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Report on the Upper Walker River Water Quality Study, 1999

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EXECUTIVE SUMMARY

In the Spring of 1999, the North Mono County Resource Conservation District contracted with Linda Vance of the UC Davis Department of Agronomy and Range Science to conduct a preliminary water quality study in the upper East Walker and West Walker watersheds. The study focused on nutrient levels in streams and rivers flowing through Bridgeport Valley into Bridgeport Reservoir. A less intense sampling effort was conducted in the West Walker River to establish baselines for future monitoring.

The study revealed that levels of Total Kjedahl Nitrogen (TKN) in Robinson and Buckeye Creeks regularly exceeded objectives set by the Lahontan Regional Water Quality Control Board. Levels of Total Kjedahl Nitrogen (TKN) in the East Walker River did not exceed objectives as frequently, but this was due to the objectives for the East Walker being set at a higher threshhold.

The study further found that although TKN levels measured at downstream locations exceed objectives, these levels were statistically indistinguishable from TKN levels at upstream locations. An Analysis of Variance on data collected from upstream and downstream sites on the East Walker River, Robinson Creek and Buckeye Creek on 12 sampling dates between April and October revealed no differences between any of the sites, suggesting that land use within the Valley is not adding TKN to the aquatic system. Howver, the study also found highly significant TKN differences between sampling dates. Because nutrient concentrations fluctuate with stream discharge, this latter result is not unusual.

Levels of Phosphorus and Nitrate showed no clear patterns. Both were frequently below the detectable level. Electroconductivity(EC) observations indicated levels of total dissolved solids above water quality objectives in approximately half the samples, and increases were noted along an upstream-downstream gradient. Oxygen concentrations remained high throughout the sampling season, although this was to be expected in shallow, flowing waters. pH levels fluctuated somewhat with flow, but were well within normal parameters. Total suspended solids (TDS) and turbidity also fluctuated with flow.
TSS

Since this study covered a single season during a good water year, and did not extend into the winter, it should not be taken as definitive. Moreover, it does not indicate why TKN levels are elevated at upstream locations. It also does not address water quality within Bridgeport Reservoir, although limited sampling downstream of the reservoir, as well as a heavy aquatic plant bloom, suggests that water quality degrades significantly over the summer. The recommendation from this study is that monitoring continue for at least another year, with particular attention being extended to the headwaters and the reservoir.

INTRODUCTION

This report summarizes findings from a 1999 surface water quality investigation conducted by Linda Vance of the Department of Agronomy & Range Science at the University of California, Davis. The study was initiated and funded by the North Mono County Resource Conservation District in response to concerns about water quality in the district, and particularly in Bridgeport Reservoir and the East Walker River, both significant fisheries in the Eastern Sierra. The study involved surface water sampling of upstream and downstream locations on three major streams on a weekly basis during the snowmelt season, and on a monthly basis from June through October. Additional sampling was conducted on feeder streams and at selected midpoints on the major streams during the season so that sources of nutrients (if any) could be more easily identified. Surface water in the West Walker River watershed was sampled on six occasions in spring, midsummer, and fall. Water samples were analyzed for Total Kjeldahl Nitrogen, Nitrate, Total Phosphorus, Dissolved Oxygen, pH, Turbidty, and Total Suspended Solids.

BACKGROUND

The East Walker and West Walker Rivers, which originate in California's Sierra Nevada Mountains, are a critical water source for wildlife, fish, and human uses in both California and Nevada, where the Walker River ends in the terminal Walker Lake. In California, these rivers provide irrigation waters for alfalfa, garlic, carrots and cattle pasture. Bridgeport Reservoir, which stores water from the East Walker, and Topaz reservoir, which stores water from the West Walker, are popular tourist attractions because of their fisheries. The East Walker River below Bridgeport Reservoir is considered to be a trophy fishery, and is managed as such by the California Department of Fish and Game.

The headwaters of the East and West Walker are fed primarily by snowmelt runoff. Precipitation varies from 25 to 65 inches a year, with most falling as snow. Except during unusual rain-on-snow events, as occurred in January of 1997, discharge in the rivers and streams usually peaks in late May/early June, while base flows prevail during the August-April period. Figure 1 shows the flow record for Buckeye and Robinson Creeks from 1995 through the end of 1999.

For many years, Bridgeport Reservoir, unlike Topaz Reservoir, has exhibited eutrophic status, indicating high nutrient concentrations. In some years, this results in a large algal bloom in mid-summer, primarily dominated by *Apanizomenon flos-aquae* species. These blooms are transported downstream by winds and by current, and as they sink and decompose, microbial processes consume available dissolved oxygen in the water. In years of especially high algal bloom, this can lead to dissolved oxygen levels low enough to harm or kill fish. It appears, however, that algal blooms may sometimes be supplanted by submerged macrophytes. In the summer of 1999, a *Polygonum L.* species was dominant in the reservoir, especially in the rich sediments near the shores. *Polygonum spp.* also contribute significantly to the reservoir's nutrient load, both through their decay and because they are highly attractive to waterfowl in early fall.

The present study was initiated in response to concerns that land use within the upper watershed, particularly in Bridgeport Valley, was contributing to nutrient loading of the reservoir. Although water sampling in the reservoir and upstream has been limited in both frequency and scope in the past, many of the reported samples have indicated nitrogen and phosphorus levels in excess of limits established under the *Water Quality Control Plan for the Lahontan Region* (see Table 1 for the limits for the East Walker and West Walker rivers). Because large numbers of cattle are present in Bridgeport Valley during the summer months, it appeared possible that erosion and manure deposition might be contributing to nitrogen and phosphorus levels downstream. the present study was designed to measure differences in nutrient concentrations between sampling sites upstream and downstream of grazed pastures. A secondary goal was to draw sufficient samples from feeder streams and from midstream locations to determine at what points nutrient inputs might be occuring, if indeed downstream nutrient levels proved higher than upstream levels.

WATER QUALITY COMPONENTS INCLUDED IN THE STUDY

Total Kjeldahl Nitrogen (TKN)

TKN is a measure of both organic and inorganic forms (including ammonia) of nitrogen. Because organic nitrogen is not available to plants until it is decomposed into inorganic forms, measures of nitrogen alone are not useful in water quality analysis. TKN is the measure of nitrogen most often used in water quality testing.

Ammonia (NH_3 and NH_4+)

Ammonia, which includes dissolved ammonia (NH3) and ammonium ion (NH4+) is the most reduced inorganic form of nitrogen in water, and promotes aquatic plant growth. It is reported in mg/L. Although ammonium is often found in fish culture environments, and in high-temperature, high-pH reservoirs during algal blooms, it is generally low in running waters. Because of the presence of cattle in Bridgeport Valley, and the possibility of urine being excreted into the waters, ammonia sampling was included in the early season. It was discontinued in July because analysis rarely found detectable levels, and because ammonia is a component of total Kjeldahl nitrogen (TKN), which was also being sampled.

Nitrate (NO_3-)

Nitrate, reported in mg/L, is the most stable form of nitrogen in water, as well as being the primary form of nitrogen used by plants for growth. When sufficient levels of phosphorus are present, high nitrate levels can stimulate excessive plant or algal growth. Nitrates are commonly found in animal wastes and in sewage.

Total phosphorus (P)

Total phosphorus measures both inorganic and organic forms of phosphorus. Phosphorus can be present in dissolved or particulate form. Except where there are anthropogenic sources like sewage or waste disposal, or high inputs of animal wastes from domestic or wild animals, phosphorus is usually a "limiting nutrient" in running water. This means that no matter how much nitrogen is added to a system, it will not support abundant plant life. However, since phosphorus binds to soil and silt particles, it will often accumulate in reservoir sediments. It is reported in mg/L. The minimum detectable level for the analysis used in this study was 0.05 mg/L. This does not mean that total P below that level is inconsequential, only that it could not be measured with the analyzing equipment used. In general, only levels of 0.01 mg/L or less can be considered limiting; anything above that level can promote some level of plant or algal growth if nitrogen is also available.

Turbidity

Turbidity measures the passage of light through water in Nephelometric Turbidity Units (NTU). It is a useful benchmark for measuring sediments, and for inferring the source of phosphorus, which tends to bind to soil particles. Pure distilled water has an NTU of 0. Water with suspended particulates (clay, silt, organic materials, microorganisms) can have an NTU of 50 or greater. Because particulates provide surfaces for bacterial growth, and because high turbidity levels reduce light penetration and therefore impair photosynthesis, high turbidity levels are considered to be detrimental to aquatic ecosystems.

Electroconductivity (EC)

Electroconductivity measures the ability of water to conduct an electric current, which in turn is determined by the content of ions --dissolved metals and other materials-- in the water. It is reported as microsiemens per centimeter (μS/cm), and generally ranges from 50-500 μS/cm in inland streams. Electroconductivity can be used to measure total dissolved salts (TDS). Although a specific correlation should be developed for each stream, a general rule of thumb is that TDS in parts per million = EC in μS/cm *0.55, so that an EC reading of 500 μS/cm would translate to a TDS level of 275 ppm. Although very high concentrations of TDS can be lethal to fish, the levels commonly found in running waters pose little danger.

pH

pH measures the concentration of hydrogen ions in water. Most natural fresh waters have a pH between 4.0 and 10.0. A pH level below 7.0 is considered acidic, and a pH above 7 is considered basic. Each full unit represents a ten-fold increase or decrease, i.e. water with a pH of 6.5 is ten times more acidic than water with a pH of 6.4. Most inland lakes and streams in California have a pH greater than 7.0. In reservoirs and other water bodies where aquatic plants are present, pH tends to increase in summer months as a result of photosynthesis. At high pH levels, the solubilization of ammonia, heavy metals, and salt is greater.

Total suspended solids (TSS)

Like turbidity, this is a measure of particulates within the water column. It is determined by filtering a water sample into a preweighed filter, drying the filter, and reweighing it. The difference between the two values is reported in mg (dry weight)/L (of water filtered). Even when suspended particulates do not greatly influence light penetration in the upper water column, they can have deleterious effects to gilled organisms like fish and aquatic insects when they settle to the bottom, and can also smother fish eggs in spawning beds. In general, TSS values will be higher during initial periods of high flow, since sediments and particulates are picked up from the streambed and from surface runoff and carried along in the water column

Dissolved Oxygen (DO)

This is simply a measure of the amount of oxygen dissolved in water. Concentration of DO in surface waters is typically less than 10 mg/L, but in fast moving, shallow waters it can be much higher because there is a constant exchange between the water and the air. DO concentrations fluctuate on a daily and seasonal basis due to temperature, flow rates and photosynthesis by plants. In general, cold flowing waters will hold more dissolved oxygen than their warmer or more sluggish counterparts. Maximum DO saturation is 15 mg/L at 32°F, and is sometimes achieved early in the season. DO is critical for most fish and aquatic organisms. Cold water fish like trout require high DO levels for feeding, swimming, and reproduction, as well as for basic physiological functioning. DO levels below 5 mg/L are considered to be instantaneously lethal to fish, as are 30 day averages below 8 mg/L. DO also affects nutrient solubility and availability, and thus controls the "productivity" (production of plants, algae, macroinvertebrates, fish etc) of aquatic systems.

METHODS

Site selection

Twenty-one sites were selected in Bridgeport Valley to be sampled during the course of the season (See Map 2 and Table 1). An additional site was sampled in the upper part of Aurora Canyon for a single sample in April. Five sites were selected on the West Walker. (See Table 1 for locations). Among the 21 sites in Bridgeport Valley, seven were sampled on each sampling date: Site 2 (Buckeye US); Site 3 (Buckeye DS); Site 14 (Robinson US), Site 15 (Robinson DS); Site 5 (E. Walker US[1]), Site 11 (E. Walker DS), and Site 19 (Summers). All of these were sampled prior to the beginning of snowmelt runoff (April 16), and at weekly intervals until the second peak of runoff declined. Sampling was suspended between June 5 and June 18 because an unusually cold period interrupted runoff (See ~~Figure 2~~). The remaining sites in the Valley were selected for a less frequent sampling regime that was primarily intended to provide supplemental information about

FIG. 1

[1] E. Walker US is in fact Green Creek. The East Walker itself is a small, low-flow channel originating as groundwater in the Valley below the Hunewill Hills. Green Creek, which joins the East Walker River near Site 6, is the major source of water in the upper portions of the river, and so was designated as the upstream site for comparison purposes.

changes occurring because of land use practices. Table ~~2~~ 1 gives a full listing of site locations and reasons for sampling.

Sample collection and analysis

500 mL samples were collected in nalgene bottles, placed under refrigeration, and transported to the Division of Agriculture and Natural Resources Analytical Laboratory at the University of California at Davis for processing. Chemical analysis was performed using the latest methods adopted by the American Pollution Control Association, with detectable levels for TKN, NH_4^+, NO_3^- and total P at 0.05 or greater (this was necessary due to budget limitations so that the greatest number of sites could be sampled). Subsamples were drawn off to analyze for electroconductivity, pH, turbidity and total suspended solids, using standard laboratory methods. Dissolved oxygen was measured in the field at the time of collection using a YSI 55 handheld dissolved oxygen meter. Chain-of-custody procedures were followed in collecting, preserving, shipment and delivery of samples for chemical analysis. Quality assurance procedures were followed at all stages, and included random resampling, coded samples, and duplicate samples.

STATISTICAL ANALYSIS

Pairwise comparisons and Analyses of Variance (ANOVA) were performed on the TKN, Turbidity, Conductivity, TSS, pH and O_2 data for upstream and downstream sites on the East Walker, Robinson Creek and Buckeye Creek to determine if differences existed between the creeks, between sampling sites on the creeks, and between sampling dates. Because Nitrate, Ammonia and Phosphorus were not present at detectable levels in most samples, statistical analysis was not possible. The remaining data was analyzed using only descriptive statistics, since one season did not provide enough data from most sites to give the analysis any real statistical power.

RESULTS

Table ~~1~~ 2 gives the existing Water Quality Objectives established by the Lahontan Regional Water Quality Control Board for the West and East Walker Hydrologic Units. Table ~~2~~ 3 lists results from water testing organized by site, and Table ~~3~~ 4 lists results organized by date. Individual components from the testing are discussed separately below.

Total Kjeldahl Nitrogen (TKN)

TKN levels for all sampling sites through the entire sampling season was 0.58 mg/L, higher than water quality objectives for any of the creeks permit. Table 2, Averages by Site, lists averages for individual sampling locations. In general, very early and late season values are highest, while lowest values prevail during periods of peak flow. Figures 3, 4 and 5, which plot TKN against flow, show this pattern clearly[2].

Nonetheless, pairwise comparisons indicated there is no significant difference in TKN levels between upstream and downstream sites on the same streams (Buckeye P=0.817, Robinson P=0.554, E. Walker P=0.421) The Analysis of Variance performed on all 6 sampling sites showed no site-based differences between seasonal averages for any of the sites, i.e. average TKN for Robinson US was not significantly different from average TKN for Robinson DS, Buckeye US, Buckeye DS, East Walker US or East Walker DS, and so on. The P-value on the ANOVA was 0.998 at a 95% confidence level. This means, in effect, that there is a 99.8% probability that any differences among the 6 sites are due purely to chance or sampling "noise" and do note reflect any genuine differences.

