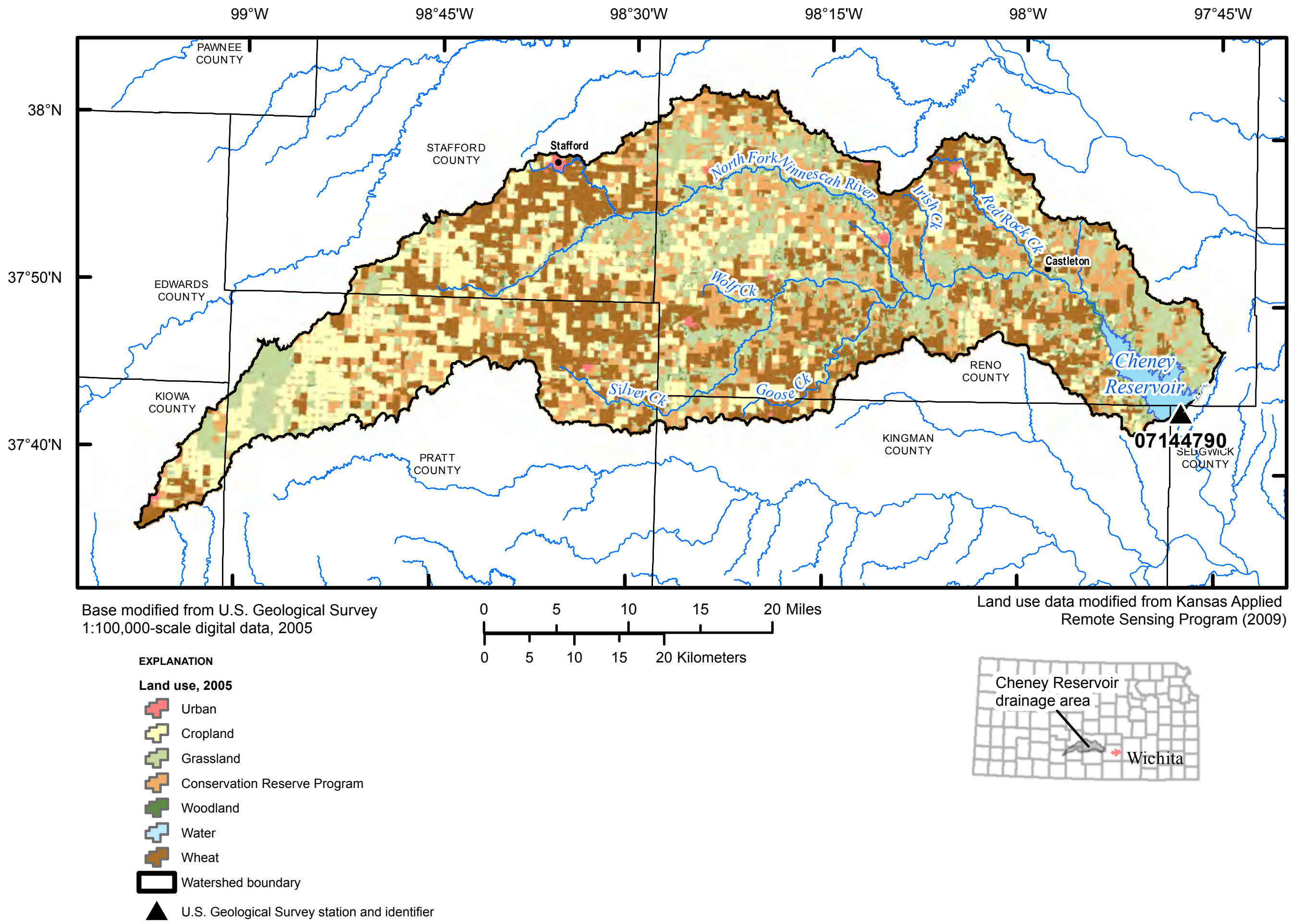

Figure 1. Location of continuous real-time water-quality monitoring station in Cheney Reservoir and land use in the Cheney Reservoir watershed.

data during the study period generally required corrections of less than 10 percent, which classifies the data quality rating as good according to established guidelines (Wagner and others, 2006). Time-series measurements occasionally were missing or deleted from the dataset because of equipment malfunction, excessive fouling caused by environmental conditions, or temporary removal of the sensors because of ice on the reservoir. During 2001 through 2009, approximately 6 percent of the water temperature, specific conductance, and pH records, 9 percent of the turbidity record, and 8 percent of the dissolved oxygen and fluorescence records were missing or deleted, largely because of sensor removal during ice cover.

Discrete Water-Quality Samples

Discrete water-quality samples collected during May 2001 through July 2004 were collected near the surface using a Teflon Kemmerer bottle or a weighted bottle sampler with a 1-liter Teflon bottle following USGS methods (U.S. Geological Survey, variously dated); these samples were not depth integrated. Starting in August 2004 discrete water-quality samples were collected as integrated photic-zone (depth at which light is approximately 1 percent of that at the surface) samples using a double check-valve bailer (Lane and others, 2003); these samples were depth integrated. Vertical profiles collected in Cheney Reservoir indicate that thermal stratification rarely occurs and water-quality conditions typically are uniform throughout the water column. Water-quality results collected before and after the sampling procedure change in summer 2004 were similar. All water samples were analyzed for dissolved solids, major ions (sodium, chloride, and magnesium), suspended solids and sediment, nutrients (total Kjeldahl nitrogen, nitrate plus nitrite, total phosphorus, orthophosphate, and dissolved phosphorus), chlorophyll-*a*, phytoplankton community composition, and the taste-and-odor causing compounds geosmin and 2-methylisoborneol (MIB). Starting in 2005, all samples also were analyzed for actinomycetes bacteria (added April) and the cyanotoxin microcystin (added June).

Dissolved and suspended solids, major ions, and nutrients (except for total Kjeldahl nitrogen) were analyzed by the Wichita Municipal Water and Wastewater Laboratory in Wichita, Kansas, according to standard methods (American Public Health Association and others, 1995); selected replicate samples were sent to the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado and analyzed according to methods presented in Fishman and Friedman (1989). Total Kjeldhal nitrogen (ammonia plus organic nitrogen) was analyzed by the NWQL using methods presented in Patton and Truitt (2000). Chlorophyll-*a* also was analyzed by the NWQL. During April 2001 through September 2004, chlorophyll-*a* was analyzed by high-performance liquid-chromatography; during October 2005 through December 2009, chlorophyll-*a* was analyzed using fluorometric methods (Arar and Collins, 1997). Suspended sediment was analyzed at the USGS Iowa Sediment Laboratory in Iowa City, Iowa according to methods described in Guy (1969). Actinomycetes bacteria were analyzed by the USGS Ohio Water Science Center Microbiology Laboratory in Columbus, Ohio, using standard plate counts (American Public Health Association, American Water Works Association, and Water Environment Federation, 2012) and reported in colonies per milliliter.

Phytoplankton samples (preserved with a 9:1 Lugol's iodine:acetic acid solution) were analyzed for taxonomic identification and enumeration by BSA Environmental Services, Inc., Beachwood, Ohio. Phytoplankton were enumerated to the lowest possible taxonomic level using membrane-filtered slides (McNabb, 1960). A minimum of 400 natural units (colonies, filaments, and unicells) were counted from each sample; in accordance with Lund and others (1958), counting 400 natural units provides accuracy within 90-percent confidence limits. In addition, an entire strip of the filter was counted at high magnification (usually 630 X) along with one-half of the filter at a lower magnification (usually 400 X) to ensure complete species reporting.

Throughout the course of the study, Montgomery Watson Laboratories, Pasadena, California (2001–2003), the USGS Organic Geochemistry Research Laboratory (OGRL), Lawrence, Kansas (2003–2007), and Engineering Performance Solutions (EPS), LLC, Gainesville, Florida (2007–2009) provided analyses for taste-and-odor compounds. All laboratories used solid phase microextraction gas chromatography/mass spectrometry for analysis of taste-and-odor compounds and generally followed USGS methods (Zimmerman and others, 2002). Each time laboratories were changed, an among-laboratory comparison was conducted before the change was made.

Total microcystin was analyzed by the USGS OGRL. Total microcystin concentration includes particulate and dissolved phase microcystin. All samples were lysed by three sequential freeze-thaw cycles and filtered using 0.7-micrometer (µm) glass-fiber filters before analysis (Loftin and others, 2008). Abraxis® enzyme-linked immunosorbent assays (ELISA) were used to measure microcystin (congener independent).

Development of Linear Regression Models to Compute Constituent Concentrations

Models were developed using simple linear (ordinary least squares) regression analyses (Helsel and Hirsch, 2002) to relate discrete sample concentrations or densities of water-quality constituents to continuously measured water-quality physicochemical properties (Rasmussen and others, 2008). The methods used for the development of these models and quantifying uncertainty are described in detail in Rasmussen and others (2009). All data for this report were analyzed using TIBCO Spotfire S+® 8.1 for Windows® statistical software (TIBCO Software, Inc., 2008).

Original models were developed from datasets containing 16 to 33 discrete samples. Models were developed in this report from datasets containing 93 to 125 discrete samples. All continuously measured physicochemical properties and seasonal components (sine and cosine variables) were tested for significance for each response variable. Concomitant in-situ continuous measurements were used to correspond with discrete measurements as described in Rasmussen and others (2009).

Outliers were identified and removed as described in Rasmussen and others (2009). Data points in discrete samples were removed from the model dataset when they were extreme outliers on bivariate plots of actual compared to computed concentrations and when there were identifiable issues with laboratory analyses. For example, data points where an orthophosphate concentration was higher than the concomitant dissolved phosphorus concentration were considered outliers. On average, approximately 2 percent of the discrete-sample data were extreme outliers on bivariate plots and 9 percent of the discrete-sample data had orthophosphate concentrations that were larger than the concomitant dissolved phosphorus concentrations and were removed from linear regression models.

Linear regression models were evaluated based on diagnostic statistics (R^2, coefficient of determination; Mallow's C_p; *RMSE*, root mean square error; *PRESS*, prediction error sum of squares), patterns in residual plots, and the range and distribution of discrete and continuous data (Helsel and Hirsch, 2002). The best model for each constituent was selected to maximize the amount of variance in the response variable explained by the model (multiple R^2 for models with one explanatory variable and adjusted R^2 for models with more than one explanatory variable), maximize fit to the data (Mallow's C_p), and minimize heteroscedasticity (irregular scatter) in the residual plots and uncertainty associated with computed values (*RMSE* and *PRESS*). Model simplicity also was considered for model selection because as more variables are included the likelihood that the variability of the system is not described by the sampling dataset increases. Significant (p-value less than 0.05) additional explanatory variables were included in final models when retaining them increased the amount of variance explained by the model by 10 percent or more, decreased Mallow's C_p, and minimized heteroscedasticity in residual plots. Models for all constituents with previously published (Christensen and others, 2006) models were updated. Models were considered suitable to use for constituent concentration computations if the amount of variance explained by the models (R^2) was 0.40 or greater.

Mean square error (*MSE*) and *RMSE* were calculated for each model to assess the variance between predicted and observed values (Helsel and Hirsch, 2002). The model standard percentage error (*MSPE*) was calculated as a percentage of the *RMSE* (Hardison, 1969). Because transformation of estimates back into original units results in a low biased estimate (Helsel and Hirsch, 2002), a bias correction factor (*BCF*) was calculated for models with logarithmically transformed response variables (Duan, 1983).

Development of Logistic Regression Models for Geosmin and Microcystin

Geosmin and microcystin were commonly detected compounds in Cheney Reservoir during May 2001 through December 2009. However, 60 percent of geosmin samples and 53 percent of microcystin samples were below analytical detection thresholds. Because of the high percentage of censored values, ordinary least squares regression is not an appropriate modeling technique for these constituents (Helsel and Hirsch, 2002). Multiple logistic regression was used to develop models to identify factors that best explained the probability of geosmin and microcystin concentrations exceeding relevant thresholds.

Logistic regression models the probability of the response variable being in one of two categorical response groups (for example, 0 equals a negative response and 1 equals a positive response). Logistic regression transforms estimated probabilities into a continuous response variable, with possible values ranging from negative to positive infinity. The transformed response variable can then be modeled as a linear function of one or more explanatory variables in a logistic regression (Helsel and Hirsch, 2002). The logistic regression equation can be expressed as:

$$ln\left(\frac{p}{1-p}\right) = b0 + bX \qquad (1)$$

where:

ln is the natural logarithm,

$(\frac{p}{1-p})$ is the odds ratio, with p equal to the probability of a 1 (positive) response,

b0 is the intercept,

X is a vector of k explanatory variables, and

bX includes the slope coefficients for each explanatory variable so that $bX = b1X_1 + b_2X_2 \ldots b_kXk$.

In this form, the logistic regression models the probability of obtaining a 1 (positive) response (Helsel and Hirsch, 2002; Systat Software, Inc., 2009). Model output is the natural logarithm of the odds ratio. The natural logarithm of the odds ratio can be converted into a probability using the following equation:

$$p = e^{b0+bX} / [1 + e^{b0+bX}] \qquad (2)$$

where:

p is the probability of a response of 1,

e is the base of the natural logarithm (approximately equal to 2.71828),

b0 is the intercept,

X is a vector of k explanatory variables, and

bX includes the slope coefficients for each explanatory variable so that $bX = b1X_1 + b_2X_2 \ldots b_kXk$.

For Cheney Reservoir model development, the response variable was based on a category assigned to constituent concentrations in which a value of 1 was assigned to concentrations greater than or equal to the human detection threshold for geosmin (0.005 µg/L; Taylor and others, 2005) and greater than or equal to the analytical detection threshold for microcystin (0.01 µg/L) and 0 was assigned to concentrations below these thresholds. Explanatory variables selected as inputs to the multiple logistic regression analyses were those physicochemical properties that were used in the linear models for other constituents: specific conductance, pH, water temperature, dissolved oxygen, turbidity, fluorescence (wavelength range 650 to 700 nanometers; estimate of total chlorophyll), and reservoir elevation. Seasonal components (sine and cosine variables) were used as explanatory variables in the models to determine if seasonal changes affected the model. All combinations of physicochemical properties and a seasonal component were evaluated to determine which combinations produced the best models.

Logistic model equations were developed using the multiple logistic regression routine in SigmaPlot® version 11.0 (Systat Software, Inc., 2008). Continuous water-quality physicochemical properties initially were evaluated individually using the variance inflation factor (VIF, Systat Software, Inc., 2008) and then the Wald Statistic *p*-value (Menard, 2002). All combinations of selected initial parameters were evaluated and the best final model was selected based on statistical tests in the following order: variance inflation factor, Wald Statistic *p*-value, Pearson Chi-Square Statistic, Likelihood Ratio Test statistic, -2 log likelihood statistic, and Hosmer-Lemeshow *p*-value (Hosmer and others, 2013).

The VIF measures multicollinearity by quantifying the inflation of the standard error of each regression coefficient for an independent variable because of redundant information in other independent variables. Physicochemical properties were selected for model development when their VIF was closest to 1 because a VIF value of 1 indicates no redundant information in the other independent variable. The Wald Statistic is the regression coefficient divided by the standard error and its *p*-value is the probability of being wrong in concluding that there is a true association between the variables. Physicochemical properties were selected for model development when their Wald Statistic *p*-value was less than 0.05. The Pearson Chi-Square statistic is the sum of the squared Pearson residuals and is a measure of the agreement between the observed and predicted values of the dependent variable. Goodness of fit is greater at lower Pearson Chi-Square statistic values. Larger Pearson Chi-Square statistic values indicate a poor agreement between the logistic regression equation and the data. Models with smaller Pearson Chi-Square statistic values were retained for final model selection. The Likelihood Ratio Test statistic is derived from the sum of the squared deviance residuals and indicates how well the logistic regression equation fits the data by comparing the likelihood of obtaining observations if the independent variables had no effect on the dependent variable with the likelihood of obtaining the observations if the independent variables had an effect on the dependent variables. A larger Likelihood Ratio Test statistic value indicates a good fit between the model equation and the data. Models with larger Likelihood Ratio Test statistic values were retained for final model selection. The -2 log likelihood statistic is a measure of the goodness of fit between the actual observations and the predicted probabilities. Models with a -2 log likelihood value that were closer to 0 were retained for final model selection because values closer to 0 reflect a better fit of the model to the data. The Hosmer-Lemsow *p*-value indicates how well the logistic regression equation fits the data by comparing the number of observations with each outcome to the number expected based on the logistic equation, and tests the null hypothesis that the logistic equation describes the data. Smaller Hosmer-Lemsow *p*-values indicate a poor fit of the model equation to the data. Models with Hosmer-Lemsow *p*-values that were greater than 0.2 were retained for final model selection (Systat Software, Inc., 2008).

After the best model was selected, the threshold probability for positive classification (TPPC) for the model was adjusted based on the fraction of positive observed geosmin or microcystin values to make the model more conservative (more likely to overestimate geosmin or microcystin presence) by guarding more strongly against false negatives. The regression then used the newly adjusted thresholds, which changed the number of predictions for positive and reference responses, but the model constants and other statistical outputs remained the same.

Calculation of Conversion Factors for Turbidity Sensors

All models in this report were developed using YSI_{6026} turbidity sensors; however, turbidity sensors were updated from YSI_{6026} to YSI_{6136} in January 2011. YSI_{6136} turbidity sensors were operated alongside the YSI_{6026} turbidity sensors during September 2006 through December 2010. Because of the change in turbidity sensor instrumentation, 4 years of concurrent YSI_{6026} and YSI_{6136} hourly turbidity measurements (September 2006 through September 2010) were used to develop a site-specific conversion factor. Ordinary least squares regression analyses were performed on the concurrent turbidity measurements to aid in conversion factor selection (Helsel and Hirsch, 2002). A median conversion factor was calculated as the ratio of the YSI_{6136} sensor value to the YSI_{6026} sensor value because the median was less likely to be affected by outliers (Rasmussen and others, 2009). The conversion factor was then applied to YSI_{6026}-based models without additional modification so the models developed in this report can be used with turbidity data collected by either sensor.

Quality Assurance and Quality Control

Quality-assurance and quality-control (QA/QC) samples were collected to evaluate variability in sample collection and processing techniques and among-laboratory variability in analytical techniques. About 8 percent of discrete water-quality samples were QA/QC samples. Approximately 180 sequential replicate constituent pairs were collected during 2001 through 2009. Relative percentage difference (RPD) was used to evaluate differences in analyte concentrations detected in replicate water samples. The RPD was calculated using the following equation:

$$RPD = \left[\left| A - B \right| / \left(\frac{A+B}{2} \right) \right] \text{x}100 \quad (3)$$

where *A* and *B* are concentrations in each replicate pair. Replicate pairs with an RPD within 10 percent were considered acceptable for inorganic constituents (Ziegler and Combs, 1997) and replicate pairs with an RPD within 20 percent were considered acceptable for nutrient and organic constituents. The median RPD between all constituent replicate pairs was less than their respective acceptability limits. All inorganic constituent replicate pairs had median RPDs that were less than 5, except for suspended sediment (9 percent). All nutrient and organic constituent replicate pairs had median RPDs that were less than 10 except for total phosphorus (16 percent), dissolved phosphorus (17 percent), and geosmin (11 percent). Larger RPDs generally resulted when the values were near the laboratory reporting level.

A comparison of taste-and-odor analysis by Montgomery Watson (analytical detection threshold=0.003 µg/L) and the

OGRL (analytical detection threshold=0.005 µg/L) was done on 8 laboratory split-replicate samples and detection frequencies of geosmin were identical between the two laboratories. The RPDs in samples with detections by both laboratories ranged from 4 to 34 percent for geosmin (median: 12 percent; number of pairs=8). The absolute difference in geosmin concentrations between replicate pairs was 0.01 µg/L or less (median: less than 0.002 µg/L; number of pairs=13).

A comparison of taste-and-odor analysis by EPS (analytical detection threshold=0.002 µg/L) and the OGRL was done on 21 laboratory split-replicate samples. Geosmin was detected in 33 percent of the samples analyzed by EPS and 14 percent of the samples analyzed by the OGRL. Detections by EPS and not the OGRL only occurred when geosmin concentrations were less than the OGRL analytical method threshold but above the EPS analytical method detection threshold (between 0.002 and 0.005 µg/L). Three samples had geosmin detections by both laboratories; RPDs for these samples were 4, 18, and 54 percent. The absolute difference in geosmin concentrations between replicate pairs ranged from 0.004 to 0.006 µg/L.

Results of Linear Regression Analysis for Selected Constituents

Relations between in-situ continuous measurements and discrete constituents were developed and evaluated using ordinary least squares regression. Linear regression models for seven constituents developed from data collected during 2001 through 2003 (Christensen and others, 2006) were successfully updated to use for constituent concentration computations. The successfully updated models were for dissolved solids, sodium, chloride, suspended-sediment concentration, total phosphorus, orthophosphate, and chlorophyll-*a*. The linear regression models for five previously published (Christensen and others, 2006) models could not be successfully updated for computing constituent concentrations because they did not meet model selection criteria (R^2 values greater than 0.40). However, the best possible models were developed for these constituents, which included total suspended solids, total Kjeldahl nitrogen, nitrate plus nitrite, *Anabaena* spp. (a cyanobacterial genus known to have toxin and taste-and-odor producing strains), and geosmin. New linear regression models were developed for four additional constituents not described in Christensen and others (2006) and included magnesium, dissolved phosphorus, actinomycetes bacteria, and microcystin. Updated, best updated, and newly developed models were developed from data collected during 2001 through 2009. Models are shown in table 1. Best updated models with R^2 values less than 0.40 are shown for comparative purposes, even though the R^2 values did not meet the requisite criteria. Model datasets are presented in tables 2–17 and model S+® statistical output is presented in figures 2–33.

Specific conductance was the single explanatory variable for dissolved solids and most other major ions. Dissolved solids, sodium, chloride, and magnesium were strongly positively correlated with specific conductance. Specific conductance also was an explanatory variable for dissolved phosphorus. Turbidity was an explanatory variable for total phosphorus, orthophosphate, and actinomycetes bacteria. Dissolved oxygen was an explanatory variable for total Kjeldahl nitrogen and dissolved phosphorus. Reservoir elevation was an explanatory variable for chloride, chlorophyll-*a*, and actinomycetes bacteria. Fluorescence was an explanatory variable for total suspended solids, orthophosphate, dissolved phosphorus, chlorophyll-*a*, and microcystin. Water temperature was an explanatory variable for total Kjeldahl nitrogen, orthophosphate, chlorophyll-*a*, and actinomycetes bacteria. Total phosphorus and microcystin models included a seasonal component.

Magnesium, dissolved phosphorus, actinomycetes bacteria, and microcystin (table 1) models were newly developed for this report. Additional data collection collected throughout a wider range of hydrological conditions facilitated the development of these models. The actinomycetes bacteria and microcystin models are particularly important because actinomycetes bacteria may be related to taste-and-odor occurrences and microcystin is a cyanotoxin.

Updated dissolved solids, sodium, chloride, and suspended solids model forms were similar to original (Christensen and others, 2006) models (table 1). The amount of variance explained in the original and updated dissolved solids models was the same. Fourteen percent less variance was explained by the updated sodium model and 9 percent more variance was explained by the updated chloride model.

The model form for five constituents is different in the updated models than in the original (Christensen and others, 2006) models (table 1). The updated models that changed substantially were for constituents that are affected by biological processes. The updated total phosphorus model includes a seasonal component instead of temperature and 8 percent less variance is explained by the updated model (table 1). The updated orthophosphate model form includes turbidity, water temperature, and fluorescence likely because orthophosphate concentrations are largely controlled by algal uptake (Wetzel, 2001). Thirteen percent more variance is explained by the updated orthophosphate model than the original model (table 1).

The updated chlorophyll-*a* model changed from the original form and includes reservoir elevation, water temperature, and fluorescence; increased reservoir elevation is related to decreases in fluorescence because there is less time for development of substantial biomass when water residence times are shorter (reservoir elevation is one indicator of water residence time), higher water temperature allows for more growth in the summer (Wetzel, 2001), and fluorescence is an estimate of chlorophyll. Two percent more variance is explained by the updated chlorophyll-*a* model than the original model (table 1).

Table 1. Christensen and others (2006), updated, best updated, and new linear regression models and summary statistics for continuous concentration computations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[R^2, coefficient of determination; *MSE*, mean square error; *RMSE*, root mean square error; *MSPE*, model standard percentage error; %, percent; ±, plus or minus; *n*, number of discrete samples; mg/L, milligrams per liter; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; ELV, reservoir elevation in feet above from National Geodetic Vertical Datum of 1929; log, $\log_{10}$; TBY_{6026}, turbidity from YSI sensor model 6026 in formazin nephelometric units; <, less than; CHL, fluorescence at a wavelength of 650 to 700 nanometers; DO, dissolved oxygen in milligrams per liter; pH, pH in standard units; T, water temperature in degrees Celsius; sin, sine; D, day of year; cos, cosine; µ/L, micrograms per liter; col/mL, colonies per milliliter; µm³/mL, micrometers cubed per milliliter; E, exponential]

Model	Multiple R^2	R^2 adjusted	*MSE*	*RMSE*	*MSPE* (upper)	*MSPE* (lower)	Bias correction factor (Duan, 1983)	90% prediction interval, in ± %	Discrete data				
									n	Range of values in variable measurements	Mean	Median	Standard deviation
Dissolved solids (DS), in mg/L													
Christensen and others (2006)													
DS = 0.5500(SC) - 8.59	0.81	0.80	0.5700	0.7550	0.2	-0.2	1.00	41	19	DS: 414–501	446	438	25.5
										SC: 761–911	826	812	40.4
Updated													
DS = 0.5093(SC) + 28.38	0.80	0.80	144.5	12.02	2.7	-2.7	1.00	39	120	DS: 371–509	442	440	26.6
										SC: 728–940	812	807	46.7
Sodium (Na), in mg/L													
Christensen and others (2006)													
Na = 0.1815(SC) - 48.97	0.88	0.87	8.341	2.888	2.9	-2.9	1.00	41	19	Na: 87.5–116	101	101	8.08
										SC: 761–911	827	812	41.8
Updated													
Na = 0.1636(SC) - 32.80	0.74	0.74	20.26	4.501	4.5	-4.5	1.00	39	119	Na: 80.1–124	100	100	8.84
										SC: 728–940	814	808	46.6
Chloride (Cl), mg/L													
Christensen and others (2006)													
Cl = 0.2600(SC) - 72.41	0.61	0.59	78.80	8.877	6.3	-6.3	1.00	41	19	Cl: 116–162	142	144	13.9
										SC: 761–911	827	812	41.8
Updated													
Cl = -3.0417(ELV-1,400) + 0.2009(SC) + 37.19	0.70	0.69	55.37	7.441	5.5	-5.5	1.00	39	120	Cl: 105–166	135	136	13.5
										ELV: 1,418–1,425	1,422	1,422	1.19
										SC: 728–940	813	809	47.0
Magnesium (Mg), in mg/L													
New													
Mg = 28.68log(SC) - 69.80	0.59	0.59	0.3541	0.5951	4.4	-4.4	1.00	39	122	Mg: 11.4–15.5	13.6	13.6	0.93
										SC: 728–940	813	808	46.6
Total suspended solids (TSS), mg/L													
Christensen and others (2006)													
TSS = 0.2125(TBY_{6026}) + 2.8474	0.42	0.39	8.509	2.9170	43.7	-43.7	1.00	41	19	TSS: <4–12	6.68	6.00	3.73
										TBY_{6026}: 1.6–40	18.1	18.0	11.4

Table 1. Christensen and others (2006), updated, best updated, and new linear regression models and summary statistics for continuous concentration computations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[R^2, coefficient of determination; *MSE*, mean square error; *RMSE*, root mean square error; *MSPE*, model standard percentage error; %, percent; ±, plus or minus; *n*, number of discrete samples; mg/L, milligrams per liter; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; ELV, reservoir elevation in feet above from National Geodetic Vertical Datum of 1929; log, $\log_{10}$; TBY_{6026}, turbidity from YSI sensor model 6026 in formazin nephelometric units; <, less than; CHL, fluorescence at a wavelength of 650 to 700 nanometers; DO, dissolved oxygen in milligrams per liter; pH, pH in standard units; T, water temperature in degrees Celsius; sin, sine; D, day of year; cos, cosine; μ/L, micrograms per liter; col/mL, colonies per milliliter; μm^3/mL, micrometers cubed per milliliter; E, exponential]

Model	Multiple R^2	R^2 adjusted	*MSE*	*RMSE*	*MSPE* (upper)	*MSPE* (lower)	Bias correction factor (Duan, 1983)	90% prediction interval, in ± %	Discrete data: *n*	Discrete data: Range of values in variable measurements	Discrete data: Mean	Discrete data: Median	Discrete data: Standard deviation
Best updated[1]													
$\log(TSS) = 0.4807\log(TBY_{6026}) + 0.3030\log(CHL) + 0.0215$[1]	0.22	0.21	0.0661	0.2571	80.8	44.7	1.15	45	121	TSS: <4.00–38.0	9.32	8.00	5.48
										TBY_{6026}: 1.60–42.0	18	18	8.73
										CHL: 2.00–49.4	11.2	8.10	7.83
Suspended-sediment concentration (SSC), in mg/L													
Christensen and others (2006)													
$\log(SSC) = 0.5966\log(TBY_{6026}) + 0.3610$	0.69	0.67	0.0246	0.1570	43.5	30.3	1.06	44	17	SSC: 3–25	13	13	6.72
										TBY_{6026}: 1.6–40	19	18	11.5
Updated													
$SSC = 0.6304(TBY_{6026}) + 2.9310$	0.66	0.65	17.08	4.133	28.1	-28.1	1.00	39	119	SSC: 2–36	15	14	7.03
										TBY_{6026}: 1.6–48	19	18	9.05
Total Kjeldahl Nitrogen (TKN), in mg/L													
Christensen and others (2006)													
$TKN = 0.0085(TBY_{6026}) + 0.7039\log(DO) + 0.6577(pH) - 5.5840$	0.66	0.59	0.0331	0.1818	23.6	-23.6	1.00	41	20	TKN: 0.46–1.40	0.77	0.63	0.28
										TBY_{6026}: 1.6–40	18	18	11.4
										DO: 5.9–17.4	9.2	8.2	3.10
										pH: 8.0–9.0	8.4	8.4	0.26
Best updated[1]													
$TKN = 0.0045(TBY_{6026}) + 0.0608(DO) + 0.0197(T) - 0.2437$[1]	0.33	0.31	0.0162	0.1271	17.4	-17.4	1.00	39	122	TKN: 0.34–1.40	0.73	0.72	0.15
										TBY_{6026}: 1.6–48	19	18	9.09
										DO: 4.3–16.4	9.0	8.3	2.81
										T: 0.3–28.6	17.5	21.1	8.82
Nitrate plus nitrite (NO_3NO_2), in mg/L													
Christensen and others (2006)													
$\log(NO_3NO_2) = -2.500\log(DO) + 0.7094\log(TBY_{6026}) - 0.0014(T)^2 + 0.9793$	0.56	0.55	0.1037	0.3220	110	52.4	1.31	56	19	NO_3NO_2: <0.02–0.36	0.08	0.04	0.10
										DO: 5.9–17.4	9.3	8.3	3.14
										TBY_{6026}: 1.6–40	18.0	17.5	11.7
										T: 0.6–27.9	20.5	24.9	9.39
Best updated[1]													
$\log(NO_3NO_2) = -0.5585(pH) - 0.0026(SC) + 5.8934$[1]	0.15	0.14	0.1999	0.4471	180	64.3	1.55	61	122	NO_3NO_2: <0.02–0.97	0.20	0.15	0.17
										pH: 7.7–8.9	8.4	8.4	0.22
										SC: 728–940	813	808	46.8

Table 1. Christensen and others (2006), updated, best updated, and new linear regression models and summary statistics for continuous concentration computations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[R^2, coefficient of determination; *MSE*, mean square error; *RMSE*, root mean square error; *MSPE*, model standard percentage error; %, percent; ±, plus or minus; *n*, number of discrete samples; mg/L, milligrams per liter; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; ELV, reservoir elevation in feet above from National Geodetic Vertical Datum of 1929; log, $\log_{10}$; TBY_{6026}, turbidity from YSI sensor model 6026 in formazin nephelometric units; <, less than; CHL, fluorescence at a wavelength of 650 to 700 nanometers; DO, dissolved oxygen in milligrams per liter; pH, pH in standard units; T, water temperature in degrees Celsius; sin, sine; D, day of year; cos, cosine; µ/L, micrograms per liter; col/mL, colonies per milliliter; μm^3/mL, micrometers cubed per milliliter; E, exponential]

Model	Multiple R^2	R^2 adjusted	*MSE*	*RMSE*	*MSPE* (upper)	*MSPE* (lower)	Bias correction factor (Duan, 1983)	90% prediction interval, in ± %	Discrete data: *n*	Discrete data: Range of values in variable measurements	Discrete data: Mean	Discrete data: Median	Discrete data: Standard deviation
Total phosphorus (TP), mg/L													
Christensen and others (2006)													
$TP = 0.0022(T) + 0.0010(TBY_{6026}) + 0.0218$	0.77	0.76	0.0004	0.0200	22.2	-22.2	1.00	41	33	TP: <0.03–0.15	0.09	0.08	0.03
										TBY_{6026}: 1.6–40	18	18	11.4
										T: 0.6–27.9	20.5	24.8	9.12
Updated													
$\log(TP) = -0.0633\sin(2\pi D/365) - 0.1357\cos(2\pi D/365) + 0.4390\log(TBY_{6026}) - 1.6626$	0.69	0.68	0.0186	0.1364	36.9	27.0	1.05	41	109	TP: <0.03–0.23	0.09	0.09	0.04
										TBY_{6026}: 1.6–48	19	18	9.33
Orthophosphate (OP), in mg/L													
Christensen and others (2006)													
$\log(OP) = 1.0100\log(TBY_{6026}) - 2.7600$	0.53	0.52	0.1218	0.3490	123	55.2	1.44	48	33	OP: <0.01–0.09	0.04	0.04	0.02
										TBY_{6026}: 1.6–40	18	18	11.4
Updated													
$\log(OP) = 0.4942\log(TBY_{6026}) + 0.0189(T) - 0.5408\log(CHL) - 2.0430$	0.66	0.65	0.0709	0.2662	84.6	45.8	1.18	46	113	OP: <0.01–0.09	0.03	0.03	0.02
										TBY_{6026}: 1.6–48	18	18	9.27
										T: 0.3–28.6	16.9	19.2	9.01
										CHL: 2.0–49.4	11.0	8.0	7.75
Dissolved phosphorus (DP), in mg/L													
New													
$\log(DP) = -0.8764\log(DO) - 0.0019(SC) - 0.0137(CHL) + 1.0851$	0.59	0.57	0.0423	0.2056	60.5	37.7	1.10	43	109	DP: <0.03–0.16	0.05	0.05	0.03
										DO: 4.3–16.4	9.1	8.4	2.86
										SC: 728–913	813	808	45.1
										CHL: 2.0–31.2	10.8	8.0	6.93
Chlorophyll-*a* (CHLA), µg/L													
Christensen and others (2006)													
$\log(CHLA) = 0.0145(TBY_{6026}) + 0.9872\log(DO) - 0.2902$	0.49	0.44	0.0256	0.1599	44.5	30.8	1.06	43	26	CHLA: 1.9–25.6	8.1	7.2	4.48
										TBY_{6026}: 1.6–36	11	5.4	10.1
										DO: 5.9–18.2	10.5	11.7	2.95
Updated													
$CHLA = -1.9656(ELV-1,400) + 0.3204(T) + 0.8463(CHL) + 40.25$	0.51	0.49	38.73	6.223	48.6	-48.6	1.00	39	117	CHLA: 0.8–47.2	12.8	11.1	8.75
										ELV: 1,418–1,425	1,421	1,422	1.24
										T: 0.3–28.6	16.8	20.2	8.97
										CHL: 0.2–49.4	11.1	8.1	7.9

Table 1. Christensen and others (2006), updated, best updated, and new linear regression models and summary statistics for continuous concentration computations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[R^2, coefficient of determination; *MSE*, mean square error; *RMSE*, root mean square error; *MSPE*, model standard percentage error; %, percent; ±, plus or minus; *n*, number of discrete samples; mg/L, milligrams per liter; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; ELV, reservoir elevation in feet above from National Geodetic Vertical Datum of 1929; log, $\log_{10}$; TBY_{6026}, turbidity from YSI sensor model 6026 in formazin nephelometric units; <, less than; CHL, fluorescence at a wavelength of 650 to 700 nanometers; DO, dissolved oxygen in milligrams per liter; pH, pH in standard units; T, water temperature in degrees Celsius; sin, sine; D, day of year; cos, cosine; µ/L, micrograms per liter; col/mL, colonies per milliliter; µm³/mL, micrometers cubed per milliliter; E, exponential]

Model	Multiple R^2	R^2 adjusted	*MSE*	*RMSE*	*MSPE* (upper)	*MSPE* (lower)	Bias correction factor (Duan, 1983)	90% prediction interval, in ± %	Discrete data: *n*	Discrete data: Range of values in variable measurements	Discrete data: Mean	Discrete data: Median	Discrete data: Standard deviation
Actinomycetes bacteria (ACT), in col/mL													
New													
log(ACT) = 11.06log(ELV - 1,400) + 0.9924log(TBY_{6026}) - 0.0163(T) - 14.93	0.61	0.59	0.0913	0.3021	100	50.1	1.23	48	93	ACT: <1.0–63.0	9.4	7.0	11.0
										TBY_{6026}: 2.7–48	19	18	8.54
										ELV: 1,418–1,425	1,422	1,422	1.27
										T: 0.7–27.9	17.4	20.2	8.48
***Anabaena* spp. (ANA), µm³/mL**													
Christensen and others (2006)													
$(ANA)E^5$ = 4.36(TBY_{6026}) - 7.01	0.47	0.44	2,200	46.90	0.00	-0.00	1.00	42	16	ANA: 48,300–22,700,000	4,063,550	1,560,000	6,242,490
										TBY_{6026}: 1.6–35	11	5.9	9.91
Best updated[1]													
log(ANA) = -25.81log(ELV - 1,400) + 0.1203(T) + 34.49[1]	0.37	0.36	2.6212	1.6190	4,059	97.6	98.3	3,845	114	ANA: 0–708,775	22,443	171	76,899
										ELV: 1,418–1,425	1,422	1,422	1.20
										T: 0.3–28.6	16.6	18.7	9.17
Geosmin (GEO), in µg/L													
Christensen and others (2006)													
log(GEO) = -1.0664log(TBY_{6026}) - 0.0097(SC) + 7.2310	0.71	0.67	0.0471	0.2170	64.8	39.3	1.12	47	18	GEO: <0.003–0.06	0.06	0.01	0.02
										TBY_{6026}: 1.6–36	11	5.9	9.41
										SC: 792–911	860	876	37.9
Best updated[1]													
log(GEO) = -0.6356log(TBY_{6026}) + 0.6115(pH) - 7.0015[1]	0.22	0.21	0.2263	0.4757	199	66.6	2.37	93	127	GEO: <0.002–0.11	0.01	0.00	0.01
										TBY_{6026}: 1.6–48	18	18	9.04
										pH: 7.7–8.9	8.4	8.4	0.22
Microcystin (MC), in µg/L													
New													
log(MC) = -0.5916sin(2πD/365) - 0.3244cos(2πD/365) + 0.8574log(CHL) - 1.8153	0.48	0.46	0.1877	0.4333	171	63.1	1.63	64	94	MC: <0.10–3.80	0.43	0.05	0.82
										CHL: 3.1–49.4	11.5	8.5	7.99

[1] Best updated model did not meet selection criteria and should not be used to compute constituent concentrations.

