Treatment of Stormwater Runoff *from an* Agricultural Basin *by a* Wet-Detention Pond in Ruskin, Florida

Final Report

Southwest Florida *Water Management District*

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Ben Bahk installed the equipment and collected data for the first two years of the project as well as writing some of the text. Melissa Musicaro collected data and kept the site up and running for another year. Rebecca Hastings was especially helpful with learning about the site and filling in between project managers. David Carr's assistance with collecting sediment samples and trouble shooting equipment was especially appreciated. In addition, many more environmental scientists and interns at the Southwest Florida Water Management District made this project possible. Special thanks also go to our great laboratory staff that analyzed the large number of samples that could not be collected by any pre-determined schedule. Also thanks to Mike Holtkamp of SWFWMD's SWIM program for suggesting that we monitor this interesting site. The site plans and report cover were designed by Allen Yarbrough of our Graphics Department. The pictures at the end of the report were taken by Takuya Okubo of the Lake Biwa Research Institute in Japan during a tour of stormwater projects in the United States.

Cover Photographs

The cover shows two aerial views of the Cockroach Bay wet-detention Pond taken in May 2000 (See Figure 2 for a site plan).

Background Picture: An aerial view of the site looking north-east. The tidal marsh and the wet-detention pond are in the foreground, the agricultural fields are in the mid view and the adjacent rock-mining pond and mining activity are shown in the background.

Inset: An aerial view looking south. The edge of the agricultural fields are in the foreground, the wet-detention pond showing the two lobes of the pond and the salt marsh are in the middle distance, and Cockroach Bay is in the background

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Cover Design: Allen Yarbrough

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Executive Summary

The use of wet-detention ponds to attenuate stormwater flow and pollutant loads has been demonstrated in many studies, but most of these have been conducted in urban or residential development. Few studies have documented the use of wet-detention ponds to treat flow from an agricultural basin dominated by row crop farming. This study in Ruskin, Florida documents water quality treatment by a wet-detention pond for a four-year period and represents both wet and dry years. Also included are water quantity and quality interactions in the watershed. Although no Best Management Practices (BMPs) such as cover crops or tailwater recovery were used in the fields, a roadside ditch provided considerable pre-treatment before stormwater entered the pond. Given the effectiveness of detention ponds and wetland areas to improve water quality, it was hypothesized that the detention pond and its littoral zone would function as a sink for nutrients, metals, and pesticides and would improve the water quality discharged from the pond.

Water Budget

A complete water budget for storm events shows most (> 70%) of the water enters and leaves the pond at the two control structures. In addition, about 25 percent of the storm input to the pond is introduced by rainfall directly on the pond. Water export from the pond for the duration of storm events was estimated at 8 percent by evapotranspiration; and 15 percent by net seepage.

A major mechanism for reducing runoff pollutants is to reduce the volume of rain that runs off the watershed and into the receiving waters. A large pond to watershed area is one method to achieve this goal. As a general rule, a pond that occupies about five percent of the watershed is recommended. The watershed (85 hectare) to pond area (5.8 hectare) gives an above average pond area of 6.8 percent for this system. This favorable ratio contributes to the 25 percent reduction in water volume measured leaving the pond compared to flow entering the pond (45 percent if rainfall is considered an input). The large pervious area in the drainage basin as well as the pre-treatment ditch and sandy soils contributed to low runoff coefficients. During the rainy season when ample moisture was available as seen when storms occur close together, the runoff coefficient showed that 10 to 30 percent of rainfall was discharged from the drainage basin into the pond. During dry periods only 1 to 10 percent of rainfall ran off. Greater than 30 percent of runoff was measured for 11 of the 88 storm events. These occurred during extreme conditions such as the El Niño storms, hurricanes, and frequent irrigation practices. The average runoff coefficient for each year for storms with enough flow to collect water quality samples was 0.14 for 1998, 0.10 for 1999, 0.19 for 2000, and 0.25 for 2001. More irrigation occurred in 2000 and 2001, which helps account for the increase in runoff.

Water Quality Concentrations

Concentrations of constituents measured at the inflow and outflow indicate processes taking place in the pond. For example, some of the highest concentrations for inorganic nitrogen (nitrate and ammonia) were measured in rainfall. This may account for the increased concentrations for organic nitrogen at the outflow as pond processes convert inorganic nitrogen into the organic form. Metal concentrations exhibit a pattern between years. In 1998, the year of the El Niño storms, average metal concentrations at the inflow were two to three times greater than any of the other years; in 1999, inflow metal concentrations were measured at their lowest levels during any of the four years; and in 2000, metal concentrations increased, especially between July 2000 and July 2001.