However, an ANOVA based on sampling date showed highly significant differences (P=2.4 E-21). This means, in effect, that there is almost no possibility that these values would be observed except if there were distinct and real differences between values observed on different dates.

Ammonia (NH_4+)

As noted earlier, the detection level for NH_4+ was 0.05 mg/L. In 154 samples, NH_4+ was only detected above this level 12 times (8%). No patterns were apparent by site or by date, and sampling for ammonia was discontinued after July 16.

Nitrate (NO_3-)

The detection level for NO_3- was also 0.05 mg/L. This level was exceeded in 23% of the samples, or 49 of 211. There appeared to be a broad seasonal pattern: 31% of the samples taken April 16 had detectable nitrate levels, as did 47%, 66% and 25% of the samples taken August 14, September 11 and October 16, suggesting a correlation with flow. Highest values occurred downstream of Bridgeport Reservoir in September and October. There also appears to be some differences between upstream and downstream samples on Buckeye and the East Walker, but there are not enough samples above the detectable level for statistical analysis.

Total phosphorus (P)

Total P was found above the above 0.05 mg/L detectable level in 9% of the samples (20 of 211). 10 of the 20 samples came from Swauger and Aurora Creeks, both of which are very low-flow streams. Aurora, in particular, is ephemeral, and most of Swauger is diverted for agriculture. However, the sampling period may not have encompassed peak flows on

[2] Flows for the East Walker US (Green), Virginia and Summers were estimated by developing a regression relationship against Buckeye Creek from 1955-1975 data. The regression for E.Walker US was especially strong, R^2= 0.93

Swauger and Aurora. Aurora runs out of the Bodie Hills, and Swauger out of the Sweetwaters, so snowm will occur earlier than in the creeks coming out of the Sierras.

Turbidity

Turbidity values throughout the sampling season were generally low, ranging from a seasonal average of 2.4 NTU at Buckeye US to 8.1 NTU at Virginia @ Strosnider and at Aurora. The value at Virginia may be attributable to a return flow influence high in tannins and/or iron, which comes in just above the sampling site. Paired t-tests between upstream and downstream sampling sites on Buckeye, Robinson and the East Walker show no significant differences, and an ANOVA for all six sampling locations shows no differences between any of the sampling sites (P=0.711). However, an ANOVA for all six locations shows highly significant differences by date (P=0.00). This is not an unusual observation; turbidity usually increases dramatically during snowmelt, as sediments are entrained by fast-moving waters.

Electroconductivity (EC)

When translated to Total Dissolved Salts (TDS) by the formula "TDS in parts per million = EC in µS/cm *0.55", 105 of the 211 samples exceed water quality objectives. Some creeks, notably Aurora and Virgina, have notably high levels, as does the East Walker below the reservoir. Pairwise comparisons between upstream and downstream sites on Buckeye and the East Walker show significant differences (P=0.009 and P-0.001 respectively), although sites on Robinson do not (P=0.72). This is not easily explained, since soil types and land use along Buckeye and Robinson are virtually identical. ANOVAS show significant differences by sites and dates (P= 0.01 and P= 0.006 respectively).

PH

PH values within the sites sampled were well within recommended values. Pairwise comparisons between upstream and downstream sites on Buckeye, Robinson and the East Walker show no significant differences, nor does an ANOVA for the six sites together (P=0.98). However, the ANOVA does show significant differences by date (P=0.001). Since pH would be expected to be lower during peaks of snowmelt, this is not an unusual finding.

Total suspended solids (TSS)

Although there are presently no published objectives for TSS, the values observed during this study are generally low, indicating a low rate of erosion, especially in the East Walker. Values appear higher in the West Walker, especially at high flows, which may reflect continuing sedimentation attributable to the 1997 floods. Neither and ANOVA on the six sites nor pairwise comparisons among upstream and downstream locations on Buckeye, Robinson and the East Walker indicate any significant differences, although an ANOVA on sampling dates is significant. As would be expected, this is correlated with flows, as can be seen in Figures 6, 7 and 8.

Dissolved Oxygen (DO)

Dissolved oxygen values in the watershed are generally high, approaching saturation in early season sampling. Since DO is closely linked to water temperatures, and since water temperatures increase during the day from upstream to downstream sites, and over the course of the season, we would expect differences both between upstream and downstream sites on the same stream, and between streams with different flow regimes. This expectation was met in these samples: the ANOVA on the six sites showed significant differences both by date (P=0.001) and by site (P=0.02).

DISCUSSION AND RECOMMENDATIONS

The seasonal patterns observed during this study are in line with expectations based on studies by other researchers in other watersheds. On the rising arm of the hydrograph, nutrient concentrations should initially be high, as nutrients are leached out of the soil, then fall due to dilution, flushing, and plant uptake, and finally increase as water levels drop in late summer. Similarly, suspended solids and turbidity should show an increase with high flows, then decline with decreasing discharge.

What is perhaps surprising in this set of observations is the lack of observable differences in TKN levels between upstream and downstream sampling sites on the same streams, and the high overall levels. As noted above, the majority of the samples exceed water quality objectives for total nitrogen. However, this is equally true for upstream and downstream sites. This suggests that there may be sources of nitrogen well upstream of grazed areas. In this regard, it is notable that a 1988-89 study of groundwater at Twin Lakes (enhanced lakes that feed Robinson Creek) found TKN levels in wells to average between 0.30 and 0.40 mg/L, not dramatically lower than the 0.50-0.60 mg/L levels observed in surface waters. Whether these levels are "background" levels or anthropogenically caused deserves further study.

While there is some indication that nitrates may be at higher levels in downstream sites, they are not as high as would be expected in a grazed system. This is probably attributable both to plant uptake and to anoxic conditions in the flood-irrigated portions of Bridgeport Valley. Because herbivory by the cattle minimizes competition between plants, and because water is readily available, there is a long and abundant period of plant growth to use the nutrients which might otherwise flow through the system. It should also be recognized that ranchers within the Valley use good grazing practices and manage irrigation water effectively, thus further reducing influences of cattle on water quality. The same management practices may also explain the relatively low levels of total suspended solids and phosphorus, both of which would be expected to be higher if active erosion were occuring.

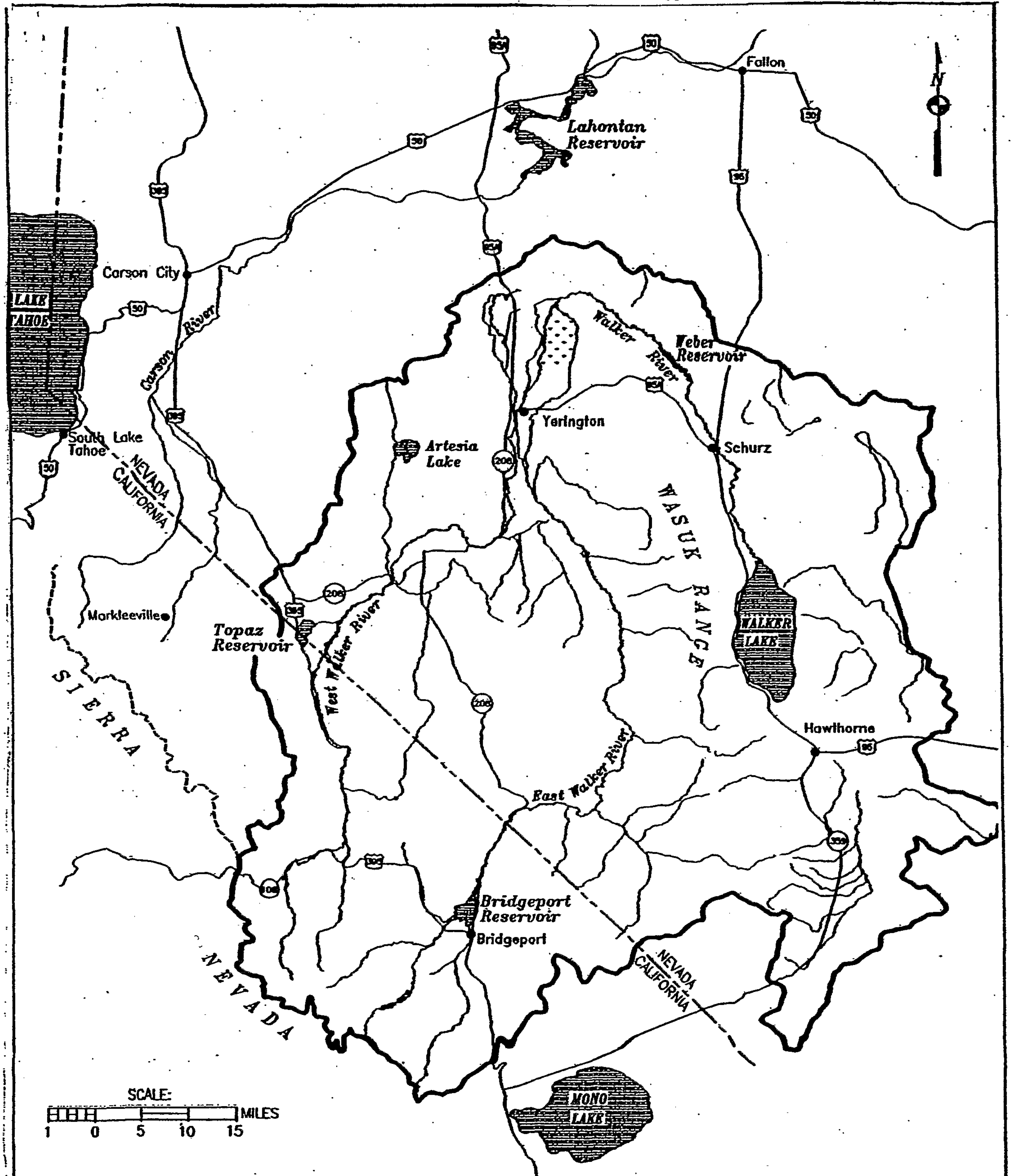
Nevertheless, a single season of sampling raises as many questions as it answers. As noted, the reason for the consistently high TKN levels is unexplained, and requires additional sampling in the upper watershed. Because the goal of this study was to carry out as broad a characterization of the watershed as possible, and because cost was a factor, tests for nitrates and phosphorus were performed with a detection level of 0.05 mg/L, making statistical analysis of those results impossible. Therefore it cannot be conclusively said that all nutrient levels do not show spatial patterns, or that land use within Bridgeport Valley does not influence downstream water quality. Nor does the present study indicate the source of the nutrients in the reservoir. The history of algal blooms in the reservoir, and the 1999 *Polygonum spp.* bloom, as well as the elevated nutrient levels in the East Walker downstream of the reservoir all indicate that there is, in fact, a nutrient problem in the reservoir. Until the source of the nutrients is identified it will be difficult to determine management options for reducing them, or to determine appropriate revisions to water quality objectives in the event that they are beyond the reach of management. Finally, the results reported in this study illustrate how dramatically flows influence water quality constituents. Given the significant differences we observe in water years in California, it is imprudent to generalize anything from a single sampling year.

Accordingly, an additional two --and perhaps three-- seasons of sampling are highly recommended, at least in the East Walker watershed, since TMDLs will have to be prepared in the near future. The sampling schedule followed in this initial study appears to be appropriate; although storm-event sampling is important in many systems, snowmelt accounts for most of the rises in the hydrograph in this system. However, snow sampling should also be considered to determine if any of the TKN comes from atmospheric deposition. At a minimum, sampling sites should be extended to include Robinson at the inlet and outlet of Twin Lakes, Eagle Creek at its headwaters and its confluence with Buckeye, Buckeye at Big Meadows, Virginia below Virginia Lakes, and Green at the trailhead leading to Green Lake. The current midpoints on Green and the East Walker can probably be eliminated. The WRID fenceline on Buckeye and Robinson, and a new site on the East Walker further downstream from the existing one should be maintained. It is also highly recommended that there be water sampling and sediment sampling in the reservoir itself. Development along the shoreline, inputs from waterfowl, releases from sediments and the influence of decaying vegetation cannot be disregarded as sources of the problem.

Finally, samples should be subjected to more sensitive analysis for nitrates and phosphorus than a 0.05 mg/L detection limit. Nitrates are the most readily available form of nitrogen for plant growth, and N:P ratios need to be known to assess ways to control algal and plant blooms in reservoirs. Clearly some shift has already occurred, if macrophytes have taken over from nitrogen-fixing algae. A more specific account of nitrate and phosphorus concentrations in the surface waters will also make it possible to model nutrient loading from the watershed as a whole.

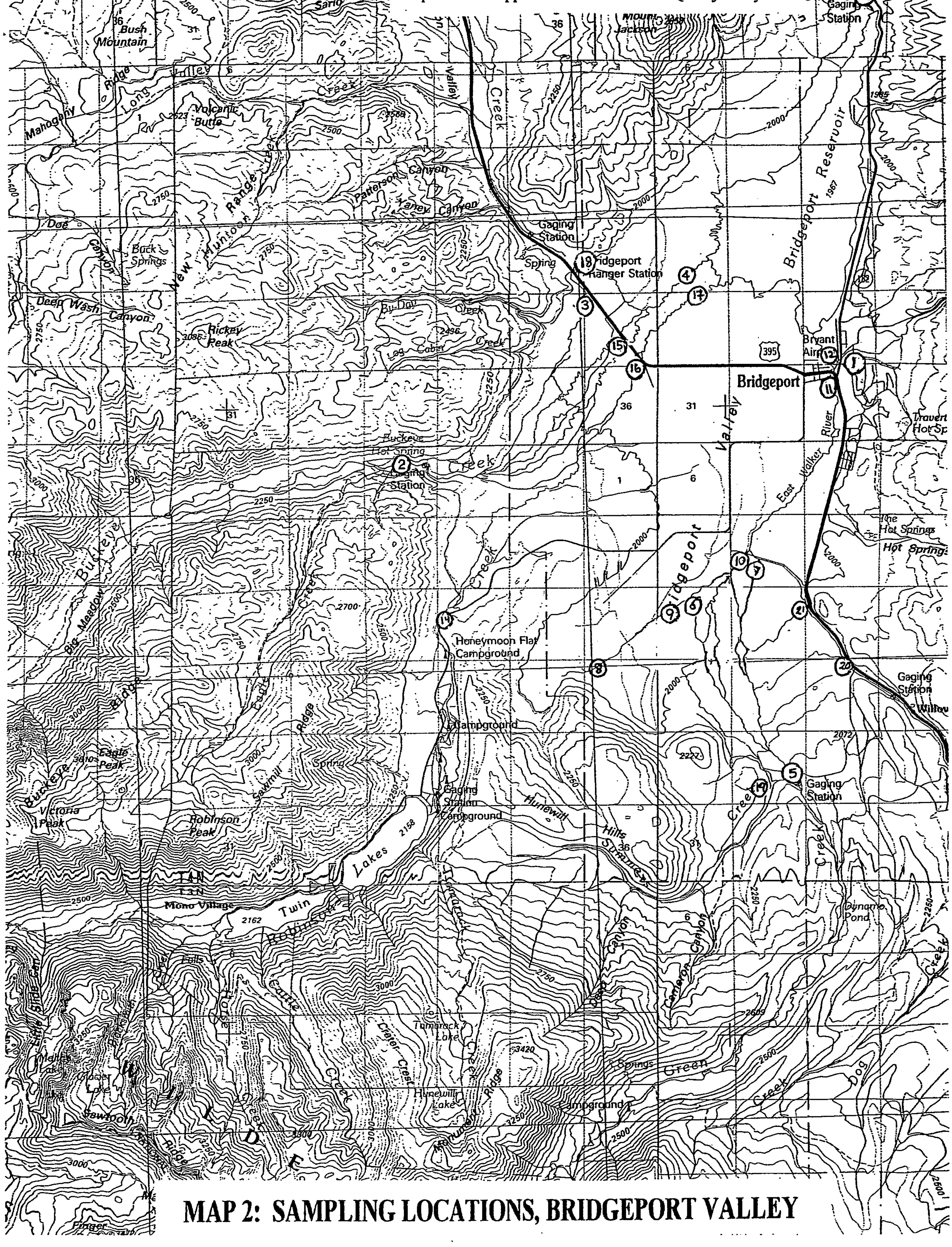
CONCLUSIONS

This study illustrated the extent of spatial and temporal variations in water quality components, and the importance of sampling both upstream and downstream sites across an entire water season. It further demonstrated that flow levels dramatically affect nutrient levels, suspended solids, turbidity, and pH, and suggested that there may be an increase in TDS downstream of flood irrigated pasture. However, it also showed that there are high levels of TKN in all the waters of the East and West Walker watersheds, regardless of land use. The results obtained provide a baseline and direction for further study and analysis. no.