Table 2. Dissolved solids linear regression dataset using specific conductance as the explanatory variable for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Date	Time, in hhmm	Specific conductance, in µS/cm at 25°C	Dissolved solids, in mg/L
May 3, 2001	1055	789	421
June 4, 2001	1030	809	454
June 22, 2001	1155	756	417
July 24, 2001	1055	776	414
August 29, 2001	1125	799	421
May 15, 2002	1115	913	492
June 19, 2002	0955	814	438
August 7, 2002	1000	863	436
September 4, 2002	1015	863	435
September 25, 2002	1010	842	444
January 23, 2003	1055	879	474
February 10, 2003	1250	891	501
March 3, 2003	1025	885	483
June 17, 2003	1045	792	438
June 20, 2003	0905	802	444
July 7, 2003	0940	806	444
July 17, 2003	1155	797	429
July 28, 2003	1150	799	431
March 10, 2004	1115	806	436
April 8, 2004	1015	801	437
May 5, 2004	1115	825	471
June 3, 2004	1000	838	464
July 15, 2004	0950	760	407
August 12, 2004	0915	738	424
August 27, 2004	1115	743	407
September 9, 2004	0935	751	404
February 2, 2005	1035	827	452
March 16, 2005	1015	841	471
April 13, 2005	1000	868	478
May 4, 2005	1120	884	487
May 16, 2005	0955	885	488
June 1, 2005	1020	890	481
June 15, 2005	0945	850	470
June 29, 2005	1000	804	432
July 13, 2005	0920	739	387
July 27, 2005	0850	745	417
August 10, 2005	0855	753	420
August 30, 2005	0945	733	371
September 7, 2005	1030	730	388
October 13, 2005	1030	745	408
October 27, 2005	1005	751	457
January 11, 2006	1210	792	458
March 1, 2006	1105	820	439
March 29, 2006	1005	833	462
April 25, 2006	1245	857	469
May 17, 2006	1055	845	473
May 31, 2006	1140	849	438
June 14, 2006	1045	852	461
June 28, 2006	0955	845	456
July 13, 2006	0940	859	456
July 26, 2006	1115	847	467
August 10, 2006	1005	844	457
August 22, 2006	1000	837	483
September 6, 2006	1020	830	461
September 20, 2006	1015	840	454
October 11, 2006	0950	854	470
October 25, 2006	0945	866	478
December 12, 2006	1115	907	487
February 7, 2007[1]	1115	822	517
March 7, 2007	1135	940	509
April 9, 2007	1045	884	477
May 8, 2007	0940	845	450
May 31, 2007	1020	754	450
June 13, 2007	1140	728	398
June 25, 2007	1000	739	406
July 9, 2007	0950	732	402
July 23, 2007	1020	732	410
August 7, 2007	0930	748	422
August 15, 2007	0955	746	394
August 28, 2007	1055	765	406
September 12, 2007	1025	776	434
September 24, 2007	1025	779	422
October 15, 2007	1005	792	423
October 29, 2007	1045	792	438
November 13, 2007	1040	806	439
December 19, 2007	1100	837	443
February 11, 2008	1100	866	463
February 14, 2008	1105	869	461
February 15, 2008	1025	867	461
March 10, 2008	1125	864	471
April 1, 2008	0955	861	475
March 16, 2008[1]	1140	864	326
April 29, 2008	1035	861	463
May 13, 2008	1020	853	460
June 3, 2008	0945	812	446
June 18, 2008	0920	802	427
June 25, 2008	1155	806	436
July 7, 2008	1035	796	427
July 21, 2008	1050	804	428
July 28, 2008	0955	797	427
August 4, 2008	1020	802	423
August 18, 2008	0945	808	444
September 2, 2008	1000	808	440
September 17, 2008	1000	778	422
October 1, 2008	1055	781	440
October 15, 2008	1150	752	388
November 4, 2008	0950	784	432
December 2, 2008	0950	805	443
January 6, 2009	1010	842	469
January 20, 2009	1010	836	461
February 2, 2009	1000	837	442
February 18, 2009	1010	819	446
February 25, 2009	1030	825	458
March 3, 2009	1050	843	457
March 9, 2009	1050	841	462
March 16, 2009	1100	841	457
March 25, 2009	1020	847	460
April 8, 2009	1010	848	461
April 29, 2009	1030	842	464
May 27, 2009	1140	765	421
June 9, 2009	1100	768	421
June 23, 2009	1045	772	427
July 7, 2009	1100	759	412
July 21, 2009	1020	763	412
August 5, 2009	1030	773	420
August 24, 2009	1000	778	418
September 2, 2009	1030	785	426
September 16, 2009	1030	773	428
October 5, 2009	1100	773	411
October 19, 2009	1100	781	422
November 23, 2009	1100	803	421
December 16, 2009	1140	838	434

[1]Data point removed from final analysis because it was an extreme outlier on a bivariate plot of actual as compared to computed concentrations.

Table 3. Sodium linear regression dataset using specific conductance as the explanatory variable for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Date	Time, in hhmm	Specific conductance, in µS/cm at 25°C	Sodium, in mg/L
May 3, 2001	1055	789	90.1
June 4, 2001	1030	809	95.2
June 22, 2001	1155	756	87.5
July 24, 2001	1055	776	90.2
August 29, 2001	1125	799	97.4
May 15, 2002	1115	913	116
June 19, 2002	0955	814	98.7
August 7, 2002	1000	863	106
September 4, 2002	1015	863	102
September 25, 2002	1010	842	107
January 23, 2003	1055	879	112
February 10, 2003	1250	891	112
March 3, 2003	1025	885	109
June 17, 2003	1045	792	93.8
June 20, 2003	0905	802	94.4
July 7, 2003	0940	806	99.9
July 17, 2003	1155	797	104
July 28, 2003	1150	799	101
March 10, 2004	1115	806	104
April 8, 2004	1015	801	99.0
May 5, 2004	1115	825	107
June 3, 2004	1000	838	96.5
July 15, 2004	0950	760	89.3
August 12, 2004	0915	738	87.9
August 27, 2004[1]	1115	743	99.3
September 9, 2004	0935	751	96.2
February 2, 2005	1035	827	102
March 16, 2005	1015	841	104
April 13, 2005	1000	868	109
May 4, 2005	1120	884	110
May 16, 2005	0955	885	103
June 1, 2005	1020	890	105
June 15, 2005	0945	850	112
June 29, 2005	1000	804	102
July 13, 2005	0920	739	91.8
July 27, 2005	0850	745	90.1
August 10, 2005	0855	753	88.9
August 30, 2005	0945	733	88.7
September 7, 2005	1030	730	89.1
October 13, 2005	1030	745	93.2
October 27, 2005	1005	751	88.1
January 11, 2006	1210	792	98.5
March 1, 2006	1105	820	109
March 29, 2006	1005	833	105
April 25, 2006	1245	857	107
May 17, 2006	1055	845	107
May 31, 2006	1140	849	110
June 14, 2006	1045	852	108
June 28, 2006	0955	845	108
July 13, 2006	0940	859	109
July 26, 2006	1115	847	117
August 10, 2006	1005	844	109
August 22, 2006	1000	837	111
September 6, 2006	1020	830	108
September 20, 2006	1015	840	112
October 11, 2006	0950	854	117
October 25, 2006	0945	866	118
December 12, 2006	1115	907	124
February 7, 2007[1]	1115	822	129
March 7, 2007	1135	940	123
April 9, 2007	1045	884	116
May 8, 2007	0940	845	106
May 31, 2007	1020	754	89.2
June 13, 2007	1140	728	87.3
June 25, 2007	1000	739	85.7
July 9, 2007	0950	732	86.2
July 23, 2007	1020	732	85.6
August 7, 2007	0930	748	87.3
August 15, 2007	0955	746	88.2
August 28, 2007	1055	765	89.8
September 12, 2007	1025	776	95.5
September 24, 2007	1025	779	97.8
October 15, 2007	1005	792	98.7
October 29, 2007	1045	792	98.3
November 13, 2007	1040	806	100
December 19, 2007	1100	837	97.5
February 11, 2008	1100	866	105
February 14, 2008	1105	869	104
February 15, 2008	1025	867	102
March 10, 2008	1125	864	104
April 1, 2008	0955	861	104
April 16, 2008	1140	864	107
April 29, 2008	1035	861	104
May 13, 2008	1020	853	105
June 3, 2008	0945	812	94.5
June 18, 2008	0920	802	92.9
June 25, 2008	1155	806	92.9
July 7, 2008	1035	796	95.2
July 21, 2008	1050	804	105
July 28, 2008	0955	797	99.0
August 4, 2008	1020	802	99.2
August 18, 2008	0945	808	101
September 2, 2008	1000	808	101
September 17, 2008	1000	778	96.2
October 1, 2008	1055	781	97.5
October 15, 2008	1150	752	94.3
November 4, 2008	0950	784	94.8
December 2, 2008	0950	805	95.2
January 6, 2009	1010	842	94.7
January 20, 2009	1010	836	101
February 2, 2009	1000	837	105
February 18, 2009	1010	819	109
February 25, 2009	1030	825	111
March 3, 2009	1050	843	110
March 9, 2009	1050	841	104
March 16, 2009	1100	841	104
March 25, 2009	1020	847	106
April 8, 2009	1010	848	114
April 29, 2009	1030	842	103
May 27, 2009	1140	765	90.1
June 9, 2009	1100	768	92.1
June 23, 2009	1045	772	90.8
July 7, 2009	1100	759	92.0
July 21, 2009	1020	763	80.1
August 5, 2009[1]	1030	773	82.7
August 24, 2009	1000	778	95.3
September 2, 2009	1030	785	95.9
September 16, 2009	1030	773	93.2
October 5, 2009	1100	773	93.5
October 19, 2009	1100	781	94.3
November 23, 2009	1100	803	94.8
December 16, 2009	1140	838	91.3

[1]Data point removed from final analysis because it was an extreme outlier on a bivariate plot of actual as compared to computed concentrations.

Table 4. Chloride linear regression dataset using reservoir elevation and specific conductance as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Specific conductance, in µS/cm at 25°C	Chloride, in mg/L
May 3, 2001	1055	1,422	789	120
June 4, 2001	1030	1,422	809	126
June 22, 2001	1155	1,422	756	116
July 24, 2001	1055	1,421	776	122
August 29, 2001	1125	1,419	799	129
May 15, 2002	1115	1,419	913	158
June 19, 2002	0955	1,421	814	141
August 7, 2002	1000	1,420	863	151
September 4, 2002	1015	1,420	863	144
September 25, 2002	1010	1,420	842	145
January 23, 2003	1055	1,422	879	162
February 10, 2003	1250	1,422	891	155
March 3, 2003	1025	1,422	885	159
June 17, 2003	1045	1,422	792	144
June 20, 2003	0905	1,422	802	140
July 7, 2003	0940	1,421	806	144
July 17, 2003	1155	1,421	797	146
July 28, 2003	1150	1,421	799	157
March 10, 2004	1115	1,423	806	146
April 8, 2004	1015	1,422	801	137
May 5, 2004	1115	1,422	825	140
June 3, 2004	1000	1,421	838	147
July 15, 2004	0950	1,422	760	136
August 12, 2004	0915	1,422	738	138
August 27, 2004	1115	1,422	743	128
September 9, 2004	0935	1,422	751	128
February 2, 2005	1035	1,422	827	139
March 16, 2005	1015	1,422	841	139
April 13, 2005	1000	1,422	868	136
May 4, 2005	1120	1,422	884	142
May 16, 2005	0955	1,422	885	147
June 1, 2005	1020	1,422	890	146
June 15, 2005	0945	1,424	850	137
June 29, 2005	1000	1,423	804	127
July 13, 2005	0920	1,423	739	105
July 27, 2005	0850	1,422	745	116
August 10, 2005	0855	1,421	753	119
August 30, 2005	0945	1,422	733	111
September 7, 2005	1030	1,422	730	114
October 13, 2005	1030	1,421	745	123
October 27, 2005	1005	1,421	751	120

Table 4. Chloride linear regression dataset using reservoir elevation and specific conductance as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Specific conductance, in µS/cm at 25°C	Chloride, in mg/L
January 11, 2006	1210	1,421	792	132
March 1, 2006	1105	1,421	820	134
March 29, 2006	1005	1,422	833	146
April 25, 2006	1245	1,421	857	140
May 17, 2006	1055	1,422	845	133
May 31, 2006	1140	1,422	849	139
June 14, 2006	1045	1,421	852	137
June 28, 2006	0955	1,421	845	131
July 13, 2006	0940	1,421	859	152
July 26, 2006	1115	1,420	847	156
August 10, 2006	1005	1,420	844	152
August 22, 2006	1000	1,420	837	150
September 6, 2006	1020	1,420	830	151
September 20, 2006	1015	1,419	840	156
October 11, 2006	0950	1,419	854	160
October 25, 2006	0945	1,418	866	161
December 12, 2006	1115	1,418	907	166
February 7, 2007	1115	1,419	822	160
March 7, 2007	1135	1,419	940	166
April 9, 2007	1045	1,421	884	160
May 8, 2007	0940	1,424	845	130
May 31, 2007	1020	1,425	754	120
June 13, 2007	1140	1,424	728	120
June 25, 2007	1000	1,422	739	120
July 9, 2007	0950	1,423	732	120
July 23, 2007	1020	1,423	732	110
August 7, 2007	0930	1,423	748	120
August 15, 2007	0955	1,422	746	120
August 28, 2007	1055	1,421	765	120
September 12, 2007	1025	1,421	776	130
September 24, 2007	1025	1,421	779	130
October 15, 2007	1005	1,420	792	130
October 29, 2007	1045	1,420	792	130
November 13, 2007	1040	1,420	806	130
December 19, 2007	1100	1,420	837	140
February 11, 2008	1100	1,421	866	140
February 14, 2008	1105	1,421	869	140
February 15, 2008	1025	1,421	867	140
March 10, 2008	1125	1,422	864	140
April 1, 2008	0955	1,422	861	140
April 16, 2008	1140	1,422	864	140

Table 4. Chloride linear regression dataset using reservoir elevation and specific conductance as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Specific conductance, in µS/cm at 25°C	Chloride, in mg/L
April 29, 2008	1035	1,423	861	140
May 13, 2008	1020	1,424	853	140
June 3, 2008	0945	1,423	812	130
June 18, 2008	0920	1,423	802	120
June 25, 2008	1155	1,423	806	130
July 7, 2008	1035	1,422	796	130
July 21, 2008	1050	1,422	804	130
July 28, 2008	0955	1,422	797	130
August 4, 2008	1020	1,421	802	130
August 18, 2008	0945	1,421	808	130
September 2, 2008[2]	1000	1,421	808	79
September 17, 2008	1000	1,422	778	130
October 1, 2008	1055	1,422	781	130
October 15, 2008	1150	1,422	752	130
November 4, 2008	0950	1,422	784	130
December 2, 2008	0950	1,422	805	130
January 6, 2009	1010	1,422	842	130
January 20, 2009	1010	1,422	836	140
February 2, 2009	1000	1,422	837	140
February 18, 2009	1010	1,422	819	140
February 25, 2009	1030	1,422	825	140
March 3, 2009	1050	1,422	843	150
March 9, 2009	1050	1,422	841	140
March 16, 2009	1100	1,422	841	140
March 25, 2009	1020	1,422	847	140
April 8, 2009	1010	1,422	848	140
April 29, 2009	1030	1,424	842	140
May 27, 2009	1140	1,424	765	110
June 9, 2009	1100	1,422	768	110
June 23, 2009	1045	1,422	772	120
July 7, 2009	1100	1,422	759	120
July 21, 2009	1020	1,421	763	120
August 5, 2009	1030	1,421	773	120
August 24, 2009	1000	1,421	778	120
September 2, 2009	1030	1,421	785	130
September 16, 2009	1030	1,422	773	120
October 5, 2009	1100	1,422	773	120
October 19, 2009	1100	1,422	781	120
November 23, 2009[2]	1100	1,422	803	170
December 16, 2009	1140	1,422	838	120

[1]Reservoir elevation above National Geodetic Vertical Datum of 1929.

[2]Data point removed from final analysis because it was an extreme outlier on a bivariate plot of actual as compared to computed concentrations.

Table 5. Magnesium linear regression dataset using specific conductance as the explanatory variable for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Date	Time, in hhmm	Specific conductance, in µS/cm at 25°C	Magnesium, in mg/L
May 3, 2001	1055	789	13.4
June 4, 2001	1030	809	14.2
June 22, 2001	1155	756	12.5
July 24, 2001	1055	776	13.4
August 29, 2001	1125	799	14.1
May 15, 2002	1115	913	15.2
June 19, 2002	0955	814	13.4
August 7, 2002	1000	863	14.2
September 4, 2002	1015	863	13.8
September 25, 2002	1010	842	14.4
January 23, 2003	1055	879	14.7
February 10, 2003	1250	891	14.5
March 3, 2003	1025	885	14.8
June 17, 2003	1045	792	13.4
June 20, 2003	0905	802	13.5
July 7, 2003	0940	806	13.9
July 17, 2003	1155	797	14.1
July 28, 2003	1150	799	13.3
March 10, 2004	1115	806	14.2
April 8, 2004	1015	801	13.9
May 5, 2004	1115	825	14.6
June 3, 2004	1000	838	13.5
July 15, 2004	0950	760	12.6
August 12, 2004	0915	738	12.1
August 27, 2004	1115	743	12.3
September 9, 2004	0935	751	12.4
February 2, 2005	1035	827	14.4
March 16, 2005	1015	841	15.1
April 13, 2005	1000	868	15.3
May 4, 2005	1120	884	15.5
May 16, 2005	0955	885	15.0
June 1, 2005	1020	890	15.2
June 15, 2005	0945	850	14.9
June 29, 2005	1000	804	14.1
July 13, 2005	0920	739	12.6
July 27, 2005	0850	745	13.5
August 10, 2005	0855	753	12.7
August 30, 2005	0945	733	12.4
September 7, 2005	1030	730	13.4
October 13, 2005	1030	745	13.3
October 27, 2005	1005	751	12.7
January 11, 2006	1210	792	13.8
March 1, 2006	1105	820	14.7
March 29, 2006	1005	833	14.3
April 25, 2006	1245	857	14.3
May 17, 2006	1055	845	14.2
May 31, 2006	1140	849	14.4
June 14, 2006	1045	852	14.3
June 28, 2006	0955	845	14.1
July 13, 2006	0940	859	14.2
July 26, 2006	1115	847	14.8
August 10, 2006	1005	844	14.0
August 22, 2006	1000	837	14.1
September 6, 2006	1020	830	13.5
September 20, 2006	1015	840	13.7
October 11, 2006	0950	854	14.3
October 25, 2006	0945	866	14.2
December 12, 2006	1115	907	15.3
February 7, 2007	1115	822	15.2
March 7, 2007	1135	940	14.9
April 9, 2007	1045	884	13.9
May 8, 2007	0940	845	13.2
May 31, 2007	1020	754	11.8
June 13, 2007	1140	728	12.0
June 25, 2007	1000	739	11.8
July 9, 2007	0950	732	11.9
July 23, 2007	1020	732	12.0
August 7, 2007	0930	748	11.8
August 15, 2007	0955	746	11.9
August 28, 2007	1055	765	12.0
September 12, 2007	1025	776	12.5
September 24, 2007	1025	779	12.7
October 15, 2007	1005	792	13.4
October 29, 2007	1045	792	13.5
November 13, 2007	1040	806	13.3
December 19, 2007	1100	837	13.4
February 11, 2008	1100	866	13.6
February 14, 2008	1105	869	13.3
February 15, 2008	1025	867	13.1
March 10, 2008	1125	864	13.3
April 1, 2008	0955	861	14.1
April 16, 2008	1140	864	14.0
April 29, 2008	1035	861	13.8
May 13, 2008	1020	853	14.3
June 3, 2008	0945	812	13.1
June 18, 2008	0920	802	13.0
June 25, 2008	1155	806	13.0
July 7, 2008	1035	796	13.5
July 21, 2008	1050	804	14.3
July 28, 2008	0955	797	13.5
August 4, 2008	1020	802	13.5
August 18, 2008	0945	808	13.7
September 2, 2008	1000	808	13.4
September 17, 2008	1000	778	12.9
October 1, 2008	1055	781	13.1
October 15, 2008	1150	752	12.6
November 4, 2008	0950	784	12.8
December 2, 2008	0950	805	13.2
January 6, 2009	1010	842	13.2
January 20, 2009	1010	836	13.9
February 2, 2009	1000	837	14.3
February 18, 2009	1010	819	14.9
February 25, 2009	1030	825	15.1
March 3, 2009	1050	843	14.9
March 9, 2009	1050	841	14.2
March 16, 2009	1100	841	14.2
March 25, 2009	1020	847	14.4
April 8, 2009	1010	848	15.4
April 29, 2009	1030	842	14.6
May 27, 2009	1140	765	13.6
June 9, 2009	1100	768	13.5
June 23, 2009	1045	772	13.3
July 7, 2009	1100	759	13.3
July 21, 2009	1020	763	11.4
August 5, 2009	1030	773	11.7
August 24, 2009	1000	778	13.7
September 2, 2009	1030	785	14.0
September 16, 2009	1030	773	13.6
October 5, 2009	1100	773	13.1
October 19, 2009	1100	781	13.1
November 23, 2009	1100	803	13.3
December 16, 2009	1140	838	12.9

Table 6. Total suspended solids linear regression dataset using turbidity and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Fluorescence at a wavelength range of 650 to 700 nanometers (YSI model 6025 sensor)	Total suspended solids, in milligrams per liter
May 3, 2001	1055	38	8.1	9
June 4, 2001	1030	20	6.5	6
June 22, 2001	1155	22	13	<4
July 24, 2001	1055	18	6.8	4
August 29, 2001	1125	13	4.8	4
May 15, 2002	1115	27	6.0	12
June 19, 2002	0955	36	18	7
August 7, 2002	1000	13	5.2	5
September 4, 2002	1015	12	7.3	9
September 25, 2002	1010	20	8.0	8
January 23, 2003	1055	3.9	24	<4
February 10, 2003	1250	1.6	4.7	4
March 3, 2003	1025	3.3	25	5
June 17, 2003	1045	14	8.4	12
June 20, 2003	0905	3.5	5.3	<4
July 7, 2003	0940	24	23	11
July 17, 2003	1155	27	10	11
July 28, 2003	1150	29	8.3	12
March 10, 2004	1115	22	22	12
April 8, 2004	1015	31	14	14
May 5, 2004	1115	21	2.0	<4
June 3, 2004	1000	21	6.5	11
July 15, 2004	0950	7.0	2.9	<4
August 12, 2004	0915	23	9.4	<4
August 27, 2004	1115	32	3.3	13
September 9, 2004	0935	26	3.1	12
February 2, 2005	1035	2.7	22	5
March 16, 2005	1015	10	25	17
April 13, 2005	1000	18	9.3	8
May 4, 2005	1120	10	4.1	9
May 16, 2005	0955	8.1	6.4	5
June 1, 2005	1020	8.1	6.4	5
June 15, 2005	0945	14	12	7
June 29, 2005	1000	25	7.1	10
July 13, 2005	0920	15	12	12
July 27, 2005	0850	20	8.0	12
August 10, 2005	0855	12	5.4	8
August 30, 2005	0945	22	12	12
September 7, 2005	1030	12	7.4	12
October 13, 2005	1030	18	10	<4
October 27, 2005	1005	20	9.2	18
January 11, 2006	1210	8.9	20	<4
March 1, 2006	1105	3.2	19	7
March 29, 2006	1005	10	23	7

Table 6. Total suspended solids linear regression dataset using turbidity and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Fluorescence at a wavelength range of 650 to 700 nanometers (YSI model 6025 sensor)	Total suspended solids, in milligrams per liter
April 25, 2006	1245	34	8.5	23
May 17, 2006	1055	20	12	12
May 31, 2006	1140	10	8.9	10
June 14, 2006	1045	25	6.6	8
June 28, 2006	0955	13	6.9	13
July 13, 2006	0940	15	5.5	8
July 26, 2006	1115	14	11	8
August 10, 2006	1005	17	10	12
August 22, 2006	1000	21	6.6	9
September 6, 2006	1020	10	15	8
September 20, 2006	1015	22	10	23
October 11, 2006	0950	29	7.3	12
October 25, 2006	0945	35	6.8	8
December 12, 2006	1115	9.2	10	11
February 7, 2007	1115	14	6.9	<4
March 7, 2007	1135	14	34	<4
April 9, 2007	1045	23	17	11
May 8, 2007	0940	11	3.1	14
May 31, 2007	1020	27	4.8	14
June 13, 2007	1140	35	5.0	<4
June 25, 2007	1000	25	5.1	<4
July 9, 2007	0950	21	7.7	17
July 23, 2007	1020	21	11	10
August 7, 2007	0930	27	10	7
August 15, 2007	0955	23	8.5	8
August 28, 2007	1055	28	7.0	12
September 12, 2007	1025	13	8.4	8
September 24, 2007	1025	17	9.0	8
October 15, 2007	1005	29	7.1	17
October 29, 2007	1045	26	7.1	10
November 13, 2007	1040	25	11	14
December 19, 2007	1100	8.1	5.8	<4
February 11, 2008	1100	2.7	12	<4
February 14, 2008	1105	2.3	13	4
February 15, 2008	1025	6.4	14	7
March 10, 2008	1125	9.0	26	6
April 1, 2008	0955	19	30	18
April 16, 2008	1140	28	11	38
April 29, 2008	1035	42	8.1	16
May 13, 2008	1020	30	5.7	10
June 3, 2008	0945	22	5.9	7
June 18, 2008	0920	31	6.8	12
June 25, 2008	1155	17	11	18
July 7, 2008	1035	18	5.3	10

Table 6. Total suspended solids linear regression dataset using turbidity and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Fluorescence at a wavelength range of 650 to 700 nanometers (YSI model 6025 sensor)	Total suspended solids, in milligrams per liter
July 21, 2008	1050	26	12	11
July 28, 2008	0955	18	24	9
August 4, 2008	1020	18	6.2	7
August 18, 2008	0945	15	3.7	4
September 2, 2008	1000	16	5.1	8
September 17, 2008	1000	20	4.9	10
October 1, 2008	1055	16	5.2	8
November 4, 2008	0950	27	8.0	10
December 2, 2008	0950	18	7.1	11
January 6, 2009	1010	7.3	23	6
January 20, 2009	1010	8.5	31	10
February 2, 2009	1000	6.9	49	12
February 18, 2009	1010	15	23	17
February 25, 2009	1030	10	24	10
March 3, 2009	1050	10	24	8
March 9, 2009	1050	10	22	9
March 16, 2009	1100	9.3	23	10
March 25, 2009	1020	25	24	19
April 8, 2009	1010	24	16	16
April 29, 2009	1030	34	4.9	<4
May 27, 2009	1140	36	7.6	16
June 9, 2009	1100	25	15	6
June 23, 2009	1045	17	16	8
July 7, 2009	1100	12	9.1	5
July 21, 2009	1020	18	3.6	6
August 5, 2009	1030	14	7.7	6
August 24, 2009	1000	16	6.9	8
September 2, 2009	1030	20	6.2	7
September 16, 2009	1030	19	4.3	6
October 5, 2009	1100	24	6.2	23
October 19, 2009	1100	22	6.2	8
November 23, 2009	1100	17	6.5	6
December 16, 2009	1140	16	4.5	<4

Table 7. Suspended-sediment concentration linear regression dataset using turbidity as the explanatory variable for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Suspended-sediment concentration, in milligrams per liter
May 3, 2001	1055	38	25
June 4, 2001	1030	20	16
June 22, 2001	1155	22	21
July 24, 2001	1055	18	16
August 29, 2001	1125	13	9
May 15, 2002	1115	27	21
June 19, 2002	0955	36	22
July 11, 2002	1005	12	7
August 7, 2002	1000	13	13
September 4, 2002	1015	12	11
January 23, 2003	1055	3.9	5
February 10, 2003	1250	1.6	4
June 17, 2003	1045	14	8
June 20, 2003	0905	3.5	3
July 7, 2003	0940	24	18
July 17, 2003	1155	27	12
July 28, 2003	1150	29	14
March 10, 2004	1115	22	15
April 8, 2004	1015	31	33
May 5, 2004	1115	21	17
June 3, 2004	1000	21	15
July 15, 2004	0950	7.0	9
August 12, 2004	0915	23	15
August 27, 2004	1115	32	20
September 9, 2004	0935	26	20
February 2, 2005	1035	2.7	5
March 16, 2005	1015	10	11
April 13, 2005	1000	18	15
May 4, 2005	1120	10	15
May 16, 2005	0955	8.1	10
June 1, 2005	1020	8.1	7
June 15, 2005	0945	14	13
June 29, 2005	1000	25	20
July 13, 2005	0920	15	5
July 27, 2005	0850	20	2
August 10, 2005	0855	12	14
August 30, 2005	0945	22	11
September 7, 2005	1030	12	12
October 13, 2005	1030	18	12
October 27, 2005	1005	20	21
January 11, 2006	1210	8.9	7

Table 7. Suspended-sediment concentration linear regression dataset using turbidity as the explanatory variable for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Suspended-sediment concentration, in milligrams per liter
March 1, 2006	1105	3.2	4
March 29, 2006	1005	10	7
April 25, 2006	1245	34	34
May 17, 2006	1055	20	15
May 31, 2006	1140	10	7
June 14, 2006	1045	25	12
June 28, 2006	0955	13	9
July 13, 2006	0940	15	12
July 26, 2006	1115	14	9
August 10, 2006	1005	17	14
August 22, 2006	1000	21	13
September 6, 2006	1020	10	10
September 20, 2006	1015	22	26
October 11, 2006	0950	29	21
October 25, 2006	0945	35	22
December 12, 2006	1115	9.2	9
February 7, 2007	1115	14	2
March 7, 2007	1135	14	12
April 9, 2007	1045	23	16
May 8, 2007	0940	11	8
May 31, 2007	1020	27	11
June 13, 2007	1140	35	25
June 25, 2007	1000	25	8
July 9, 2007	0950	21	20
July 23, 2007	1020	21	14
August 7, 2007	0930	27	16
August 15, 2007	0955	23	14
August 28, 2007	1055	28	24
September 12, 2007	1025	13	12
September 24, 2007	1025	17	15
October 15, 2007	1005	29	34
October 29, 2007	1045	26	14
November 13, 2007	1040	25	20
December 19, 2007	1100	8.1	6
February 11, 2008	1100	2.7	4
February 14, 2008	1105	2.3	3
March 10, 2008	1125	9.0	7
April 1, 2008	0955	19	15
April 16, 2008	1140	28	23
April 29, 2008	1035	42	36
May 13, 2008	1020	30	27

Table 7. Suspended-sediment concentration linear regression dataset using turbidity as the explanatory variable for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Suspended-sediment concentration, in milligrams per liter
June 3, 2008	0945	22	19
June 18, 2008	0920	31	26
July 7, 2008	1035	18	18
July 21, 2008	1050	26	20
July 28, 2008	0955	18	16
August 4, 2008	1020	18	14
August 18, 2008	0945	15	14
September 2, 2008	1000	16	12
September 17, 2008	1000	20	16
October 1, 2008	1055	16	15
October 15, 2008	1150	48	26
November 4, 2008	0950	27	18
December 2, 2008	0950	18	16
January 6, 2009	1010	7.3	8
January 20, 2009	1010	8.5	10
February 2, 2009	1000	6.9	12
February 18, 2009	1010	15	18
February 25, 2009	1030	10	11
March 3, 2009	1050	10	10
March 9, 2009	1050	10	9
March 16, 2009	1100	9.3	11
March 25, 2009	1020	25	22
April 8, 2009	1010	24	21
April 29, 2009	1030	34	17
May 27, 2009	1140	36	35
June 9, 2009	1100	25	18
June 23, 2009	1045	17	18
July 7, 2009	1100	12	10
July 21, 2009	1020	18	17
August 5, 2009	1030	14	16
August 24, 2009	1000	16	16
September 2, 2009	1030	20	13
September 16, 2009	1030	19	16
October 5, 2009	1100	24	20
October 19, 2009	1100	22	14
November 23, 2009	1100	17	13
December 16, 2009	1140	16	11