Phosphorus is measured at relatively high levels at the inflow to the pond with average concentrations of total phosphorus near 1 mg/L. Although average concentrations at the outflow for phosphorus are reduced by about 40 percent, the concentrations still exceed by a factor of 5 to 8 the suggested EPA goal for streams and rivers of 0.1 mg/L. Although not strictly relevant since the pond discharges to a mixing zone at the salt/fresh water interface, the average outflow water quality values for copper and iron were in non-compliance of marine standards for all years.

Reduction of Pollutant Loads

The efficiency of a wet detention pond is measured by the percent reduction in pollutant loads from the inflow to the outflow. In this pond the efficiency is usually greater than 60 percent, but there are differences between years caused by rainfall patterns and agricultural activity. During the four years of study (88 rain events), over 40 percent of all the pollutant loads for potentially toxic metals entered the pond during five El Niño storms. Larger loads are more easily reduced in wet-detention ponds and the goal of 80 percent reduction is met for most metals in 1998 and 2000, the years with some of the highest influent constituent concentrations. But pond efficiency does not tell the entire story, for example, percent reduction was poorest for 1999, but the average concentrations for most constituents at both the inflow and outflow were also the lowest measured during all four years. Also, even though copper is reduced by 90 percent during all years, it exceeds the marine water quality standards for all years. The total suspended solids (TSS) removal rate was 98 percent for 1998 but TSS loads were measured at higher levels at the outflow than the inflow in 1999. Organic nitrogen shows increasingly poorer efficiency in each succeeding year and is actually increased by the pond in 2000, the year of greatest agricultural activity.

In-Situ Water Quality

Field parameters of temperature, dissolved oxygen, specific conductivity and pH indicate a highly productive (eutrophic) system with the daily fluctuations usually moderated by the pond when water levels are high and the pond cells are connected. In general, dissolved oxygen and pH are higher at the inflow than at the outflow. The dissolved oxygen standard set by the state of an absolute minimum of 4 mg/L is rarely met at the outflow and only about half of the time at the inflow. The standard set by the state for pH allows a permissible range between 6.5 and 8.5 for most waters. The wet detention pond in this study has values higher than 8.5 at the inflow during the summer.

Pesticides

Storm flow samples taken of organochlorine and organophosphorous pesticides at the inflow and outflow indicate lower concentrations at the outflow for most samples. Concentrations of ten pesticides and pesticide residues were detected at the inflow while only four pesticides were detected at the outflow. Although the quantity of pesticides detected in this study was usually below the detection limit, diazinon, DDE and endosulfan were detected at quantifiable concentrations at the inflow, but were most often reduced to undetectable amounts at the outflow. Even though DDT has not been used in the United States since 1972, some soils still contain small amount of DDT and DDE and this appears to be one of those sites. Both diazinon and endosulfan are considered toxic and are currently on the EPA December 2000 list to be phased out or eliminated.

Bacteria

Bacteria exhibited widely fluctuating concentrations with no consistent pattern between the inflow and outflow. The pond does not appear to be a sink for bacteria with concentrations usually higher at the outflow. Some of the higher concentrations at the ouflow can be explained by stagnant conditions that often occur behind the outflow weir where these grab samples were collected. Another source of coliform bacteria could be migration by atmospheric deposition or ground water movement from the adjacent sewage treatment lagoon. The discharge of fecal coliform may be a problem since samples appear to exceed the standards established to protect the propagation and harvesting of shellfish. Bacteria were measured at concentrations many times greater in the ditch than in the pond.

Chlorophyll

Chlorophyll was measured about four times a year at the inflow and outflow of the pond and except during periods of stagnant conditions the pond reduced all species of Chlorophyll by a significant amount. For example, the median concentration of Chlorophyll *a* (trichromatic) at the inflow is 55.3 ug/L and is 11.5 ug/L at the outflow. This outflow value is close to the target level set by the Tampa Bay Estuary Program for Middle Tampa Bay of 7.4 ug/L. There were several large chlorophyll *a* spikes that skewed average values much higher than the median values (129.7 ug/L at the inflow compared to 44.5 ug/L at the outflow).

Ambient Water Quality in the Pre-Treatment Ditch

Runoff from the agricultural fields is collected by a roadside ditch before water is discharged into the wet-detention pond. Grab samples collected at three stations in the ditch about every three months characterized ambient water quality conditions. The ditch was totally excavated and re-sodded when the pond was built in 1997. Results indicate that metal and Kjeldahl nitrogen concentrations were measured at low levels for about a year after the clean out and then slowly increased through part of 2000 but have been low since that time. Vegetation in the ditch is cut down at regular intervals and allowed to rot in the ditch. This maintenance practice and the uneven agricultural practices may have contributed to the wide variations in the constituent concentrations measured in the ditch.