Walker River Watershed

MAP 1



MAP 2: SAMPLING LOCATIONS, BRIDGEPORT VALLEY

Table 1: Map Key and Sampling Rationale

Name	Map #	Remarks
Aurora US	none	In Aurora Canyon, near headspring. Sampled 4/16 only.
Aurora DS	1	At confluence with E. Walker. Sampling discontinued after 5/29 because of insignificant flows
Buckeye US	2	At bridge crossing near stream guage. Sampled throughout season
Buckeye @ 395	3	US of highway bridge (4/16 sampled taken DS). Sampled throughout season. Used as Buckeye DS for comparisons
Buckeye DS (ASCUA))	none	Fenceline just SW of Walker River Irrigation District Boundary. Alternate to 5 when WRID sampling separately.
Buckeye DS (WRID)	4	Just NE of Walker River Irrigation District Boundary. Less than 200m from Ascuagua line.
Green (US)	5	At bridge crossing on Upper Summers Meadow Rd. Used as "E. Walker US" and sampled throughout season.
Green @ E. Walker	6	Near Dressler diversion in center of valley, just US of confluene with E. Walker
Green @ strosnider	7	US of crossing of Strosnider lane (Point Ranch). May be mostly return flow, but enters E. Walker
E. Walker below pond	8	Just DS of headwater spring below Hunewill Hills. Only sampled 2X because of low flows, poor access
E. Walker At Green	9	Just US of Dressler diversion and site 6
E. Walker @ strosnider	10	US of crossing of Strosnider lane (Point Ranch).
E. Walker US of bridge	11	Just US of Highway 395 bridge.
E. Walker DS of bridge	12	DS of Airport Bridge. Sampled to determine impacts (if any) from town and old sewage ponds.
E. Walker below res	13	Below Bridgeport reservoir.
Robinson US	14	At bridge crossing just US of Doc & Al's Resort. Sampled throughout season.
Robinson (N) @ 395	15	Upstream of highway bridge (4/16 sampled DS). Sampled throughout season. Used as Robinson DS for comparison.
Robison (S) @ 395	16	Upstream of highway bridge (4/16 sampled DS). Sampled early season only; flows diverted during irrigation.
Robinson DS(WRID)	17	Just NE of Walker River Irrigation District Boundary. Less than 200m from Ascuagua line.
Robinson DS(ASCUA)	none	Fenceline just SW of Walker River Irrigation District Boundary. Alternate to 17 when WRID sampling separately.
Swauger	18	Just DS of Forest Service Compound, at Ascuaga diversion
Summers (ds)	19	US of culvert on Fulstone access road off Upper Summers Meadow. Drains Summers Meadow.
Virginia @ 395	20	At bridge crossing at intersection of Green Ck Road and Highway 395.
Virginia @ strosnider	21	US of Point Ranch diversion. Contains return flow from irrigation.
Little Walker@108	none	At stream guaging station just downstream of Highway 108
W. Walker @395	none	At stream guaging station US of Highway 395 crossing
Walker in town	none	Under bridge at S. end of town of Walker
Mill Ck	none	US of highway 395 crossing
Walker @ Cunningham	none	Us of bridge on Cunningham Lane in Coleville/Topaz

Table 2. Water Quality Objectives for West and East Walker River Hydrologic Units, from Lahontan Regional Water Quality Control Board Plan.

Surface Waters	TDS mg/L	Total N	Total P
West Walker River at Coleville	60 75	0.20 0.40	0.01 0.02
East Walker River at Bridgeport	145 160	0.5 0.8	0.06 0.1
Robinson Ck and all other tributaries above Bridgeport Valley	45 70	0.05 0.10	0.02 0.03

The upper value in each set represents the annual average; the lower value is the 90th Percentile value (90% of sampled values in a given year should be below this value.

TABLE 3 . Results by site. Boxed values exceed water quality standards. Shaded values are above detectable levels, but do not exceed standards unless they are also boxed. Note that no specific standards exist for NO3-N or NH4-N.

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Aurora DS	04/16/99	1.1	<0.05	<0.05	<0.05	5.3	250.0	8.0	44.8	10.2
Aurora DS	05/01/99	0.4	<0.05	0.07	0.29	1.5	548.0	9.2	29.2	10.9
Aurora DS	05/06/99	0.5	<0.05	<0.05	<0.05	18.5	288.4	7.7	58.0	10.6
Aurora DS	05/14/99	0.1	<0.05	<0.05	0.18	11.0	231.0	7.8	40.0	10.1
Aurora DS	05/21/99	0.2	<0.05	<0.05	0.20	11.7	292.0	7.8	37.9	10.4
Aurora DS	04/16/99	0.7	<0.05	0.10	<0.05	0.8	115.2	7.5	33.0	10.2
	Averages	**0.50**	**0.0**	**0.0**	**0.1**	**8.1**	**287.4**	**8.0**	**40.5**	**10.4**
	Stan. Dev	**0.33**				**6.2**	**130.5**	**0.6**	**9.3**	**0.3**
Buckeye US	04/16/99	0.5	<0.05	<0.05	<0.05	1.0	76.3	7.6	27.9	11.4
Buckeye US	05/01/99	0.6	<0.05	<0.05	<0.05	1.4	89.5	7.5	30.3	11.8
Buckeye US	05/06/99	1.0	<0.05	<0.05	<0.05	6.5	28.0	7.3	24.0	14.2
Buckeye US	05/14/99	0.2	<0.05	<0.05	<0.05	2.7	47.8	7.3	30.5	11.4
Buckeye US	05/21/99	0.2	<0.05	<0.05	<0.05	3.0	32.8	6.9	33.3	12.6
Buckeye US	05/29/99	0.3	<0.05	<0.05	<0.05	2.0	23.3	6.2	60.0	12.6
Buckeye US	06/06/99	0.3	<0.05	<0.05	<0.05	1.8	40.3	7.2	104.0	13.7
Buckeye US	06/18/99	0.2	<0.05	<0.05	<0.05	5.6	16.5	6.6	44.0	11.9
Buckeye US	07/16/99	0.4	0.10	<0.05	<0.05	2.8	41.5	7.2	28.0	11.0
Buckeye US	08/14/99	0.9	**	<0.05	<0.05	1.1	60.9	7.4	28.0	10.6
Buckeye US	09/11/99	0.7	**	<0.05	<0.05	0.6	81.1	7.5	44.0	10.2
Buckeye US	10/16/99	1.2	**	0.09	<0.05	0.7	87.0	7.4	18.0	10.8
	Averages	**0.54**	**n/a**	**n/a**	**n/a**	**2.4**	**52.1**	**7.2**	**39.3**	**11.9**
	Stan. Dev	**0.34**				**1.9**	**26.0**	**0.4**	**23.2**	**1.2**
Buckeye @ 395	04/16/99	1.0	0.54	0.16	<0.05	0.7	83.2	7.3	26.6	10.8
Buckeye @ 395	05/01/99	0.3	<0.05	<0.05	<0.05	1.6	93.1	7.5	29.3	11.4
Buckeye @ 395	05/06/99	0.7	<0.05	<0.05	<0.05	22.2	83.8	7.5	42.0	11.1
Buckeye @ 395	05/14/99	0.1	<0.05	<0.05	<0.05	3.4	67.4	7.4	31.2	9.7
Buckeye @ 395	05/21/99	0.2	<0.05	<0.05	<0.05	4.1	46.9	6.9	32.9	9.2
Buckeye @ 395	05/29/99	0.2	<0.05	<0.05	<0.05	2.0	27.5	6.9	42.0	12.7
Buckeye @ 395	06/06/99	0.4	<0.05	<0.05	<0.05	1.6	45.5	7.1	18.0	12.1
Buckeye @ 395	06/18/99	0.1	<0.05	<0.05	<0.05	6.2	28.3	6.6	32.0	10.9
Buckeye @ 395	07/16/99	0.3	<0.05	0.07	<0.05	3.6	105.3	7.0	26.0	10.8
Buckeye @ 395	08/14/99	1.1	**	0.13	<0.05	1.4	154.0	7.1	28.0	9.8
Buckeye @ 395	09/11/99	1.0	**	0.10	<0.05	1.2	189.4	7.9	40.0	9.9
Buckeye @ 395	10/16/99	1.0	**	0.10	<0.05	1.0	103.3	7.7	14.0	10.1
	Averages	**0.53**	**n/a**	**n/a**	**n/a**	**4.1**	**85.6**	**7.2**	**30.2**	**10.7**
	Stan. Dev	**0.40**				**5.9**	**48.9**	**0.4**	**8.7**	**1.0**
Buckeye DS (WRID)	05/29/99	0.2	<0.05	<0.05	<0.05	4.0	35.0	5.8	44.0	12.5
Buckeye DS (WRID)	06/05/99	0.3	<0.05	<0.05	<0.05	1.3	56.8	7.1	30.0	12.3
Buckeye DS (WRID)	06/18/99	0.2	<0.05	<0.05	0.12	13.9	30.9	6.7	40.0	11.2
Buckeye DS (WRID)	07/16/99	0.3	<0.05	<0.05	<0.05	2.9	56.9	7.1	18.0	10.8
Buckeye DS (ASCUA))	08/14/99	0.9	**	<0.05	<0.05	4.2	143.6	7.4	32.0	10.1
Buckeye DS (ASCUA))	09/11/99	1.1	**	0.18	<0.05	3.1	171.1	7.8	36.0	10.1
Buckeye DS (WRID)	09/11/99	1.0	**	0.08	<0.05	4.7	193.2	7.8	40.0	10.2
Buckeye DS (WRID)	10/16/99	1.1	**	<0.05	<0.05	2.1	117.2	7.9	22.0	10.2
	Averages*	**0.57**	**n/a**	**n/a**	**n/a**	**4.9**	**98.2**	**7.1**	**34.3**	**11.0**
	Stan. Dev	**0.42**				**4.0**	**64.0**	**0.7**	**9.1**	**1.0**

**** Averages for Buckeye DS include only the highest value for the two sampling sites on 9/11***

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Green (US)	04/16/99	0.4	<0.05	<0.05	<0.05	0.7	66.1	7.4	27.6	10.7
Green (US)	05/01/99	0.6	<0.05	<0.05	<0.05	1.0	56.5	7.4	42.0	12.2
Green (US)	05/06/99	0.9	<0.05	<0.05	<0.05	16.2	76.0	7.5	42.0	13.7
Green (US)	05/14/99	0.1	<0.05	<0.05	<0.05	4.1	43.2	6.9	31.8	11.9
Green (US)	05/21/99	0.1	<0.05	<0.05	<0.05	1.6	37.3	6.7	32.2	11.8
Green (US)	05/29/99	0.3	<0.05	<0.05	<0.05	1.0	27.4	6.9	30.0	11.8
Green (US)	06/05/99	0.3	<0.05	<0.05	<0.05	0.9	35.9	6.8	18.0	12.2
Green (US)	06/18/99	0.1	<0.05	<0.05	<0.05	5.1	23.9	6.2	18.0	10.0
Green (US)	07/16/99	0.3	<0.05	<0.05	<0.05	8.3	105.7	7.3	40.0	10.3
Green (US)	08/14/99	1.1	**	<0.05	<0.05	0.8	49.3	6.8	30.0	11.6
Green (US)	09/11/99	1.2	**	<0.05	<0.05	1.2	106.8	7.8	56.0	10.6
Green (US)	10/16/99	0.8	**	<0.05	<0.05	1.2	67.1	7.7	14.0	10.6
	Averages	**0.52**	**n/a**	**n/a**	**n/a**	**3.5**	**57.9**	**7.1**	**31.8**	**11.5**
	Stan. Dev	**0.40**				**4.6**	**27.7**	**0.5**	**12.0**	**1.0**

Green @ E. Walker	05/21/1999	0.2	<0.05	<0.05	<0.05	2.3	51.9	6.6	30.8	10.9
Green @ E. Walker	05/29/99	0.3	<0.05	<0.05	<0.05	1.3	32.9	6.8	34.0	10.2
Green @ E. Walker	06/05/99	0.3	<0.05	<0.05	<0.05	1.2	45.1	7.0	24.0	12.1
Green @ E. Walker	06/18/99	0.1	<0.05	<0.05	<0.05	5.6	41.3	6.6	26.0	10.2
Green @ E. Walker	07/16/99	0.2	0.07	<0.05	<0.05	4.5	88.0	7.1	18.0	10.4
Green @ E. Walker	08/14/99	1.0	**	<0.05	<0.05	2.3	112.8	7.5	24.0	11.1
Green @ E. Walker	09/11/99	1.1	**	0.15	<0.05	1.5	84.7	7.8	56.0	10.7
Green @ E. Walker	10/16/99	1.4	**	<0.05	<0.05	1.1	78.0	7.7	10.0	10.7
	Averages	**0.58**	**n/a**	**n/a**	**n/a**	**2.5**	**66.8**	**7.1**	**27.9**	**10.8**
	Stan. Dev	**0.51**				**1.7**	**28.0**	**0.5**	**13.6**	**0.6**

Green @ strosnider	07/16/99	0.3	<0.05	0.05	0.06	10.1	94.4	7.6	28.0	10.5
Green @ strosnider	08/14/99	1.3	**	<0.05	<0.05	5.1	133.3	7.2	28.0	9.0
Green @ strosnider	09/11/99	1.1	**	<0.05	<0.05	2.9	142.5	7.8	56.0	10.6
Green @ strosnider	10/16/99	1.5	**	<0.05	<0.05	1.0	118.8	7.7	10.0	10.7
	Averages	**1.05**	**n/a**	**n/a**	**n/a**	**4.8**	**122.3**	**7.6**	**30.5**	**10.2**
	Stan. Dev	**0.53**				**3.9**	**21.0**	**0.3**	**19.0**	**0.8**