Table 8. Total Kjeldahl nitrogen linear regression dataset using turbidity, dissolved oxygen, and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Dissolved oxygen, in milligrams per liter	Water temperature, in degrees Celsius	Total Kjeldahl nitrogen, in milligrams per liter
May 3, 2001	1055	38	7.8	18.4	0.63
June 4, 2001	1030	20	7.9	19.2	0.58
June 22, 2001	1155	22	10.7	24.1	0.61
July 24, 2001	1055	18	7.0	27.7	0.63
August 29, 2001	1125	13	7.3	26.2	0.46
May 15, 2002	1115	27	9.6	17.9	0.81
June 19, 2002	0955	36	7.5	22.6	0.67
July 11, 2002	1005	12	9.7	26.9	1.20
August 7, 2002	1000	13	6.1	27.2	0.59
September 4, 2002	1015	12	7.0	25.9	0.56
September 25, 2002	1010	20	6.3	20.8	0.65
January 23, 2003	1055	3.9	15.2	0.3	0.58
February 10, 2003	1250	1.6	14.4	1.2	0.56
March 3, 2003	1025	3.3	16.1	1.8	0.77
June 17, 2003	1045	14	12.2	25.0	1.40
June 20, 2003	0905	3.5	6.2	22.5	0.62
July 7, 2003	0940	24	8.0	25.7	0.79
July 17, 2003	1155	27	8.4	27.5	1.30
July 28, 2003	1150	29	11.2	28.6	1.20
March 10, 2004	1115	22	12.4	6.4	0.65
April 8, 2004	1015	31	9.3	14.7	0.71
May 5, 2004	1115	21	9.4	16.1	0.65
June 3, 2004	1000	21	7.7	21.7	0.63
July 15, 2004	0950	7.0	6.2	26.0	0.72
August 12, 2004	0915	23	7.3	24.9	0.69
August 27, 2004	1115	32	6.8	24.4	0.80
September 9, 2004	0935	26	4.3	23.3	0.76
February 2, 2005	1035	2.7	16.4	1.8	0.58
March 16, 2005	1015	10	10.8	8.5	0.77
April 13, 2005	1000	18	10.1	13.4	0.69
May 4, 2005	1120	10	10.3	14.7	0.73
May 16, 2005	0955	8.1	9.5	18.4	0.71
June 1, 2005	1020	8.1	7.2	22.1	0.74
June 15, 2005	0945	14	7.2	23.5	0.79
June 29, 2005	1000	25	6.1	25.2	0.64
July 13, 2005	0920	15	9.5	26.8	0.92
July 27, 2005	0850	20	6.4	25.7	0.81
August 30, 2005	0945	22	6.9	26.6	0.81
September 7, 2005	1030	12	4.6	25.1	0.70
October 13, 2005	1030	18	9.4	18.1	0.75
October 27, 2005	1005	20	8.5	14.4	0.74

Table 8. Total Kjeldahl nitrogen linear regression dataset using turbidity, dissolved oxygen, and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Dissolved oxygen, in milligrams per liter	Water temperature, in degrees Celsius	Total Kjeldahl nitrogen, in milligrams per liter
January 11, 2006	1210	8.9	13.8	4.2	0.73
March 1, 2006	1105	3.2	14.9	3.7	0.73
March 29, 2006	1005	10	12.7	7.6	0.75
April 25, 2006	1245	34	8.5	17.0	0.89
May 17, 2006	1055	20	10.2	18.1	0.74
May 31, 2006	1140	10	9.0	23.6	0.84
June 14, 2006	1045	25	6.5	24.3	0.77
June 28, 2006	0955	13	8.0	25.0	0.78
July 13, 2006	0940	15	6.8	25.3	0.86
July 26, 2006	1115	14	7.2	26.7	0.76
August 10, 2006	1005	17	8.6	27.6	1.20
August 22, 2006	1000	21	4.3	26.8	0.90
September 6, 2006	1020	10	9.2	24.2	0.94
September 20, 2006	1015	22	7.5	20.8	0.91
October 11, 2006	0950	29	8.0	17.1	0.82
October 25, 2006	0945	35	9.0	12.7	0.76
December 12, 2006	1115	9.2	13.2	3.8	0.94
February 7, 2007	1115	14	13.6	5.6	0.71
March 7, 2007	1135	14	12.3	6.7	0.68
April 9, 2007	1045	23	10.0	11.4	0.81
May 8, 2007	0940	11	7.2	18.2	0.75
May 31, 2007	1020	27	6.8	21.3	0.91
June 13, 2007	1140	35	6.5	22.6	0.63
June 25, 2007	1000	25	6.3	24.4	0.60
July 9, 2007	950	21	6.6	25.2	0.74
July 23, 2007	1020	21	6.2	26.1	0.73
August 7, 2007	0930	27	5.7	27.0	0.72
August 15, 2007	0955	23	6.9	27.9	0.70
August 28, 2007	1055	28	6.5	26.6	0.70
September 12, 2007	1025	13	7.7	23.7	0.67
September 24, 2007	1025	17	7.5	22.1	0.72
October 15, 2007	1005	29	8.0	18.9	0.68
October 29, 2007	1045	26	8.9	13.9	0.67
November 13, 2007	1040	25	9.7	11.8	0.68
December 19, 2007	1100	8.1	12.6	1.8	0.60
February 11, 2008	1100	2.7	13.6	1.8	0.67
February 14, 2008	1105	2.3	13.6	2.0	0.71
February 15, 2008	1025	6.4	13.2	1.8	0.67
March 10, 2008	1125	9.0	13.3	4.3	0.77
April 1, 2008	0955	19	11.2	9.1	0.77
April 16, 2008	1140	28	10.5	10.1	0.85

Table 8. Total Kjeldahl nitrogen linear regression dataset using turbidity, dissolved oxygen, and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Dissolved oxygen, in milligrams per liter	Water temperature, in degrees Celsius	Total Kjeldahl nitrogen, in milligrams per liter
April 29, 2008	1035	42	8.8	13.8	0.97
May 13, 2008	1020	30	8.8	16.0	1.00
June 3, 2008	0945	22	6.8	22.7	0.68
June 18, 2008	0920	31	6.0	23.5	0.84
June 25, 2008	1155	17	6.4	24.7	0.66
July 7, 2008	1035	18	6.8	25.3	0.75
July 21, 2008	1050	26	7.5	26.2	0.83
July 28, 2008	0955	18	6.7	26.5	0.72
August 4, 2008	1020	18	6.3	26.8	0.66
August 18, 2008	0945	15	5.4	24.6	0.60
September 2, 2008	1000	16	7.5	25.1	0.72
September 17, 2008	1000	20	8.0	20.2	0.64
October 1, 2008	1055	16	8.4	21.6	0.65
October 15, 2008	1150	48	8.4	16.8	0.65
November 4, 2008	0950	27	9.4	12.7	0.61
December 2, 2008	0950	18	11.6	5.3	0.54
January 6, 2009	1010	7.3	13.2	0.8	0.34
January 20, 2009	1010	8.5	15.2	0.9	0.80
February 2, 2009	1000	6.9	15.2	0.7	0.74
February 18, 2009	1010	15	11.9	5.2	0.68
February 25, 2009	1030	10	12.3	5.4	0.68
March 3, 2009	1050	10	12.3	4.4	0.63
March 9, 2009	1050	10	11.9	6.4	0.62
March 16, 2009	1100	9.3	11.6	6.3	0.82
March 25, 2009	1020	25	10.2	11.0	0.68
April 8, 2009	1010	24	10.9	7.6	0.75
April 29, 2009	1030	34	8.1	14.9	0.84
May 27, 2009	1140	36	8.1	22.1	0.79
June 9, 2009	1100	25	6.5	22.0	0.67
June 23, 2009	1045	17	7.1	25.0	0.70
July 7, 2009	1100	12	5.6	25.8	0.74
July 21, 2009	1020	18	5.3	25.4	0.73
August 5, 2009	1030	14	5.9	25.1	0.59
August 24, 2009	1000	16	6.1	24.3	0.63
September 2, 2009	1030	20	6.6	23.2	0.64
September 16, 2009	1030	19	6.5	22.0	0.49
October 5, 2009	1100	24	8.0	17.3	0.55
October 19, 2009	1100	22	9.9	12.2	0.58
November 23, 2009	1100	17	9.9	9.8	0.55
December 16, 2009	1140	16	12.6	0.9	0.56

Table 9. Nitrate plus nitrite linear regression dataset using pH and specific conductance as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; <, less than]

Date	Time, in hhmm	pH, in standard units	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	Nitrate plus nitrite, in milligrams per liter
May 3, 2001	1055	8.5	789	0.29
June 4, 2001	1030	8.4	809	0.36
June 22, 2001	1155	8.7	756	0.17
July 24, 2001	1055	8.3	776	0.06
August 29, 2001	1125	8.2	799	0.05
May 15, 2002	1115	8.4	913	0.10
June 19, 2002	0955	8.3	814	0.11
August 7, 2002	1000	8.4	863	0.03
September 4, 2002	1015	8.4	863	0.07
January 21, 2003	1210	8.9	871	0.02
January 23, 2003	1055	8.8	879	<0.02
February 10, 2003	1250	8.0	891	<0.02
March 3, 2003	1025	8.6	885	<0.02
June 17, 2003	1045	8.9	792	<0.02
June 20, 2003	0905	8.2	802	0.17
July 7, 2003	0940	8.6	806	0.03
July 17, 2003	1155	8.7	797	0.02
July 28, 2003	1150	8.8	799	<0.02
March 10, 2004	1115	8.3	806	0.32
April 8, 2004	1015	8.2	801	0.75
May 5, 2004	1115	8.0	825	0.39
June 3, 2004	1000	8.2	838	0.38
July 15, 2004	0950	8.3	760	0.04
August 12, 2004	0915	8.2	738	0.97
August 27, 2004	1115	8.4	743	0.02
September 9, 2004	0935	7.7	751	0.06
February 2, 2005	1035	8.9	827	0.04
March 16, 2005	1015	8.7	841	<0.02
April 13, 2005	1000	8.4	868	0.03
May 4, 2005	1120	8.5	884	0.06
May 16, 2005	0955	8.5	885	0.05
June 1, 2005	1020	8.3	890	0.03
June 15, 2005	0945	8.1	850	0.05
June 29, 2005	1000	8.2	804	0.18
July 13, 2005	0920	8.8	739	0.57
July 27, 2005	0850	8.2	745	0.07
August 10, 2005	0855	8.2	753	0.16
August 30, 2005	0945	8.3	733	0.12
September 7, 2005	1030	8.1	730	0.13
October 13, 2005	1030	8.7	745	0.04
October 27, 2005	1005	8.5	751	0.04

Table 9. Nitrate plus nitrite linear regression dataset using pH and specific conductance as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; <, less than]

Date	Time, in hhmm	pH, in standard units	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	Nitrate plus nitrite, in milligrams per liter
January 11, 2006	1210	8.6	792	0.17
March 1, 2006	1105	8.6	820	0.04
March 29, 2006	1005	8.5	833	0.10
April 25, 2006	1245	8.3	857	0.15
May 17, 2006	1055	8.4	845	0.22
May 31, 2006	1140	8.3	849	0.08
June 14, 2006	1045	8.0	852	0.20
June 28, 2006	0955	8.7	845	0.39
July 13, 2006	0940	8.3	859	0.04
July 26, 2006	1115	8.3	847	0.03
August 10, 2006	1005	8.5	844	0.17
August 22, 2006	1000	8.2	837	0.08
September 6, 2006	1020	8.4	830	0.20
September 20, 2006	1015	8.3	840	0.06
October 11, 2006	0950	8.4	854	0.18
October 25, 2006	0945	8.3	866	0.03
December 12, 2006	1115	8.5	907	0.15
February 7, 2007	1115	8.5	822	0.20
March 7, 2007	1135	8.6	940	0.18
April 9, 2007	1045	8.6	884	0.18
May 8, 2007	0940	8.4	845	0.11
May 31, 2007	1020	8.0	754	0.25
June 13, 2007	1140	8.0	728	0.54
June 25, 2007	1000	8.2	739	0.47
July 9, 2007	0950	8.3	732	0.37
July 23, 2007	1020	8.4	732	0.24
August 7, 2007	0930	8.4	748	0.07
August 15, 2007	0955	8.5	746	0.07
August 28, 2007	1055	8.2	765	0.17
September 12, 2007	1025	8.5	776	0.14
September 24, 2007	1025	8.4	779	0.12
October 15, 2007	1005	8.4	792	0.12
October 29, 2007	1045	8.4	792	0.21
November 13, 2007	1040	8.6	806	0.15
December 19, 2007	1100	8.5	837	0.17
February 11, 2008	1100	8.6	866	0.19
February 14, 2008	1105	8.6	869	0.20
February 15, 2008	1025	8.6	867	0.19
March 10, 2008	1125	8.6	864	0.17
April 1, 2008	0955	8.6	861	0.06
April 16, 2008	1140	8.3	864	<0.04

Table 9. Nitrate plus nitrite linear regression dataset using pH and specific conductance as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; <, less than]

Date	Time, in hhmm	pH, in standard units	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	Nitrate plus nitrite, in milligrams per liter
April 29, 2008	1035	8.1	861	0.10
May 13, 2008	1020	8.2	853	0.18
June 3, 2008	0945	8.2	812	0.54
June 18, 2008	0920	8.2	802	0.54
June 25, 2008	1155	8.3	806	0.53
July 7, 2008	1035	8.4	796	0.24
July 21, 2008	1050	8.4	804	0.17
July 28, 2008	0955	8.3	797	0.13
August 4, 2008	1020	8.4	802	0.11
August 18, 2008	0945	8.2	808	0.24
September 2, 2008	1000	8.5	808	0.06
September 17, 2008	1000	8.4	778	0.21
October 1, 2008	1055	8.4	781	0.20
October 15, 2008	1150	8.3	752	0.25
November 4, 2008	0950	8.3	784	0.42
December 2, 2008	0950	8.7	805	0.48
January 6, 2009	1010	8.2	842	0.47
January 20, 2009	1010	8.6	836	0.22
February 2, 2009	1000	8.6	837	0.09
February 18, 2009	1010	8.7	819	0.07
February 25, 2009	1030	8.8	825	0.07
March 3, 2009	1050	8.8	843	0.06
March 9, 2009	1050	8.7	841	0.12
March 16, 2009	1100	8.6	841	<0.02
March 25, 2009	1020	8.6	847	<0.02
April 8, 2009	1010	8.6	848	0.02
April 29, 2009	1030	8.1	842	0.07
May 27, 2009	1140	8.3	765	0.36
June 9, 2009	1100	8.1	768	0.49
June 23, 2009	1045	8.4	772	0.40
July 7, 2009	1100	8.6	759	0.04
July 21, 2009	1020	8.5	763	0.07
August 5, 2009	1030	8.4	773	0.18
August 24, 2009	1000	8.6	778	0.22
September 2, 2009	1030	8.3	785	0.15
September 16, 2009	1030	8.3	773	0.28
October 5, 2009	1100	8.5	773	0.37
October 19, 2009	1100	8.4	781	0.42
November 23, 2009	1100	8.5	803	0.51
December 16, 2009	1140	8.6	838	0.58

Table 10. Total phosphorus linear regression dataset using seasonal data and turbidity as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Total phosphorus, in milligrams per liter
May 3, 2001	1055	0.8543	-0.5197	38	0.06
June 4, 2001	1030	0.4559	-0.8900	20	0.08
June 22, 2001	1155	0.1628	-0.9867	22	0.08
July 24, 2001	1055	-0.3777	-0.9259	18	0.09
August 29, 2001	1125	-0.8453	-0.5344	13	0.09
May 15, 2002	1115	0.7296	-0.6839	27	0.11
June 19, 2002[1]	0955	0.2135	-0.9769	36	0.15
August 7, 2002	1000	-0.5878	-0.8090	13	0.11
September 4, 2002	1015	-0.8958	-0.4444	12	0.11
September 25, 2002	1010	-0.9951	-0.0988	20	0.07
January 21, 2003	1210	0.3537	0.9354	6.5	0.04
January 23, 2003	1055	0.3857	0.9226	3.9	0.04
February 10, 2003	1250	0.6486	0.7611	1.6	<0.03
March 3, 2003	1025	0.8759	0.4825	3.3	0.05
June 17, 2003[1]	1045	0.2470	-0.9690	14	0.08
June 20, 2003	0905	0.1967	-0.9805	3.5	0.05
July 7, 2003	0940	-0.0945	-0.9955	24	0.13
July 17, 2003	1155	-0.2637	-0.9646	27	0.13
July 28, 2003	1150	-0.4405	-0.8977	29	0.13
March 10, 2004	1115	0.9338	0.3577	22	0.08
April 8, 2004	1015	0.9911	-0.1330	31	0.08
May 5, 2004	1115	0.8264	-0.5632	21	0.11
June 3, 2004	1000	0.4559	-0.8900	21	0.12
July 15, 2004	0950	-0.2470	-0.9690	7.0	0.05
August 12, 2004	0915	-0.6681	-0.7441	23	0.08
August 27, 2004	1115	-0.8359	-0.5488	32	0.14
September 9, 2004	0935	-0.9369	-0.3496	26	0.11
February 2, 2005	1035	0.5380	0.8429	2.7	0.03
March 16, 2005	1015	0.9611	0.2761	10	0.05
April 13, 2005	1000	0.9796	-0.2009	18	0.09
May 4, 2005	1120	0.8452	-0.5344	10	0.11
May 16, 2005	0955	0.7177	-0.6964	8.1	0.06
June 1, 2005	1020	0.5012	-0.8653	8.1	0.08
June 15, 2005[1]	0945	0.2802	-0.9599	14	0.04
June 29, 2005	1000	0.0430	-0.9991	25	0.17
July 13, 2005[1]	0920	-0.1967	-0.9805	15	0.10
July 27, 2005	0850	-0.4250	-0.9052	20	0.10
August 10, 2005[1]	0855	-0.6288	-0.7776	12	0.03
August 30, 2005[1]	0945	-0.8543	-0.5197	22	0.11
September 7, 2005[1]	1030	-0.9176	-0.3975	12	0.04
October 13, 2005	1030	-0.9778	0.2093	18	0.05
October 27, 2005	1005	-0.8996	0.4367	20	0.07

Table 10. Total phosphorus linear regression dataset using seasonal data and turbidity as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Total phosphorus, in milligrams per liter
January 11, 2006	1210	0.1882	0.9821	8.9	<0.03
March 1, 2006	1105	0.8588	0.5124	3.2	<0.03
March 29, 2006	1005	0.9984	0.0559	10	0.07
April 25, 2006	1245	0.9176	-0.3975	34	0.09
May 17, 2006	1055	0.7056	-0.7086	20	0.08
May 31, 2006	1140	0.5161	-0.8566	10	0.07
June 14, 2006[1]	1045	0.2967	-0.9550	25	0.17
June 28, 2006	0955	0.0602	-0.9982	13	0.07
July 13, 2006[1]	0940	-0.1967	-0.9805	15	0.09
July 26, 2006	1115	-0.4094	-0.9124	14	0.08
August 10, 2006	1005	-0.6288	-0.7776	17	0.08
August 22, 2006	1000	-0.7749	-0.6321	21	0.12
September 6, 2006	1020	-0.9106	-0.4133	10	0.11
September 20, 2006[1]	1015	-0.9829	-0.1840	22	0.09
October 11, 2006	0950	-0.9845	0.1755	29	0.13
October 25, 2006	0945	-0.9141	0.4054	35	0.09
December 12, 2006	1115	-0.3213	0.9470	9.2	0.09
February 7, 2007	1115	0.6085	0.7936	14	0.06
March 7, 2007[1]	1135	0.9070	0.4211	14	0.11
April 9, 2007	1045	0.9911	-0.1330	23	0.12
May 8, 2007[1]	0940	0.8065	-0.5913	11	0.09
May 31, 2007	1020	0.5161	-0.8566	27	0.17
June 13, 2007	1140	0.3131	-0.9497	35	0.15
June 25, 2007	1000	0.1117	-0.9937	25	0.23
July 9, 2007	0950	-0.1288	-0.9917	21	0.22
July 23, 2007	1020	-0.3617	-0.9323	21	0.17
August 7, 2007	0930	-0.5878	-0.8090	27	0.19
August 15, 2007	0955	-0.6933	-0.7207	23	0.12
August 28, 2007	1055	-0.8359	-0.5488	28	0.12
September 12, 2007	1025	-0.9484	-0.3172	13	0.11
September 24, 2007	1025	-0.9933	-0.1159	17	0.11
October 15, 2007	1005	-0.9701	0.2429	29	0.10
October 29, 2007	1045	-0.8841	0.4674	26	0.10
November 13, 2007	1040	-0.7354	0.6776	25	0.07
December 19, 2007	1100	-0.2051	0.9787	8.1	0.07
February 11, 2008	1100	0.6616	0.7498	2.7	<0.03
February 14, 2008	1105	0.6995	0.7147	2.3	<0.03
February 15, 2008	1025	0.7117	0.7025	6.4	<0.03
March 10, 2008	1125	0.9338	0.3577	9.0	0.06
April 1, 2008	0955	0.9999	-0.0129	19	0.06
April 16, 2008	1140	0.9635	-0.2678	28	0.08
April 29, 2008	1035	0.8800	-0.4750	42	0.08

Table 10. Total phosphorus linear regression dataset using seasonal data and turbidity as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Total phosphorus, in milligrams per liter
May 13, 2008	1020	0.7412	-0.6713	30	0.09
June 3, 2008	0945	0.4559	-0.8900	22	0.09
June 18, 2008	0920	0.2135	-0.9769	31	0.08
June 25, 2008[1]	1155	0.0945	-0.9955	17	0.07
July 7, 2008	1035	-0.1117	-0.9937	18	0.12
July 21, 2008	1050	-0.3456	-0.9384	26	0.10
July 28, 2008	955	-0.4559	-0.8900	18	0.09
August 4, 2008	1020	-0.5596	-0.8288	18	0.09
August 18, 2008	0945	-0.7412	-0.6713	15	0.11
September 2, 2008	1000	-0.8881	-0.4597	16	0.09
September 17, 2008	1000	-0.9760	-0.2177	20	0.11
October 1, 2008	1055	-0.9998	0.0215	16	0.06
October 15, 2008	1150	-0.9657	0.2595	48	0.10
November 4, 2008	0950	-0.8215	0.5703	27	0.09
December 2, 2008	0950	-0.4635	0.8861	18	0.09
January 6, 2009	1010	0.1031	0.9947	7.3	0.06
January 20, 2009	1010	0.3375	0.9413	8.5	0.04
February 2, 2009[1]	1000	0.5380	0.8429	6.9	<0.03
February 18, 2009	1010	0.7470	0.6649	15	0.04
February 25, 2009	1030	0.8215	0.5702	10	0.04
March 3, 2009	1050	0.8759	0.4825	10	0.05
March 9, 2009	1050	0.9210	0.3896	10	0.04
March 16, 2009	1100	0.9611	0.2761	9.3	0.03
March 25, 2009	1020	0.9922	0.1245	25	0.07
April 8, 2009	1010	0.9933	-0.1159	24	0.09
April 29, 2009	1030	0.8881	-0.4597	34	0.08
May 27, 2009	1140	0.5738	-0.8190	36	0.13
June 9, 2009	1100	0.3777	-0.9259	25	0.13
June 23, 2009	1045	0.1458	-0.9893	17	0.16
July 7, 2009	1100	-0.0945	-0.9955	12	0.09
July 21, 2009	1020	-0.3294	-0.9442	18	0.11
August 5, 2009	1030	-0.5596	-0.8288	14	0.10
August 24, 2009	1000	-0.7962	-0.6050	16	0.10
September 2, 2009	1030	-0.8800	-0.4749	20	0.09
September 16, 2009	1030	-0.9679	-0.2512	19	0.09
October 5, 2009	1100	-0.9973	0.0731	24	0.07
October 19, 2009	1100	-0.9511	0.3090	22	0.09
November 23, 2009	1100	-0.6085	0.7936	17	0.09
December 16, 2009	1140	-0.2553	0.9669	16	0.10

[1]Data point removed from final analysis because of laboratory issues with phosphorus analysis. The filtered orthophosphate value was larger than the dissolved phosphorus value.

Table 11. Orthophosphate linear regression dataset using turbidity, water temperature, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units	Water temperature, in degrees Celsius	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Orthophosphate, in milligrams per liter
May 3, 2001	1055	38	18.4	8.1	0.04
June 4, 2001	1030	20	19.2	6.5	0.05
June 22, 2001	1155	22	24.1	12.5	0.06
July 24, 2001	1055	18	27.7	6.8	0.05
August 29, 2001	1125	13	26.2	4.8	0.03
May 15, 2002	1115	27	17.9	6.0	0.06
June 19, 2002[1]	0955	36	22.6	18.1	0.09
August 7, 2002	1000	13	27.2	5.2	<0.01
September 4, 2002	1015	12	25.9	7.3	0.05
September 25, 2002	1010	20	20.8	8.0	0.03
January 21, 2003	1210	6.5	1.4	13.7	<0.01
January 23, 2003	1055	3.9	0.3	24.2	<0.01
February 10, 2003	1250	1.6	1.2	4.7	<0.01
March 3, 2003	1025	3.3	1.8	24.5	<0.01
June 17, 2003[1]	1045	14	25.0	8.4	0.04
June 20, 2003	0905	3.5	22.5	5.3	<0.01
July 7, 2003	0940	24	25.7	22.8	0.06
July 17, 2003	1155	27	27.5	9.6	0.04
July 28, 2003	1150	29	28.6	8.3	0.03
March 10, 2004	1115	22	6.4	21.7	<0.01
April 8, 2004	1015	31	14.7	14.1	0.01
May 5, 2004	1115	21	16.1	2.0	0.03
June 3, 2004	1000	21	21.7	6.5	0.04
July 15, 2004	0950	7.0	26.0	2.9	0.03
August 12, 2004	0915	23	24.9	9.4	0.02
August 27, 2004	1115	32	24.4	3.3	0.04
September 9, 2004	0935	26	23.3	3.1	0.04
February 2, 2005	1035	2.7	1.8	21.5	<0.01
March 16, 2005	1015	10	8.5	25.3	<0.01
April 13, 2005	1000	18	13.4	9.3	<0.01
May 4, 2005	1120	10	14.7	4.1	0.02
May 16, 2005	0955	8.1	18.4	6.4	0.02
June 1, 2005	1020	8.1	22.1	6.4	0.02
June 15, 2005	0945	14	23.5	12.2	0.03
June 29, 2005	1000	25	25.2	7.1	0.06
July 13, 2005[1]	0920	15	26.8	11.6	0.06
July 27, 2005	0850	20	25.7	8.0	0.06
August 10, 2005	0855	12	26.2	5.4	0.05
August 30, 2005[1]	0945	22	26.6	11.8	0.09
September 7, 2005[1]	1030	12	25.1	7.4	0.05
October 13, 2005	1030	18	18.1	9.5	0.02

Table 11. Orthophosphate linear regression dataset using turbidity, water temperature, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units	Water temperature, in degrees Celsius	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Orthophosphate, in milligrams per liter
October 27, 2005	1005	20	14.4	9.2	0.01
January 11, 2006	1210	8.9	4.2	19.7	<0.01
March 1, 2006	1105	3.2	3.7	19.1	<0.01
March 29, 2006	1005	10	7.6	23.0	<0.01
April 25, 2006	1245	34	17.0	8.5	0.03
May 17, 2006	1055	20	18.1	11.7	0.02
May 31, 2006	1140	10	23.6	8.9	0.03
June 14, 2006[1]	1045	25	24.3	6.6	0.04
June 28, 2006	0955	13	25.0	6.9	0.02
July 13, 2006	0940	15	25.3	5.5	0.02
July 26, 2006	1115	14	26.7	10.7	0.02
August 10, 2006	1005	17	27.6	10.2	<0.01
August 22, 2006	1000	21	26.8	6.6	0.03
September 6, 2006	1020	10	24.2	14.7	0.02
September 20, 2006[1]	1015	22	20.8	9.9	0.04
October 11, 2006	0950	29	17.1	7.3	0.03
October 25, 2006	0945	35	12.7	6.8	0.03
December 12, 2006	1115	9.2	3.8	10.2	<0.01
February 7, 2007	1115	14	5.6	6.9	<0.01
March 7, 2007[1]	1135	14	6.7	33.6	0.05
April 9, 2007	1045	23	11.4	17.2	0.02
May 8, 2007[1]	0940	11	18.2	3.1	0.05
May 31, 2007	1020	27	21.3	4.8	0.08
June 13, 2007	1140	35	22.6	5.0	0.09
June 25, 2007	1000	25	24.4	5.1	0.09
July 9, 2007	0950	21	25.2	7.7	0.08
July 23, 2007	1020	21	26.1	10.6	0.06
August 7, 2007	0930	27	27.0	9.9	0.05
August 15, 2007	0955	23	27.9	8.5	0.04
August 28, 2007	1055	28	26.6	7.0	0.06
September 12, 2007	1025	13	23.7	8.4	0.04
September 24, 2007	1025	17	22.1	9.0	0.03
October 15, 2007	1005	29	18.9	7.1	0.04
October 29, 2007	1045	26	13.9	7.1	0.04
November 13, 2007	1040	25	11.8	10.6	0.02
December 19, 2007	1100	8.1	1.8	5.8	0.02
February 11, 2008	1100	2.7	1.8	12.5	<0.01
February 14, 2008	1105	2.3	2.0	12.8	<0.01
February 15, 2008	1025	6.4	1.8	14.2	<0.01
March 10, 2008	1125	9.0	4.3	25.6	<0.01
April 1, 2008	0955	19	9.1	29.6	<0.01

Table 11. Orthophosphate linear regression dataset using turbidity, water temperature, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units	Water temperature, in degrees Celsius	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Orthophosphate, in milligrams per liter
April 16, 2008	1140	28	10.1	10.7	<0.01
April 29, 2008	1035	42	13.8	8.1	0.03
May 13, 2008	1020	30	16.0	5.7	0.05
June 3, 2008	0945	22	22.7	5.9	0.05
June 18, 2008	0920	31	23.5	6.8	0.05
June 25, 2008[1]	1155	17	24.7	11.1	0.07
July 7, 2008	1035	18	25.3	5.3	0.05
July 21, 2008	1050	26	26.2	11.7	0.05
July 28, 2008	0955	18	26.5	24.4	0.05
August 4, 2008	1020	18	26.8	6.2	0.05
August 18, 2008	0945	15	24.6	3.7	0.07
September 2, 2008	1000	16	25.1	5.1	0.03
September 17, 2008	1000	20	20.2	4.9	0.05
October 1, 2008	1055	16	21.6	5.2	0.04
October 15, 2008	1150	48	16.8	5.7	0.04
November 4, 2008	0950	27	12.7	8.0	0.06
December 2, 2008	0950	18	5.3	7.1	0.04
January 6, 2009	1010	7.3	0.8	23.1	<0.01
January 20, 2009	1010	8.5	0.9	31.2	<0.01
February 2, 2009	1000	6.9	0.7	49.4	<0.01
February 18, 2009	1010	15	5.2	23.0	<0.01
February 25, 2009	1030	10	5.4	23.7	<0.01
March 3, 2009	1050	10	4.4	24.4	<0.01
March 9, 2009	1050	10	6.4	22.0	<0.01
March 16, 2009	1100	9.3	6.3	23.1	<0.01
March 25, 2009	1020	25	11.0	23.5	<0.01
April 8, 2009	1010	24	7.6	16.2	<0.01
April 29, 2009	1030	34	14.9	4.9	0.04
May 27, 2009	1140	36	22.1	7.6	0.06
June 9, 2009	1100	25	22.0	14.8	0.08
June 23, 2009	1045	17	25.0	15.5	0.07
July 7, 2009	1100	12	25.8	9.1	0.05
July 21, 2009	1020	18	25.4	3.6	0.08
August 5, 2009	1030	14	25.1	7.7	0.06
August 24, 2009	1000	16	24.3	6.9	0.06
September 2, 2009	1030	20	23.2	6.2	0.05
September 16, 2009	1030	19	22.0	4.3	0.07
October 5, 2009	1100	24	17.3	6.2	0.07
October 19, 2009	1100	22	12.2	6.2	0.07
November 23, 2009	1100	17	9.8	6.5	0.07
December 16, 2009	1140	16	0.9	4.5	0.07

[1]Data point removed from final analysis because of laboratory issues with phosphorus analysis. Orthophosphorus was larger than dissolved phosphorus.