E. Walker below pond	04/16/99	0.9	<0.05	<0.05	0.15	2.7	193.1	7.8	28.0	9.8
E. Walker below pond	08/14/99	1.6	**	0.31	<0.05	159.0	141.8	7.3	170.0	8.9
	Averages	**1.25**	**n/a**	**n/a**	**n/a**	**80.9**	**167.5**	**7.6**	**99.0**	**9.4**
	Stan. Dev	**0.49**				**110.5**	**36.3**	**0.4**	**100.4**	**0.6**

E. Walker At Green	05/21/1999	0.1	<0.05	<0.05	<0.05	3.4	117.6	7.2	30.2	10.7
E. Walker At Green	05/29/99	0.2	<0.05	<0.05	<0.05	0.8	55.1	6.9	20.0	10.2
E. Walker At Green	06/05/99	0.3	<0.05	<0.05	<0.05	1.4	88.4	7.1	18.0	11.2
E. Walker At Green	06/18/99	0.2	0.05	<0.05	<0.05	5.9	145.0	6.7	22.0	9.9
E. Walker At Green	07/16/99	0.2	<0.05	0.07	<0.05	5.0	81.7	7.4	28.0	9.8
E. Walker At Green	08/14/99	1.1	**	<0.05	<0.05	1.8	118.3	7.5	26.0	10.2
E. Walker At Green	09/11/99	1.0	**	0.10	<0.05	3.1	173.2	7.9	32.0	19.8
	Averages	**0.44**	**n/a**	**n/a**	**n/a**	**3.1**	**111.3**	**7.2**	**25.2**	**11.7**
	Stan. Dev	**0.42**				**1.9**	**40.0**	**0.4**	**5.3**	**3.6**

E. Walker @ strosnider	04/16/99	0.8	<0.05	<0.05	<0.05	1.8	105.6	7.5	27.6	11.0
E. Walker @ strosnider	05/01/99	0.4	<0.05	<0.05	<0.05	1.9	106.4	7.4	29.5	11.4
E. Walker @ strosnider	05/14/99	0.1	<0.05	<0.05	<0.05	8.2	91.6	7.2	37.0	10.6
E. Walker @ strosnider	06/05/99	0.3	<0.05	<0.05	<0.05	1.4	71.1	7.1	26.0	11.5
E. Walker @ strosnider	06/18/99	0.2	<0.05	<0.05	<0.05	5.9	74.6	6.2	22.0	10.0
E. Walker @ strosnider	07/16/99	0.1	0.05	<0.05	<0.05	1.9	57.4	7.3	16.0	10.6
E. Walker @ strosnider	08/14/99	0.9	**	0.07	<0.05	3.4	113.2	6.9	36.0	10.1
E. Walker @ strosnider	10/16/99	1.2	**	<0.05	<0.05	2.2	113.6	7.6	22.0	10.5
	Averages	**0.50**	**n/a**	**n/a**	**n/a**	**3.3**	**91.7**	**7.2**	**27.0**	**10.7**
	Stan. Dev	**0.41**				**2.4**	**21.5**	**0.4**	**7.2**	**0.6**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
E. Walker US of bridge	04/16/99	1.1	0.09	<0.05	<0.05	4.8	148.8	7.5	31.3	10.7
E. Walker US of bridge	05/01/99	0.6	<0.05	<0.05	0.05	1.7	213.0	7.5	30.6	11.4
E. Walker US of bridge	05/06/99	1.0	<0.05	<0.05	<0.05	15.2	78.8	7.4	30.0	10.7
E. Walker US of bridge	05/14/99	0.1	<0.05	<0.05	<0.05	8.0	134.3	7.4	35.4	12.4
E. Walker US of bridge	05/21/99	0.2	<0.05	<0.05	<0.05	4.8	126.7	6.9	34.6	11.3
E. Walker US of bridge	05/29/99	0.3	<0.05	0.13	<0.05	5.3	65.8	6.7	48.0	10.3
E. Walker US of bridge	06/05/99	0.3	0.09	<0.05	<0.05	1.1	100.5	7.2	26.0	11.5
E. Walker US of bridge	06/18/99	0.1	<0.05	<0.05	<0.05	13.1	95.0	6.7	40.0	9.8
E. Walker US of bridge	07/16/99	0.3	<0.05	<0.05	<0.05	5.7	46.8	6.9	24.0	10.7
E. Walker US of bridge	08/14/99	1.1	**	0.13	<0.05	1.4	154.0	7.1	28.0	9.8
E. Walker US of bridge	09/11/99	1.0	**	0.10	<0.05	1.2	189.4	7.9	40.0	9.9
E. Walker US of bridge	10/16/99	1.5	**	<0.05	<0.05	0.9	140.3	7.6	14.0	10.6
	Averages	**0.63**	**n/a**	**n/a**	**n/a**	**5.3**	**124.5**	**7.2**	**31.8**	**10.8**
	Stan. Dev	**0.48**				**4.8**	**49.4**	**0.4**	**8.8**	**0.8**
E. Walker DS of bridge	05/01/99	0.6	<0.05	<0.05	0.06	1.2	30.0	6.9	34.1	11.5
E. Walker DS of bridge	05/06/99	0.6	<0.05	<0.05	<0.05	13.0	51.2	7.5	42.0	10.7
E. Walker DS of bridge	05/14/99	0.2	<0.05	<0.05	<0.05	7.2	140.3	7.1	34.7	13.0
E. Walker DS of bridge	05/21/99	0.1	<0.05	<0.05	<0.05	2.7	138.2	6.9	33.1	11.3
E. Walker DS of bridge	06/05/99	0.4	<0.05	<0.05	<0.05	1.5	101.6	7.1	40.0	11.6
E. Walker DS of bridge	06/18/99	0.2	<0.05	<0.05	<0.05	9.6	92.3	6.5	30.0	9.8
E. Walker DS of bridge	07/16/99	0.3	<0.05	<0.05	<0.05	7.0	73.1	7.2	26.0	10.7
E. Walker DS of bridge	09/11/99	1.3	**	0.07	<0.05	5.3	190.9	7.6	56.0	9.9
E. Walker DS of bridge	10/16/99	1.0	**	<0.05	<0.05	1.3	143.5	7.6	22.0	10.7
	Averages	**0.52**	**n/a**	**n/a**	**n/a**	**5.4**	**106.8**	**7.2**	**35.3**	**11.0**
	Stan. Dev	**0.40**				**4.2**	**51.1**	**0.4**	**10.0**	**1.0**
E. Walker below res	04/16/99	1.1	<0.05	0.06	<0.05	1.9	162.0	7.7	41.0	10.5
E. Walker below res	05/01/99	0.4	<0.05	<0.05	<0.05	1.1	170.3	7.6	34.0	11.2
E. Walker below res	05/06/99	0.5	<0.05	<0.05	<0.05	6.1	134.9	7.5	26.0	10.5
E. Walker below res	05/14/99	0.1	<0.05	<0.05	<0.05	3.3	181.0	7.6	31.1	10.7
E. Walker below res	05/21/99	0.1	<0.05	<0.05	<0.05	2.6	174.5	7.6	33.0	11.1
E. Walker below res	05/29/99	0.2	<0.05	<0.05	<0.05	1.2	147.2	6.9	16.0	11.0
E. Walker below res	09/11/99	1.4	**	0.79	0.13	7.6	139.7	7.5	56.0	8.7
E. Walker below res	10/16/99	2.2	**	0.52	0.15	3.3	157.4	7.3	18.0	9.7
	Averages	**0.75**	**n/a**	**n/a**	**n/a**	**3.4**	**158.4**	**7.5**	**31.9**	**10.4**
	Stan. Dev	**0.75**				**2.3**	**16.7**	**0.3**	**12.8**	**0.8**
Robinson US	04/16/99	0.5	<0.05	<0.05	<0.05	0.8	66.5	7.5	26.7	10.8
Robinson US	05/01/99	0.3	<0.05	<0.05	<0.05	1.8	105.8	7.4	30.7	10.9
Robinson US	05/06/99	0.8	0.05	0.05	<0.05	13.6	87.6	7.5	34.0	13.2
Robinson US	05/14/99	0.1	<0.05	<0.05	<0.05	2.2	62.9	7.2	30.0	11.5
Robinson US	05/21/99	0.1	<0.05	<0.05	<0.05	1.5	58.4	7.1	32.1	11.6
Robinson US	05/29/99	0.4	<0.05	<0.05	<0.05	1.0	46.3	6.2	22.0	11.6
Robinson US	06/05/99	0.3	<0.05	0.06	<0.05	3.7	81.4	7.2	20.0	11.1
Robinson US	06/18/99	0.1	<0.05	<0.05	<0.05	5.8	51.4	6.8	20.0	10.7
Robinson US	07/16/99	0.3	<0.05	<0.05	<0.05	3.1	91.9	7.2	16.0	10.7
Robinson US	08/14/99	1.7	**	<0.05	<0.05	0.7	51.6	7.2	4.0	10.9
Robinson US	09/11/99	0.9	**	<0.05	<0.05	0.7	58.3	7.5	52.0	10.4
Robinson US	10/16/99	1.5	**	<0.05	<0.05	1.0	64.0	7.5	18.0	10.9
	Averages	**0.58**	**n/a**	**n/a**	**n/a**	**3.0**	**68.8**	**7.2**	**25.5**	**11.2**
	Stan. Dev	**0.54**				**3.7**	**18.6**	**0.4**	**11.9**	**0.7**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Robinson (N) @ 395	04/16/99	0.7	0.17	0.19	<0.05	1.2	107.7	7.4	28.1	10.9
Robinson (N) @ 395	05/01/99	0.4	<0.05	<0.05	<0.05	1.8	110.1	7.4	25.0	10.8
Robinson (N) @ 395	05/06/99	1.1	<0.05	<0.05	<0.05	16.8	52.0	7.5	32.0	11.2
Robinson (N) @ 395	05/14/99	0.1	<0.05	<0.05	<0.05	2.6	63.8	7.5	30.4	9.8
Robinson (N) @ 395	05/21/99	0.2	<0.05	<0.05	<0.05	2.5	49.2	7.0	29.3	9.9
Robinson (N) @ 395	05/29/99	0.2	<0.05	<0.05	<0.05	1.0	46.6	7.0	28.0	11.7
Robinson (N) @ 395	06/05/99	0.3	<0.05	<0.05	<0.05	2.1	54.7	6.9	20.0	11.7
Robinson (N) @ 395	06/18/99	0.2	<0.05	<0.05	<0.05	6.9	50.1	6.3	36.0	10.7
Robinson (N) @ 395	07/16/99	0.2	<0.05	<0.05	<0.05	6.3	90.3	7.0	38.0	10.4
Robinson (N) @ 395	08/14/99	1.1	**	0.07	<0.05	2.6	76.0	7.4	30.0	10.3
Robinson (N) @ 395	09/11/99	1.2	**	0.06	<0.05	1.1	89.2	7.6	48.0	10.2
Robinson (N) @ 395	10/16/99	1.0	**	<0.05	<0.05	0.7	64.0	7.4	18.0	11.1
	Averages	**0.56**	**n/a**	**n/a**	**n/a**	**3.8**	**71.1**	**7.2**	**30.2**	**10.7**
	Stan. Dev	**0.43**				**4.5**	**23.0**	**0.4**	**8.0**	**0.6**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Robinson (S) @ 395	04/16/99	0.7	0.11	0.06	<0.05	1.0	107.6	7.4	27.9	11.1
Robinson (S) @ 395	05/01/99	0.3	<0.05	<0.05	<0.05	1.9	106.7	7.4	29.5	10.9
	Averages	**0.50**	**n/a**	**n/a**	**n/a**	**1.5**	**107.2**	**7.4**	**28.7**	**11.0**
	Stan. Dev	**0.28**				**0.6**	**0.6**	**0.0**	**1.1**	**0.1**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Robinson DS(WRID)	05/29/99	0.2	<0.05	<0.05	<0.05	1.4	45.9	6.9	34.0	11.8
Robinson DS(WRID)	06/05/99	0.2	<0.05	<0.05	<0.05	1.1	56.3	6.9	20.0	11.2
Robinson DS(WRID)	06/18/99	0.1	<0.05	<0.05	<0.05	7.4	47.9	6.2	26.0	10.8
Robinson DS(WRID)	07/16/99	0.4	<0.05	<0.05	<0.05	5.1	58.0	7.2	22.0	10.6
Robinson DS(ASCUA)	08/14/99	1.4	**	<0.05	<0.05	4.7	89.4	7.9	34.0	10.6
Robinson DS(WRID)	09/11/99	1.0	**	0.17	<0.05	1.5	113.5	7.8	52.0	10.2
Robinson DS(ASCUA)	09/11/99	1.1	**	<0.05	<0.05	2.1	109.6	8.2	44.0	10.3
Robinson DS(WRID)	10/16/99	1.0	**	<0.05	<0.05	1.5	75.7	7.4	18.0	11.3
	Averages*	**0.63**	**n/a**	**n/a**	**n/a**	**3.3**	**74.4**	**7.3**	**33.1**	**10.8**
	Stan. Dev	**0.53**				**2.4**	**29.2**	**0.7**	**11.7**	**0.6**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Swauger	05/01/99	0.4	<0.05	<0.05	0.05	2.4	110.4	7.4	39.0	10.8
Swauger	05/06/99	0.4	<0.05	0.06	0.07	13.6	46.9	7.4	44.0	11.4
Swauger	05/21/99	0.1	<0.05	<0.05	0.06	7.3	121.9	6.8	36.5	10.7
Swauger	05/29/99	0.2	<0.05	<0.05	0.06	8.5	84.5	6.6	52.0	10.1
Swauger	06/05/99	0.3	<0.05	0.10	0.06	1.1	96.3	7.4	34.0	10.6
Swauger	06/18/99	0.2	<0.05	0.11	0.13	10.9	121.0	6.7	32.0	12.0
Swauger	08/14/99	1.1	**	<0.05	0.15	4.1	189.2	7.2	36.0	8.9
Swauger	09/11/99	0.9	**	0.11	<0.05	0.5	166.2	7.7	36.0	9.2
	Averages	**0.45**	**n/a**	**n/a**	**n/a**	**6.0**	**117.1**	**7.2**	**38.7**	**10.5**
	Stan. Dev	**0.36**				**4.8**	**44.9**	**0.4**	**6.5**	**1.0**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Summers (ds)	04/16/99	0.7	<0.05	<0.05	<0.05	2.0	87.3	7.6	27.8	11.2
Summers (ds)	05/01/99	1.3	<0.05	<0.05	<0.05	1.3	57.1	7.2	34.2	11.9
Summers (ds)	05/06/99	0.6	<0.05	<0.05	<0.05	15.1	50.2	7.5	35.0	11.3
Summers (ds)	05/14/99	0.2	<0.05	<0.05	<0.05	3.3	86.5	7.8	31.1	11.3
Summers (ds)	05/21/99	0.1	<0.05	<0.05	<0.05	3.9	83.8	7.4	30.6	9.3
Summers (ds)	05/29/99	0.3	<0.05	<0.05	<0.05	6.3	68.1	6.5	28.0	10.6
Summers (ds)	06/05/99	0.3	<0.05	<0.05	0.05	1.4	83.6	7.1	26.0	10.9
Summers (ds)	06/18/99	0.2	<0.05	<0.05	<0.05	4.8	69.6	6.9	22.0	9.8
Summers (ds)	07/16/99	0.3	<0.05	<0.05	<0.05	5.1	59.0	7.5	25.0	10.2
Summers (ds)	08/14/99	1.2	**	0.12	<0.05	2.2	72.5	7.2	30.0	9.8
Summers (ds)	09/11/99	1.4	**	<0.05	<0.05	4.1	73.6	7.7	48.0	9.4
Summers (ds)	10/16/99	0.8	**	<0.05	<0.05	1.1	85.8	7.5	12.0	10.8
	Averages	**0.62**	**n/a**	**n/a**	**n/a**	**4.2**	**73.1**	**7.3**	**29.1**	**10.5**
	Stan. Dev	**0.46**				**3.8**	**12.7**	**0.4**	**8.5**	**0.8**

*** Averages for Robinson DS include only the highest value for the two sites sampled on 9/11**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Virginia @ 395	05/14/99	0.1	<0.05	<0.05	<0.05	3.3	90.0	7.4	31.1	10.5
Virginia @ 395	05/21/99	0.2	<0.05	<0.05	<0.05	4.4	78.9	7.2	34.3	10.8
Virginia @ 395	05/29/99	0.3	<0.05	<0.05	0.05	3.5	73.5	7.1	44.0	10.5
Virginia @ 395	06/05/99	0.2	<0.05	0.08	<0.05	0.8	93.7	7.5	24.0	11.1
Virginia @ 395	06/18/99	0.2	0.07	<0.05	<0.05	13.8	81.8	6.6	40.0	9.6
Virginia @ 395	07/16/99	0.2	<0.05	<0.05	<0.05	7.8	58.2	7.0	36.0	10.3
Virginia @ 395	08/14/99	1.2	**	0.13	<0.05	3.1	108.5	7.3	24.0	10.3
Virginia @ 395	09/11/99	1.5	**	0.09	<0.05	1.6	100.5	7.9	48.0	10.7
Virginia @ 395	10/16/99	1.0	**	0.07	<0.05	0.8	106.3	7.7	18.0	11.2
	Averages	**0.54**	**n/a**	**n/a**	**n/a**	**4.3**	**87.9**	**7.3**	**33.3**	**10.6**
	Stan. Dev	**0.53**				**4.1**	**16.5**	**0.4**	**10.0**	**0.5**
Virginia @ strosnider	04/16/99	0.7	<0.05	<0.05	<0.05	1.1	104.5	7.5	28.0	10.9
Virginia @ strosnider	05/01/99	0.3	<0.05	<0.05	<0.05	1.2	119.5	7.5	30.1	11.1
Virginia @ strosnider	05/06/99	1.4	0.06	0.05	<0.05	18.4	48.1	7.4	48.0	10.9
Virginia @ strosnider	05/21/99	0.2	<0.05	<0.05	0.05	2.9	124.7	7.2	31.8	9.8
Virginia @ strosnider	05/29/99	0.2	<0.05	<0.05	<0.05	16.4	58.0	6.2	60.0	10.6
Virginia @ strosnider	06/05/99	0.3	<0.05	<0.05	<0.05	0.9	78.2	7.1	24.0	10.9
Virginia @ strosnider	06/18/99	0.1	<0.05	<0.05	<0.05	24.8	62.2	6.5	106.0	9.5
Virginia @ strosnider	07/16/99	0.3	<0.05	<0.05	<0.05	8.6	99.7	7.7	32.0	10.5
Virginia @ strosnider	08/14/99	1.2	**	0.06	<0.05	1.6	191.2	7.5	18.0	9.9
Virginia @ strosnider	09/11/99	1.3	**	0.09	<0.05	2.1	155.5	7.5	44.0	10.8
Virginia @ strosnider	10/16/99	1.2	**	<0.05	<0.05	11.2	125.3	7.4	36.0	11.2
	Averages	**0.65**	**n/a**	**n/a**	**n/a**	**8.1**	**106.1**	**7.2**	**41.6**	**10.6**
	Stan. Dev	**0.52**				**8.5**	**43.6**	**0.5**	**24.4**	**0.6**
Little Walker@108	04/16/99	0.7	<0.05	<0.05	<0.05	0.9	170.6	7.9	32.0	11.5
Little Walker@108	05/01/99	0.4	<0.05	<0.05	<0.05	1.1	68.1	7.3	28.9	11.1
Little Walker@108	05/21/99	0.1	<0.05	<0.05	<0.05	12.5	46.1	7.2	40.9	11.2
Little Walker@108	05/29/99	0.3	<0.05	<0.05	<0.05	1.5	48.7	7.0	32.0	11.8
Little Walker@108	06/18/99	0.2	<0.05	0.09	<0.05		43.6	7.4	31.0	11.7
Little Walker@108	09/11/99	1.1	**	0.11	<0.05	0.4	58.2	7.5	34.0	11.1
	Averages	**0.47**	**n/a**	**n/a**	**n/a**	**3.3**	**72.6**	**7.4**	**33.1**	**11.4**
	Stan. Dev	**0.37**				**5.2**	**48.9**	**0.3**	**4.1**	**0.3**
W. Walker @395	04/16/99	1.1	<0.05	0.08	<0.05	4.1	115.8	7.6	23.0	11.4
W. Walker @395	05/21/99	0.2	<0.05	<0.05	<0.05	13.4	53.2	7.4	41.2	11.2
W. Walker @395	05/29/99	0.3	<0.05	<0.05	<0.05	4.3	25.2	7.0	58.0	11.4
W. Walker @395	06/18/99	0.2	<0.05	0.06	<0.05	4.5	31.3	7.2	47.0	11.5
W. Walker @395	09/11/99	1.1	**	0.22	<0.05	0.4	187.8	7.6	34.0	11.1
	Averages	**0.58**	**n/a**	**n/a**	**n/a**	**5.3**	**82.7**	**7.4**	**40.6**	**11.3**
	Stan. Dev	**0.48**				**4.8**	**68.8**	**0.3**	**13.2**	**0.2**
Walker in town	04/16/99	0.6	<0.05	<0.05	<0.05	1.4	101.4	7.6	30.0	11.2
Walker in town	05/01/99	0.5		<0.05	<0.05	1.3	89.8	7.4	30.2	11.3
Walker in town	05/21/99	0.2	<0.05	<0.05	<0.05	7.8	59.0	7.3	34.3	10.9
Walker in town	05/29/99	0.2	<0.05	<0.05	<0.05	3.5	31.5	6.9	80.0	11.6
Walker in town	06/18/99	0.3	<0.05	<0.05	<0.05	3.9	41.4	7.0	85.0	11.2
Walker in town	09/11/99	1.0	**	<0.05	<0.05	0.4	122.4	7.6	28.0	10.9
	Averages	**0.47**	**n/a**	**n/a**	**n/a**	**3.0**	**74.3**	**7.3**	**47.9**	**11.2**
	Stan. Dev	**0.31**				**2.7**	**35.9**	**0.3**	**26.9**	**0.3**

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Mill Ck	04/16/99	1.0	<0.05	<0.05	<0.05	3.5	78.5	7.5	43.2	10.9
Mill Ck	05/01/99	0.6	<0.05	<0.05	<0.05	3.4	74.8	7.4	32.2	11.2
Mill Ck	05/21/99	0.2	<0.05	<0.05	<0.05	22.9	52.1	6.9	50.8	10.9
Mill Ck	05/29/99	0.2	<0.05	<0.05	<0.05	1.4	41.3	5.9	30.0	11.6
Mill Ck	06/18/99	0.4	<0.05	<0.05	<0.05	2.3	48.4	6.3	41.0	11.3
Mill Ck	09/11/99	1.2	**	<0.05	<0.05	3.1	85.1	7.5	44.0	10.2
	Averages	**0.60**	**n/a**	**n/a**	**n/a**	**6.1**	**63.4**	**6.9**	**40.2**	**11.0**
	Stan. Dev	**0.42**				**8.3**	**18.3**	**0.7**	**7.8**	**0.5**
Walker @ Cunningham	05/01/99	0.8	<0.05	0.09	<0.05	0.7	55.2	7.5	28.6	11.8
Walker @ Cunningham	05/21/99	0.1	<0.05	<0.05	<0.05	9.6	67.2	7.5	35.9	10.8
Walker @ Cunningham	05/29/99	0.2	<0.05	<0.05	<0.05	8.6	33.9	7.0	36.0	12.1
Walker @ Cunningham	06/18/99	0.1	<0.05	<0.05	<0.05	17.1	41.0	6.9	64.0	10.9
Walker @ Cunningham	09/11/99	1.1	**	0.13	<0.05	1.3	153.0	7.5	36.0	11.2
	Averages	0.53	n/a	n/a	n/a	6.8	62.5	6.6	37.7	10.3
	Stan. Dev	0.39				6.7	33.1	1.8	13.0	3.0

Table 4 . Results by date. Shaded values indicate readings above minimum detectable level. For identification of values above water quanlity standards, refer to Table 3, Results by site.

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Aurora DS	04/16/99	1.1	<0.05	<0.05	<0.05	5.30	250.0	8	45	10.2
Aurora US	04/16/99	0.7	<0.05	0.10	<0.05	0.80	115.2	7.5	33	10.2
Buckeye US	04/16/99	0.5	<0.05	<0.05	<0.05	1.00	76.3	7.6	28	11.4
Buckeye @ 395	04/16/99	1.0	0.54	0.18	<0.05	0.70	83.2	7.3	27	10.8
Green (US)	04/16/99	0.4	<0.05	<0.05	<0.05	0.70	66.1	7.4	28	10.7
E. Walker below pond	04/16/99	0.9	<0.05	<0.05	0.19	2.7	193.1	7.8	28	9.8
E. Walker @ strosnider	04/16/99	0.8	<0.05	<0.05	<0.05	1.8	105.6	7.5	28	11
E. Walker US of bridge	04/16/99	1.1	0.09	<0.05	<0.05	4.8	148.8	7.5	31	10.7
E. Walker below res	04/16/99	1.1	<0.05	0.05	<0.05	1.9	162	7.7	41	10.5
Robinson US	04/16/99	0.5	<0.05	<0.05	<0.05	0.8	66.5	7.5	27	10.8
Robinson (N) @ 395	04/16/99	0.7	0.17	0.19	<0.05	1.2	107.7	7.4	28	10.9
Robinson (S) @ 395	04/16/99	0.7	0.11	0.08	<0.05	1	107.6	7.4	28	11.1
Summers (ds)	04/16/99	0.7	<0.05	<0.05	<0.05	2	87.3	7.6	28	11.2
Virginia @ strosnider	04/16/99	0.7	<0.05	<0.05	<0.05	1.1	104.5	7.5	28	10.9
Little Walker@108	04/16/99	0.7	<0.05	<0.05	<0.05	0.9	170.6	7.9	32	11.5
W. Walker @395	04/16/99	1.1	<0.05	0.08	<0.05	4.1	115.8	7.6	23	11.4
Walker in town	04/16/99	0.6	<0.05	<0.05	<0.05	1.4	101.4	7.6	30	11.2
Mill Ck	04/16/99	1.0	<0.05	<0.05	<0.05	3.5	78.5	7.5	43	10.9
Walker @ Cunningham	04/16/99	0.8	<0.05	<0.05	<0.05	2.2	109.9	7.5	28	11.4
	Average	0.79	n/a	n/a	n/a	2.0	118.4	7.6	30.7	10.9
	Stan. dev	0.22				1.4	46.1	0.2	5.8	0.4

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Aurora DS	05/01/99	0.4	<0.05	0.07	0.29	1.50	548.0	9.2	29	10.9
Buckeye US	05/01/99	0.6	<0.05	<0.05	<0.05	1.40	89.5	7.5	30	11.8
Buckeye @ 395	05/01/99	0.3	<0.05	<0.05	<0.05	1.60	93.1	7.5	29	11.4
Green (US)	05/01/99	0.6	<0.05	<0.05	<0.05	1.00	56.5	7.4	42	12.2
E. Walker @ strosnider	05/01/99	0.4	<0.05	<0.05	<0.05	1.9	106.4	7.4	30	11.4
E. Walker US of bridge	05/01/99	0.6	<0.05	<0.05	0.05	1.7	213	7.5	31	11.4
E. Walker DS of bridge	05/01/99	0.6	<0.05	<0.05	0.05	1.2	30	6.9	34	11.5
E. Walker below res	05/01/99	0.4	<0.05	<0.05	<0.05	1.1	170.3	7.6	34	11.2
Robinson US	05/01/99	0.3	<0.05	<0.05	<0.05	1.8	105.8	7.4	31	10.9
Robinson (N) @ 395	05/01/99	0.4	<0.05	<0.05	<0.05	1.8	110.1	7.4	25	10.8
Robinson (S) @ 395	05/01/99	0.3	<0.05	<0.05	<0.05	1.9	106.7	7.4	30	10.9
Swauger	05/01/99	0.4	<0.05	<0.05	0.05	2.4	110.4	7.4	39	10.8
Summers (ds)	05/01/99	1.3	<0.05	<0.05	<0.05	1.3	57.1	7.2	34	11.9
Virginia @ strosnider	05/01/99	0.3	<0.05	<0.05	<0.05	1.2	119.5	7.5	30	11.1
Little Walker@108	05/01/99	0.4	<0.05	<0.05	<0.05	1.1	68.1	7.3	29	11.1
Walker in town	05/01/99	0.5	<0.05	<0.05	<0.05	1.3	89.8	7.4	30	11.3
Mill Ck	05/01/99	0.6	<0.05	<0.05	<0.05	3.4	74.8	7.4	32	11.2
Walker @ Cunningham	05/01/99	0.8	<0.05	0.09	<0.05	0.7	55.2	7.5	29	11.8
	Average	0.51	n/a	n/a	n/a	1.6	122.5	7.5	31.5	11.3
	Stan. dev	0.24				0.6	111.2	0.4	3.9	0.4