Table 12. Dissolved phosphorus linear regression dataset using dissolved oxygen, specific conductance, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; °C, degrees Celsius; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Dissolved oxygen, in mg/L	Specific conductance, in µS/cm at 25°C	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Dissolved phosphorus, in mg/L
May 3, 2001	1055	7.8	789	8.1	0.04
June 4, 2001	1030	7.9	809	6.5	0.06
June 22, 2001	1155	10.7	756	12.5	0.06
July 24, 2001	1055	7.0	776	6.8	0.06
August 29, 2001	1125	7.3	799	4.8	0.07
May 15, 2002	1115	9.6	913	6.0	0.06
June 19, 2002[1]	0955	7.5	814	18.1	0.08
August 7, 2002	1000	6.1	863	5.2	0.09
September 4, 2002	1015	7.0	863	7.3	0.07
September 25, 2002	1010	6.3	842	8.0	0.05
January 21, 2003	1210	15.8	871	13.7	<0.03
January 23, 2003	1055	15.2	879	24.2	<0.03
February 10, 2003	1250	14.4	891	4.7	<0.03
March 3, 2003	1025	16.1	885	24.5	<0.03
June 17, 2003	1045	12.2	792	8.4	<0.03
June 20, 2003	0905	6.2	802	5.3	<0.03
July 7, 2003	0940	8.0	806	22.8	0.07
July 17, 2003	1155	8.4	797	9.6	0.05
July 28, 2003	1150	11.2	799	8.3	0.05
March 10, 2004	1115	12.4	806	21.7	<0.03
April 8, 2004	1015	9.3	801	14.1	0.03
May 5, 2004	1115	9.4	825	2.0	0.03
June 3, 2004	1000	7.7	838	6.5	0.06
July 15, 2004	0950	6.2	760	2.9	0.03
August 12, 2004	0915	7.3	738	9.4	0.03
August 27, 2004	1115	6.8	743	3.3	0.05
September 9, 2004	0935	4.3	751	3.1	0.06
February 2, 2005	1035	16.4	827	21.5	<0.03
March 16, 2005	1015	10.8	841	25.3	<0.03
April 13, 2005	1000	10.1	868	9.3	<0.03
May 4, 2005	1120	10.3	884	4.1	0.03
May 16, 2005	0955	9.5	885	6.4	0.03
June 1, 2005	1020	7.2	890	6.4	0.04
June 15, 2005[1]	0945	7.2	850	12.2	0.06
June 29, 2005	1000	6.1	804	7.1	0.07
July 13, 2005[1]	0920	9.5	739	11.6	0.06
July 27, 2005	0850	6.4	745	8.0	0.09
August 10, 2005[1]	0855	4.7	753	5.4	0.07
August 30, 2005[1]	0945	6.9	733	11.8	0.06
September 7, 2005	1030	4.6	730	7.4	<0.03
October 13, 2005	1030	9.4	745	9.5	<0.03

Table 12. Dissolved phosphorus linear regression dataset using dissolved oxygen, specific conductance, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; °C, degrees Celsius; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Dissolved oxygen, in mg/L	Specific conductance, in µS/cm at 25°C	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Dissolved phosphorus, in mg/L
October 27, 2005	1005	8.5	751	9.2	<0.03
January 11, 2006	1210	13.8	792	19.7	<0.03
March 1, 2006	1105	14.9	820	19.1	<0.03
March 29, 2006	1005	12.7	833	23.0	<0.03
April 25, 2006	1245	8.5	857	8.5	0.04
May 17, 2006	1055	10.2	845	11.7	0.04
May 31, 2006	1140	9.0	849	8.9	<0.03
June 14, 2006	1045	6.5	852	6.6	<0.03
June 28, 2006	0955	8.0	845	6.9	<0.03
July 13, 2006[1]	0940	6.8	859	5.5	0.10
July 26, 2006	1115	7.2	847	10.7	0.03
August 10, 2006	1005	8.6	844	10.2	0.03
August 22, 2006	1000	4.3	837	6.6	0.07
September 6, 2006	1020	9.2	830	14.7	<0.03
September 20, 2006[1]	1015	7.5	840	9.9	0.04
October 11, 2006	0950	8.0	854	7.3	<0.03
October 25, 2006	0945	9.0	866	6.8	0.04
December 12, 2006	1115	13.2	907	10.2	<0.03
February 7, 2007	1115	13.6	822	6.9	0.04
March 7, 2007	1135	12.3	940	33.6	<0.03
April 9, 2007	1045	10.0	884	17.2	<0.03
May 8, 2007[1]	0940	7.2	845	3.1	0.04
May 31, 2007	1020	6.8	754	4.8	0.11
June 13, 2007	1140	6.5	728	5.0	0.11
June 25, 2007	1000	6.3	739	5.1	0.11
July 9, 2007	0950	6.6	732	7.7	0.16
July 23, 2007	1020	6.2	732	10.6	0.13
August 7, 2007	0930	5.7	748	9.9	0.13
August 15, 2007	0955	6.9	746	8.5	0.06
August 28, 2007	1055	6.5	765	7.0	0.09
September 12, 2007	1025	7.7	776	8.4	0.06
September 24, 2007	1025	7.5	779	9.0	0.06
October 15, 2007	1005	8.0	792	7.1	0.04
October 29, 2007	1045	8.9	792	7.1	0.06
November 13, 2007	1040	9.7	806	10.6	<0.03
December 19, 2007	1100	12.6	837	5.8	0.06
February 11, 2008	1100	13.6	866	12.5	<0.03
February 14, 2008	1105	13.6	869	12.8	<0.03
February 15, 2008	1025	13.2	867	14.2	<0.03
March 10, 2008	1125	13.3	864	25.6	<0.03
April 1, 2008	0955	11.2	861	29.6	<0.03

Table 12. Dissolved phosphorus linear regression dataset using dissolved oxygen, specific conductance, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; °C, degrees Celsius; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Dissolved oxygen, in mg/L	Specific conductance, in µS/cm at 25°C	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Dissolved phosphorus, in mg/L
April 16, 2008	1140	10.5	864	10.7	0.03
April 29, 2008	1035	8.8	861	8.1	0.04
May 13, 2008	1020	8.8	853	5.7	0.07
June 3, 2008	0945	6.8	812	5.9	0.08
June 18, 2008	0920	6.0	802	6.8	0.05
June 25, 2008[1]	1155	6.4	806	11.1	0.04
July 7, 2008	1035	6.8	796	5.3	0.07
July 21, 2008	1050	7.5	804	11.7	0.08
July 28, 2008	0955	6.7	797	24.4	0.06
August 4, 2008	1020	6.3	802	6.2	0.07
August 18, 2008	0945	5.4	808	3.7	0.09
September 2, 2008	1000	7.5	808	5.1	0.06
September 17, 2008	1000	8.0	778	4.9	0.07
October 1, 2008	1055	8.4	781	5.2	0.06
October 15, 2008	1150	8.4	752	5.7	0.05
November 4, 2008	0950	9.4	784	8.0	0.06
December 2, 2008	0950	11.6	805	7.1	0.06
January 6, 2009	1010	13.2	842	23.1	<0.03
January 20, 2009	1010	15.2	836	31.2	<0.03
February 2, 2009[1]	1000	15.2	837	49.4	0.04
February 18, 2009	1010	11.9	819	23.0	<0.03
February 25, 2009	1030	12.3	825	23.7	<0.03
March 3, 2009	1050	12.3	843	24.4	<0.03
March 9, 2009	1050	11.9	841	22.0	<0.03
March 16, 2009	1100	11.6	841	23.1	<0.03
March 25, 2009	1020	10.2	847	23.5	<0.03
April 8, 2009	1010	10.9	848	16.2	0.03
April 29, 2009	1030	8.1	842	4.9	0.05
May 27, 2009	1140	8.1	765	7.6	0.08
June 9, 2009	1100	6.5	768	14.8	0.09
June 23, 2009	1045	7.1	772	15.5	0.11
July 7, 2009	1100	5.6	759	9.1	0.06
July 21, 2009	1020	5.3	763	3.6	0.08
August 5, 2009	1030	5.9	773	7.7	0.08
August 24, 2009	1000	6.1	778	6.9	0.08
September 2, 2009	1030	6.6	785	6.2	0.06
September 16, 2009	1030	6.5	773	4.3	0.08
October 5, 2009	1100	8.0	773	6.2	0.07
October 19, 2009	1100	9.9	781	6.2	0.09
November 23, 2009	1100	9.9	803	6.5	0.08
December 16, 2009	1140	12.6	838	4.5	0.09

[1]Data point removed from final analysis because of issues with phosphorus analysis. The filtered orthophosphate value was larger than the dissolved phosphorus value.

Table 13. Chlorophyll-*a* linear regression dataset using reservoir elevation, water temperature, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Water temperature, in degrees Celsius	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Chlorophyll-*a*, in micrograms per liter
December 3, 2001	1210	1,418	6.9	6.8	3.0
March 19, 2002	1400	1,418	5.8	0.2	10.4
June 19, 2002	0955	1,421	22.6	18.1	6.1
July 11, 2002	1005	1,421	26.9	12.8	6.2
August 7, 2002	1000	1,420	27.2	5.2	3.1
September 4, 2002	1015	1,420	25.9	7.3	5.2
September 25, 2002	1010	1,420	20.8	8.0	6.7
January 21, 2003	1210	1,422	1.4	13.7	6.8
January 23, 2003	1055	1,422	0.3	24.2	7.3
February 10, 2003	1250	1,422	1.2	4.7	8.7
March 3, 2003	1025	1,422	1.8	24.5	7.6
March 12, 2003	1200	1,422	4.2	11.8	9.0
March 13, 2003	1200	1,422	4.4	6.1	7.0
June 20, 2003	0905	1,422	22.5	5.3	1.9
July 7, 2003	0940	1,421	25.7	22.8	12.2
July 17, 2003	1155	1,421	27.5	9.6	25.6
July 28, 2003	1150	1,421	28.6	8.3	14.7
March 10, 2004	1115	1,423	6.4	21.7	12.2
April 8, 2004	1015	1,422	14.7	14.1	7.6
May 5, 2004	1115	1,422	16.1	2.0	2.2
June 3, 2004	1000	1,421	21.7	6.5	17.0
July 15, 2004	0950	1,422	26.0	2.9	3.7
August 12, 2004	0915	1,422	24.9	9.4	12.5
August 27, 2004	1115	1,422	24.4	3.3	11.6
September 9, 2004	935	1,422	23.3	3.1	11.8
March 16, 2005	1015	1,422	8.5	25.3	18.7
April 13, 2005	1000	1,422	13.4	9.3	7.5
May 4, 2005	1120	1,422	14.7	4.1	3.2
May 16, 2005	955	1,422	18.4	6.4	14.9
June 1, 2005	1020	1,422	22.1	6.4	0.8
June 15, 2005	0945	1,424	23.5	12.2	6.6
June 29, 2005	1000	1,423	25.2	7.1	3.7
July 13, 2005	0920	1,423	26.8	11.6	19.7
July 27, 2005	0850	1,422	25.7	8.0	24.4
August 10, 2005	0855	1,421	26.2	5.4	4.0
August 30, 2005	0945	1,422	26.6	11.8	12.1
September 7, 2005	1030	1,422	25.1	7.4	12.4
October 13, 2005	1030	1,421	18.1	9.5	18.8
October 27, 2005	1005	1,421	14.4	9.2	8.1
January 11, 2006	1210	1,421	4.2	19.7	21.8
March 1, 2006	1105	1,421	3.7	19.1	19.8

Table 13. Chlorophyll-*a* linear regression dataset using reservoir elevation, water temperature, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Water temperature, in degrees Celsius	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Chlorophyll-*a*, in micrograms per liter
March 29, 2006	1005	1,422	7.6	23.0	19.2
April 25, 2006	1245	1,421	17.0	8.5	11.1
May 17, 2006	1055	1,422	18.1	11.7	16.3
May 31, 2006	1140	1,422	23.6	8.9	16.1
June 14, 2006	1045	1,421	24.3	6.6	10.8
June 28, 2006	0955	1,421	25.0	6.9	12.2
July 13, 2006	0940	1,421	25.3	5.5	14.0
July 26, 2006	1115	1,420	26.7	10.7	20.5
August 10, 2006	1005	1,420	27.6	10.2	27.5
August 22, 2006	1000	1,420	26.8	6.6	23.6
September 6, 2006	1020	1,420	24.2	14.7	41.2
September 20, 2006	1015	1,419	20.8	9.9	31.3
October 11, 2006	0950	1,419	17.1	7.3	21.9
October 25, 2006	0945	1,418	12.7	6.8	16.2
December 12, 2006	1115	1,418	3.8	10.2	15.0
February 7, 2007	1115	1,419	5.6	6.9	10.4
March 7, 2007	1135	1,419	6.7	33.6	20.2
April 9, 2007	1045	1,421	11.4	17.2	18.4
May 8, 2007	0940	1,424	18.2	3.1	1.2
May 31, 2007	1020	1,425	21.3	4.8	2.7
June 13, 2007	1140	1,424	22.6	5.0	2.2
June 25, 2007	1000	1,422	24.4	5.1	4.2
July 9, 2007	0950	1,423	25.2	7.7	12.4
July 23, 2007	1020	1,423	26.1	10.6	20.6
August 7, 2007	0930	1,423	27.0	9.9	18.8
August 15, 2007	0955	1,422	27.9	8.5	14.8
August 28, 2007	1055	1,421	26.6	7.0	15.6
September 12, 2007	1025	1,421	23.7	8.4	18.6
September 24, 2007	1025	1,421	22.1	9.0	16.6
October 15, 2007	1005	1,420	18.9	7.1	11.7
October 29, 2007	1045	1,420	13.9	7.1	9.7
November 13, 2007	1040	1,420	11.8	10.6	12.7
December 19, 2007	1100	1,420	1.8	5.8	4.5
February 11, 2008	1100	1,421	1.8	12.5	10.8
February 14, 2008	1105	1,421	2.0	12.8	7.9
April 1, 2008	0955	1,422	9.1	29.6	24.9
April 16, 2008	1140	1,422	10.1	10.7	9.6
April 29, 2008	1035	1,423	13.8	8.1	3.5
May 13, 2008	1020	1,424	16.0	5.7	2.5
June 3, 2008	0945	1,423	22.7	5.9	7.4
June 18, 2008	0920	1,423	23.5	6.8	6.5

Table 13. Chlorophyll-*a* linear regression dataset using reservoir elevation, water temperature, and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Water temperature, in degrees Celsius	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Chlorophyll-*a*, in micrograms per liter
July 7, 2008	1035	1,422	25.3	5.3	11.0
July 21, 2008	1050	1,422	26.2	11.7	26.9
July 28, 2008	0955	1,422	26.5	24.4	22.3
August 18, 2008	0945	1,421	24.6	3.7	7.2
September 2, 2008	1000	1,421	25.1	5.1	10.9
September 17, 2008	1000	1,422	20.2	4.9	11.2
October 1, 2008	1055	1,422	21.6	5.2	10.5
October 15, 2008	1150	1,422	16.8	5.7	8.4
November 4, 2008	0950	1,422	12.7	8.0	3.7
December 2, 2008	0950	1,422	5.3	7.1	6.7
January 6, 2009	1010	1,422	0.8	23.1	21.1
January 20, 2009	1010	1,422	0.9	31.2	22.4
February 2, 2009	1000	1,422	0.7	49.4	47.2
February 18, 2009	1010	1,422	5.2	23.0	19.8
February 25, 2009	1030	1,422	5.4	23.7	21.9
March 3, 2009	1050	1,422	4.4	24.4	24.9
March 9, 2009	1050	1,422	6.4	22.0	22.6
March 12, 2009	1120	1,422	5.9	24.2	23.5
March 16, 2009	1100	1,422	6.3	23.1	27.5
March 25, 2009	1020	1,422	11.0	23.5	25.9
April 8, 2009	1010	1,422	7.6	16.2	20.8
April 29, 2009	1030	1,424	14.9	4.9	2.2
May 27, 2009	1140	1,424	22.1	7.6	10.6
June 9, 2009	1100	1,422	22.0	14.8	2.6
June 23, 2009	1045	1,422	25.0	15.5	29.1
July 7, 2009	1100	1,422	25.8	9.1	20.2
July 21, 2009	1020	1,421	25.4	3.6	3.4
August 5, 2009	1030	1,421	25.1	7.7	3.8
August 24, 2009	1000	1,421	24.3	6.9	5.8
September 2, 2009	1030	1,421	23.2	6.2	7.4
September 16, 2009	1030	1,422	22.0	4.3	2.4
October 5, 2009	1100	1,422	17.3	6.2	4.0
October 19, 2009	1100	1,422	12.2	6.2	2.5
November 23, 2009	1100	1,422	9.8	6.5	2.8
December 16, 2009	1140	1,422	0.9	4.5	2.8

[1]Reservoir elevation above National Geodetic Vertical Datum of 1929.

Table 14. Actinomycetes bacteria linear regression dataset using reservoir elevation, turbidity, and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Water temperature, in degrees Celsius	Actinomycetes bacteria, in colonies per milliliter
April 13, 2005	1000	1,422	18	13.4	6.0
May 4, 2005	1120	1,422	10	14.7	3.0
May 16, 2005	0955	1,422	8.1	18.4	1.0
June 1, 2005	1020	1,422	8.1	22.1	2.0
June 15, 2005	0945	1,424	14	23.5	12
June 29, 2005	1000	1,423	25	25.2	9.0
July 13, 2005	0920	1,423	15	26.8	5.0
July 27, 2005	0850	1,422	20	25.7	2.0
August 10, 2005	0855	1,421	12	26.2	2.0
August 30, 2005	0945	1,422	22	26.6	8.0
September 7, 2005	1030	1,422	12	25.1	2.0
October 13, 2005	1030	1,421	18	18.1	2.0
October 27, 2005	1005	1,421	20	14.4	5.0
January 11, 2006	1210	1,421	8.9	4.2	4.0
March 1, 2006	1105	1,421	3.2	3.7	1.0
March 29, 2006	1005	1,422	10	7.6	7.0
April 25, 2006	1245	1,421	34	17.0	8.0
May 17, 2006	1055	1,422	20	18.1	21
May 31, 2006	1140	1,422	10	23.6	4.0
June 14, 2006	1045	1,421	25	24.3	4.0
June 28, 2006	0955	1,421	13	25.0	1.0
July 13, 2006	0940	1,421	15	25.3	2.0
July 26, 2006	1115	1,420	14	26.7	1.0
August 10, 2006	1005	1,420	17	27.6	<1.0
August 22, 2006	1000	1,420	21	26.8	<1.0
September 6, 2006	1020	1,420	10	24.2	2.0
September 20, 2006	1015	1,419	22	20.8	6.0
September 26, 2006	1130	1,419	10	19.7	1.0
October 11, 2006	0950	1,419	29	17.1	4.0
October 25, 2006	0945	1,418	35	12.7	<1.0
December 12, 2006	1115	1,418	9.2	3.8	1.0
February 7, 2007	1115	1,419	14	5.6	1.0
March 7, 2007	1135	1,419	14	6.7	2.0
April 9, 2007	1045	1,421	23	11.4	30
May 8, 2007	0940	1,424	11	18.2	24
May 31, 2007	1020	1,425	27	21.3	60
June 13, 2007	1140	1,424	35	22.6	63
June 25, 2007	1000	1,422	25	24.4	24
July 9, 2007	0950	1,423	21	25.2	16
July 23, 2007	1020	1,423	21	26.1	3.0
August 7, 2007	0930	1,423	27	27.0	8.0

Table 14. Actinomycetes bacteria linear regression dataset using reservoir elevation, turbidity, and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Water temperature, in degrees Celsius	Actinomycetes bacteria, in colonies per milliliter
August 15, 2007	0955	1,422	23	27.9	8.0
August 28, 2007	1055	1,421	28	26.6	12
September 12, 2007	1025	1,421	13	23.7	4.0
September 24, 2007	1025	1,421	17	22.1	8.0
October 15, 2007	1005	1,420	29	18.9	14
October 29, 2007	1045	1,420	26	13.9	11
November 13, 2007	1040	1,420	25	11.8	4.0
December 19, 2007	1100	1,420	8.1	1.8	6.0
February 11, 2008	1100	1,421	2.7	1.8	4.0
March 10, 2008	1125	1,422	9.0	4.3	8.0
April 1, 2008	0955	1,422	19	9.1	12
April 16, 2008	1140	1,422	28	10.1	17
April 29, 2008	1035	1,423	42	13.8	28
May 13, 2008	1020	1,424	30	16.0	17
June 3, 2008	0945	1,423	22	22.7	17
June 18, 2008	0920	1,423	31	23.5	15
June 25, 2008	1155	1,423	17	24.7	9.0
July 7, 2008	1035	1,422	18	25.3	12
July 21, 2008	1050	1,422	26	26.2	<1.0
July 28, 2008	0955	1,422	18	26.5	5.0
August 4, 2008	1020	1,421	18	26.8	3.0
August 18, 2008	0945	1,421	15	24.6	3.0
September 2, 2008	1000	1,421	16	25.1	2.0
September 17, 2008	1000	1,422	20	20.2	29
October 1, 2008	1055	1,422	16	21.6	8.0
October 15, 2008	1150	1,422	48	16.8	14
November 4, 2008	0950	1,422	27	12.7	15
December 2, 2008	0950	1,422	18	5.3	9.0
January 6, 2009	1010	1,422	7.3	0.8	2.0
January 20, 2009	1010	1,422	8.5	0.9	10
February 2, 2009	1000	1,422	6.9	0.7	3.0
February 18, 2009	1010	1,422	15	5.2	8.0
February 25, 2009	1030	1,422	10	5.4	7.0
March 3, 2009	1050	1,422	10	4.4	4.0
March 9, 2009	1050	1,422	10	6.4	1.0
March 16, 2009	1100	1,422	9.3	6.3	5.0
March 25, 2009	1020	1,422	25	11.0	7.0
April 8, 2009	1010	1,422	24	7.6	13
April 29, 2009	1030	1,424	34	14.9	34
May 27, 2009	1140	1,424	36	22.1	37
June 9, 2009	1100	1,422	25	22.0	12

Table 14. Actinomycetes bacteria linear regression dataset using reservoir elevation, turbidity, and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Water temperature, in degrees Celsius	Actinomycetes bacteria, in colonies per milliliter
June 23, 2009	1045	1,422	17	25.0	7.0
July 7, 2009	1100	1,422	12	25.8	3.0
July 21, 2009	1020	1,421	18	25.4	5.0
August 5, 2009	1030	1,421	14	25.1	7.0
August 24, 2009	1000	1,421	16	24.3	7.0
September 2, 2009	1030	1,421	20	23.2	5.0
September 16, 2009	1030	1,422	19	22.0	11
October 5, 2009	1100	1,422	24	17.3	13
October 19, 2009	1100	1,422	22	12.2	9.0
November 23, 2009	1100	1,422	17	9.8	7.0
December 16, 2009	1140	1,422	16	0.9	7.0

[1]Reservoir elevation above National Geodetic Vertical Datum of 1929.

Table 15. *Anabaena* spp. linear regression dataset using reservoir elevation and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Water temperature, in degrees Celsius	*Anabaena* spp., in micrometers cubed per milliliter
June 22, 2001	1155	1,422	24.1	34,721
August 29, 2001	1125	1,419	26.2	966
May 15, 2002	1115	1,419	17.9	531
July 11, 2002	1005	1,421	26.9	1,455
August 7, 2002	1000	1,420	27.2	0
September 4, 2002	1015	1,420	25.9	5,194
January 21, 2003	1210	1,422	1.4	1,190
January 23, 2003	1055	1,422	0.3	1,169
February 10, 2003	1250	1,422	1.2	83
March 3, 2003	1025	1,422	1.8	48
March 12, 2003	1200	1,422	4.2	11,485
March 13, 2003	1200	1,422	4.4	4,768
June 17, 2003	1045	1,422	25.0	54,010
June 20, 2003	0905	1,422	22.5	3,748
July 7, 2003	0940	1,421	25.7	9,622
July 17, 2003	1155	1,421	27.5	28,872
July 28, 2003	1150	1,421	28.6	72,403
March 10, 2004	1115	1,423	6.4	0
April 8, 2004	1015	1,422	14.7	0
May 5, 2004	1115	1,422	16.1	0
July 15, 2004	0950	1,422	26.0	12,126
August 12, 2004	0915	1,422	24.9	571
August 27, 2004	1115	1,422	24.4	2,440
September 9, 2004	0935	1,422	23.3	94
February 2, 2005	1035	1,422	1.8	0
March 16, 2005	1015	1,422	8.5	0
April 13, 2005	1000	1,422	13.4	0
May 4, 2005	1120	1,422	14.7	0
May 16, 2005	0955	1,422	18.4	0
June 1, 2005	1020	1,422	22.1	108
June 15, 2005	0945	1,424	23.5	14,916
June 29, 2005	1000	1,423	25.2	771
July 13, 2005	0920	1,423	26.8	33,502
July 27, 2005	0850	1,422	25.7	25,548
August 10, 2005	0855	1,421	26.2	64
October 27, 2005	1005	1,421	14.4	0
January 11, 2006	1210	1,421	4.2	0
March 1, 2006	1105	1,421	3.7	0
March 29, 2006	1005	1,422	7.6	0
April 25, 2006	1245	1,421	17.0	0
May 17, 2006	1055	1,422	18.1	1,481

Table 15. *Anabaena* spp. linear regression dataset using reservoir elevation and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Water temperature, in degrees Celsius	*Anabaena* spp., in micrometers cubed per milliliter
May 31, 2006	1140	1,422	23.6	708,775
June 14, 2006	1045	1,421	24.3	54
June 28, 2006	0955	1,421	25.0	33,348
July 13, 2006	0940	1,421	25.3	75,065
July 26, 2006	1115	1,420	26.7	102,349
August 10, 2006	1005	1,420	27.6	83,432
August 22, 2006	1000	1,420	26.8	53,810
September 6, 2006	1020	1,420	24.2	202,296
September 20, 2006	1015	1,419	20.8	2,363
October 11, 2006	0950	1,419	17.1	274,097
October 25, 2006	0945	1,418	12.7	201,177
December 12, 2006	1115	1,418	3.8	18,196
February 7, 2007	1115	1,419	5.6	70
March 7, 2007	1135	1,419	6.7	0
April 9, 2007	1045	1,421	11.4	0
May 8, 2007	0940	1,424	18.2	0
May 31, 2007	1020	1,425	21.3	233
June 13, 2007	1140	1,424	22.6	0
June 25, 2007	1000	1,422	24.4	542
July 9, 2007	0950	1,423	25.2	6,179
July 23, 2007	1020	1,423	26.1	11,521
August 7, 2007	0930	1,423	27.0	5,047
August 15, 2007	0955	1,422	27.9	17,177
August 28, 2007	1055	1,421	26.6	55,286
September 12, 2007	1025	1,421	23.7	96,876
September 24, 2007	1025	1,421	22.1	81,340
October 15, 2007	1005	1,420	18.9	29,020
October 29, 2007	1045	1,420	13.9	5,719
November 13, 2007	1040	1,420	11.8	0
December 19, 2007	1100	1,420	1.8	2,243
February 11, 2008	1100	1,421	1.8	0
February 14, 2008	1105	1,421	2.0	0
February 15, 2008	1025	1,421	1.8	0
March 10, 2008	1125	1,422	4.3	0
April 1, 2008	0955	1,422	9.1	0
April 16, 2008	1140	1,422	10.1	0
April 29, 2008	1035	1,423	13.8	0
May 13, 2008	1020	1,424	16.0	0
June 3, 2008	0945	1,423	22.7	0
June 18, 2008	0920	1,423	23.5	5,719
July 7, 2008	1035	1,422	25.3	705

Table 15. *Anabaena* spp. linear regression dataset using reservoir elevation and water temperature as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes]

Date	Time, in hhmm	Reservoir elevation[1], in feet	Water temperature, in degrees Celsius	*Anabaena* spp., in micrometers cubed per milliliter
July 21, 2008	1050	1,422	26.2	63,356
August 4, 2008	1020	1,421	26.8	0
August 18, 2008	0945	1,421	24.6	21,936
September 17, 2008	1000	1,422	20.2	779
October 1, 2008	1055	1,422	21.6	3,173
October 15, 2008	1150	1,422	16.8	1,723
November 4, 2008	0950	1,422	12.7	0
December 2, 2008	0950	1,422	5.3	0
January 6, 2009	1010	1,422	0.8	0
January 20, 2009	1010	1,422	0.9	2,308
February 2, 2009	1000	1,422	0.7	0
February 18, 2009	1010	1,422	5.2	0
February 25, 2009	1030	1,422	5.4	0
March 3, 2009	1050	1,422	4.4	0
March 9, 2009	1050	1,422	6.4	0
March 16, 2009	1100	1,422	6.3	0
March 25, 2009	1020	1,422	11.0	0
April 8, 2009	1010	1,422	7.6	0
April 29, 2009	1030	1,424	14.9	0
May 27, 2009	1140	1,424	22.1	0
June 9, 2009	1100	1,422	22.0	2,341
June 23, 2009	1045	1,422	25.0	0
July 7, 2009	1100	1,422	25.8	30,108
July 21, 2009	1020	1,421	25.4	25,456
August 5, 2009	1030	1,421	25.1	12,847
August 24, 2009	1000	1,421	24.3	0
September 2, 2009	1030	1,421	23.2	0
September 16, 2009	1030	1,422	22.0	0
October 5, 2009	1100	1,422	17.3	0
October 19, 2009	1100	1,422	12.2	0
November 23, 2009	1100	1,422	9.8	0
December 16, 2009	1140	1,422	0.9	0

[1]Reservoir elevation above National Geodetic Vertical Datum of 1929.

Table 16. Geosmin linear regression dataset using turbidity and pH as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	pH, in standard units	Geosmin, in micrograms per liter
May 3, 2001	1055	38	8.5	<0.003
June 4, 2001	1030	20	8.4	0.005
June 22, 2001	1155	22	8.7	0.011
July 24, 2001	1055	18	8.3	0.003
August 29, 2001	1125	13	8.2	0.004
May 15, 2002	1115	27	8.4	<0.003
June 19, 2002	0955	36	8.3	<0.002
July 11, 2002	1005	12	8.7	0.007
August 7, 2002	1000	13	8.4	0.004
September 4, 2002	1015	12	8.4	0.005
September 25, 2002	1010	20	8.4	0.006
January 21, 2003	1210	6.5	8.9	0.029
January 23, 2003	1055	3.9	8.8	0.024
February 10, 2003	1250	1.6	8.0	0.022
March 3, 2003	1025	3.3	8.6	0.012
March 12, 2003	1200	4.5	8.8	0.006
March 13, 2003	1200	5.6	8.7	0.005
June 17, 2003	1045	14	8.9	0.015
June 20, 2003	0905	3.5	8.2	0.063
July 7, 2003	0940	24	8.6	0.007
July 17, 2003	1155	27	8.7	0.113
March 10, 2004	1115	22	8.3	<0.005
April 8, 2004	1015	31	8.2	<0.005
May 5, 2004	1115	21	8.0	<0.005
June 3, 2004	1000	21	8.2	<0.005
July 15, 2004	0950	7.0	8.3	0.005
August 12, 2004	0915	23	8.2	<0.005
August 27, 2004	1115	32	8.4	<0.005
September 9, 2004	0935	26	7.7	<0.005
February 2, 2005	1035	2.7	8.9	0.024
March 16, 2005	1015	10	8.7	<0.005
April 13, 2005	1000	18	8.4	<0.005
May 4, 2005	1120	10	8.5	<0.005
May 16, 2005	0955	8.1	8.5	<0.005
June 1, 2005	1020	8.1	8.3	<0.005
June 15, 2005	0945	14	8.1	0.043
June 29, 2005	1000	25	8.2	<0.005
July 13, 2005	0920	15	8.8	0.043
July 27, 2005	0850	20	8.2	0.064
August 10, 2005	0855	12	8.2	<0.005
August 30, 2005	0945	22	8.3	<0.005
September 7, 2005	1030	12	8.1	<0.005
October 13, 2005	1030	18	8.7	<0.005

Table 16. Geosmin linear regression dataset using turbidity and pH as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	pH, in standard units	Geosmin, in micrograms per liter
October 27, 2005	1005	20	8.5	<0.005
January 11, 2006	1210	8.9	8.6	<0.005
March 1, 2006	1105	3.2	8.6	0.005
March 29, 2006	1005	10	8.5	<0.005
April 25, 2006	1245	34	8.3	<0.005
May 17, 2006	1055	20	8.4	<0.005
May 31, 2006	1140	10	8.3	<0.005
June 14, 2006	1045	25	8.0	<0.005
June 28, 2006	0955	13	8.7	<0.005
July 13, 2006	0940	15	8.3	<0.005
July 26, 2006	1115	14	8.3	<0.005
August 10, 2006	1005	17	8.5	<0.005
August 22, 2006	1000	21	8.2	<0.005
September 6, 2006	1020	10	8.4	0.005
September 20, 2006	1015	22	8.3	<0.005
September 26, 2006	1130	10	8.6	<0.005
September 28, 2006	1120	28	8.7	<0.005
September 29, 2006	1130	28	8.6	<0.005
October 11, 2006	0950	29	8.4	<0.005
October 25, 2006	0945	35	8.3	0.005
December 12, 2006	1115	9.2	8.5	<0.002
February 7, 2007	1115	14	8.5	0.032
March 7, 2007	1135	14	8.6	0.020
April 9, 2007	1045	23	8.6	<0.005
May 8, 2007	0940	11	8.4	<0.005
May 31, 2007	1020	27	8.0	<0.005
June 13, 2007	1140	35	8.0	<0.005
June 25, 2007	1000	25	8.2	<0.002
July 9, 2007	0950	21	8.3	<0.002
July 23, 2007	1020	21	8.4	<0.002
August 7, 2007	0930	27	8.4	0.0024
August 15, 2007	0955	23	8.5	<0.002
August 28, 2007	1055	28	8.2	<0.002
September 12, 2007	1025	13	8.5	<0.005
September 24, 2007	1025	17	8.4	0.0022
October 15, 2007	1005	29	8.4	<0.002
October 29, 2007	1045	26	8.4	<0.002
November 13, 2007	1040	25	8.6	<0.002
December 19, 2007	1100	8.1	8.5	<0.002
February 11, 2008	1100	2.7	8.6	0.0058
March 10, 2008	1125	9.0	8.6	0.0083
April 1, 2008	0955	19	8.6	0.0106
April 16, 2008	1140	28	8.3	0.0139

Table 16. Geosmin linear regression dataset using turbidity and pH as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	pH, in standard units	Geosmin, in micrograms per liter
April 29, 2008	1035	42	8.1	<0.002
May 13, 2008	1020	30	8.2	<0.002
June 3, 2008	0945	22	8.2	<0.002
June 18, 2008	0920	31	8.2	<0.002
June 25, 2008	1200	17	8.3	0.0061
July 7, 2008	1035	18	8.4	0.0043
July 21, 2008	1050	26	8.4	<0.002
July 28, 2008	0955	18	8.3	<0.002
August 4, 2008	1200	18	8.4	<0.002
August 18, 2008	0945	15	8.2	<0.002
September 2, 2008	1000	16	8.5	0.005
September 17, 2008	1000	20	8.4	<0.002
October 1, 2008	1055	16	8.4	0.003
October 15, 2008	1150	48	8.3	<0.002
November 4, 2008	0950	27	8.3	<0.002
December 2, 2008	0950	18	8.7	<0.002
January 6, 2009	1010	7.3	8.2	0.003
January 20, 2009	1010	8.5	8.6	<0.002
February 2, 2009	1000	6.9	8.6	<0.002
February 18, 2009	1010	15	8.7	0.010
February 25, 2009	1030	10	8.8	0.008
March 3, 2009	1050	10	8.8	0.017
March 9, 2009	1050	10	8.7	0.012
March 12, 2009	1120	16	8.7	0.011
March 16, 2009	1100	9.3	8.6	0.009
March 25, 2009	1020	25	8.6	0.009
April 8, 2009	1010	24	8.6	0.004
April 29, 2009	1030	34	8.1	<0.002
May 27, 2009	1140	36	8.3	<0.002
June 9, 2009	1100	25	8.1	<0.002
June 23, 2009	1045	17	8.4	0.005
July 7, 2009	1100	12	8.6	0.014
July 21, 2009	1020	18	8.5	0.005
August 5, 2009	1030	14	8.4	<0.002
August 24, 2009	1000	16	8.6	<0.002
September 2, 2009	1030	20	8.3	<0.002
September 16, 2009	1030	19	8.3	<0.002
October 5, 2009	1100	24	8.5	<0.002
October 19, 2009	1100	22	8.4	<0.002
November 23, 2009	1100	17	8.5	<0.002
December 16, 2009	1140	16	8.6	<0.002

Table 17. Microcystin linear regression dataset using seasonal data and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Microcystin, in micrograms per liter
June 1, 2005	1020	0.5012	-0.8653	6.4	<0.1
June 15, 2005	0945	0.2802	-0.9599	12.2	0.1
June 29, 2005	1000	0.0430	-0.9991	7.1	<0.1
July 13, 2005	0920	-0.1967	-0.9805	11.6	1.7
July 27, 2005	0850	-0.4250	-0.9052	8.0	0.6
August 10, 2005	0855	-0.6288	-0.7776	5.4	0.2
August 30, 2005	0945	-0.8543	-0.5197	11.8	2.3
September 7, 2005	1030	-0.9176	-0.3975	7.4	2.1
October 13, 2005	1030	-0.9778	0.2093	9.5	0.4
October 27, 2005	1005	-0.8996	0.4367	9.2	0.2
January 11, 2006	1210	0.1882	0.9821	19.7	<0.1
March 1, 2006	1105	0.8588	0.5124	19.1	<0.1
March 29, 2006	1005	0.9984	0.0559	23.0	<0.1
April 25, 2006	1245	0.9176	-0.3975	8.5	<0.1
May 17, 2006	1055	0.7056	-0.7086	11.7	<0.1
May 31, 2006	1140	0.5161	-0.8566	8.9	<0.1
June 14, 2006	1045	0.2967	-0.9550	6.6	<0.1
June 28, 2006	0955	0.0602	-0.9982	6.9	0.2
July 13, 2006	0940	-0.1967	-0.9805	5.5	0.2
July 26, 2006	1115	-0.4094	-0.9124	10.7	0.2
August 10, 2006	1005	-0.6288	-0.7776	10.2	1.6
August 22, 2006	1000	-0.7749	-0.6321	6.6	0.6
September 6, 2006	1020	-0.9106	-0.4133	14.7	2.6
September 20, 2006	1015	-0.9829	-0.1840	9.9	1.2
September 26, 2006	1130	-0.9967	-0.0817	11.8	3.6
September 28, 2006	1120	-0.9989	-0.0473	10.9	3.8
September 29, 2006	1130	-0.9995	-0.0301	9.7	3.4
October 11, 2006	0950	-0.9845	0.1755	7.3	0.7
October 25, 2006	0945	-0.9141	0.4054	6.8	0.3
December 12, 2006	1115	-0.3213	0.9470	10.2	<0.1
February 7, 2007	1115	0.6085	0.7936	6.9	<0.1
March 7, 2007	1135	0.9070	0.4211	33.6	<0.1
April 9, 2007	1045	0.9911	-0.1330	17.2	<0.1
May 8, 2007	0940	0.8065	-0.5913	3.1	0.1
May 31, 2007	1020	0.5161	-0.8566	4.8	0.2
June 13, 2007	1140	0.3131	-0.9497	5.0	<0.1
June 25, 2007	1000	0.1117	-0.9937	5.1	<0.1
July 9, 2007	0950	-0.1288	-0.9917	7.7	0.2
July 23, 2007	1020	-0.3617	-0.9323	10.6	0.6
August 7, 2007	0930	-0.5878	-0.8090	9.9	0.7
August 15, 2007	0955	-0.6933	-0.7207	8.5	1.4

Table 17. Microcystin linear regression dataset using seasonal data and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Microcystin, in micrograms per liter
August 28, 2007	1055	-0.8359	-0.5488	7.0	1.1
September 12, 2007	1025	-0.9484	-0.3172	8.4	0.6
September 24, 2007	1025	-0.9933	-0.1159	9.0	0.7
October 15, 2007	1005	-0.9701	0.2429	7.1	0.3
October 29, 2007	1045	-0.8841	0.4674	7.1	0.1
November 13, 2007	1040	-0.7354	0.6776	10.6	<0.1
December 19, 2007	1100	-0.2051	0.9787	5.8	<0.1
February 11, 2008	1100	0.6616	0.7498	12.5	0.1
February 14, 2008	1105	0.6995	0.7147	12.8	<0.1
February 15, 2008	1025	0.7117	0.7025	14.2	0.1
March 10, 2008	1125	0.9338	0.3577	25.6	<0.1
April 1, 2008	0955	0.9999	-0.0129	29.6	0.1
April 16, 2008	1140	0.9635	-0.2678	10.7	<0.1
April 29, 2008	1035	0.8800	-0.4750	8.1	<0.1
May 13, 2008	1020	0.7412	-0.6713	5.7	<0.1
June 3, 2008	0945	0.4559	-0.8900	5.9	<0.1
June 18, 2008	0920	0.2135	-0.9769	6.8	0.1
July 7, 2008	1035	-0.1117	-0.9937	5.3	0.8
July 21, 2008	1050	-0.3456	-0.9384	11.7	1.1
July 28, 2008	0955	-0.4559	-0.8900	24.4	0.4
August 4, 2008	1020	-0.5596	-0.8288	6.2	0.2
August 18, 2008	0945	-0.7412	-0.6713	3.7	0.2
September 2, 2008	1000	-0.8881	-0.4597	5.1	<0.1
September 17, 2008	1000	-0.9760	-0.2177	4.9	0.1
October 1, 2008	1055	-0.9998	0.0215	5.2	<0.1
October 15, 2008	1150	-0.9657	0.2595	5.7	<0.1
November 4, 2008	0950	-0.8215	0.5703	8.0	0.1
December 2, 2008	0950	-0.4635	0.8861	7.1	<0.1
January 6, 2009	1010	0.1031	0.9947	23.1	<0.1
January 20, 2009	1010	0.3375	0.9413	31.2	<0.1
February 2, 2009	1000	0.5380	0.8429	49.4	<0.1
February 18, 2009	1010	0.7470	0.6649	23.0	<0.1
February 25, 2009	1030	0.8215	0.5702	23.7	<0.1
March 3, 2009	1050	0.8759	0.4825	24.4	<0.1
March 9, 2009	1050	0.9210	0.3896	22.0	<0.1
March 12, 2009	1120	0.9399	0.3416	24.2	<0.1
March 16, 2009	1100	0.9611	0.2761	23.1	<0.1
March 25, 2009	1020	0.9922	0.1245	23.5	<0.1
April 8, 2009	1010	0.9933	-0.1159	16.2	<0.1
April 29, 2009	1030	0.8881	-0.4597	4.9	<0.1
May 27, 2009	1140	0.5738	-0.8190	7.6	<0.1

Table 17. Microcystin linear regression dataset using seasonal data and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments; <, less than]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Microcystin, in micrograms per liter
June 9, 2009	1100	0.3777	-0.9259	14.8	<0.1
June 23, 2009	1045	0.1458	-0.9893	15.5	<0.1
July 7, 2009	1100	-0.0945	-0.9955	9.1	0.1
July 21, 2009	1020	-0.3294	-0.9442	3.6	<0.1
August 5, 2009	1030	-0.5596	-0.8288	7.7	<0.1
August 24, 2009	1000	-0.7962	-0.6050	6.9	<0.1
September 2, 2009	1030	-0.8800	-0.4749	6.2	<0.1
September 16, 2009	1030	-0.9679	-0.2512	4.3	2.9
October 5, 2009	1100	-0.9973	0.0731	6.2	<0.1
October 19, 2009	1100	-0.9511	0.3090	6.2	<0.1
November 23, 2009	1100	-0.6085	0.7936	6.5	<0.1
December 16, 2009	1140	-0.2553	0.9669	4.5	<0.1

```
       *** Linear Model ***

Call: lm(formula = DS ~ SC, data = DS, na.action =
       na.exclude)
Residuals:
    Min     1Q  Median    3Q   Max
 -32.67 -6.676 0.09518 6.783 46.12

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept) 28.3795 19.1958     1.4784  0.1420
         SC  0.5093  0.0236    21.5880  0.0000

Residual standard error: 12.02 on 118 degrees of freedom
Multiple R-Squared: 0.798      Adjusted R-squared: 0.7962
F-statistic: 466 on 1 and 118 degrees of freedom, the p-value is 0

Correlation of Coefficients:
   (Intercept)
SC -0.9984

Analysis of Variance Table

Response: DS

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value Pr(F)
       SC   1  67386.77 67386.77 466.0428     0
Residuals 118  17062.03   144.59

model.formula nvars   stderr    adjr2       Cp    press
      DS ~ SC     1 12.02470 79.62478 1.003052 17701.67

Test criteria
 leverage cooksD dfits
     0.05  0.793 0.258
       Observations exceeding at least one test criterion
    DS yhat resids stnd.res stud.res leverage   cooksD   dfits
 8 436  468 -31.67    -2.66   -2.730   0.0180 0.064889 -0.3700
 9 435  468 -32.67    -2.74   -2.822   0.0180 0.069052 -0.3824
12 501  482  18.81     1.59    1.601   0.0322 0.042044  0.2919
24 424  404  19.74     1.67    1.679   0.0296 0.042319  0.2932
35 387  405 -17.77    -1.50   -1.508   0.0290 0.033603 -0.2606
38 371  402 -30.71    -2.60   -2.663   0.0325 0.113401 -0.4884
41 457  411  46.12     3.88    4.136   0.0228 0.175557  0.6317
59 509  507   1.85     0.16    0.159   0.0711 0.000981  0.0441
62 450  412  37.59     3.16    3.289   0.0214 0.109257  0.4865
94 388  411 -23.39    -1.97   -1.992   0.0223 0.044197 -0.3010
```

Figure 2. S+® output of regression model development using specific conductance (SC) as an explanatory variable for dissolved solids (DS) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

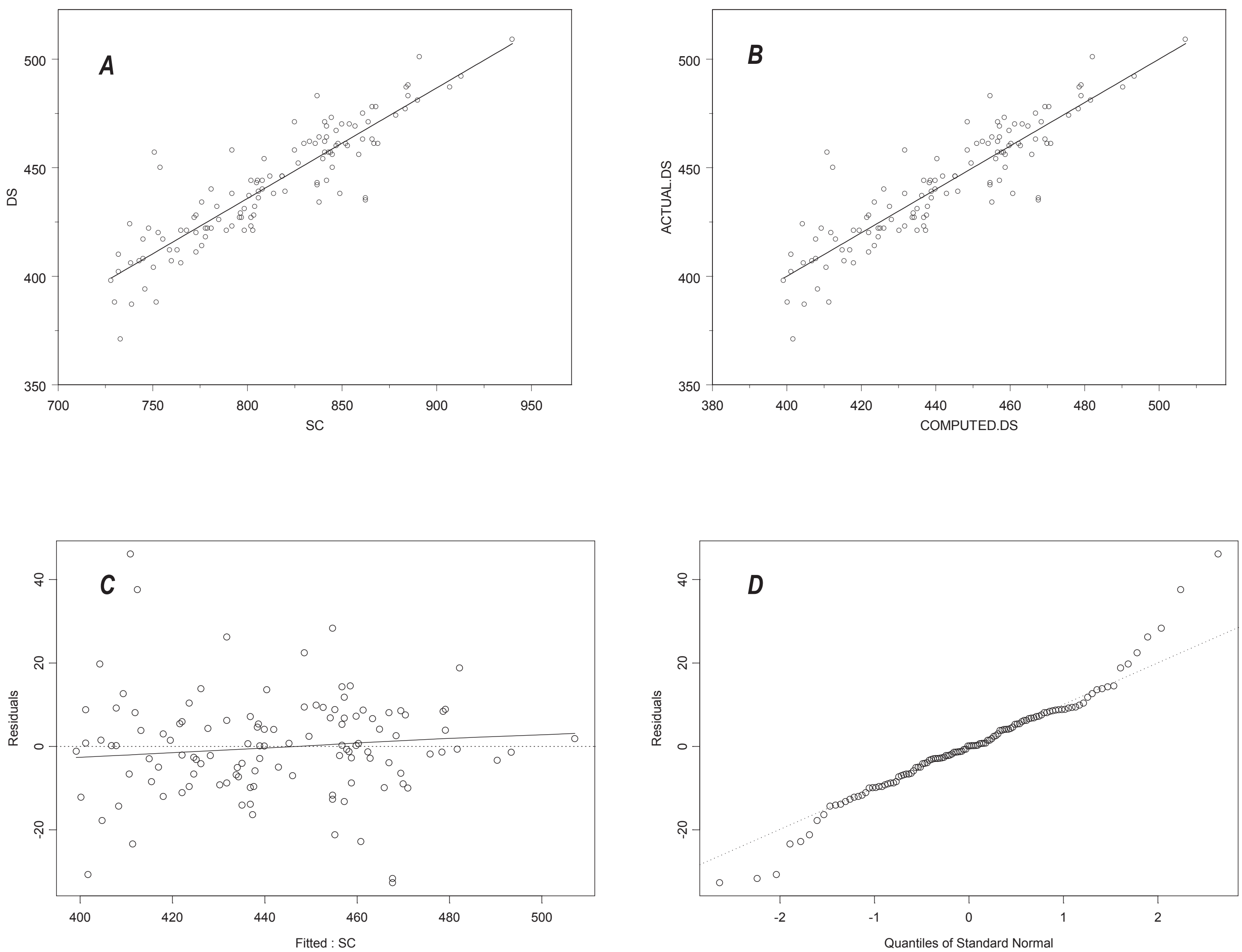

Figure 3. S+® output graphs from simple linear regression analysis showing *A*, specific conductance (SC) compared to dissolved solids (DS) concentrations; *B*, computed compared to actual DS concentrations; *C*, computed DS concentrations compared to regression residuals; and *D*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = NA ~ SC, data = NA, na.action = na.exclude)
Residuals:
    Min     1Q  Median    3Q   Max
 -13.03 -2.348 -0.1978 2.225 11.19

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept) -32.7950   7.2517    -4.5224   0.0000
         SC   0.1636   0.0089    18.3900   0.0000

Residual standard error: 4.501 on 117 degrees of freedom
Multiple R-Squared: 0.743      Adjusted R-squared: 0.7408
F-statistic: 338.2 on 1 and 117 degrees of freedom, the p-value is 0

Correlation of Coefficients:
   (Intercept)
SC -0.9984

Analysis of Variance Table

Response: NA

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value Pr(F)
       SC   1  6851.872 6851.872 338.1907     0
Residuals 117  2370.465   20.260

model.formula nvars   stderr    adjr2       Cp    press
      NA ~ SC     1 4.501153 74.07680 1.072877 2446.346

Test criteria
 leverage cooksD dfits
   0.0504  0.793 0.259
       Observations exceeding at least one test criterion
       NA  yhat resids stnd.res stud.res leverage  cooksD  dfits
 30 103.0 112.0  -9.03   -2.034   -2.062   0.0283 0.06026 -0.352
 31 105.0 112.8  -7.84   -1.770   -1.787   0.0312 0.05046 -0.321
 50 117.0 105.8  11.19    2.503    2.561   0.0128 0.04045  0.291
 55 117.0 107.0  10.05    2.249    2.289   0.0148 0.03791  0.280
 56 118.0 108.9   9.08    2.038    2.066   0.0191 0.04046  0.288
 57 124.0 115.6   8.37    1.901    1.923   0.0425 0.08017  0.405
 58 123.0 121.0   1.97    0.455    0.454   0.0708 0.00789  0.125
112  80.1  92.1 -11.96   -2.682   -2.757   0.0184 0.06752 -0.378
119  91.3 104.3 -13.03   -2.911   -3.010   0.0107 0.04594 -0.313
```

Figure 4. S+® output of regression model development using specific conductance (SC) as an explanatory variable for sodium (NA) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

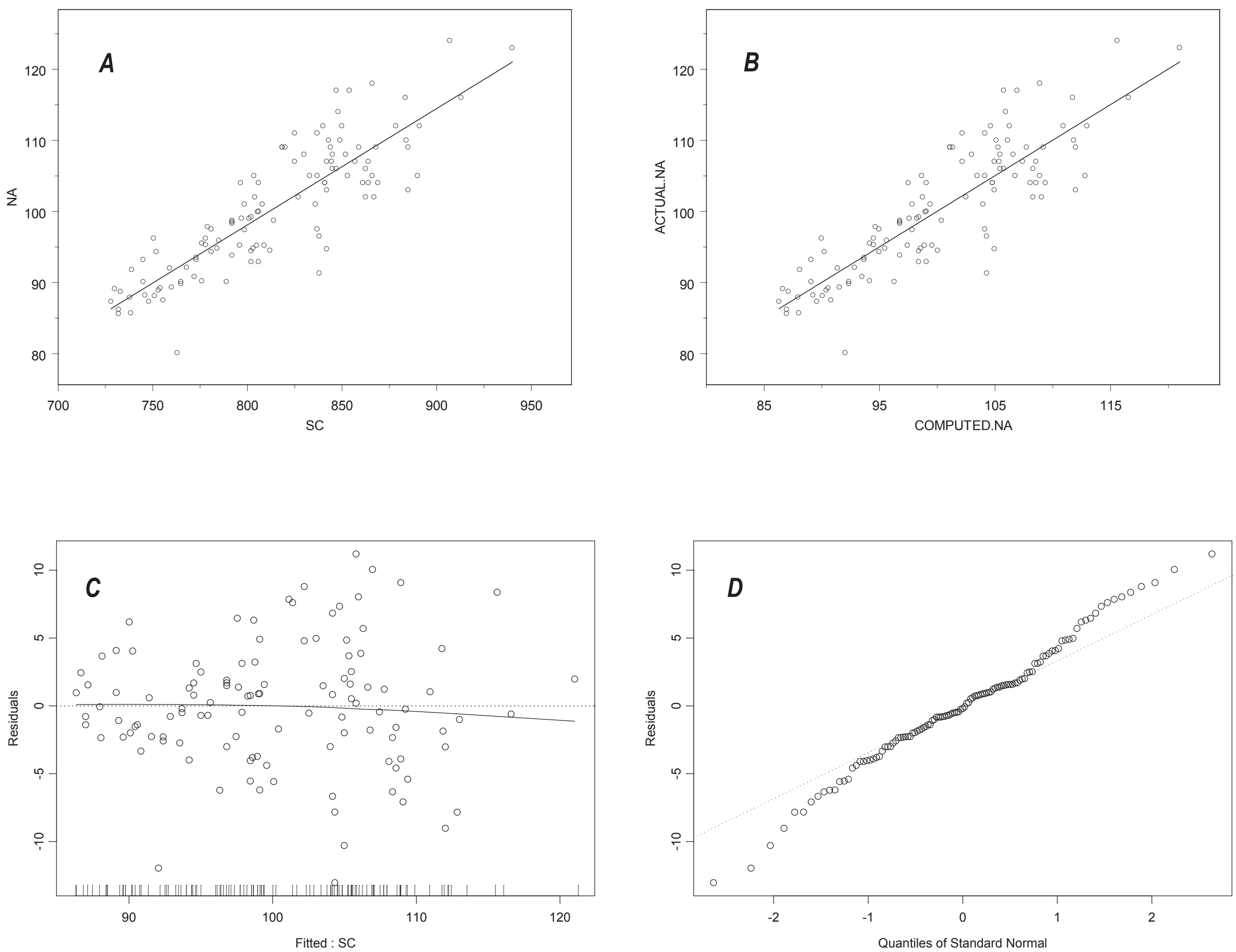

Figure 5. S+® output graphs from simple linear regression analysis showing *A*, specific conductance (SC) compared to sodium (NA) concentrations; *B*, computed compared to actual NA concentrations; *C*, computed NA concentrations compared to regression residuals; and *D*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = CL ~ ELV.1400 + SC, data = Chloride.Splus, na.action = na.exclude)
Residuals:
    Min     1Q Median   3Q   Max
 -19.12 -5.011 -1.034 4.83 22.14

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)  37.1865  21.4482     1.7338   0.0856
   ELV.1400  -3.0417   0.6166    -4.9331   0.0000
         SC   0.2009   0.0156    12.8762   0.0000

Residual standard error: 7.441 on 117 degrees of freedom
Multiple R-Squared: 0.6997      Adjusted R-squared: 0.6946
F-statistic: 136.3 on 2 and 117 degrees of freedom, the p-value is 0

Correlation of Coefficients:
         (Intercept) ELV.1400
ELV.1400 -0.8342
      SC -0.8167      0.3645

Analysis of Variance Table

Response: CL

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value Pr(F)
 ELV.1400   1  5916.637 5916.637 106.8499     0
       SC   1  9180.648 9180.648 165.7955     0
Residuals 117  6478.681   55.373

     model.formula nvars   stderr    adjr2       Cp    press
CL ~ ELV.1400 + SC     2 7.441327 69.45941  3.00000 6814.175

Variance inflation factors
ELV.1400      SC
 1.15317 1.15317

Test criteria
 leverage cooksD dfits
    0.075  0.844 0.316
       Observations exceeding at least one test criterion
    CL yhat resids stnd.res stud.res leverage  cooksD  dfits
11 162  147  14.54    1.983    2.008   0.0296 0.03999  0.351
18 157  135  22.14    3.000    3.109   0.0165 0.05023  0.402
19 146  128  17.72    2.416    2.468   0.0282 0.05653  0.421
24 138  118  20.46    2.792    2.877   0.0298 0.07980  0.504
33 137  134   3.44    0.484    0.483   0.0870 0.00745  0.149
58 166  164   1.59    0.223    0.222   0.0879 0.00160  0.069
59 160  146  14.36    1.994    2.020   0.0628 0.08875  0.523
60 166  169  -2.61   -0.366   -0.365   0.0849 0.00415 -0.111
62 130  133  -3.07   -0.429   -0.428   0.0763 0.00508 -0.123
63 120  113   7.00    0.979    0.979   0.0756 0.02612  0.280
64 120  109  10.61    1.475    1.482   0.0643 0.04977  0.388
```

Figure 6. S+® output of regression model development using reservoir elevation (ELV) and specific conductance (SC) as explanatory variables for chloride (CL) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

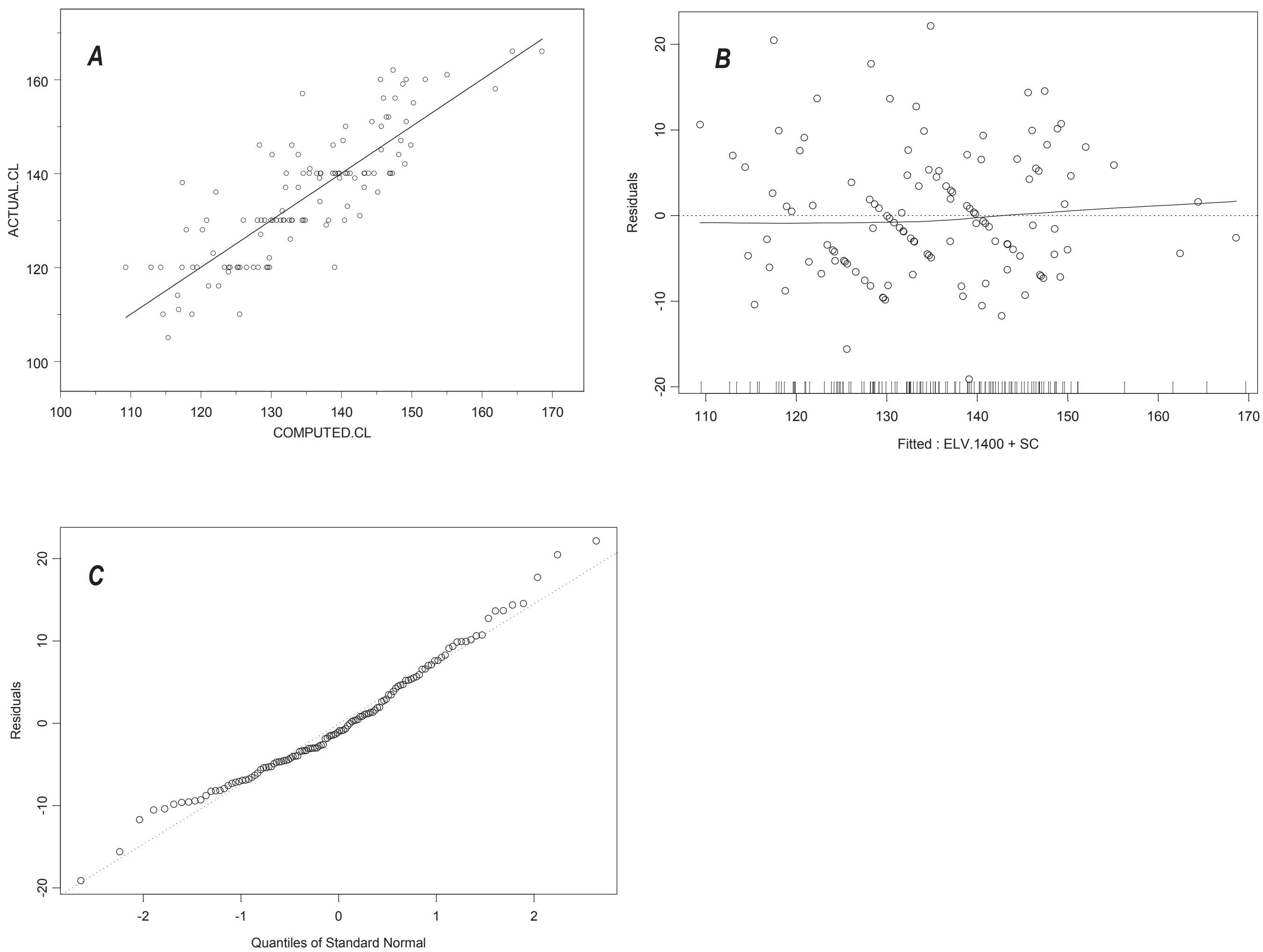

Figure 7. S+® output graphs from simple linear regression analysis using reservoir elevation (ELV) and specific conductance (SC) as explanatory variables for chloride (CL) showing *A*, computed compared to actual CL concentrations; *B*, computed CL concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
       *** Linear Model ***

Call: lm(formula = MG ~ LOGSC, data = MG, na.action = na.exclude)
Residuals:
    Min      1Q  Median     3Q   Max
 -1.477 -0.3616 0.02158 0.4144 1.395

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept) -69.8049   6.3200   -11.0451   0.0000
      LOGSC  28.6839   2.1723    13.2045   0.0000

Residual standard error: 0.5951 on 120 degrees of freedom
Multiple R-Squared: 0.5923      Adjusted R-squared: 0.5889
F-statistic: 174.4 on 1 and 120 degrees of freedom, the p-value is 0

Correlation of Coefficients:
      (Intercept)
LOGSC -1

Analysis of Variance Table

Response: MG

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq F Value Pr(F)
    LOGSC   1  61.75738 61.75738 174.359     0
Residuals 120  42.50360  0.35420

model.formula nvars    stderr    adjr2       Cp    press
   MG ~ LOGSC     1 0.5951443 58.89373 4.575412 43.91914

Test criteria
 leverage cooksD dfits
   0.0492  0.793 0.256
       Observations exceeding at least one test criterion
      MG yhat resids stnd.res stud.res leverage cooksD  dfits
 36 13.5 12.6  0.920    1.567    1.577   0.0266 0.0335  0.260
 39 13.4 12.3  1.074    1.838    1.857   0.0363 0.0637  0.360
 60 14.9 15.5 -0.576   -0.999   -0.999   0.0625 0.0333 -0.258
 78 13.3 14.5 -1.198   -2.033   -2.060   0.0200 0.0421 -0.294
 79 13.1 14.5 -1.369   -2.322   -2.366   0.0192 0.0528 -0.331
 80 13.3 14.4 -1.126   -1.909   -1.930   0.0181 0.0335 -0.262
114 11.4 12.9 -1.477   -2.504   -2.561   0.0177 0.0566 -0.344
115 11.7 13.0 -1.339   -2.266   -2.307   0.0141 0.0368 -0.276
```

Figure 8. S+® output of regression model development using specific conductance (SC) as an explanatory variable for magnesium (MG) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

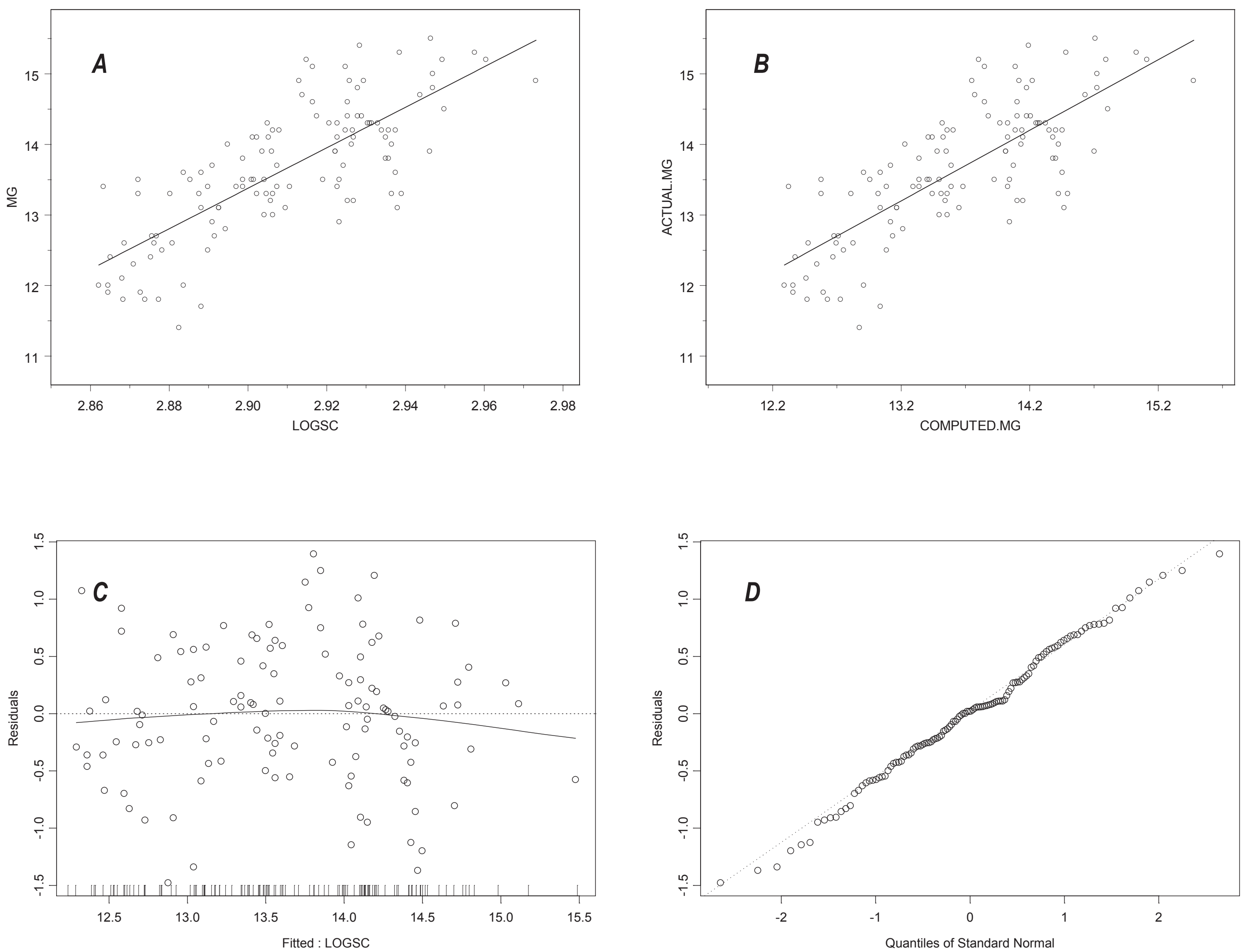

Figure 9. S+® output graphs from simple linear regression analysis showing *A*, log-transformed specific conductance (SC) compared to magnesium (MG) concentrations; *B*, computed compared to actual MG concentrations; *C*, computed MG concentrations compared to regression residuals; and *D*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = LOGTSS ~ LOGTBY + LOGCHL, data = TSS, na.action = na.exclude)
Residuals:
     Min       1Q  Median     3Q    Max
 -0.7339 -0.07061 0.04525 0.1526 0.5507

Coefficients:
             Value Std. Error t value Pr(>|t|)
(Intercept) 0.0215 0.1571     0.1368  0.8914
     LOGTBY 0.4807 0.0889     5.4085  0.0000
     LOGCHL 0.3030 0.0919     3.2985  0.0013

Residual standard error: 0.2571 on 118 degrees of freedom
Multiple R-Squared: 0.2183      Adjusted R-squared: 0.2051
F-statistic: 16.48 on 2 and 118 degrees of freedom, the p-value is 4.879e-007

Correlation of Coefficients:
       (Intercept)  LOGTBY
LOGTBY -0.8268
LOGCHL -0.7434      0.2668

Analysis of Variance Table

Response: LOGTSS

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value       Pr(F)
   LOGTBY   1  1.459163 1.459163 22.07895 0.000007141
   LOGCHL   1  0.719059 0.719059 10.88025 0.001285096

Residuals 118  7.798437 0.066088

           model.formula nvars    stderr    adjr2       Cp    press
LOGTSS ~ LOGTBY + LOGCHL     2 0.2570767 20.50832  3.00000 8.233660

Variance inflation factors
   LOGTBY   LOGCHL
 1.076635 1.076635

Test criteria
 leverage cooksD dfits
   0.0744  0.844 0.315
       Observations exceeding at least one test criterion
    LOGTSS  yhat  resids stnd.res stud.res leverage  cooksD   dfits
  3  0.301 0.994 -0.6934   -2.716   -2.793   0.0140 0.03493 -0.3329
 11  0.301 0.722 -0.4210   -1.688   -1.701   0.0585 0.05895 -0.4239
 12  0.602 0.323  0.2788    1.180    1.182   0.1556 0.08558  0.5076
 15  0.301 0.501 -0.2002   -0.811   -0.810   0.0770 0.01828 -0.2338
 21  0.301 0.748 -0.4473   -1.795   -1.813   0.0605 0.06923 -0.4601
 27  0.699 0.633  0.0664    0.269    0.268   0.0770 0.00201  0.0773
 42  0.301 0.870 -0.5691   -2.241   -2.281   0.0242 0.04153 -0.3592
 60  0.301 1.035 -0.7339   -2.925   -3.024   0.0473 0.14157 -0.6738
 62  1.146 0.671  0.4751    1.890    1.912   0.0443 0.05519  0.4114
 64  0.301 0.971 -0.6702   -2.641   -2.711   0.0254 0.06048 -0.4373
 65  0.301 0.907 -0.6056   -2.378   -2.426   0.0183 0.03507 -0.3310
 78  0.602 0.530  0.0717    0.292    0.291   0.0862 0.00268  0.0893
100  1.079 0.938  0.1412    0.571    0.569   0.0746 0.00876  0.1616
108  0.301 0.967 -0.6658   -2.623   -2.692   0.0252 0.05921 -0.4325
```

Figure 10. S+® output of regression model development using turbidity (TBY, YSI model 6026 sensor) and fluorescence (CHL) as explanatory variables for total suspended solids (TSS) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

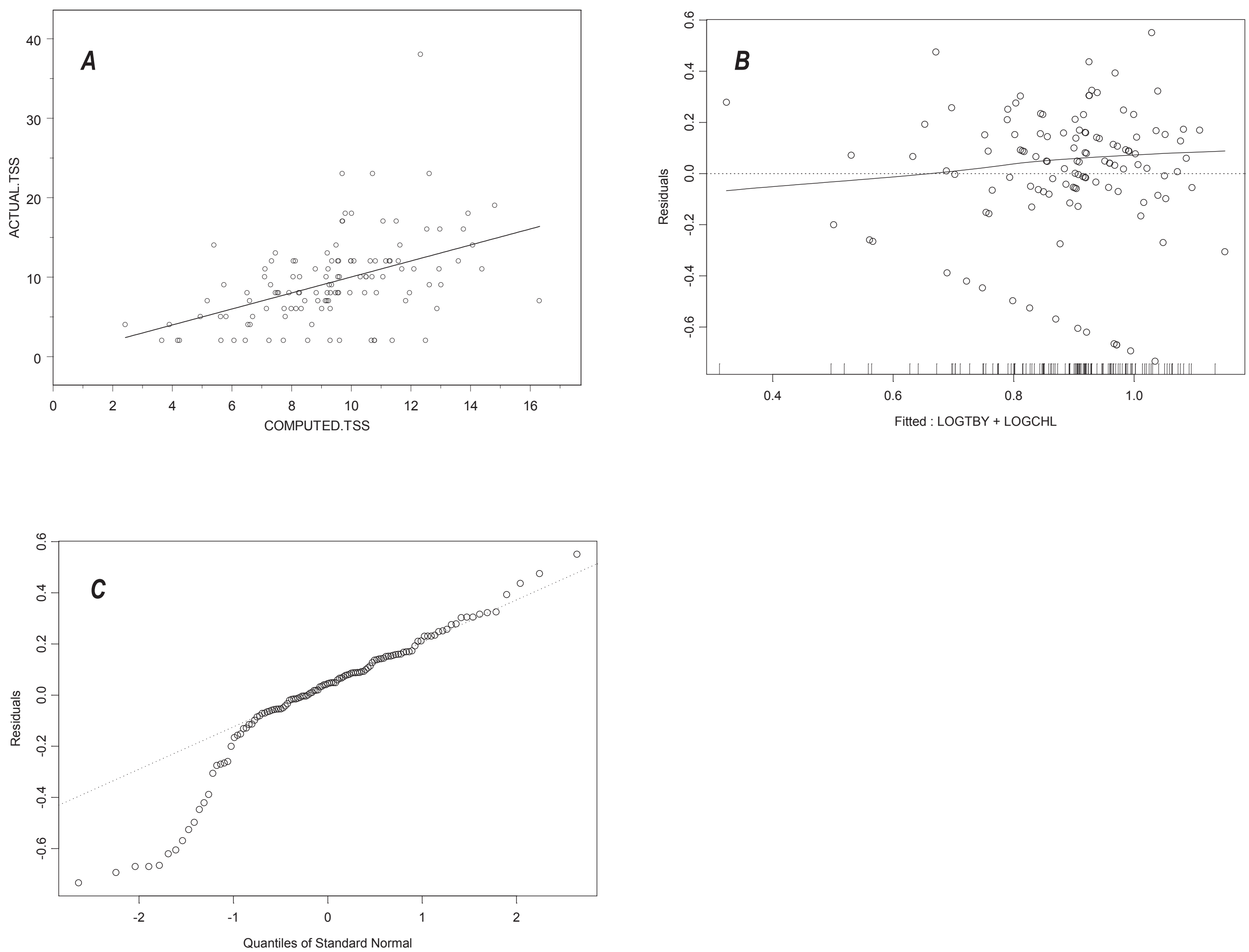

Figure 11. S+® output graphs from simple linear regression analysis using turbidity (TBY, YSI model 6026 sensor) and fluorescence (CHL) as explanatory variables for total suspended solids (TSS) showing *A*, computed compared to actual TSS concentrations; *B*, computed log-transformed TSS concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
       *** Linear Model ***