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Aurora DS	05/06/99	0.5	<0.05	<0.05	<0.05	18.50	288.4	7.7	58	10.6
Buckeye US	05/06/99	1.0	<0.05	<0.05	<0.05	6.50	28.0	7.3	24	14.2
Buckeye @ 395	05/06/99	0.7	<0.05	<0.05	<0.05	22.20	83.8	7.5	42	11.1
Green (US)	05/06/99	0.9	<0.05	<0.05	<0.05	16.20	76	7.5	42	13.7
E. Walker US of bridge	05/06/99	1.0	<0.05	<0.05	<0.05	15.2	78.8	7.4	30	10.7
E. Walker DS of bridge	05/06/99	0.6	<0.05	<0.05	<0.05	13.0	51.2	7.5	42	10.7
E. Walker below res	05/06/99	0.5	<0.05	<0.05	<0.05	6.1	134.9	7.5	26	10.5
Robinson US	05/06/99	0.8	0.05	0.06	<0.05	13.6	87.6	7.5	34	13.2
Robinson (N) @ 395	05/06/99	1.1	<0.05	<0.05	<0.05	16.8	52	7.5	32	11.2
Swauger	05/06/99	0.4	<0.05	0.06	0.07	13.6	46.9	7.4	44	11.4
Summers (ds)	05/06/99	0.6	<0.05	<0.05	<0.05	15.1	50.2	7.5	35	11.3
Virginia @ strosnider	05/06/99	1.4	0.05	0.05	<0.05	18.4	48.1	7.4	48	10.9
	Average	0.79	n/a	n/a	n/a	14.6	85.5	7.5	38.1	11.6
	Stan. dev	0.30				4.6	69.7	0.1	9.8	1.3

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Aurora DS	05/14/99	0.1	<0.05	<0.05	0.16	11.00	231	7.8	40	10.1
Buckeye US	05/14/99	0.2	<0.05	<0.05	<0.05	2.70	47.8	7.3	31	11.4
Buckeye @ 395	05/14/99	0.1	<0.05	<0.05	<0.05	3.40	67.4	7.4	31	9.7
Green (US)	05/14/99	0.1	<0.05	<0.05	<0.05	4.10	43.2	6.9	32	11.9
E. Walker @ strosnider	05/14/99	0.1	<0.05	<0.05	<0.05	8.2	91.6	7.2	37	10.6
E. Walker US of bridge	05/14/99	0.1	<0.05	<0.05	<0.05	8	134.3	7.4	35	12.4
E. Walker DS of bridge	05/14/99	0.2	<0.05	<0.05	<0.05	7.2	140.3	7.1	35	13
E. Walker below res	05/14/99	0.1	<0.05	<0.05	<0.05	3.3	181	7.6	31	10.7
Robinson US	05/14/99	0.1	<0.05	<0.05	<0.05	2.2	62.9	7.2	30	11.5
Robinson (N) @ 395	05/14/99	0.1	<0.05	<0.05	<0.05	2.6	63.8	7.5	30	9.8
Summers (ds)	05/14/99	0.2	<0.05	<0.05	<0.05	3.3	86.5	7.8	31	11.3
Virginia @ 395	05/14/99	0.1	<0.05	<0.05	<0.05	3.3	90	7.4	31	10.5
	Average	0.13	n/a	n/a	n/a	4.9	103.3	7.4	32.9	11.1
	Stan. dev	0.05				2.9	57.6	0.3	3.2	1.0

Aurora DS	05/21/99	0.2	<0.05	<0.05	0.20	11.70	292	7.8	38	10.4
Buckeye US	05/21/99	0.2	<0.05	<0.05	<0.05	3.00	32.8	6.9	33	12.6
Buckeye @ 395	05/21/99	0.2	<0.05	<0.05	<0.05	4.10	46.9	6.9	33	9.2
Green (US)	05/21/99	0.1	<0.05	<0.05	<0.05	1.60	37.3	6.7	32	11.8
Green @ E. Walker	########	0.2	<0.05	<0.05	<0.05	2.3	51.9	6.6	31	10.9
E. Walker At Green	########	0.1	<0.05	<0.05	<0.05	3.4	117.6	7.2	30	10.7
E. Walker US of bridge	05/21/99	0.2	<0.05	<0.05	<0.05	4.8	126.7	6.9	35	11.3
E. Walker DS of bridge	05/21/99	0.1	<0.05	<0.05	<0.05	2.7	138.2	6.9	33	11.3
E. Walker below res	05/21/99	0.1	<0.05	<0.05	<0.05	2.6	174.5	7.6	33	11.1
Robinson US	05/21/99	0.1	<0.05	<0.05	<0.05	1.5	58.4	7.1	32	11.6
Robinson (N) @ 395	05/21/99	0.2	<0.05	<0.05	<0.05	2.5	49.2	7	29	9.9
Swauger	05/21/99	0.1	<0.05	<0.05	0.08	7.3	121.9	6.8	37	10.7
Summers (ds)	05/21/99	0.1	<0.05	<0.05	<0.05	3.9	83.8	7.4	31	9.3
Virginia @ 395	05/21/99	0.2	<0.05	<0.05	<0.05	4.4	78.9	7.2	34	10.8
Virginia @ strosnider	05/21/99	0.2	<0.05	<0.05	0.05	2.9	124.7	7.2	32	9.8
Little Walker@108	05/21/99	0.1	<0.05	<0.05	<0.05	12.5	46.1	7.2	41	11.2
W. Walker @395	05/21/99	0.2	<0.05	<0.05	<0.05	13.4	53.2	7.4	41	11.2
Walker in town	05/21/99	0.2	<0.05	<0.05	<0.05	7.8	59	7.3	34	10.9
Mill Ck	05/21/99	0.2	<0.05	<0.05	<0.05	22.9	52.1	6.9	51	10.9
Walker @ Cunningham	05/21/99	0.1	<0.05	<0.05	<0.05	9.6	67.2	7.5	36	10.8
	Average	0.16	n/a	n/a	n/a	6.2	90.6	7.1	34.8	10.8
	Stan. dev	0.05				5.4	62.0	0.3	5.0	0.8

Buckeye US	05/29/99	0.3	<0.05	<0.05	<0.05	2.00	23.3	6.2	60	12.6
Buckeye @ 395	05/29/99	0.2	<0.05	<0.05	<0.05	2.00	27.5	6.9	42	12.7
Buckeye DS (WRID)	05/29/99	0.2	<0.05	<0.05	<0.05	4.00	35.0	5.8	44	12.5
Green (US)	05/29/99	0.3	<0.05	<0.05	<0.05	1.00	27.4	6.9	30	11.8
Green @ E. Walker	05/29/99	0.3	<0.05	<0.05	<0.05	1.3	32.9	6.8	34	10.2
E. Walker At Green	05/29/99	0.2	<0.05	<0.05	<0.05	0.8	55.1	6.9	20	10.2
E. Walker US of bridge	05/29/99	0.3	<0.05	0.13	<0.05	5.3	65.8	6.7	48	10.3
E. Walker below res	05/29/99	0.2	<0.05	<0.05	<0.05	1.2	147.2	6.9	16	11.0
Robinson US	05/29/99	0.4	<0.05	<0.05	<0.05	1.0	46.3	6.2	22	11.6
Robinson (N) @ 395	05/29/99	0.2	<0.05	<0.05	<0.05	1.0	46.6	7.0	28	11.7
Robinson DS(WRID)	05/29/99	0.2	<0.05	<0.05	<0.05	1.4	45.9	6.9	34	11.8
Swauger	05/29/99	0.2	<0.05	<0.05	0.08	8.5	84.5	6.6	52	10.1
Summers (ds)	05/29/99	0.3	<0.05	<0.05	<0.05	6.3	68.1	6.5	28	10.6
Virginia @ 395	05/29/99	0.3	<0.05	<0.05	0.05	3.5	73.5	7.1	44	10.5
Virginia @ strosnider	05/29/99	0.2	<0.05	<0.05	<0.05	16.4	58.0	6.2	60	10.6
Little Walker@108	05/29/99	0.3	<0.05	<0.05	<0.05	1.5	48.7	7.0	32	11.8
W. Walker @395	05/29/99	0.3	<0.05	<0.05	<0.05	4.3	25.2	7.0	58	11.4
Walker in town	05/29/99	0.2	<0.05	<0.05	<0.05	3.5	31.5	6.9	80	11.6
Mill Ck	05/29/99	0.2	<0.05	<0.05	<0.05	1.4	41.3	5.9	30	11.6
Walker @ Cunningham	05/29/99	0.2	<0.05	<0.05	<0.05	8.6	33.9	7.0	36	12.1
	Average	0.25	n/a	n/a	n/a	3.8	50.9	6.7	39.9	11.3
	Stan. dev	0.06				3.9	28.5	0.4	16.1	0.8

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Buckeye DS (WRID)	06/05/99	0.3	<0.05	<0.05	<0.05	1.30	56.8	7.1	30	12.3
Green (US)	06/05/99	0.3	<0.05	<0.05	<0.05	0.90	35.9	6.8	18	12.2
Green @ E. Walker	06/05/99	0.3	<0.05	<0.05	<0.05	1.2	45.1	7.0	24	12.1
E. Walker At Green	06/05/99	0.3	<0.05	<0.05	<0.05	1.4	88.4	7.1	18	11.2
E. Walker @ strosnider	06/05/99	0.3	<0.05	<0.05	<0.05	1.4	71.1	7.1	26	11.5
E. Walker US of bridge	06/05/99	0.3	0.08	<0.05	<0.05	1.1	100.5	7.2	26	11.5
E. Walker DS of bridge	06/05/99	0.4	<0.05	<0.05	<0.05	1.5	101.6	7.1	40	11.6
Robinson US	06/05/99	0.3	<0.05	0.06	<0.05	3.7	81.4	7.2	20	11.1
Robinson (N) @ 395	06/05/99	0.3	<0.05	<0.05	<0.05	2.1	54.7	6.9	20	11.7
Robinson DS(WRID)	06/05/99	0.2	<0.05	<0.05	<0.05	1.1	56.3	6.9	20	11.2
Swauger	06/05/99	0.3	<0.05	0.10	0.06	1.1	96.3	7.4	34	10.6
Summers (ds)	06/05/99	0.3	<0.05	<0.05	0.05	1.4	83.6	7.1	26	10.9
Virginia @ 395	06/05/99	0.2	<0.05	0.08	<0.05	0.8	93.7	7.5	24	11.1
Virginia @ strosnider	06/05/99	0.3	<0.05	<0.05	<0.05	0.9	78.2	7.1	24	10.9
Buckeye US	06/05/99	0.3	<0.05	<0.05	<0.05	1.80	40.3	7.2	104	13.7
Buckeye @ 395	06/05/99	0.4	<0.05	<0.05	<0.05	1.60	45.5	7.1	18	12.1
	Average	0.30	n/a	n/a	n/a	1.5	70.6	7.1	29.5	11.6
	Stan. dev	0.05				0.7	22.7	0.2	20.8	0.8

Buckeye US	06/18/99	0.2	<0.05	<0.05	<0.05	5.60	16.49	6.6	44	11.9
Buckeye @ 395	06/18/99	0.1	<0.05	<0.05	<0.05	6.20	28.3	6.6	32	10.9
Buckeye DS (WRID)	06/18/99	0.2	<0.05	<0.05	0.12	13.90	30.9	6.7	40	11.2
Green (US)	06/18/99	0.1	<0.05	<0.05	<0.05	5.10	23.9	6.2	18	10
Green @ E. Walker	06/18/99	0.1	<0.05	<0.05	<0.05	5.6	41.3	6.6	26	10.2
E. Walker At Green	06/18/99	0.2	0.06	<0.05	<0.05	5.9	145.0	6.7	22	9.9
E. Walker @ strosnider	06/18/99	0.2	<0.05	<0.05	<0.05	5.9	74.6	6.2	22	10
E. Walker US of bridge	06/18/99	0.1	<0.05	<0.05	<0.05	13.1	95.0	6.7	40	9.8
E. Walker DS of bridge	06/18/99	0.2	<0.05	<0.05	<0.05	9.6	92.3	6.5	30	9.8
Robinson US	06/18/99	0.1	<0.05	<0.05	<0.05	5.8	51.4	6.8	20	10.7
Robinson (N) @ 395	06/18/99	0.2	<0.05	<0.05	<0.05	6.9	50.1	6.3	36	10.7
Robinson DS(WRID)	06/18/99	0.1	<0.05	<0.05	<0.05	7.4	47.9	6.2	26	10.8
Swauger	06/18/99	0.2	<0.05	0.11	0.13	10.9	121.0	6.7	32	12
Summers (ds)	06/18/99	0.2	<0.05	<0.05	<0.05	4.8	69.6	6.9	22	9.8
Virginia @ 395	06/18/99	0.2	0.07	<0.05	<0.05	13.8	81.8	6.6	40	9.6
Virginia @ strosnider.	06/18/99	0.1	<0.05	<0.05	<0.05	24.8	62.2	6.5	106	9.5
Little Walker@108	06/18/99	0.2	<0.05	0.09	<0.05		43.6	7.4	31	11.7
W. Walker @395	06/18/99	0.2	<0.05	0.08	<0.05	4.5	31.3	7.2	47	11.5
Walker in town	06/18/99	0.3	<0.05	<0.05	<0.05	3.9	41.4	7	85	11.2
Mill Ck	06/18/99	0.4	<0.05	<0.05	<0.05	2.3	48.4	6.3	41	11.3
Walker @ Cunningham	06/18/99	0.1	<0.05	<0.05	<0.05	17.1	41.0	6.9	64	10.9
	Average	0.18	n/a	n/a	n/a	8.7	58.9	6.6	39.2	10.6
	Stan. dev	0.08				5.5	32.9	0.3	21.9	0.8

Buckeye US	07/16/99	0.4	0.10	<0.05	<0.05	2.80	41.5	7.2	28	11.0
Buckeye @ 395	07/16/99	0.3	<0.05	0.07	<0.05	3.60	105.3	7.0	26	10.8
Buckeye DS (WRID)	07/16/99	0.3	<0.05	<0.05	<0.05	2.90	56.9	7.1	18	10.8
Green (US)	07/16/99	0.3	<0.05	<0.05	<0.05	8.30	105.7	7.3	40	10.3
Green @ E. Walker	07/16/99	0.2	0.07	<0.05	<0.05	4.5	88.0	7.1	18	10.4
Green @ strosnider	07/16/99	0.3	<0.05	0.05	0.06	10.1	94.4	7.6	28	10.5
E. Walker At Green	07/16/00	0.2	<0.05	0.07	<0.05	5.0	81.7	7.4	28	9.8
E. Walker @ strosnider	07/16/99	0.1	0.05	<0.05	<0.05	1.9	57.4	7.3	16	10.6
E. Walker US of bridge	07/16/99	0.3	<0.05	<0.05	<0.05	5.7	46.8	6.9	24	10.7
E. Walker DS of bridge	07/16/99	0.3	<0.05	<0.05	<0.05	7.0	73.1	7.2	26	10.7
Robinson US	07/16/99	0.3	<0.05	<0.05	<0.05	3.1	91.9	7.2	16	10.7
Robinson (N) @ 395	07/16/99	0.2	<0.05	<0.05	<0.05	6.3	90.3	7.0	38	10.4
Robinson DS(WRID)	07/16/99	0.4	<0.05	<0.05	<0.05	5.1	58.0	7.2	22	10.6
Summers (ds)	07/16/99	0.3	<0.05	<0.05	<0.05	5.1	59.0	7.5	25	10.2
Virginia @ 395	07/16/99	0.2	<0.05	<0.05	<0.05	7.8	58.2	7.0	36	10.3
Virginia @ strosnider	07/16/99	0.3	<0.05	<0.05	<0.05	8.6	99.7	7.7	32	10.5
	Average	0.28	n/a	n/a	n/a	5.5	75.5	7.2	26.3	10.5
	Stan. dev	0.08				2.4	21.5	0.2	7.5	0.3