Call: lm(formula = SSC ~ TBY, data = SSC, na.action = na.exclude)
Residuals:
    Min     1Q Median    3Q   Max
 -13.54 -2.027 0.2694 1.951 12.79

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)  2.9310  0.8746     3.3512  0.0011
        TBY  0.6304  0.0421    14.9908  0.0000

Residual standard error: 4.133 on 117 degrees of freedom
Multiple R-Squared: 0.6576      Adjusted R-squared: 0.6547
F-statistic: 224.7 on 1 and 117 degrees of freedom, the p-value is 0

Correlation of Coefficients:
    (Intercept)
TBY -0.9013

Analysis of Variance Table

Response: SSC

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value Pr(F)
      TBY   1  3839.469 3839.469 224.7249     0
Residuals 117  1998.968   17.085

model.formula nvars   stderr    adjr2       Cp    press
    SSC ~ TBY     1 4.133424 65.46930 1.021886 2083.105

Test criteria
 leverage cooksD dfits
   0.0504  0.793 0.259
       Observations exceeding at least one test criterion
    SSC yhat resids stnd.res stud.res leverage cooksD  dfits
 19  33 22.5  10.53     2.58     2.64  0.02395 0.0815  0.414
 35   2 15.5 -13.54    -3.29    -3.44  0.00857 0.0467 -0.320
 44  34 24.4   9.64     2.37     2.42  0.03249 0.0943  0.443
 62  11 20.0  -8.95    -2.18    -2.22  0.01546 0.0374 -0.278
 64   8 18.7 -10.69    -2.60    -2.67  0.01245 0.0427 -0.300
 72  34 21.2  12.79     3.12     3.25  0.01929 0.0960  0.456
 81  36 29.4   6.59     1.65     1.66  0.06437 0.0935  0.436
 93  26 33.2  -7.19    -1.83    -1.85  0.09698 0.1799 -0.606
106  17 24.4  -7.36    -1.81    -1.83  0.03249 0.0551 -0.335
107  35 25.6   9.37     2.31     2.36  0.03922 0.1093  0.477
```

Figure 12. S+® output of regression model development using turbidity (TBY, YSI model 6026 sensor) as an explanatory variable for suspended sediment concentrations (SSC) for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

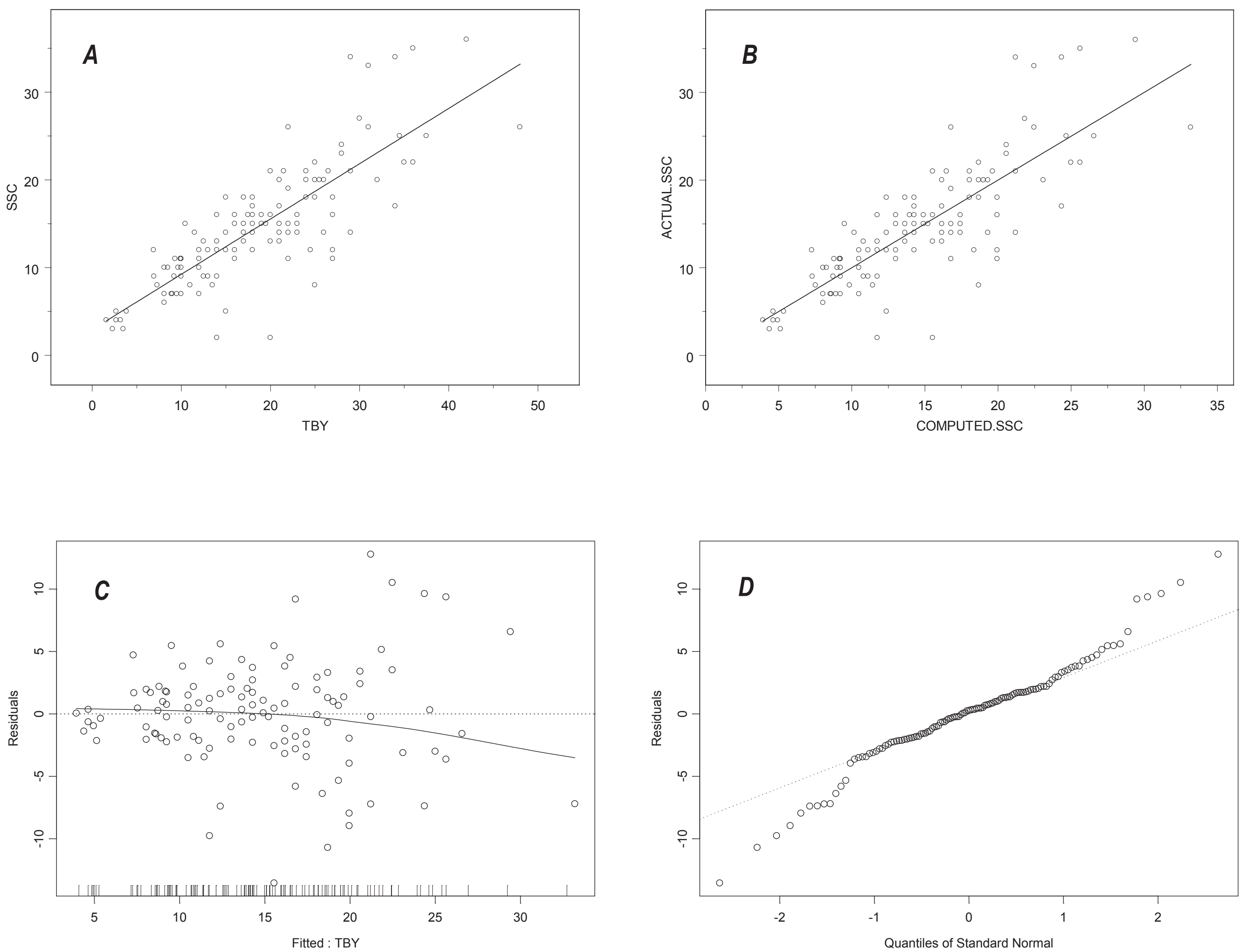

Figure 13. S+® output graphs from simple linear regression analysis showing *A*, turbidity (TBY, YSI model 6026 sensor) compared to suspended-solids concentration (SSC) data; *B*, computed compared to actual SSC; *C*, comparison of estimated SSC and regression residuals; and *D*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
*** Linear Model ***

Call: lm(formula = TKN ~ TBY + DO + T, data = TKN, na.action = na.exclude)
Residuals:
     Min       1Q   Median      3Q    Max
 -0.3653 -0.08153 -0.01264 0.07024 0.3696

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept) -0.2437  0.1342    -1.8153  0.0720
        TBY  0.0045  0.0014     3.1593  0.0020
         DO  0.0608  0.0090     6.7441  0.0000
          T  0.0197  0.0027     7.2028  0.0000

Residual standard error: 0.1271 on 118 degrees of freedom
Multiple R-Squared: 0.3293      Adjusted R-squared: 0.3123
F-statistic: 19.31 on 3 and 118 degrees of freedom, the p-value is 2.954e-010

Correlation of Coefficients:
    (Intercept)     TBY      DO
TBY -0.4280
 DO -0.9739      0.3204
  T -0.8942      0.0984  0.8574

Analysis of Variance Table

Response: TKN

Terms added sequentially (first to last)
           Df Sum of Sq   Mean Sq  F Value     Pr(F)
      TBY   1  0.078261 0.0782607  4.84373 0.0296935
       DO   1  0.019716 0.0197158  1.22026 0.2715575
        T   1  0.838246 0.8382458 51.88094 0.0000000
Residuals 118  1.906538 0.0161571

     model.formula nvars    stderr     adjr2       Cp    press
TKN ~ TBY + DO + T     3 0.1271106 31.228481  4.00000 2.108368

Variance inflation factors
      TBY      DO        T
 1.282006 4.79267 4.342717

Test criteria
 leverage cooksD dfits
   0.0984  0.875 0.362
       Observations exceeding at least one test criterion
    TKN  yhat  resids stnd.res stud.res leverage cooksD  dfits
 3 0.61 0.975 -0.3653   -2.987   -3.094   0.0745 0.1796 -0.878
 5 0.46 0.772 -0.3121   -2.489   -2.546   0.0265 0.0422 -0.420
 8 1.20 0.929  0.2705    2.205    2.243   0.0685 0.0894  0.608
15 1.40 1.050  0.3501    2.971    3.075   0.1401 0.3594  1.241
18 1.30 0.930  0.3696    2.984    3.090   0.0507 0.1190  0.714
19 1.20 1.131  0.0687    0.598    0.596   0.1838 0.0201  0.283
28 0.58 0.801 -0.2207   -1.807   -1.825   0.0773 0.0684 -0.528
52 1.20 0.899  0.3009    2.423    2.475   0.0452 0.0694  0.538
53 0.90 0.640  0.2598    2.087    2.118   0.0412 0.0468  0.439
58 0.94 0.675  0.2649    2.116    2.149   0.0303 0.0350  0.380
83 0.97 0.753  0.2165    1.776    1.793   0.0804 0.0690  0.530
96 0.65 0.815 -0.1655   -1.382   -1.387   0.1121 0.0603 -0.493
99 0.34 0.607 -0.2675   -2.151   -2.185   0.0434 0.0525 -0.466
```

Figure 14. S+® output of regression model development using turbidity (TBY, YSI model 6026 sensor), dissolved oxygen (DO), and water temperature (T) as explanatory variables for total Kjeldahl nitrogen (TKN) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

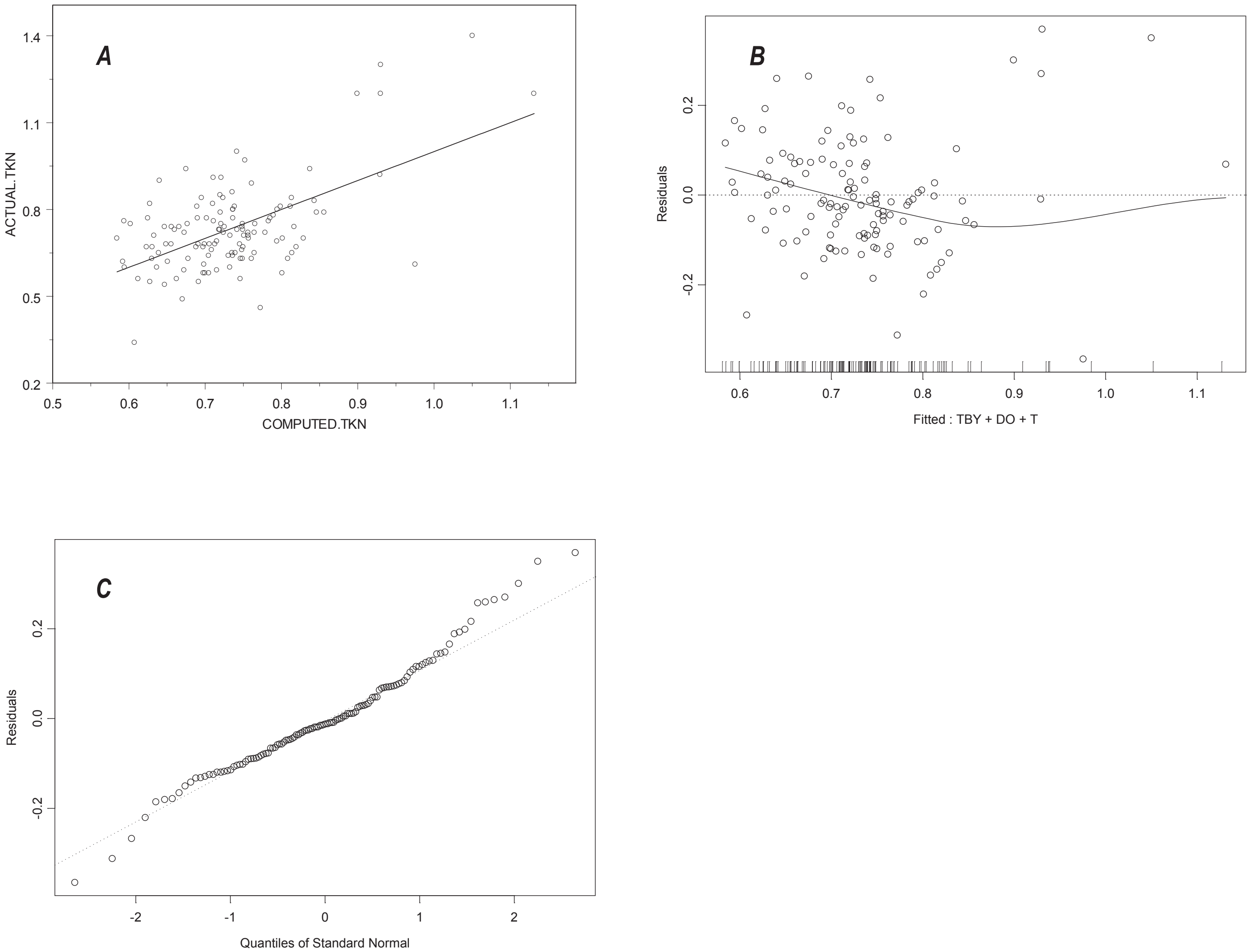

Figure 15. S+® output graphs from simple linear regression analysis using turbidity (TBY, YSI model 6026 sensor), dissolved oxygen (DO), and water temperature (T) as explanatory variables for total Kjeldahl nitrogen (TKN) showing *A*, computed compared to actual TKN concentrations; *B*, computed TKN concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = LOGNO3NO2 ~ PH + SC, data = NO3NO2, na.action = na.exclude)
Residuals:
    Min      1Q  Median     3Q    Max
 -1.077 -0.3307 0.05465 0.3194 0.8815

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)  5.8934  1.6309     3.6137  0.0004
         PH -0.5585  0.1927    -2.8985  0.0045
         SC -0.0026  0.0009    -2.9664  0.0036

Residual standard error: 0.4471 on 119 degrees of freedom
Multiple R-Squared: 0.1546      Adjusted R-squared: 0.1404
F-statistic: 10.88 on 2 and 119 degrees of freedom, the p-value is 0.00004564

Correlation of Coefficients:
   (Intercept)      PH
PH -0.9011
SC -0.2343     -0.2098

Analysis of Variance Table

Response: LOGNO3NO2

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value       Pr(F)
       PH   1   2.59224 2.592243 12.96711 0.000463536
       SC   1   1.75910 1.759104  8.79952 0.003642422
Residuals 119  23.78918 0.199909

      model.formula nvars    stderr     adjr2       Cp    press
LOGNO3NO2 ~ PH + SC     2 0.4471119 14.042130 3.000000 25.33309

Variance inflation factors
       PH       SC
 1.046048 1.046048

Test criteria
 leverage cooksD dfits
   0.0738  0.844 0.314
       Observations exceeding at least one test criterion
   LOGNO3NO2   yhat resids stnd.res stud.res leverage cooksD  dfits
11    -2.000 -1.309 -0.691    -1.58    -1.59   0.0384 0.0331 -0.317
12    -2.000 -0.923 -1.077    -2.51    -2.56   0.0753 0.1705 -0.732
14    -2.000 -1.164 -0.836    -1.93    -1.95   0.0578 0.0758 -0.482
18    -2.000 -1.098 -0.902    -2.05    -2.08   0.0320 0.0463 -0.378
25    -1.699 -0.756 -0.943    -2.14    -2.17   0.0273 0.0427 -0.364
26    -1.222 -0.385 -0.837    -1.98    -2.00   0.1019 0.1475 -0.674
35    -0.244 -0.969  0.725     1.68     1.69   0.0681 0.0686  0.457
60    -0.745 -1.387  0.642     1.49     1.50   0.0698 0.0555  0.410
```

Figure 16. S+® output of linear regression model development of pH (PH) and specific conductance (SC) as explanatory variables for nitrate plus nitrite (NO3NO2) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

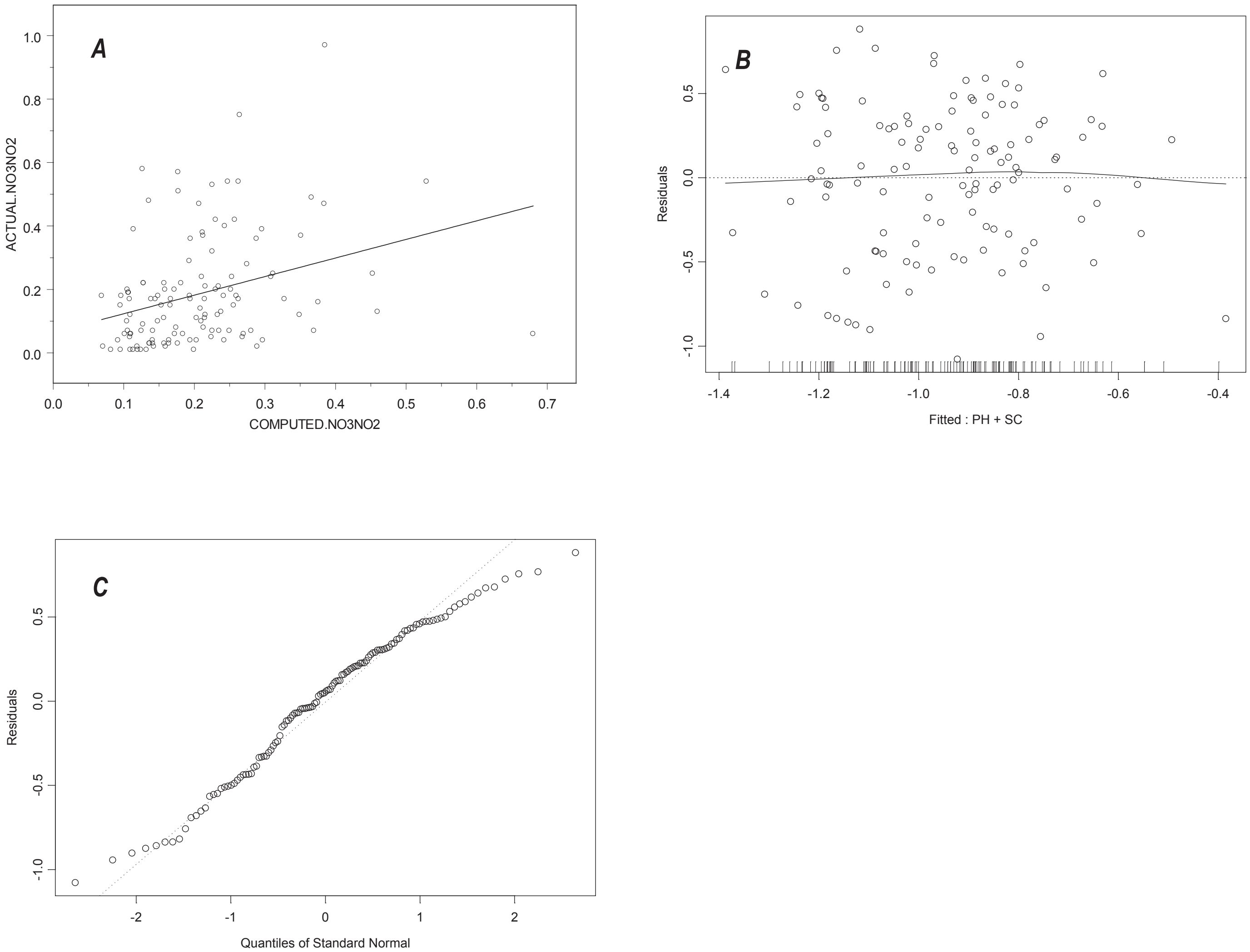

Figure 17. S+® output graphs from simple linear regression analysis using pH (PH) and specific conductance (SC) as explanatory variables for nitrate plus nitrite (NO3NO2) showing *A*, computed compared to actual NO3NO2 concentrations; *B*, computed log-transformed NO3NO2 concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = LOGTP ~ SIN + COS + LOGTBY, data = TP, na.action = na.exclude)
Residuals:
     Min       1Q   Median      3Q    Max
 -0.4324 -0.08188 0.002713 0.08266 0.2911

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)  -1.6626   0.0618   -26.9105   0.0000
        SIN  -0.0663   0.0190    -3.4862   0.0007
        COS  -0.1357   0.0218    -6.2154   0.0000
     LOGTBY   0.4390   0.0520     8.4405   0.0000

Residual standard error: 0.1364 on 105 degrees of freedom
Multiple R-Squared: 0.6918      Adjusted R-squared: 0.683
F-statistic: 78.58 on 3 and 105 degrees of freedom, the p-value is 0

Correlation of Coefficients:
       (Intercept)     SIN     COS
   SIN -0.2424
   COS -0.3435     -0.0018
LOGTBY -0.9747      0.2411  0.4197

Analysis of Variance Table

Response: LOGTP

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value         Pr(F)
      SIN   1  0.909736 0.909736  48.9103 2.581102e-010
      COS   1  2.149665 2.149665 115.5728 0.000000e+000
   LOGTBY   1  1.325118 1.325118  71.2426 1.874000e-013
Residuals 105  1.953010 0.018600

             model.formula nvars    stderr    adjr2        Cp    press
LOGTP ~ SIN + COS + LOGTBY     3 0.1363822 68.30295   4.00000 2.119644

Variance inflation factors
      SIN      COS  LOGTBY
 1.076425 1.230612 1.30656

Test criteria
 leverage cooksD dfits
     0.11  0.876 0.383
       Observations exceeding at least one test criterion
    LOGTP   yhat resids stnd.res stud.res leverage cooksD  dfits
  1 -1.22 -0.958 -0.264   -1.986   -2.015   0.0489 0.0507 -0.457
 12 -1.82 -1.719 -0.105   -0.818   -0.817   0.1191 0.0226 -0.300
 13 -1.30 -1.561  0.260    1.974    2.002   0.0651 0.0678  0.528
 36 -1.82 -1.391 -0.432   -3.235   -3.394   0.0396 0.1079 -0.689
 37 -1.82 -1.567 -0.257   -1.947   -1.974   0.0658 0.0668 -0.524
 49 -1.06 -1.347  0.291    2.181    2.222   0.0422 0.0524  0.466
 66 -1.82 -1.619 -0.205   -1.565   -1.576   0.0761 0.0505 -0.452
 67 -1.82 -1.647 -0.177   -1.357   -1.363   0.0877 0.0443 -0.423
 68 -1.82 -1.451 -0.373   -2.786   -2.882   0.0376 0.0759 -0.570
109 -1.00 -1.248  0.248    1.864    1.887   0.0472 0.0431  0.420
```

Figure 18. S+® output of regression model development using season (SIN and COS) and turbidity (TBY, YSI model 6026 sensor) as explanatory variables for total phosphorus (TP) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

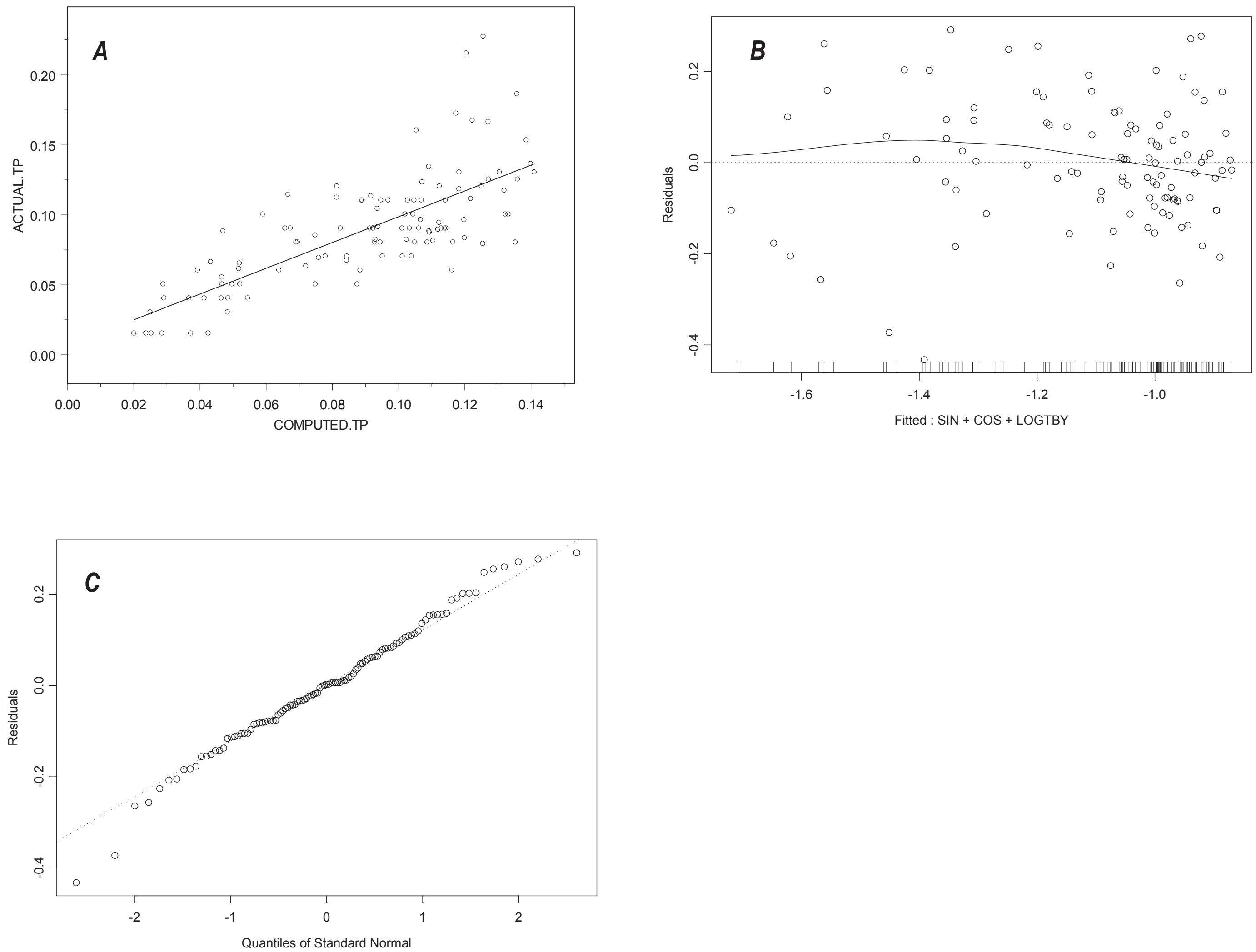

Figure 19. S+® output graphs from simple linear regression analysis using season (SIN and COS) and turbidity (TBY, YSI model 6026 sensor) as explanatory variables for total phosphorus (TP) showing *A*, computed compared to actual TP concentrations; *B*, computed log-transformed TP concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
       *** Linear Model ***

Call: lm(formula = LOGOP ~ LOGTBY + T + LOGCHL, data = OP, na.action = na.exclude)
Residuals:
    Min      1Q  Median     3Q    Max
 -0.927 -0.1352 0.02488 0.1766 0.6298

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)  -2.0430   0.1788   -11.4243   0.0000
     LOGTBY   0.4942   0.1023     4.8324   0.0000
          T   0.0189   0.0036     5.2416   0.0000
     LOGCHL  -0.5408   0.1116    -4.8479   0.0000

Residual standard error: 0.2662 on 109 degrees of freedom
Multiple R-Squared: 0.6552      Adjusted R-squared: 0.6457
F-statistic: 69.04 on 3 and 109 degrees of freedom, the p-value is 0

Correlation of Coefficients:
       (Intercept)  LOGTBY       T
LOGTBY -0.5819
     T -0.3155     -0.4206
LOGCHL -0.7961      0.0719  0.4377

Analysis of Variance Table

Response: LOGOP

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value        Pr(F)
   LOGTBY   1  8.258913 8.258913 116.5335 0.00000e+000
        T   1  4.753859 4.753859  67.0771 1.00000e-012
   LOGCHL   1  1.665614 1.665614  23.5018 4.16733e-006
Residuals 109  7.725004 0.070872

              model.formula nvars    stderr    adjr2       Cp     press
LOGOP ~ LOGTBY + T + LOGCHL     3 0.2662172 64.56956  4.00000  8.398949

Variance inflation factors
   LOGTBY        T   LOGCHL
 1.347654 1.658468 1.372232

Test criteria
 leverage cooksD dfits
    0.106  0.876 0.376
      Observations exceeding at least one test criterion
    LOGOP  yhat  resids stnd.res stud.res leverage   cooksD   dfits
  7 -2.30 -1.37 -0.9270  -3.5398  -3.7454   0.0323 0.104406 -0.6838
 12 -2.30 -2.28 -0.0181  -0.0747  -0.0744   0.1737 0.000293 -0.0341
 14 -2.30 -1.74 -0.5616  -2.2230  -2.2647   0.0993 0.136239 -0.7521
 15 -1.22 -1.61  0.3893   1.5146   1.5237   0.0676 0.041578  0.4103
 47 -2.30 -1.46 -0.8410  -3.2096  -3.3574   0.0312 0.082914 -0.6024
 74 -2.30 -1.69 -0.6070  -2.3191  -2.3675   0.0334 0.046500 -0.4403
 81 -1.30 -1.68  0.3784   1.4793   1.4876   0.0770 0.045617  0.4295
113 -1.15 -1.78  0.6298   2.4894   2.5516   0.0970 0.166363  0.8361
```

Figure 20. S+® output of regression model development using turbidity (TBY, YSI model 6026 sensor), water temperature (T), and fluorescence (CHL) as explanatory variables for orthophosphate (OP) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

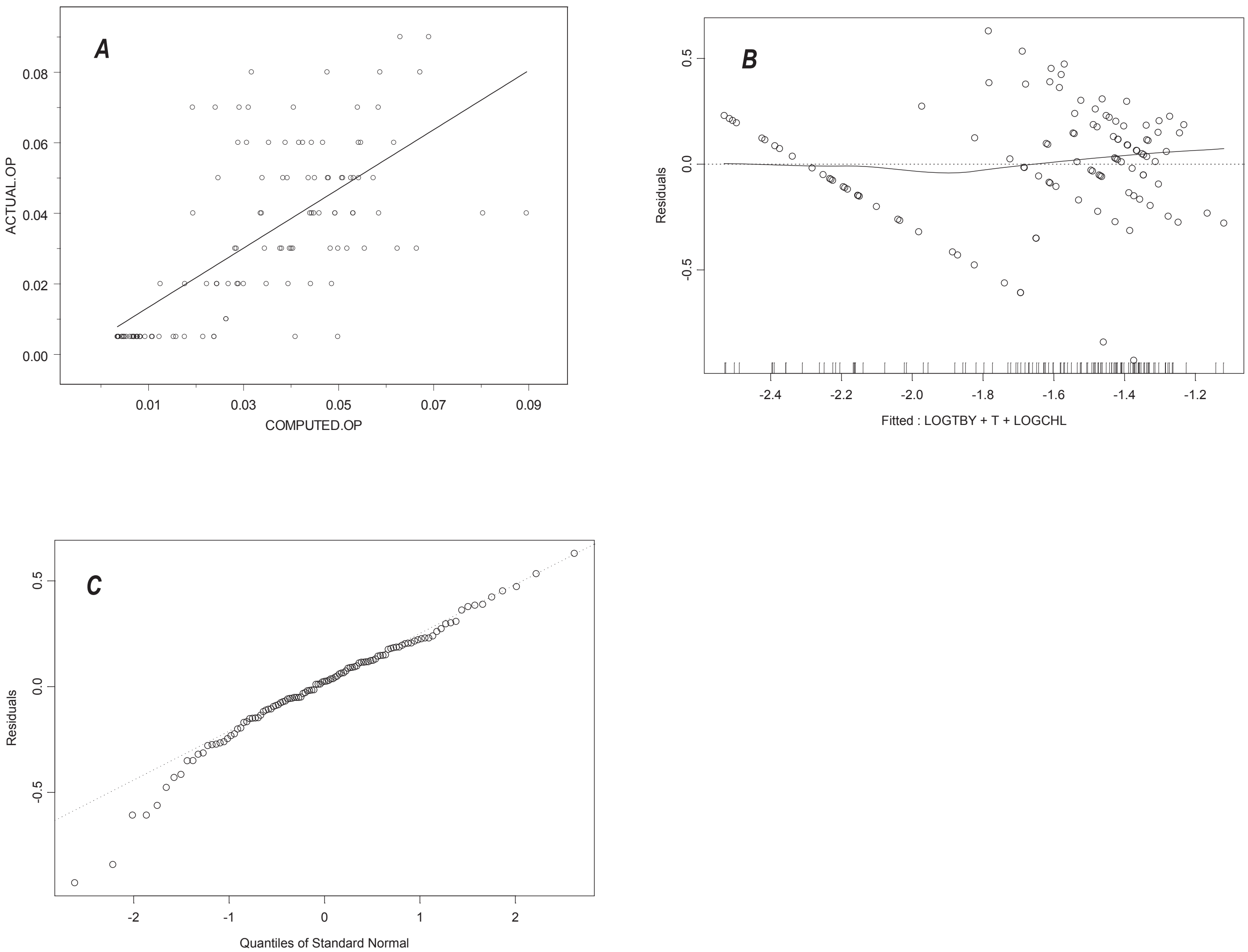

Figure 21. S+® output graphs from simple linear regression analysis using turbidity (TBY, YSI model 6026 sensor), water temperature (T), and fluorescence (CHL) as explanatory variables for orthophosphate (OP) showing *A*, computed compared to actual OP concentrations; *B*, computed log-transformed OP concentrations and regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = LOGDP ~ LOGDO + SC + CHL, data = DP,na.action = na.exclude)
Residuals:
    Min       1Q  Median     3Q    Max
 -0.642 -0.09622 0.03565 0.1162 0.4633

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept)  1.0851  0.3671     2.9560  0.0038
      LOGDO -0.8764  0.2121    -4.1329  0.0001
         SC -0.0019  0.0005    -3.5470  0.0006
        CHL -0.0137  0.0035    -3.8822  0.0002

Residual standard error: 0.2056 on 105 degrees of freedom
Multiple R-Squared: 0.5858      Adjusted R-squared: 0.5739
F-statistic: 49.49 on 3 and 105 degrees of freedom, the p-value is 0

Correlation of Coefficients:
      (Intercept)   LOGDO      SC
LOGDO  0.0879
   SC -0.9058     -0.4928
  CHL  0.1305     -0.5342  0.0480

Analysis of Variance Table

Response: LOGDP

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value       Pr(F)
    LOGDO   1  5.163193 5.163193 122.0919 0.000000000
       SC   1  0.478769 0.478769  11.3212 0.001070848
      CHL   1  0.637355 0.637355  15.0713 0.000181166
Residuals 105  4.440386 0.042289

           model.formula nvars    stderr    adjr2       Cp    press
LOGDP ~ LOGDO + SC + CHL     3 0.2056439 57.39383  4.00000 4.794384

Variance inflation factors
    LOGDO      SC      CHL
 2.016798 1.44452 1.530531

Test criteria
 leverage cooksD dfits
     0.11  0.876 0.383
       Observations exceeding at least one test criterion
    LOGDP   yhat  resids stnd.res stud.res leverage  cooksD   dfits
  6 -1.22 -1.567  0.3450    1.743    1.761   0.0741 0.06077  0.4979
 14 -1.82 -1.182 -0.6420   -3.158   -3.304   0.0228 0.05819 -0.5047
 15 -1.16 -1.525  0.3643    1.828    1.849   0.0607 0.05393  0.4698
 22 -1.52 -1.068 -0.4549   -2.244   -2.289   0.0287 0.03723 -0.3936
 25 -1.25 -0.916 -0.3357   -1.684   -1.699   0.0599 0.04516 -0.4288
 34 -1.82 -1.292 -0.5320   -2.652   -2.732   0.0484 0.08933 -0.6159
 35 -1.82 -1.261 -0.5632   -2.786   -2.881   0.0338 0.06786 -0.5388
 45 -1.17 -1.127 -0.0473   -0.244   -0.243   0.1127 0.00189 -0.0867
 78 -1.22 -1.465  0.2428    1.247    1.250   0.1033 0.04477  0.4243
109 -1.05 -1.509  0.4633    2.323    2.374   0.0600 0.08607  0.5996
```

Figure 22. S+® output of regression model development using dissolved oxygen (DO), specific conductance (SC), and fluorescence (CHL) as explanatory variables for dissolved phosphorus (DP) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

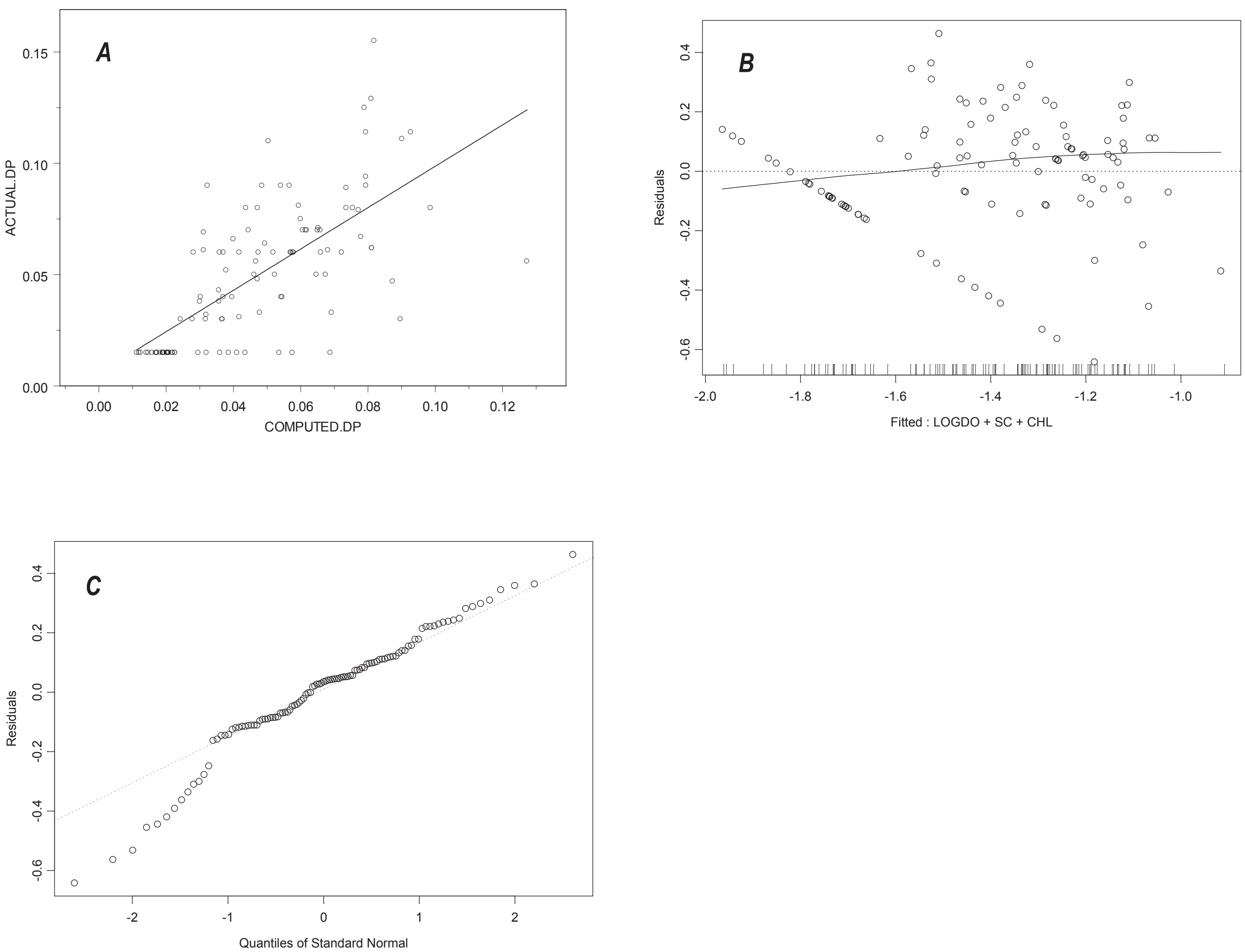

Figure 23. S+® output graphs from simple linear regression analysis using dissolved oxygen (DO), specific conductance (SC), and fluorescence (CHL) as explanatory variables for dissolved phosphorus (DP) showing *A*, computed compared to actual DP concentrations; *B*, computed log-transformed DP concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = CHLA ~ ELV.1400 + T + CHL, data = Chlorophyll.a.Splus, na.action = na.exclude)
Residuals:
    Min     1Q Median    3Q   Max
 -14.76 -3.129 0.1915 3.852 19.21

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept)  40.2468  10.0971     3.9860   0.0001
   ELV.1400  -1.9656   0.4722    -4.1623   0.0001
          T   0.3204   0.0741     4.3229   0.0000
        CHL   0.8463   0.0834    10.1493   0.0000

Residual standard error: 6.223 on 113 degrees of freedom
Multiple R-Squared: 0.5078      Adjusted R-squared: 0.4947
F-statistic: 38.86 on 3 and 113 degrees of freedom, the p-value is 0

Correlation of Coefficients:
         (Intercept) ELV.1400       T
ELV.1400 -0.9812
       T -0.0215     -0.1457
     CHL -0.0859     -0.0651   0.4820

Analysis of Variance Table

Response: CHLA

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value     Pr(F)
 ELV.1400   1   508.790  508.790  13.1379 0.0004353
        T   1    16.334   16.334   0.4218 0.5173755
      CHL   1  3989.229 3989.229 103.0088 0.0000000
Residuals 113  4376.157   38.727

            model.formula nvars   stderr     adjr2        Cp    press
CHLA ~ ELV.1400 + T + CHL     3 6.223106 49.470410   4.00000 4759.741

Variance inflation factors
 ELV.1400       T      CHL
 1.021719 1.32527 1.302671

Test criteria
 leverage cooksD dfits
    0.103  0.876  0.37
       Observations exceeding at least one test criterion
   CHLA  yhat resids stnd.res stud.res leverage cooksD  dfits
 1  3.0 12.69  -9.69   -1.631   -1.643   0.0891 0.0651 -0.514
 2 10.4  6.01   4.39    0.746    0.745   0.1058 0.0165  0.256
 3  6.1 20.86 -14.76   -2.407   -2.460   0.0287 0.0428 -0.423
 9  7.3 17.99 -10.69   -1.759   -1.776   0.0460 0.0373 -0.390
11  7.6 18.84 -11.24   -1.847   -1.867   0.0427 0.0380 -0.394
15 12.2 25.81 -13.61   -2.257   -2.299   0.0605 0.0819 -0.583
52 41.2 21.99  19.21    3.164    3.300   0.0487 0.1283  0.747
53 31.3 17.69  13.61    2.238    2.279   0.0445 0.0583  0.492
58 20.2 33.74 -13.54   -2.318   -2.365   0.1192 0.1819 -0.870
95 47.2 39.55   7.65    1.387    1.393   0.2138 0.1308  0.726
```

Figure 24. S+® output of regression model development using reservoir elevation (ELV), water temperature (T), and fluorescence (CHL) as explanatory variables for chlorophyll-*a* (CHLA) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

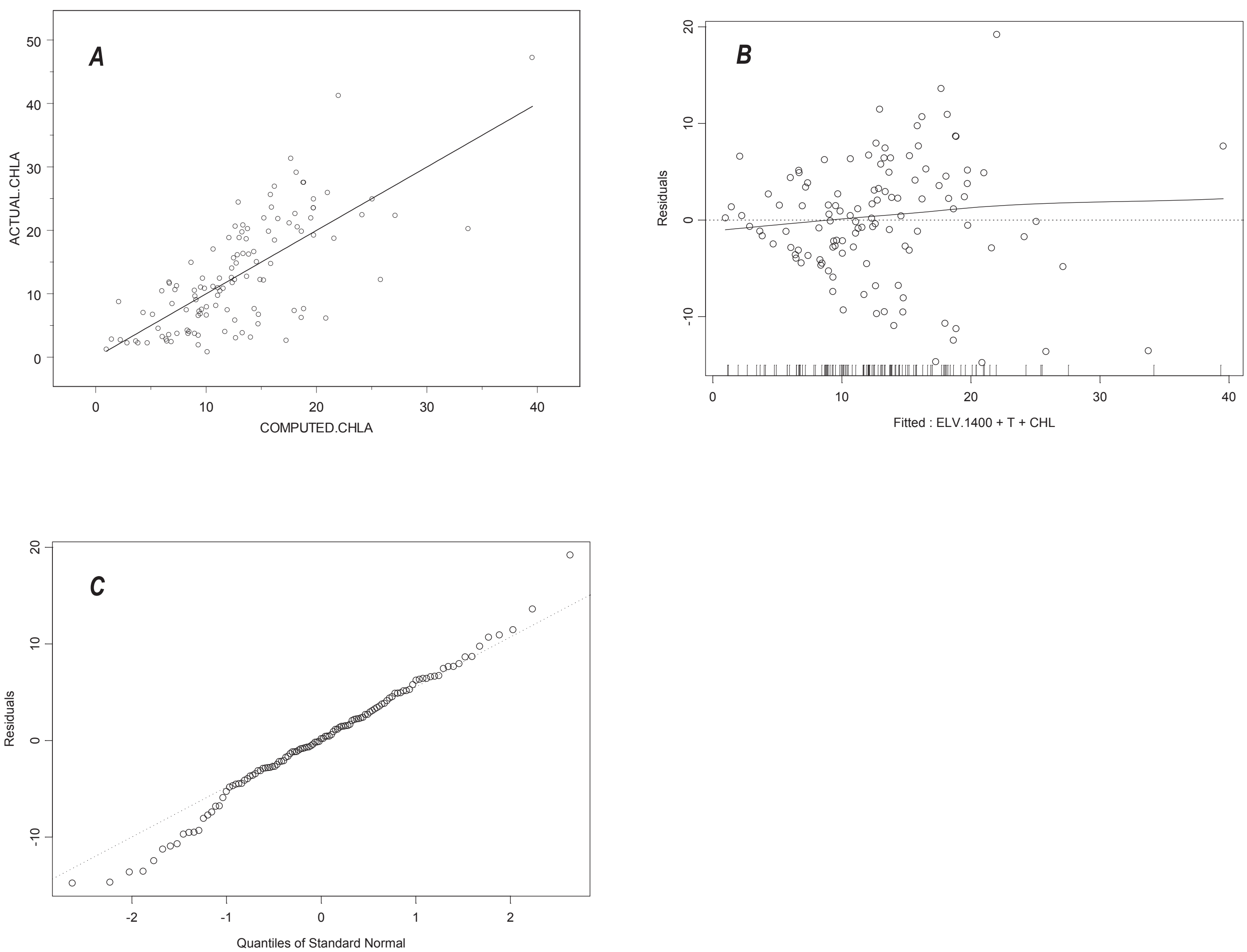

Figure 25. S+® output graphs from simple linear regression analysis using reservoir elevation (ELV), water temperature (T), and fluorescence (CHL) as explanatory variables for chlorophyll-*a* (CHLA) showing *A*, computed compared to actual CHLA concentrations; *B*, computed CHLA concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
             *** Linear Model ***

Call: lm(formula = LOGACT ~ LOGELV.1400 + LOGTBY + T, data = Actinomycetes.Splus,
      na.action = na.exclude)
Residuals:
    Min      1Q   Median     3Q    Max
 -1.089 -0.1621 0.004718 0.1837 0.5495

Coefficients:
               Value Std. Error  t value Pr(>|t|)
(Intercept) -14.9286   1.6263    -9.1797   0.0000
LOGELV.1400  11.0619   1.2383     8.9335   0.0000
     LOGTBY   0.9924   0.1572     6.3112   0.0000
          T  -0.0163   0.0041    -4.0136   0.0001

Residual standard error: 0.3021 on 89 degrees of freedom
Multiple R-Squared: 0.6076      Adjusted R-squared: 0.5944
F-statistic: 45.94 on 3 and 89 degrees of freedom, the p-value is 0

Correlation of Coefficients:
            (Intercept) LOGELV.1400  LOGTBY
LOGELV.1400 -0.9940
     LOGTBY  0.0380     -0.1379
          T  0.1023     -0.0994     -0.3799

Analysis of Variance Table

Response: LOGACT

Terms added sequentially (first to last)
            Df Sum of Sq  Mean Sq  F Value        Pr(F)
LOGELV.1400  1  8.662210 8.662210 94.94122 0.0000000000
     LOGTBY  1  2.442792 2.442792 26.77396 0.0000014012
          T  1  1.469750 1.469750 16.10904 0.0001244246
  Residuals 89  8.120147 0.091238

                    model.formula nvars    stderr    adjr2       Cp     press
LOGACT ~ LOGELV.1400 + LOGTBY + T     3 0.3020556 59.43996  4.00000 12.554020

Variance inflation factors
 LOGELV.1400   LOGTBY        T
    1.048162 1.212831 1.201626

Test criteria
 leverage cooksD dfits
    0.129  0.877 0.415
       Observations exceeding at least one test criterion
   LOGACT  yhat resids stnd.res stud.res leverage cooksD  dfits
15  0.000 0.213 -0.213   -0.758   -0.756   0.1309 0.0216 -0.293
25 -0.301 0.236 -0.537   -1.832   -1.857   0.0590 0.0526 -0.465
27  0.778 0.242  0.536    1.834    1.859   0.0634 0.0569  0.484
30 -0.301 0.393 -0.694   -2.471   -2.546   0.1357 0.2396 -1.009
50  0.602 0.121  0.481    1.732    1.752   0.1556 0.1381  0.752
60 -0.301 0.788 -1.089   -3.650   -3.936   0.0251 0.0857 -0.631
76  0.000 0.765 -0.765   -2.579   -2.666   0.0353 0.0609 -0.510
```

Figure 26. S+® output of regression model development using reservoir elevation (ELV), turbidity (TBY, YSI model 6026 sensor), and water temperature (T) as explanatory variables for actinomycetes bacteria (ACT) densities for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

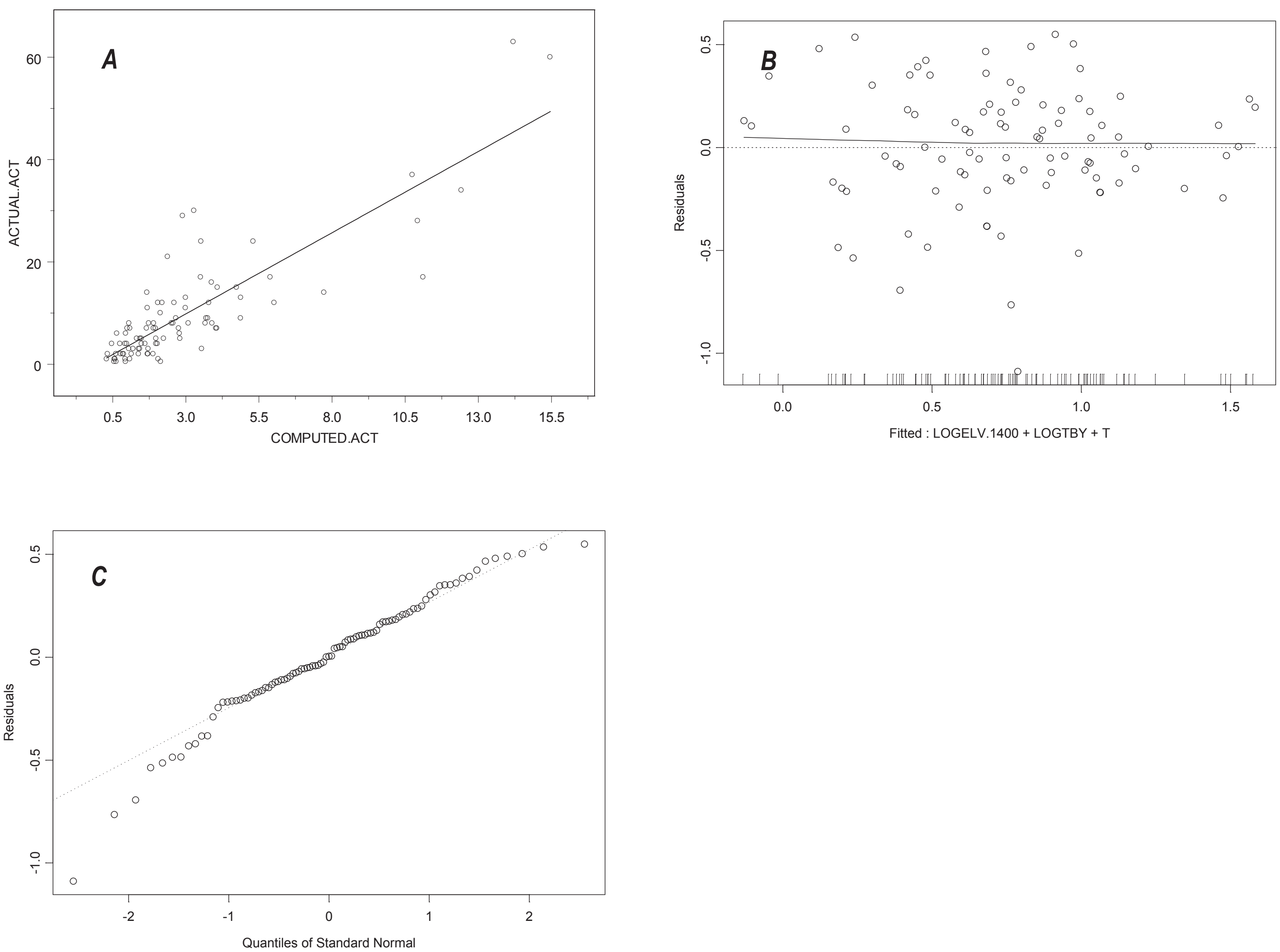

Figure 27. S+® output graphs from simple linear regression analysis using reservoir elevation (ELV), turbidity (TBY, YSI model 6026 sensor), and water temperature (T) as explanatory variables for actinomycetes bacteria (ACT) showing *A*, computed compared to actual ACT concentrations; *B*, computed log-transformed ACT concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = LOGANA ~ LOG.ELV.1400 + T, data = Anabaena.Splus, na.action =
      na.exclude)
Residuals:
    Min      1Q   Median    3Q   Max
 -4.196 -0.9902 -0.09599 1.253 3.504

Coefficients:
                Value Std. Error  t value Pr(>|t|)
 (Intercept)  34.4946   8.2782     4.1669   0.0001
LOG.ELV.1400 -25.8073   6.2229    -4.1471   0.0001
           T   0.1203   0.0166     7.2324   0.0000

Residual standard error: 1.619 on 111 degrees of freedom
Multiple R-Squared: 0.3724      Adjusted R-squared: 0.3611
F-statistic: 32.93 on 2 and 111 degrees of freedom, the p-value is 5.901e-012

Correlation of Coefficients:
             (Intercept) LOG.ELV.1400
LOG.ELV.1400 -0.9993
           T  0.0321     -0.0653

Analysis of Variance Table

Response: LOGANA

Terms added sequentially (first to last)
              Df Sum of Sq  Mean Sq  F Value        Pr(F)
LOG.ELV.1400   1   35.5214  35.5214 13.55996 0.0003585721
           T   1  137.0251 137.0251 52.30801 0.0000000001
   Residuals 111  290.7735   2.6196

            model.formula nvars   stderr    adjr2       Cp    press
LOGANA ~ LOG.ELV.1400 + T     2 1.618512 36.11054  3.00000 307.3110

Variance inflation factors
 LOG.ELV.1400        T
     1.004288 1.004288

Test criteria
 leverage cooksD dfits
   0.0789  0.844 0.324
       Observations exceeding at least one test criterion
   LOGANA    yhat resids stnd.res stud.res leverage cooksD  dfits
 5   0.00 4.19575  -4.20    -2.64    -2.72   0.0370 0.0894 -0.532
 7   3.08 0.13138   2.94     1.85     1.87   0.0342 0.0404  0.352
 8   3.07 0.00334   3.06     1.93     1.95   0.0379 0.0490  0.388
11   4.06 0.55603   3.50     2.19     2.23   0.0253 0.0416  0.359
31   4.17 1.49381   2.68     1.71     1.72   0.0583 0.0600  0.428
52   5.30 3.36865   1.93     1.24     1.25   0.0752 0.0419  0.355
53   4.26 2.51305   1.75     1.14     1.14   0.1048 0.0508  0.391
55   0.00 2.37637  -2.38    -1.52    -1.53   0.0633 0.0519 -0.397
92   3.36 0.07123   3.29     2.07     2.10   0.0358 0.0531  0.405
```

Figure 28. S+® output of regression model development using reservoir elevation (ELV) and water temperature (T) as explanatory variables for *Anabaena* spp. (ANA) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

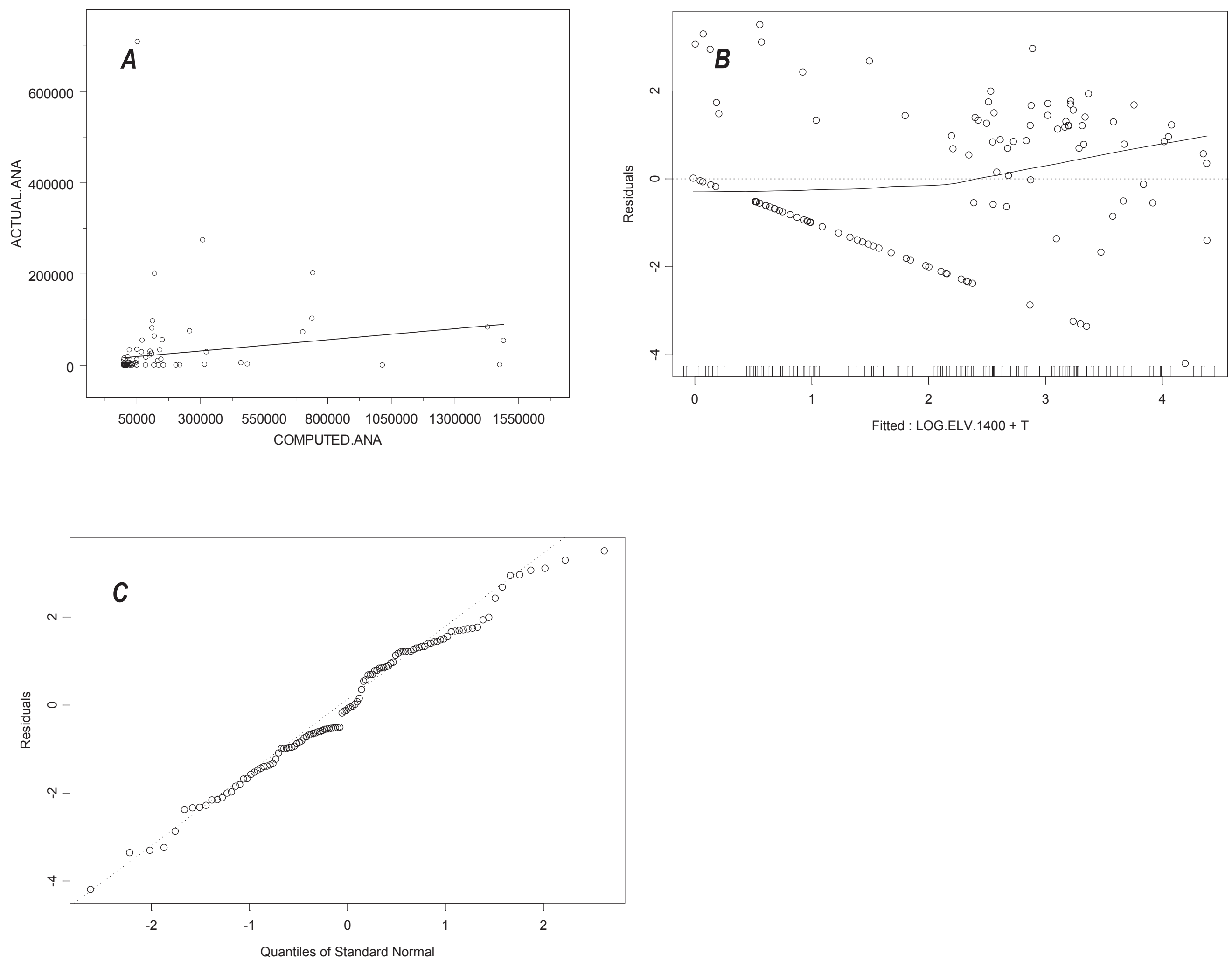

Figure 29. S+® output graphs from simple linear regression analysis using reservoir elevation (ELV) and water temperature (T) as explanatory variables for *Anabaena* spp. (ANA) showing *A*, computed compared to actual ANA concentrations; *B*, computed log-transformed ANA concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
       *** Linear Model ***

Call: lm(formula = LOGGEO ~ LOGTBY + PH, data = Geosmin.Splus.New, na.action =
       na.exclude)
Residuals:
     Min      1Q  Median    3Q   Max
 -0.7243 -0.3228 -0.1244 0.268 1.644

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept) -7.0015  1.8357    -3.8141  0.0002
     LOGTBY -0.6356  0.1685    -3.7727  0.0002
         PH  0.6115  0.2082     2.9374  0.0039

Residual standard error: 0.4757 on 124 degrees of freedom
Multiple R-Squared: 0.2216      Adjusted R-squared: 0.2091
F-statistic: 17.65 on 2 and 124 degrees of freedom, the p-value is 1.792e-007

Correlation of Coefficients:
       (Intercept)  LOGTBY
LOGTBY -0.4516
    PH -0.9944      0.3577

Analysis of Variance Table

Response: LOGGEO

Terms added sequentially (first to last)
           Df Sum of Sq  Mean Sq  F Value       Pr(F)
   LOGTBY   1   6.03799 6.037987 26.67987 0.000000929
       PH   1   1.95264 1.952637  8.62806 0.003947642
Residuals 124  28.06275 0.226312

       model.formula nvars    stderr    adjr2       Cp    press
LOGGEO ~ LOGTBY + PH     2 0.4757231 20.90789 3.000000 29.71152

Variance inflation factors
   LOGTBY       PH
 1.146753 1.146753

Test criteria
 leverage cooksD dfits
   0.0709  0.844 0.307
       Observations exceeding at least one test criterion
   LOGGEO  yhat resids stnd.res stud.res leverage  cooksD  dfits
14 -1.658 -2.24  0.582    1.377    1.382   0.2123 0.17043  0.718
19 -1.201 -2.33  1.132    2.491    2.545   0.0870 0.19706  0.786
21 -0.947 -2.59  1.644    3.522    3.697   0.0367 0.15768  0.722
29 -3.000 -3.19  0.192    0.425    0.424   0.0962 0.00641  0.138
30 -1.620 -1.83  0.213    0.469    0.467   0.0848 0.00679  0.142
36 -1.367 -2.78  1.410    3.010    3.113   0.0299 0.09298  0.546
38 -1.367 -2.37  1.001    2.142    2.174   0.0344 0.05452  0.410
39 -1.194 -2.81  1.620    3.434    3.595   0.0161 0.06423  0.460
83 -2.237 -2.02 -0.220   -0.480   -0.479   0.0725 0.00601 -0.134
```

Figure 30. S+® output of regression model development using turbidity (TBY, YSI model 6026 sensor) and pH (PH) as explanatory variables for geosmin (GEO) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

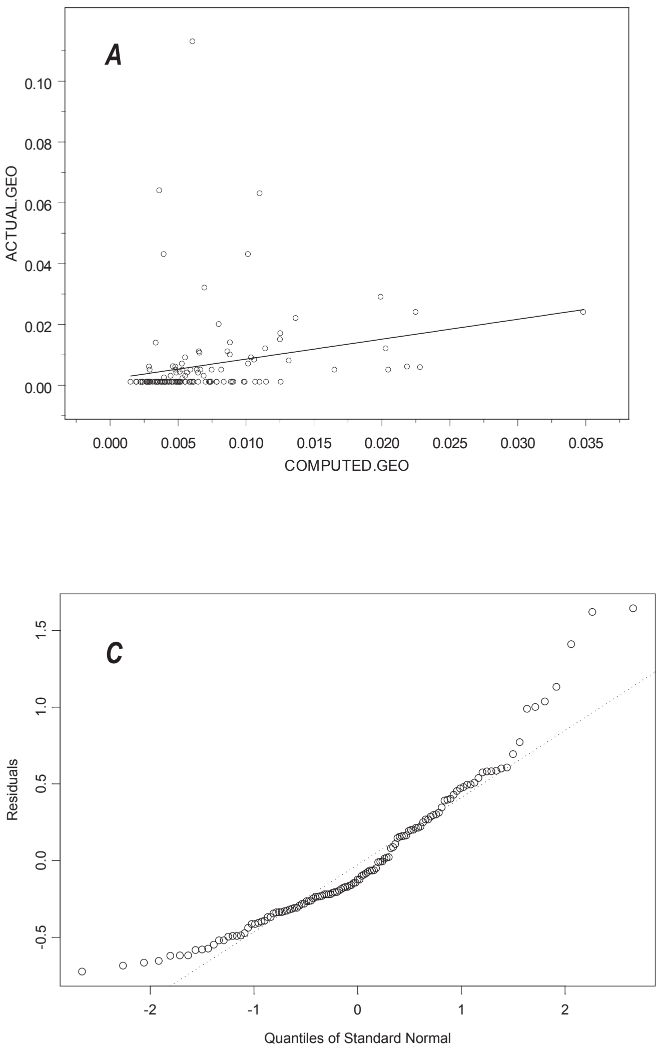

Figure 31. S+® output graphs from simple linear regression analysis using turbidity (TBY, YSI model 6026 sensor) and pH (PH) as explanatory variables for geosmin (GEO) showing *A*, computed compared to actual GEO concentrations; *B*, computed log-transformed GEO concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

```
      *** Linear Model ***

Call: lm(formula = LOGMC ~ SIN + COS + LOGCHL, data = Microcystin.Splus, na.action
        = na.exclude)
Residuals:
     Min      1Q    Median     3Q  Max
 -0.8723 -0.2689 -0.001287 0.2157 1.08

Coefficients:
              Value Std. Error t value Pr(>|t|)
(Intercept) -1.8153  0.2319    -7.8268  0.0000
        SIN -0.5916  0.0706    -8.3810  0.0000
        COS -0.3244  0.0748    -4.3392  0.0000
     LOGCHL  0.8574  0.2222     3.8588  0.0002

Residual standard error: 0.4333 on 90 degrees of freedom
Multiple R-Squared: 0.4822      Adjusted R-squared: 0.4649
F-statistic: 27.93 on 3 and 90 degrees of freedom, the p-value is 7.376e-013

Correlation of Coefficients:
       (Intercept)     SIN     COS
   SIN  0.4812
   COS  0.4505      0.1249
LOGCHL -0.9794     -0.4753 -0.4072

Analysis of Variance Table

Response: LOGMC

Terms added sequentially (first to last)
          Df Sum of Sq  Mean Sq  F Value       Pr(F)
      SIN  1  11.21395 11.21395 59.72654 0.000000000
      COS  1   1.72434  1.72434  9.18399 0.003187402
   LOGCHL  1   2.79567  2.79567 14.89001 0.000214012
Residuals 90  16.89795  0.18775

             model.formula nvars    stderr     adjr2        Cp    press
LOGMC ~ SIN + COS + LOGCHL     3 0.4333070 46.490383  4.487311 18.33903

Variance inflation factors
      SIN      COS   LOGCHL
 1.301281 1.207573 1.535598

Test criteria
 leverage cooksD dfits
    0.128  0.877 0.413
       Observations exceeding at least one test criterion
    LOGMC   yhat resids stnd.res stud.res leverage cooksD dfits
26  0.580 -0.319  0.899     2.11     2.16   0.0367 0.0426 0.421
34 -1.000 -1.679  0.679     1.67     1.69   0.1181 0.0933 0.617
90  0.462 -0.618  1.080     2.54     2.62   0.0379 0.0637 0.521
```

Figure 32. S+® output of regression model development using season (SIN and COS) and fluorescence (CHL) as explanatory variables for microcystin (MC) concentrations for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, during 2001 through 2009.

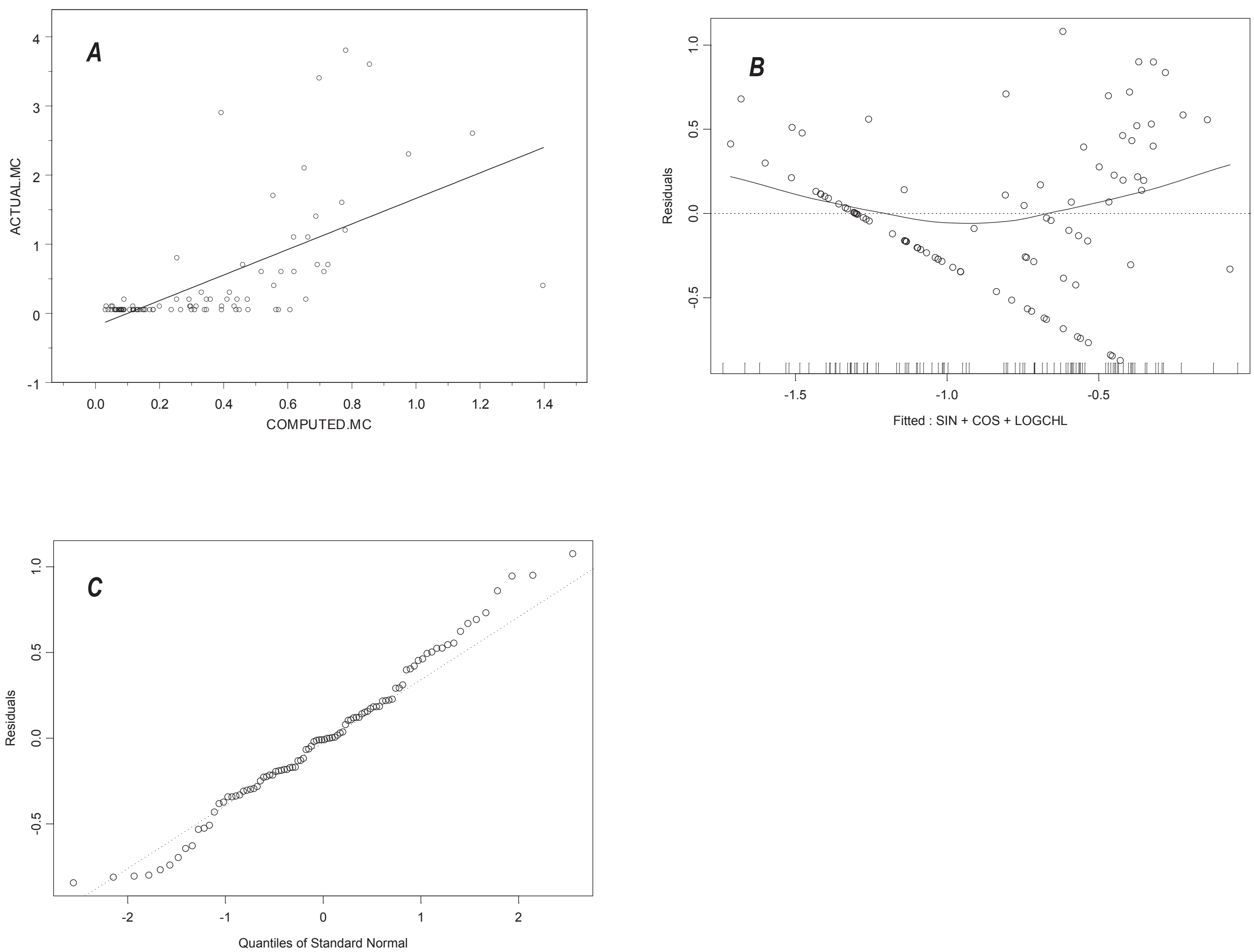

Figure 33. S+® output graphs from simple linear regression analysis using season (SIN and COS) and fluorescence (CHL) as explanatory variables for microcystin (MC) showing *A*, computed compared to actual MC concentrations; *B*, computed log-transformed MC concentrations compared to regression residuals; and *C*, standard normal quantiles compared to regression residuals for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

Results of Multiple Logistic Regression Analysis for Geosmin and Microcystin

The multiple logistic regression models that estimate the probability of the occurrence of geosmin and microcystin concentrations above relevant thresholds (0.005 µg/L and 0.1 µg/L, respectively) are shown in table 18. Model datasets are presented in tables 19 and 20 and SigmaPlot® statistical model output (Systat Software, Inc., 2008) is presented in figures 34 and 35. The best fit model for geosmin occurrence included a seasonal component and turbidity as explanatory variables, likely because geosmin occurrences in Cheney Reservoir have seasonal patterns mediated by light. The threshold of the geosmin model was reset from 0.5 to 0.32, which was the estimated proportion of detections in the dataset. The final logistic geosmin model correctly estimated the likelihood of geosmin concentrations exceeding the detection threshold 70 percent of the time and not exceeding the detection threshold 71 percent of the time, resulting in an overall sensitivity of 71 percent (table 18, fig. 34).