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Buckeye US	08/14/99	0.9	**	<0.05	<0.05	1.08	60.9	7.4	28	10.6
Buckeye @ 395	08/14/99	1.1	**	0.13	<0.05	1.39	154	7.1	28	9.8
Buckeye DS (ASCUA))	08/14/99	0.9	**	<0.05	<0.05	4.22	143.6	7.4	32	10.1
Green (US)	08/14/99	1.1	**	<0.05	<0.05	0.84	49.3	6.8	30	11.6
Green @ E. Walker	08/14/99	1.0	**	<0.05	<0.05	2.25	112.8	7.5	24	11.1
Green @ strosnider	08/14/99	1.3	**	<0.05	<0.05	5.14	133.3	7.2	28	9
E. Walker below pond	08/14/99	1.6	**	0.31	<0.05	159	141.8	7.3	170	8.9
E. Walker At Green	08/14/99	1.1	**	<0.05	<0.05	1.75	118.3	7.5	26	10.2
E. Walker @ strosnider	08/14/99	0.9	**	0.07	<0.05	3.35	113.2	6.9	36	10.1
E. Walker US of bridge	08/14/99	1.1	**	0.13	<0.05	1.39	154	7.1	28	9.8
Robinson US	08/14/99	1.7	**	<0.05	<0.05	0.71	51.6	7.2	4	10.9
Robinson (N) @ 395	08/14/99	1.1	**	0.07	<0.05	2.58	76	7.4	30	10.3
Robinson DS(ASCUA)	08/14/99	1.4	**	<0.05	<0.05	4.73	89.4	7.9	34	10.6
Swauger	08/14/99	1.1	**	<0.05	0.15	4.05	189.2	7.2	36	8.9
Summers (ds)	08/14/99	1.2	**	0.12	<0.05	2.17	72.5	7.2	30	9.8
Virginia @ 395	08/14/99	1.2	**	0.13	<0.05	3.11	108.5	7.3	24	10.3
Virginia @ strosnider	08/14/99	1.2	**	0.06	<0.05	1.58	191.2	7.5	18	9.9
	Average	1.17	n/a	n/a	n/a	11.73	115.27	7.29	35.65	10.11
	Stan. dev	0.23				37.98	44.39	0.25	35.42	0.74

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Buckeye US	09/11/99	0.7	**	<0.05	<0.05	0.57	81.1	7.5	44	10.2
Buckeye @ 395	09/11/99	1.0	**	0.10	<0.05	1.18	189.4	7.9	40	9.9
Buckeye DS (ASCUA))	09/11/99	1.1	**	0.18	<0.05	3.10	171.1	7.8	36	10.1
Buckeye DS (WRID)	09/11/99	1.0	**	0.08	<0.05	4.73	193.2	7.8	40	10.2
Green (US)	09/11/99	1.2	**	<0.05	<0.05	1.16	106.8	7.8	56	10.6
Green @ E. Walker	09/11/99	1.1	**	0.15	<0.05	1.47	84.7	7.8	56	10.7
Green @ strosnider	09/11/99	1.1	**	<0.05	<0.05	2.94	142.5	7.8	56	10.6
E. Walker At Green	09/11/99	1.0	**	0.10	<0.05	3.13	173.2	7.9	32	19.8
E. Walker US of bridge	09/11/99	1.0	**	0.10	<0.05	1.18	189.4	7.9	40	9.9
E. Walker DS of bridge	09/11/99	1.3	**	0.07	<0.05	5.31	190.9	7.6	56	9.9
E. Walker below res	09/11/99	1.4	**	0.79	0.13	7.55	139.7	7.5	56	8.7
Robinson US	09/11/99	0.9	**	<0.05	<0.05	0.68	58.3	7.5	52	10.4
Robinson (N) @ 395	09/11/99	1.2	**	0.08	<0.05	1.13	89.2	7.6	48	10.2
Robinson DS(WRID)	09/11/99	1.0	**	0.17	<0.05	1.48	113.5	7.8	52	10.2
Robinson DS(ASCUA)	09/11/99	1.1	**	<0.05	<0.05	2.14	109.6	8.2	44	10.3
Swauger	09/11/99	0.9	**	0.11	<0.05	0.48	166.2	7.7	36	9.2
Summers (ds)	09/11/99	1.4	**	<0.05	<0.05	4.07	73.6	7.7	48	9.4
Virginia @ 395	09/11/99	1.5	**	0.08	<0.05	1.61	100.5	7.9	48	10.7
Virginia @ strosnider	09/11/99	1.3	**	0.09	<0.05	2.08	155.5	7.5	44	10.8
Little Walker@108	09/11/99	1.1	**	0.11	<0.05	0.4	58.2	7.5	34	11.1
W. Walker @395	09/11/99	1.1	**	0.22	<0.05	0.4	187.8	7.6	34	11.1
Walker in town	09/11/99	1.0	**	<0.05	<0.05	0.35	122.4	7.6	28	10.9
Mill Ck	09/11/99	1.2	**	<0.05	<0.05	3.07	85.1	7.5	44	10.2
Walker @ Cunningham	09/11/99	1.1	**	0.13	<0.05	1.34	153	7.5	36	11.2
	Average	1.11	n/a	n/a	n/a	2.1	130.6	7.7	44.2	10.7
	Stan. dev	0.18				1.8	45.8	0.2	8.7	2.0

Site name	DATE	TKN mg/L	NH4-N mg/L	NO3-N mg/L	P mg/L	Turbidity	EC	pH	TSS mg/L	O2 mg/L
Buckeye US	10/16/99	1.2	**	0.08	<0.05	0.67	87	7.4	18	10.8
Buckeye @ 395	10/16/99	1.0	**	0.10	<0.05	1.04	103.3	7.7	14	10.1
Buckeye DS (WRID)	10/16/99	1.1	**	<0.05	<0.05	2.08	117.2	7.9	22	10.2
Green (US)	10/16/99	0.8	**	<0.05	<0.05	1.15	67.1	7.7	14	10.6
Green @ E. Walker	10/16/99	1.4	**	<0.05	<0.05	1.1	78	7.7	10	10.7
Green @ strosnider	10/16/99	1.5	**	<0.05	<0.05	1.04	118.8	7.7	10	10.7
E. Walker @ strosnider	10/16/99	1.2	**	<0.05	<0.05	2.22	113.6	7.6	22	10.5
E. Walker US of bridge	10/16/99	1.5	**	<0.05	<0.05	0.88	140.3	7.6	14	10.6
E. Walker DS of bridge	10/16/99	1.0	**	<0.05	<0.05	1.32	143.5	7.6	22	10.7
E. Walker below res	10/16/99	2.2	**	0.52	0.15	3.25	157.4	7.3	18	9.7
Robinson US	10/16/99	1.5	**	<0.05	<0.05	1.01	64	7.5	18	10.9
Robinson (N) @ 395	10/16/99	1.0	**	<0.05	<0.05	0.74	64	7.4	18	11.1
Robinson DS(WRID)	10/16/99	1.0	**	<0.05	<0.05	1.48	75.7	7.4	18	11.3
Summers (ds)	10/16/99	0.8	**	<0.05	<0.05	1.12	85.8	7.5	12	10.8
Virginia @ 395	10/16/99	1.0	**	0.07	<0.05	0.77	106.3	7.7	18	11.2
Virginia @ strosnider	10/16/99	1.2	**	<0.05	<0.05	11.2	125.3	7.4	36	11.2
	Average	1.21	n/a	n/a	n/a	1.9	103.0	7.6	17.8	10.7
	Stan. dev	0.35				2.6	29.8	0.2	6.2	0.4

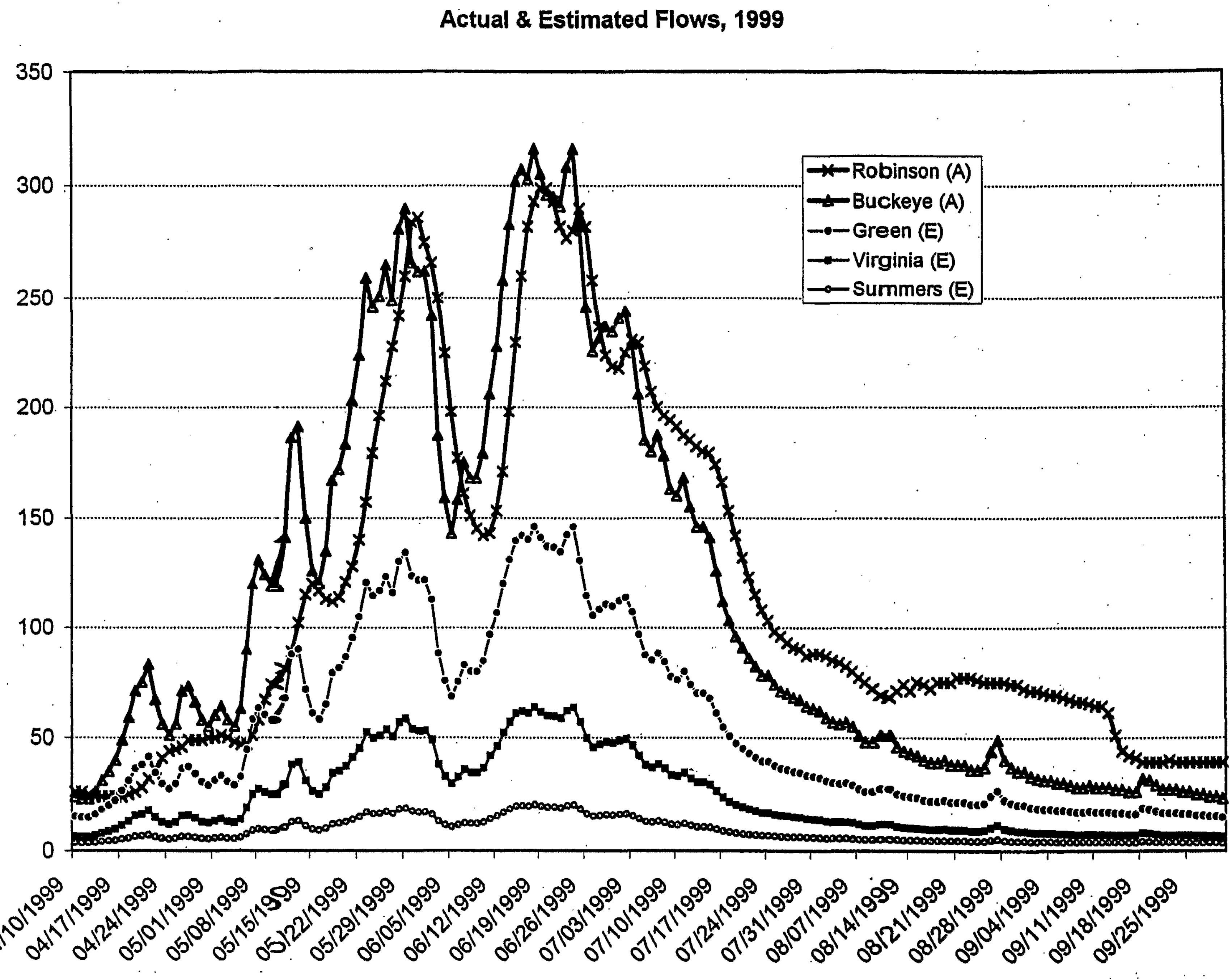


FIGURE 1: Actual and Estimated Flows, 1999

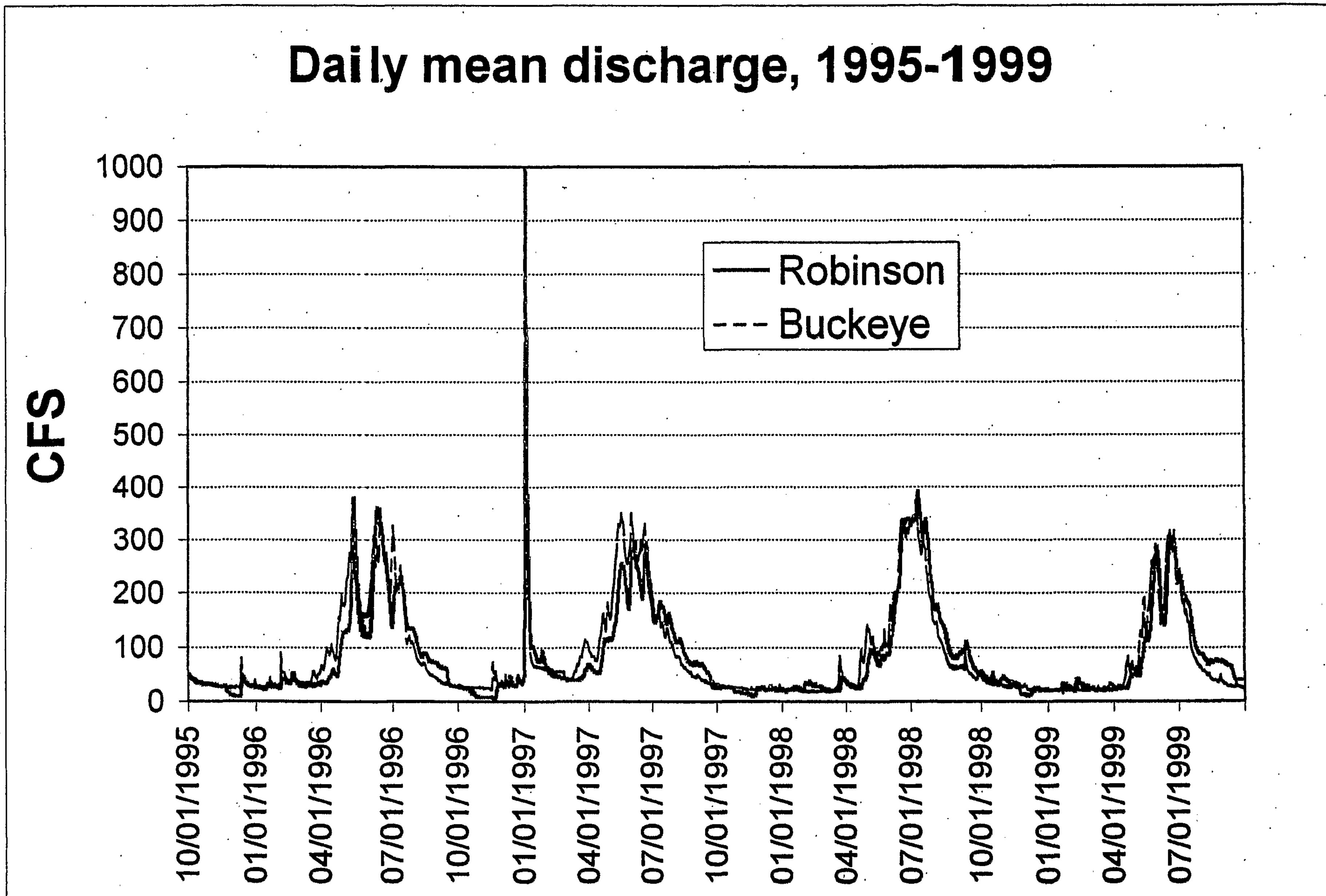
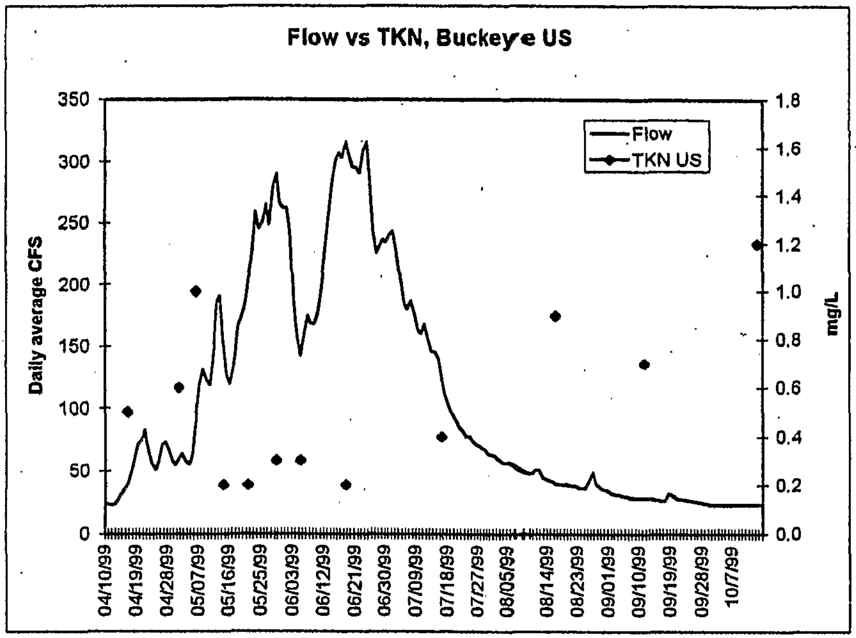
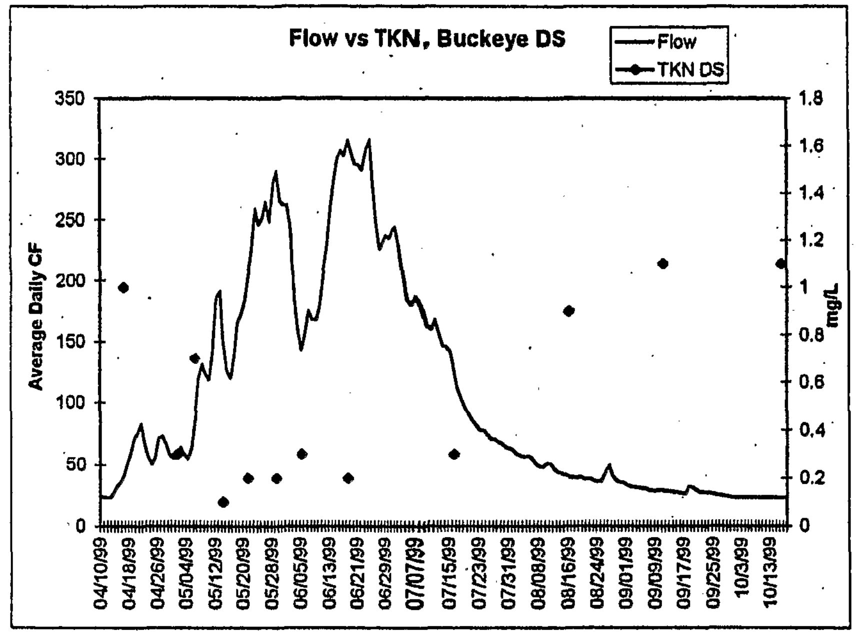
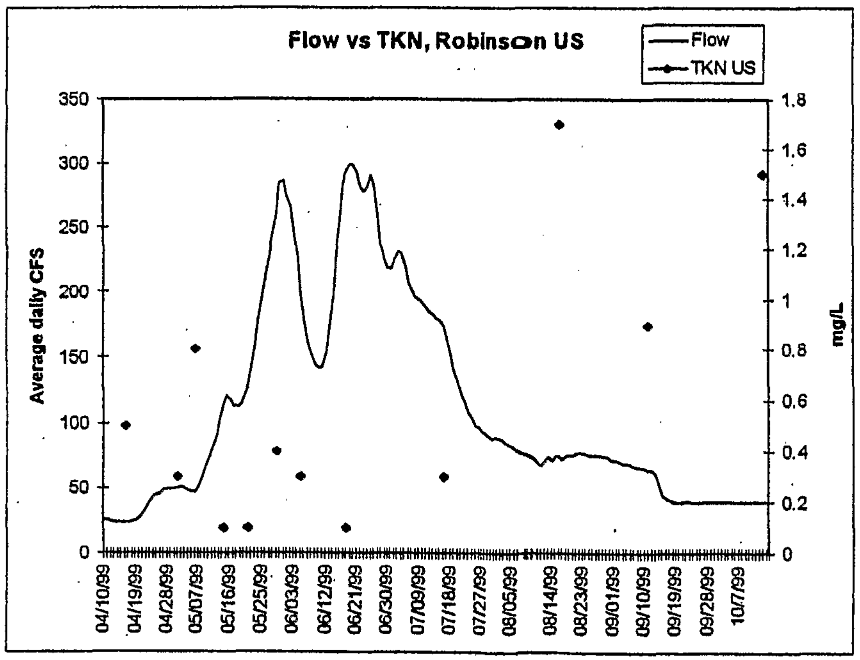


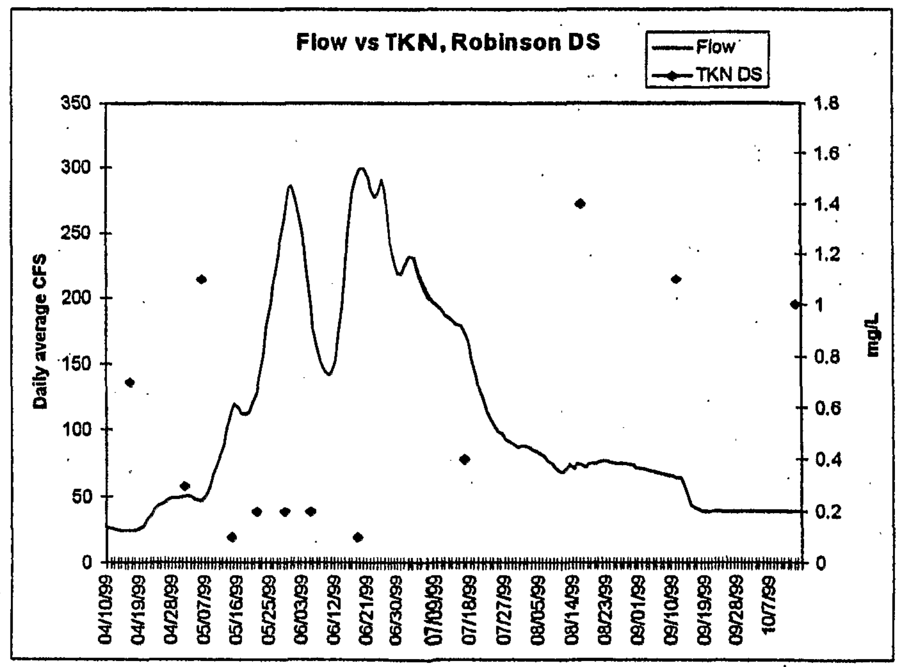
FIGURE 2: Daily mean discharges, 1995-1999

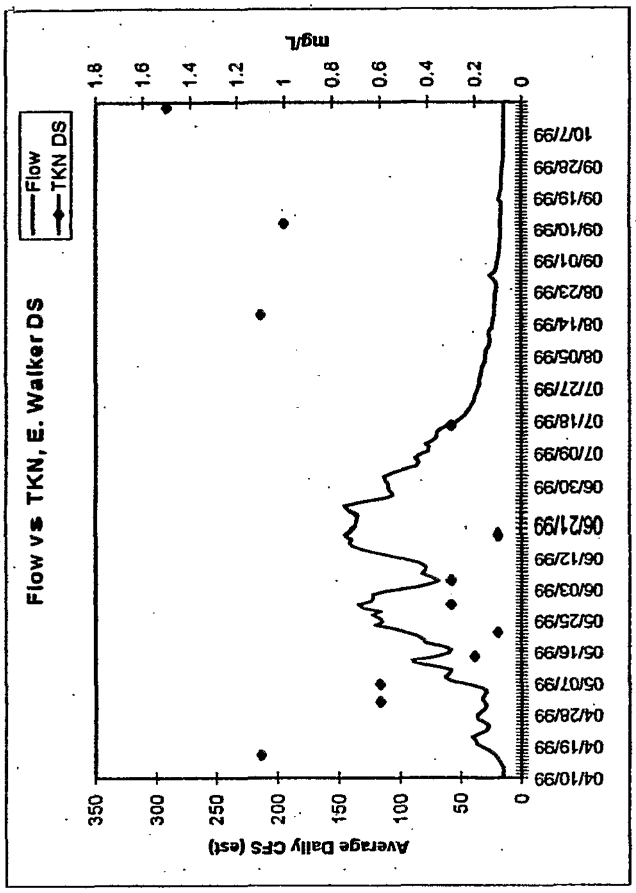
FIGURES 3 and 4: Flow vs TKN, Buckeye and Robinson

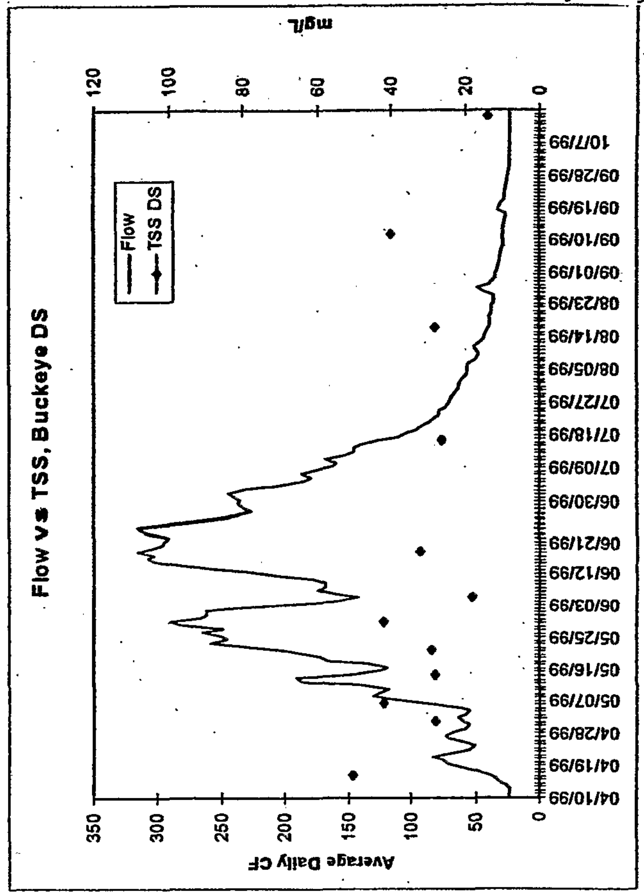


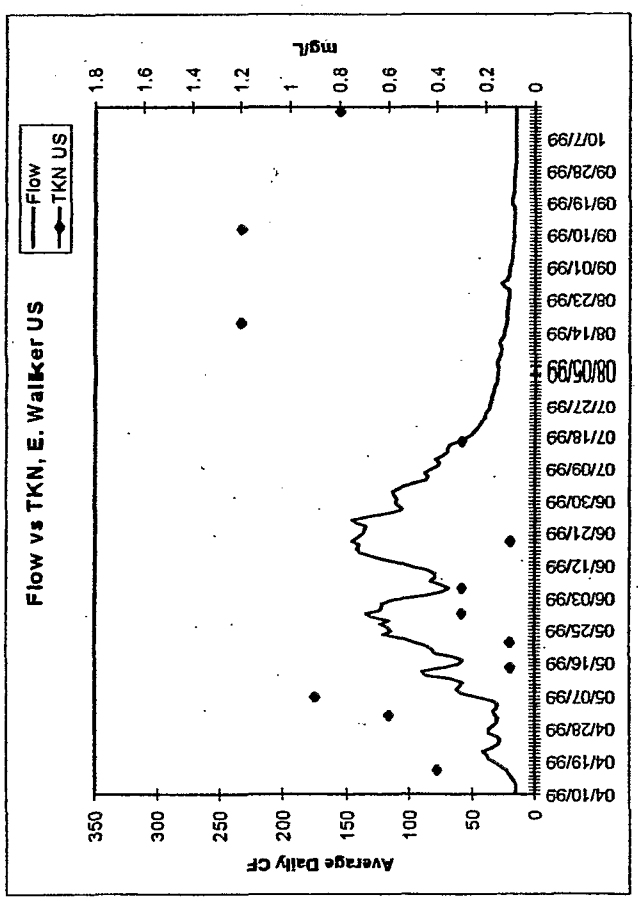












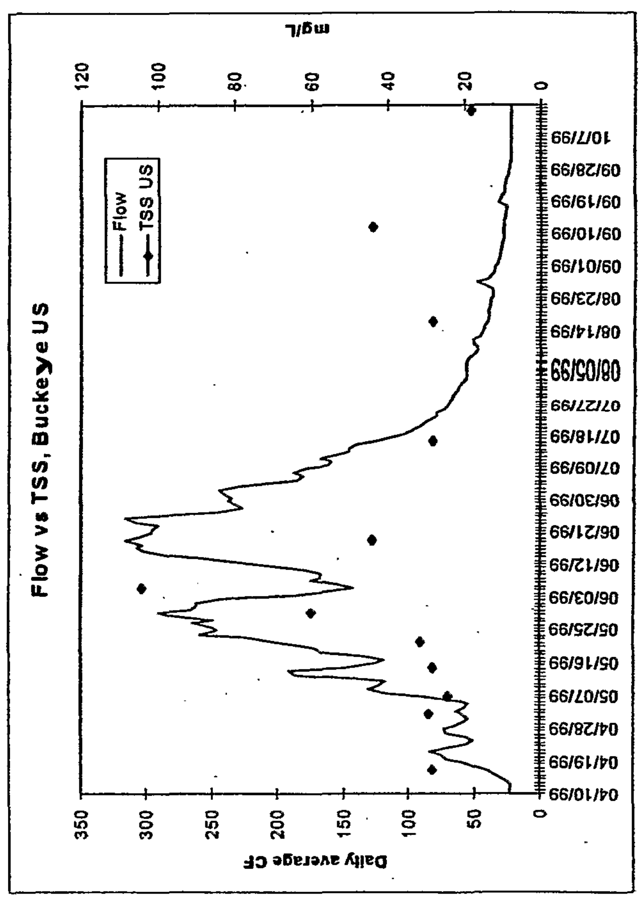


FIGURE 5: Flow vs TKN, E. Walker

FIGURE 6: Flow vs TSS, Buckeye

FIGURES 7 and 8: Flow vs TSS, Robinson and E. Walker