The best fit model for microcystin occurrence also included a seasonal component as well as fluorescence likely because microcystin occurrences in Cheney Reservoir have seasonal patterns mediated by algal community composition and abundance. The threshold of the microcystin model was reset from 0.5 to 0.47, which was the estimated proportion of detections in the dataset. The final logistic microcystin model correctly estimated the likelihood of microcystin concentrations exceeding the detection threshold 89 percent of the time and not exceeding the detection threshold 74 percent of the time, resulting in an overall sensitivity of 81 percent (table 18, fig. 35).

Turbidity, YSI Model 6026 and 6136 Sensors

Regression models were developed in this report and by Christensen and others (2006) using YSI_{6026} turbidity sensor data to compute concentrations or densities of physical, chemical, and biological water properties. Because of the change in turbidity instrumentation from YSI_{6026} to YSI_{6136} sensors in January 2011, the regression models that were developed using YSI_{6026} data require modification. The computation of a conversion factor allows the YSI_{6026} sensor regression models to include turbidity measurements from the YSI_{6136} sensor.

The ordinary least squares regression shows the linear association between the YSI_{6026} and YSI_{6136} turbidity sensors and explains 80 percent of the variance between the sensor turbidity readings (fig. 36, table 21). YSI_{6136} sensor measurements were on average 24 percent lower than YSI_{6026} measurements. The ratios of the YSI_{6136} sensor values to the YSI_{6026} sensor values ranged from 0.16 to 3.43 and had a median of 0.74 (table 21). To convert YSI_{6026} turbidity measurements to YSI_{6136} turbidity measurements in Cheney Reservoir, the YSI_{6026} turbidity measurement should be multiplied by the conversion factor of 0.74. Original and newly developed models from this report are shown in tables 22, 23, and 24 in addition to converted models that should be used to calculate concentrations when turbidity is measured using the YSI_{6136} turbidity sensor at the Cheney Reservoir site.

Table 18. Best fit multiple logistic regression models and summary statistics for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[Logit P Pres, logistic probability of presence; sin, sine; D, day of year; cos, cosine; TBY_{6026}, turbidity from YSI sensor 6026 in formazin nephelometric units; <, less than; CHL, fluorescence at a wavelength of 650 to 700 nanometers]

Multiple logistic regression equation	Threshold probability for positive classification	Response information						Pearson chi-squared (*p*-value)	Likelihood ratio test (*p*-value)	-2 log liklihood statistic	Hosmer-Lemshow (*p*-value)
		Classification table	Predicted reference responses	Predicted positive responses	Diagnostic	Totals	Percent				
Geosmin (GEO)											
Logit P Pres = 0.825sin(2πD/365) - 0.262cos(2πD/365) - 0.102(TBY_{6026}) + 0.829	0.32	Actual reference responses	62	25	Specificity	87	71	143.8 (0.087)	25.551 (<0.001)	132.694	3.650 (0.887)
		Actual positive responses	12	28	Sensitivity	40	70				
		Totals	74	53	Overall	127	71				
Microcystin (MC)											
Logit P Pres = -1.990sin(2πD/365) - 1.340cos(2πD/365) + 0.0511(CHL) - 1.305	0.47	Actual reference responses	37	13	Specificity	50	74	110.273 (0.063)	36.408 (<0.001)	93.521	10.239 (0.249)

Table 19. Geosmin logistic regression dataset using seasonal data and turbidity as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Geosmin occurrence[1]
May 3, 2001	1055	0.8543	-0.5197	38	0
June 4, 2001	1030	0.4559	-0.8900	20	1
June 22, 2001	1155	0.1628	-0.9867	22	1
July 24, 2001	1055	-0.3777	-0.9259	18	0
August 29, 2001	1125	-0.8453	-0.5344	13	0
May 15, 2002	1115	0.7296	-0.6839	27	0
June 19, 2002	0955	0.2135	-0.9769	36	0
July 11, 2002	1005	-0.1628	-0.9867	12	1
August 7, 2002	1000	-0.5878	-0.8090	13	0
September 4, 2002	1015	-0.8958	-0.4444	12	1
September 25, 2002	1010	-0.9951	-0.0988	20	1
January 21, 2003	1210	0.3537	0.9354	6.5	1
January 23, 2003	1055	0.3857	0.9226	3.9	1
February 10, 2003	1250	0.6486	0.7611	1.6	1
March 3, 2003	1025	0.8759	0.4825	3.3	1
March 12, 2003	1200	0.9399	0.3416	4.5	1
March 13, 2003	1200	0.9456	0.3253	5.6	1
June 17, 2003	1045	0.2470	-0.9690	14	1
June 20, 2003	0905	0.1967	-0.9805	3.5	1
July 7, 2003	0940	-0.0945	-0.9955	24	1
July 17, 2003	1155	-0.2637	-0.9646	27	1
March 10, 2004	1115	0.9338	0.3577	22	0
April 8, 2004	1015	0.9911	-0.1330	31	0
May 5, 2004	1115	0.8264	-0.5632	21	0
June 3, 2004	1000	0.4559	-0.8900	21	0
July 15, 2004	0950	-0.2470	-0.9690	7.0	1
August 12, 2004	0915	-0.6681	-0.7441	23	0
August 27, 2004	1115	-0.8359	-0.5488	32	0
September 9, 2004	0935	-0.9369	-0.3496	26	0
February 2, 2005	1035	0.5380	0.8429	2.7	1
March 16, 2005	1015	0.9611	0.2761	10	0
April 13, 2005	1000	0.9796	-0.2009	18	0
May 4, 2005	1120	0.8452	-0.5344	10	0
May 16, 2005	0955	0.7177	-0.6964	8.1	0
June 1, 2005	1020	0.5012	-0.8653	8.1	0
June 15, 2005	0945	0.2802	-0.9599	14	1
June 29, 2005	1000	0.0430	-0.9991	25	0
July 13, 2005	0920	-0.1967	-0.9805	15	1
July 27, 2005	0850	-0.4250	-0.9052	20	1
August 10, 2005	0855	-0.6288	-0.7776	12	0
August 30, 2005	0945	-0.8543	-0.5197	22	0
September 7, 2005	1030	-0.9176	-0.3975	12	0
October 13, 2005	1030	-0.9778	0.2093	18	0

Table 19. Geosmin logistic regression dataset using seasonal data and turbidity as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Geosmin occurrence[1]
October 27, 2005	1005	-0.8996	0.4367	20	0
January 11, 2006	1210	0.1882	0.9821	8.9	0
March 1, 2006	1105	0.8588	0.5124	3.2	1
March 29, 2006	1005	0.9984	0.0559	10	0
April 25, 2006	1245	0.9176	-0.3975	34	0
May 17, 2006	1055	0.7056	-0.7086	20	0
May 31, 2006	1140	0.5161	-0.8566	10	0
June 14, 2006	1045	0.2967	-0.9550	25	0
June 28, 2006	0955	0.0602	-0.9982	13	0
July 13, 2006	0940	-0.1967	-0.9805	15	0
July 26, 2006	1115	-0.4094	-0.9124	14	0
August 10, 2006	1005	-0.6288	-0.7776	17	0
August 22, 2006	1000	-0.7749	-0.6321	21	0
September 6, 2006	1020	-0.9106	-0.4133	10	1
September 20, 2006	1015	-0.9829	-0.1840	22	0
September 26, 2006	1130	-0.9967	-0.0817	10	0
September 28, 2006	1120	-0.9989	-0.0473	28	0
September 29, 2006	1130	-0.9995	-0.0301	28	0
October 11, 2006	0950	-0.9845	0.1755	29	0
October 25, 2006	0945	-0.9141	0.4054	35	1
December 12, 2006	1115	-0.3213	0.9470	9.2	0
February 7, 2007	1115	0.6085	0.7936	14	1
March 7, 2007	1135	0.9070	0.4211	14	1
April 9, 2007	1045	0.9911	-0.1330	23	0
May 8, 2007	0940	0.8065	-0.5913	11	0
May 31, 2007	1020	0.5161	-0.8566	27	0
June 13, 2007	1140	0.3131	-0.9497	35	0
June 25, 2007	1000	0.1117	-0.9937	25	0
July 9, 2007	0950	-0.1288	-0.9917	21	0
July 23, 2007	1020	-0.3617	-0.9323	21	0
August 7, 2007	0930	-0.5878	-0.8090	27	0
August 15, 2007	0955	-0.6933	-0.7207	23	0
August 28, 2007	1055	-0.8359	-0.5488	28	0
September 12, 2007	1025	-0.9484	-0.3172	13	0
September 24, 2007	1025	-0.9933	-0.1159	17	0
October 15, 2007	1005	-0.9701	0.2429	29	0
October 29, 2007	1045	-0.8841	0.4674	26	0
November 13, 2007	1040	-0.7354	0.6776	25	0
December 19, 2007	1100	-0.2051	0.9787	8.1	0
February 11, 2008	1100	0.6616	0.7498	2.7	0
March 10, 2008	1125	0.9338	0.3577	9.0	1
April 1, 2008	0955	0.9999	-0.0129	19	1
April 16, 2008	1140	0.9635	-0.2678	28	1

Table 19. Geosmin logistic regression dataset using seasonal data and turbidity as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Turbidity, in formazin nephelometric units (YSI model 6026 sensor)	Geosmin occurrence[1]
April 29, 2008	1035	0.8800	-0.4750	42	0
May 13, 2008	1020	0.7412	-0.6713	30	0
June 3, 2008	0945	0.4559	-0.8900	22	0
June 18, 2008	0920	0.2135	-0.9769	31	0
June 2005, 2008	1200	0.0945	-0.9955	17	1
July 7, 2008	1035	-0.1117	-0.9937	18	0
July 21, 2008	1050	-0.3456	-0.9384	26	0
July 28, 2008	0955	-0.4559	-0.8900	18	0
August 4, 2008	1020	-0.5596	-0.8288	18	0
August 18, 2008	0945	-0.7412	-0.6713	15	1
September 2, 2008	1000	-0.8881	-0.4597	16	0
September 17, 2008	1000	-0.9760	-0.2177	20	0
October 1, 2008	1055	-0.9998	0.0215	16	0
October 15, 2008	1150	-0.9657	0.2595	48	0
November 4, 2008	0950	-0.8215	0.5703	27	0
December 2, 2008	0950	-0.4635	0.8861	18	0
January 6, 2009	1010	0.1031	0.9947	7.3	0
January 20, 2009	1010	0.3375	0.9413	8.5	0
February 2, 2009	1000	0.5380	0.8429	6.9	0
February 18, 2009	1010	0.7470	0.6649	15	1
February 25, 2009	1030	0.8215	0.5702	10	1
March 3, 2009	1050	0.8759	0.4825	10	1
March 9, 2009	1050	0.9210	0.3896	10	1
March 12, 2009	1120	0.9399	0.3416	16	1
March 16, 2009	1100	0.9611	0.2761	9.3	1
March 25, 2009	1020	0.9922	0.1245	25	1
April 8, 2009	1010	0.9933	-0.1159	24	0
April 29, 2009	1030	0.8881	-0.4597	34	0
May 27, 2009	1140	0.5738	-0.8190	36	0
June 9, 2009	1100	0.3777	-0.9259	25	0
June 23, 2009	1045	0.1458	-0.9893	17	1
July 7, 2009	1100	-0.0945	-0.9955	12	1
July 21, 2009	1020	-0.3294	-0.9442	18	1
August 5, 2009	1030	-0.5596	-0.8288	14	0
August 24, 2009	1000	-0.7962	-0.6050	16	0
September 2, 2009	1030	-0.8800	-0.4749	20	0
September 16, 2009	1030	-0.9679	-0.2512	19	0
October 5, 2009	1100	-0.9973	0.0731	24	0
October 19, 2009	1100	-0.9511	0.3090	22	0
November 23, 2009	1100	-0.6085	0.7936	17	0
December 16, 2009	1140	-0.2553	0.9669	16	0

[1]A value of 1 indicates occurrence and a value of 0 indicates a non-occurrence.

Table 20. Microcystin logistic regression dataset using seasonal data and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Microcystin occurrence[1]
June 1, 2005	1020	0.5012	-0.8653	6.4	0
June 15, 2005	0945	0.2802	-0.9599	12.2	1
June 29, 2005	1000	0.0430	-0.9991	7.1	0
July 13, 2005	0920	-0.1967	-0.9805	11.6	1
July 27, 2005	0850	-0.4250	-0.9052	8.0	1
August 10, 2005	0855	-0.6288	-0.7776	5.4	1
August 30, 2005	0945	-0.8543	-0.5197	11.8	1
September 7, 2005	1030	-0.9176	-0.3975	7.4	1
October 13, 2005	1030	-0.9778	0.2093	9.5	1
October 27, 2005	1005	-0.8996	0.4367	9.2	1
January 11, 2006	1210	0.1882	0.9821	19.7	0
March 1, 2006	1105	0.8588	0.5124	19.1	0
March 29, 2006	1005	0.9984	0.0559	23.0	0
April 25, 2006	1245	0.9176	-0.3975	8.5	0
May 17, 2006	1055	0.7056	-0.7086	11.7	0
May 31, 2006	1140	0.5161	-0.8566	8.9	0
June 14, 2006	1045	0.2967	-0.9550	6.6	0
June 28, 2006	0955	0.0602	-0.9982	6.9	1
July 13, 2006	0940	-0.1967	-0.9805	5.5	1
July 26, 2006	1115	-0.4094	-0.9124	10.7	1
August 10, 2006	1005	-0.6288	-0.7776	10.2	1
August 22, 2006	1000	-0.7749	-0.6321	6.6	1
September 6, 2006	1020	-0.9106	-0.4133	14.7	1
September 20, 2006	1015	-0.9829	-0.1840	9.9	1
September 26, 2006	1130	-0.9967	-0.0817	11.8	1
September 28, 2006	1120	-0.9989	-0.0473	10.9	1
September 29, 2006	1130	-0.9995	-0.0301	9.7	1
October 11, 2006	0950	-0.9845	0.1755	7.3	1
October 25, 2006	0945	-0.9141	0.4054	6.8	1
December 12, 2006	1115	-0.3213	0.9470	10.2	0
February 7, 2007	1115	0.6085	0.7936	6.9	0
March 7, 2007	1135	0.9070	0.4211	33.6	0
April 9, 2007	1045	0.9911	-0.1330	17.2	0
May 8, 2007	0940	0.8065	-0.5913	3.1	1
May 31, 2007	1020	0.5161	-0.8566	4.8	1
June 13, 2007	1140	0.3131	-0.9497	5.0	0
June 25, 2007	1000	0.1117	-0.9937	5.1	0
July 9, 2007	0950	-0.1288	-0.9917	7.7	1
July 23, 2007	1020	-0.3617	-0.9323	10.6	1
August 7, 2007	0930	-0.5878	-0.8090	9.9	1
August 15, 2007	0955	-0.6933	-0.7207	8.5	1

Table 20. Microcystin logistic regression dataset using seasonal data and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Microcystin occurrence[1]
August 28, 2007	1055	-0.8359	-0.5488	7.0	1
September 12, 2007	1025	-0.9484	-0.3172	8.4	1
September 24, 2007	1025	-0.9933	-0.1159	9.0	1
October 15, 2007	1005	-0.9701	0.2429	7.1	1
October 29, 2007	1045	-0.8841	0.4674	7.1	1
November 13, 2007	1040	-0.7354	0.6776	10.6	0
December 19, 2007	1100	-0.2051	0.9787	5.8	0
February 11, 2008	1100	0.6616	0.7498	12.5	1
February 14, 2008	1105	0.6995	0.7147	12.8	0
February 15, 2008	1025	0.7117	0.7025	14.2	1
March 10, 2008	1125	0.9338	0.3577	25.6	0
April 1, 2008	0955	0.9999	-0.0129	29.6	1
April 16, 2008	1140	0.9635	-0.2678	10.7	0
April 29, 2008	1035	0.8800	-0.4750	8.1	0
May 13, 2008	1020	0.7412	-0.6713	5.7	0
June 3, 2008	0945	0.4559	-0.8900	5.9	0
June 18, 2008	0920	0.2135	-0.9769	6.8	1
July 7, 2008	1035	-0.1117	-0.9937	5.3	1
July 21, 2008	1050	-0.3456	-0.9384	11.7	1
July 28, 2008	0955	-0.4559	-0.8900	24.4	1
August 4, 2008	1020	-0.5596	-0.8288	6.2	1
August 18, 2008	0945	-0.7412	-0.6713	3.7	1
September 2, 2008	1000	-0.8881	-0.4597	5.1	0
September 17, 2008	1000	-0.9760	-0.2177	4.9	1
October 1, 2008	1055	-0.9998	0.0215	5.2	0
October 15, 2008	1150	-0.9657	0.2595	5.7	0
November 4, 2008	0950	-0.8215	0.5703	8.0	1
December 2, 2008	0950	-0.4635	0.8861	7.1	0
January 6, 2009	1010	0.1031	0.9947	23.1	0
January 20, 2009	1010	0.3375	0.9413	31.2	0
February 2, 2009	1000	0.5380	0.8429	49.4	0
February 18, 2009	1010	0.7470	0.6649	23.0	0
February 25, 2009	1030	0.8215	0.5702	23.7	0
March 3, 2009	1050	0.8759	0.4825	24.4	0
March 9, 2009	1050	0.9210	0.3896	22.0	0
March 12, 2009	1120	0.9399	0.3416	24.2	0
March 16, 2009	1100	0.9611	0.2761	23.1	0
March 25, 2009	1020	0.9922	0.1245	23.5	0
April 8, 2009	1010	0.9933	-0.1159	16.2	0
April 29, 2009	1030	0.8881	-0.4597	4.9	0
May 27, 2009	1140	0.5738	-0.8190	7.6	0

Table 20. Microcystin logistic regression dataset using seasonal data and fluorescence as explanatory variables for Cheney Reservoir near Cheney, Kansas (site 07144790), south-central Kansas, 2001 through 2009.—Continued

[hhmm, hours and minutes; sin, sine; D, day of year; cos, cosine; YSI, Yellow Springs Instruments]

Date	Time, in hhmm	sin(2πD/365)	cos(2πD/365)	Fluorescence at a wavelength of 650 to 700 nanometers (YSI model 6025 sensor)	Microcystin occurrence[1]
June 9, 2009	1100	0.3777	-0.9259	14.8	0
June 23, 2009	1045	0.1458	-0.9893	15.5	0
July 7, 2009	1100	-0.0945	-0.9955	9.1	1
July 21, 2009	1020	-0.3294	-0.9442	3.6	0
August 5, 2009	1030	-0.5596	-0.8288	7.7	0
August 24, 2009	1000	-0.7962	-0.6050	6.9	0
September 2, 2009	1030	-0.8800	-0.4749	6.2	0
September 16, 2009	1030	-0.9679	-0.2512	4.3	1
October 5, 2009	1100	-0.9973	0.0731	6.2	0
October 19, 2009	1100	-0.9511	0.3090	6.2	0
November 23, 2009	1100	-0.6085	0.7936	6.5	0
December 16, 2009	1140	-0.2553	0.9669	4.5	0

[1]A value of 1 indicates occurrence and a value of 0 indicates a non-occurrence.

Multiple Logistic Regression

Data source: Geosmin Data in GEO.JNB

Logit P = 0.829 + (0.825 * SIN) - (0.262 * COS) - (0.102 * TBY)

N = 127
Estimation Criterion: Maximum likelihood
Dependent Variable: Geo
Positive response (1): 1
Reference response (0): 0
Number of unique independent variable combinations: 126

Pearson Chi-square Statistic: 143.776 (P = 0.087)
Likelihood Ratio Test Statistic: 25.551 (P = <0.001)
-2*Log(Likelihood) = 132.694
Hosmer-Lemeshow Statistic: 3.650 (P = 0.887)

Threshold probability for positive classification: 0.320
Classification Table:

	Predicted Reference	**Predicted Positive**	**Totals**
Actual Reference Responses	62	25	87
Actual Positive Responses	12	28	40
Totals	74	53	127

Details of the Logistic Regression Equation

Ind. Variable	**Coefficient**	**Standard Error**	**Wald Statistic**	**P value**	**VIF**
Constant	0.829	0.500	2.746	0.097	
SIN	0.825	0.327	6.357	0.012	1.036
COS	-0.262	0.351	0.555	0.456	1.107
TBY	-0.102	0.0299	11.536	<0.001	1.129

Ind. Variable	**Odds Ratio**	**5% Conf. Lower**	**95% Conf. Upper**
Constant	2.292	0.859	6.112
SIN	2.282	1.202	4.332
COS	0.770	0.387	1.532
TBY	0.903	0.852	0.958

Figure 34. SigmaPlot® output results of multiple logistic regression analysis using season (SIN and COS), turbidity (TBY), and geosmin (GEO) data.

Multiple Logistic Regression

Data source: Microcystin Data in MC.JNB

Logit P = -1.305 - (1.990 * SIN) - (1.340 * COS) + (0.0511 * CHL)

N = 94
Estimation Criterion: Maximum likelihood
Dependent Variable: DET MC
Positive response (1): 1
Reference response (0): 0
Number of unique independent variable combinations: 94

Pearson Chi-square Statistic: 110.273 (P = 0.063)
Likelihood Ratio Test Statistic: 36.408 (P = <0.001)
-2*Log(Likelihood) = 93.521
Hosmer-Lemeshow Statistic: 10.239 (P = 0.249)

Threshold probability for positive classification: 0.470
Classification Table:

	Predicted Reference	Predicted Positive	Totals
Actual Reference Responses	37	13	50
Actual Positive Responses	5	39	44
Totals	42	52	94

Details of the Logistic Regression Equation

Ind. Variable	Coefficient	Standard Error	Wald Statistic	P value	VIF
Constant	-1.305	0.645	4.092	0.043	
SIN	-1.990	0.464	18.405	<0.001	1.348
COS	-1.340	0.456	8.621	0.003	1.239
CHL	0.0511	0.0439	1.355	0.244	1.620

Ind. Variable	Odds Ratio	5% Conf. Lower	95% Conf. Upper
Constant	0.271	0.0766	0.960
SIN	0.137	0.0551	0.339
COS	0.262	0.107	0.640
CHL	1.052	0.966	1.147

Figure 35. SigmaPlot® output results of multiple logistic regression analysis using season (SIN and COS), fluorescence (CHL), and microcystin (MC) data.

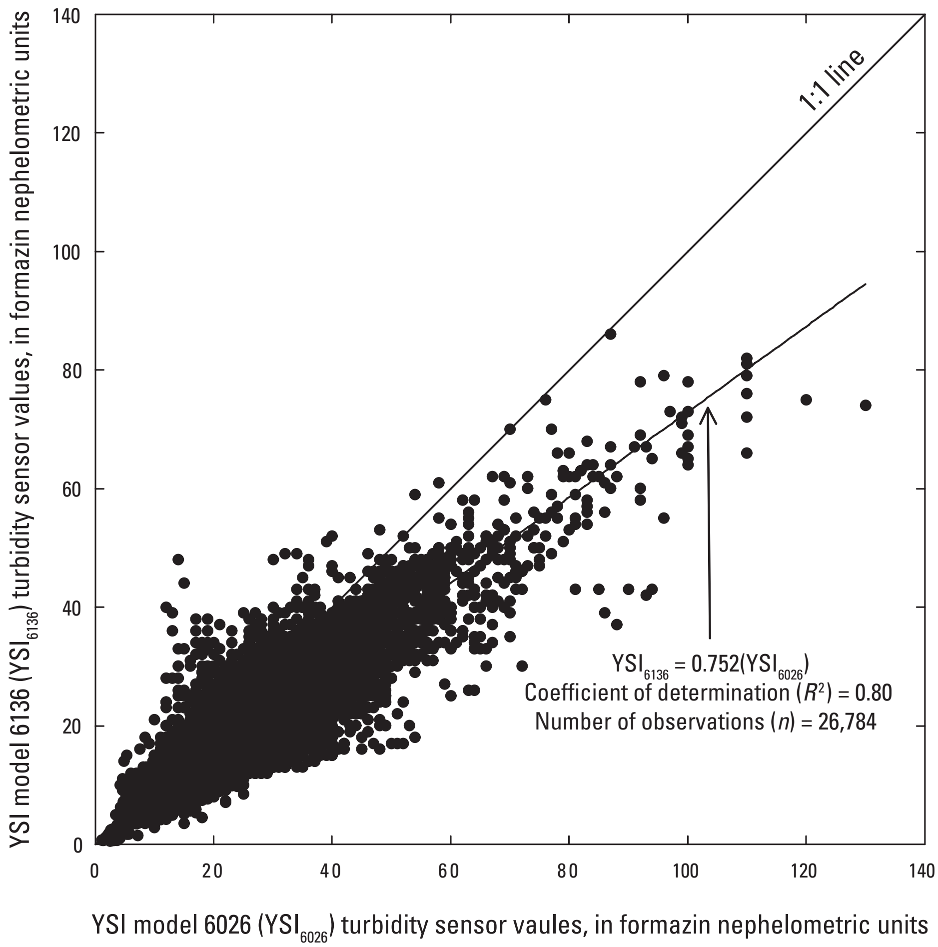

Figure 36. Relation between Yellow Springs Instruments (YSI) model 6026 (YSI_{6026}) and YSI model 6136 (YSI_{6136}) turbidity sensor values at Cheney Reservoir near Cheney, Kansas (site 07144790), September 2006 through September 2010.

Table 21. Summary statistics for data used in turbidity sensor linear regression analyses for Cheney Reservoir near Cheney, Kansas (site 07144790), September 2006 through September 2010.

[R^2, coefficient of determination; *n*, number of observations; TBY_{6136}, YSI model 6136 turbidity in formazin nephelometric units (FNU); TBY_{6026}, YSI model 6026 turbidity in FNU]

Regression equation	R^2	Turbidity sensor type or ratio	*n*	Range	Mean	Median
$TBY_{6136} = 0.752(TBY_{6026})$	0.80	YSI_{6026}	26,784	1.10–130	23	22
		YSI_{6136}	26,784	0.50–86.0	18	16
		YSI_{6136}/YSI_{6026} ratio	26,784	0.16–3.43	0.75	0.74

Table 22. Updated Christensen and others (2006) linear regression models for Cheney Reservoir near Cheney, Kansas (site 07144790).

[mg/L, milligrams per liter; 6026, YSI model 6026 turbidity sensor; TSS, total suspended solids in milligrams per liter; TBY_{6026}, turbidity from YSI sensor 6026 in formazin nephelometric units; 6136, YSI model 6136 turbidity sensor; TBY_{6136}, turbidity from YSI sensor 6136 in formazin nephelometric units; SSC, suspended sediment concentration in milligrams per liter; log, $\log_{10}$; NO_2NO_3, nitrite plus nitrate in milligrams per liter; DO, dissolved oxygen in milligrams per liter; T, water temperature in degrees Celsius; TKN, total Kjeldahl nitrogen (total ammonia plus organic nitrogen) in milligrams per liter; pH, pH in standard units; TP, total phosphorus in milligrams per liter; OP, orthophosphate in milligrams per liter; GEO, geosmin in micrograms per liter; CHL, fluorescence at a wavelength of 650 to 700 nanometers; col/100 mL, colonies per 100 milliliters; ANA, *Anabaena* spp. in colonies per 100 milliliters]

Constituent	Sensor type	Regression model
Total suspended solids (mg/L)	6026	$TSS = 0.2125(TBY_{6026}) + 2.8474$
	6136	$TSS = 0.2872(TBY_{6136}) +2.8474$
Suspended sediment (mg/L)	6026	$\log(SSC) = 0.5966\log(TBY_{6026}) + 0.3610$
	6136	$\log(SSC) = 0.5966\log(TBY_{6136}) + 0.4390$
Nitrite plus nitrate (mg/L)	6026	$\log(NO_2NO_3) = -2.5\log(DO) + 0.7094\log(TBY_{6026}) - 0.0014(T^2) + 0.9793$
	6136	$\log(NO_2NO_3) = -2.5\log(DO) + 0.7094\log(TBY_{6136}) - 0.0014(T^2) + 1.0721$
Total Kjeldahl nitrogen (mg/L)	6026	$TKN = 0.0085(TBY_{6026}) + 0.7039\log(DO) + 0.6577(pH) - 5.5840$
	6136	$TKN = 0.0115(TBY_{6136}) + 0.7039\log(DO) + 0.6577(pH) - 5.5840$
Total phosphorus (mg/L)	6026	$TP = 0.0022(T) + 0.0010(TBY_{6026}) + 0.0218$
	6136	$TP = 0.0022(T) + 0.0014(TBY_{6136}) + 0.0218$
Orthophosphorus (mg/L)	6026	$\log(OP) = 1.0067\log(TBY_{6026}) - 2.7586$
	6136	$\log(OP) = 1.0067\log(TBY_{6136}) - 2.6270$
Geosmin (µg/L)	6026	$\log(GEO) = -1.0664\log(TBY_{6026}) - 0.0097(SC) + 7.2310$
	6136	$\log(GEO) = -1.0664\log(TBY_{6136}) - 0.0097(SC) + 7.0994$
Chlorophyll-*a* (µg/L)	6026	$\log(CHL) = 0.0145(TBY_{6026}) - 0.9872\log(DO) - 0.2902$
	6136	$\log(CHL) = 0.0196(TBY_{6136}) - 0.9872\log(DO) - 0.2902$
Anabaena spp. (col/100 mL)	6026	$(ANA)10^5 = 4.3634(TBY_{6026}) - 7.0070$
	6136	$(ANA)10^5 = 5.8965(TBY_{6136}) - 7.0070$

Table 23. Updated new linear regression models for Cheney Reservoir near Cheney, Kansas (site 07144790).

[mg/L, milligrams per liter; 6026, YSI model 6026 turbidity sensor; log, $\log_{10}$, TBY_{6026}, turbidity from YSI sensor 6026 in formazin nephelometric units; 6136, YSI model 6136 turbidity sensor; TBY_{6136}, turbidity from YSI sensor 6136 in formazin nephelometric units; SSC, suspended sediment concentration in milligrams per liter; TP, total phosphorus in milligrams per liter; sin, sine; D, day of year; cos, cosine; OP, orthophosphate in milligrams per liter; T, water temperature in degrees Celsius; CHL, fluorescence at a wavelength of 650 to 700 nanometers; ACT, actinomycetes bacteria in colonies per milliliter; ELV, reservoir elevation in feet]

Constituent	Sensor type	Regression model
Suspended sediment (mg/L)	6026	$SSC = 0.6304(TBY_{6026}) + 2.9310$
	6136	$SSC = 0.8519(TBY_{6136}) + 2.9310$
Total phosphorus (mg/L)	6026	$\log(TP) = -0.0633\sin(2\pi D/365) - 0.1357\cos(2\pi D/365) + 0.4390\log(TBY_{6026}) - 1.6626$
	6136	$\log(TP) = -0.0633\sin(2\pi D/365) - 0.1357\cos(2\pi D/365) + 0.4390\log(TBY_{6136}) - 1.6052$
Orthohphosphate (mg/L)	6026	$\log(OP) = 0.4942\log(TBY_{6026}) + 0.0189(T) - 0.5408\log(CHL) - 2.0430$
	6136	$\log(OP) = 0.4942\log(TBY_{6136}) + 0.0189(T) - 0.5408\log(CHL) - 1.9784$
Actinomycetes bacteria (col/mL)	6026	$\log(ACT) = 11.06\log(ELV - 1{,}400) + 0.9924\log(TBY_{6026}) - 0.0163(T) - 14.93$
	6136	$\log(ACT) = 11.06\log(ELV - 1{,}400) + 0.9924\log(TBY_{6136}) - 0.0163(T) - 14.80$

Table 24. Updated new logistic regression model for Cheney Reservoir near Cheney, Kansas (site 07144790).

[6026, YSI model 6026 turbidity sensor; Logit P Pres, logistic probability of presence; sin, sine; D, day of year; cos, cosine; TBY_{6026}, turbidity from YSI sensor 6026 in formazin nephelometric units; 6136, YSI model 6136 turbidity sensor; TBY_{6136}, turbidity from YSI sensor 6136 in formazin nephelometric units]

Constituent	Sensor type	Regression model
Geosmin	6026	$\text{Logit P Pres} = 0.825\sin(2\pi D/365) - 0.262\cos(2\pi D/365) - 0.102(TBY_{6026}) + 0.829$
	6136	$\text{Logit P Pres} = 0.825\sin(2\pi D/365) - 0.262\cos(2\pi D/365) - 0.138(TBY_{6136}) + 0.829$

Summary

Cheney Reservoir in south-central Kansas is one of the primary sources of water for the city of Wichita. The U.S. Geological Survey has operated a continuous real-time water-quality monitoring station since 2001 in Cheney Reservoir. Continuously measured physicochemical properties include specific conductance, pH, water temperature, dissolved oxygen, turbidity, fluorescence, and reservoir elevation. Discrete water-quality samples were collected during 2001 through 2009 and were analyzed for sediment, major ions, nutrients, taste-and-odor compounds, cyanotoxins, cyanotoxin producers, and other water-quality measures.

Regression models were developed to establish relations between discretely sampled constituent concentrations and continuously measured physicochemical properties to estimate concentrations of those constituents of interest that are not easily measured in real time. Regression models based on data collected during 2001 through 2003 were published in 2006. This report updates those models using discrete and continuous data collected during March 2001 through December 2009. Regression equations were updated based on continuous physical property measurements and analyses of discretely collected water samples. The previously published models for dissolved solids, sodium, chloride, suspended-sediment concentration, total phosphorus, orthophosphate, and chlorophyll-*a* were updated. New regression models were developed for magnesium, dissolved phosphorus, actinomycetes bacteria, and microcystin. The actinomycetes bacteria and microcystin models are particularly important because actinomycetes bacteria may be related to taste-and-odor occurrences and microcystin is a cyanotoxin.

Specific conductance was the single explanatory variable for dissolved solids, most other major ions, and some nutrient species. Turbidity was an explanatory variable for some nutrient species and actinomycetes bacteria. Fluroescence (an estimate of chlorophyll) was an explanatory variable for total suspended solids, orthophosphate, dissolved phosphorus, chlorophyll-*a*, and microcystin. Total phosphorus and microcystin models included a seasonal component.

Updated dissolved solids, sodium, chloride, and suspended solids model forms were similar to previously published models. Some updated models changed substantially from previously published models or an acceptable model could not be developed. Those constituents with updated models that were different from original models are those that are affected by biological processes.

Because a high percentage of geosmin and microcystin data were below analytical detection thresholds (censored data), multiple logistic regression was used to develop models that best explained the probability of geosmin and microcystin concentrations exceeding relevant thresholds. The best fit multiple logistic regression model for geosmin included a seasonal component and turbidity as explanatory variables. The best fit multiple logistic regression model for microcystin also included a seasonal component as well as fluorescence as explanatory variables.

In-situ continuous turbidimeters were changed from Yellow Springs Instruments (YSI) model 6026 (YSI_{6026}) to YSI model 6136 (YSI_{6136}) sensors in 2011, and a relation between the continuous turbidity values of both sensors was developed using four years (September 2006 through September 2010) of concurrent YSI_{6026} and YSI_{6136} hourly turbidity measurements. The relation between turbidity values measured by the two sensor models was updated and a conversion factor of 0.74 was established to convert the YSI_{6026} turbidity measurements to YSI_{6136} measurements for Cheney Reservoir.

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