There were differences between sampling stations in the ditch with the highest concentrations measured at the most shallow station that also had low flow, low dissolved oxygen and low redox potential. Phosphorus concentrations in the ditch were usually measured between 1 and 7 mg/L making average concentrations about two times higher than those measured at the inflow to the pond during storm events. Field parameters shed some insight in explaining high phosphorus concentrations -- much higher P concentrations were measured when dissolved oxygen levels fell below 1 mg/L. Except for one spike in concentration, nitrate was measured at low levels in the ditch and were below the laboratory limit of detection for about half of the samples collected indicating the system is strongly nitrogen limited. Of the 45 pesticides analyzed at the three sites, seven were detected and two pesticides were above the laboratory quantification limit. Three of the samples exceeded the standard for endosulfan sulfate (0.056 ug/L for fresh water). Diazinon was measured during January 2000 at concentrations well above the detection limit with values of 0.66 and 1.6 ug/L.

Sediment Samples

Sediment samples were collected for the entire system, which included a pre-treatment ditch, the pond and the marsh, in July 1997 right after the system was constructed and one year later in July 1998. These samples were analyzed for nutrients, metals and pesticides. In addition, sediment samples for pesticides were collected in June 2000 and at the end of the study in July 2002. The pesticides most often detected were chlordane, dieldrin, bromacil and DDT residuals. Chlordane was detected in almost all the sediment samples and was frequently measured well above the quantification level.

Nutrients and metals samples measured in the first two years of the study, showed a dramatic increase from 1997 to 1998. Phosphorus and metal concentrations were highest in the most overgrown part of the ditch and in the center of the two cells of the wet-detention pond.

Ground Water

Ground water levels were measured in 12 shallow wells surrounding the pond and showed a close interaction with the pond level. The water table gradient is toward the pond and eventually the outflow marsh. When pond levels are high the gradient is out of the pond and when pond levels are low the surrounding water table to the north seeps into the pond. Water quality was measured in the ground water wells on several occasions. None of the metals exceeded drinking water standards except for iron which consistently reached concentrations above 1,000 ug/L with one measurement over 14,000 ug/L. Ammonia and phosphorus were also measured at high levels in the wells. Ammonia concentrations frequently were at concentrations greater than 1 mg/L, and in well 10, which is adjacent to a sewage treatment lagoon, the concentrations were between 13 and 16 mg/L. The concentrations of phosphorus in wells closest to the fields were most often measured above 1 mg/L, suggesting some groundwater migration of phosphorus, but still, total P concentrations are much lower in the wells than the 2 to 3 mg/L measured in the ditch.

Key Words: agricultural runoff, detention pond, water quality, stormwater, sediments

Introduction

Agriculture has been identified as a significant source of water pollution in the United States. The use of agricultural fertilizers and pesticides doubled from the mid 1960s to the early 1980s and may be responsible for a major portion of surface and ground water contamination (Cohen and Mallard 1993). The effects of agricultural pollution are numerous: they include sediment contamination and deposition with subsequent impairment of aquatic habitat, pesticide contamination, eutrophication of surface waters, and general water quality degradation of downstream water bodies. The Environmental Protection Agency (EPA) ranks agricultural activity as the greatest threat to water quality in streams and lakes (US EPA 1992). The EPA also notes that nutrient and silt runoff are the leading causes of water quality impairment. Based on data collected by the States and Territories, EPA estimated that 70% of the impaired river miles, 49% of the impaired lake acres, and 27% of the impaired estuarine square miles are polluted due to agricultural nonpoint sources (NPSs) (US EPA 2000). One of the water bodies in Florida impacted by agricultural runoff is Cockroach Bay.

Cockroach Bay had some of the areas most pristine salt-water habitat and, until it was closed in 1983, it was one of the last areas still approved for shellfish harvesting in Tampa Bay. In an effort to improve the degraded estuary a multifaceted habitat enhancement/restoration project known as the larger Cockroach Bay Restoration Project was initiated and partially funded through an Environmental Protection Agency (EPA) section 319(h) set-aside grant. Assisting in the effort was the Cockroach Bay Restoration Alliance (COBRA), a coalition of local, state and federal agencies. When the project was initiated in the early 1990s, this habitat restoration effort was the largest ever undertaken in Florida. Funding for the first phase was $1.5 million, which included the construction of tidal and freshwater marshes as well as the stormwater system monitored in this study. Since Cockroach Bay was designated as an aquatic preserve and an Outstanding Florida Water, the Hillsborough Board of County Commissioners requested that the City-County Planning Commission develop a management plan for the preserve. In addition, the federal Coastal America Program provided $300,000 toward an estuarine restoration project on Cockroach Bay's northern shore and Florida's Surface Water Improvement and Management program (SWIM) funded an equal amount of effort on the restoration project.

Given the problems associated with agriculture and the amount of effort expended to improve Cockroach Bay, staff at the Southwest Florida Water Management District (SWFWMD) initiated a research project to study the effectiveness of a wet-detention pond in treating storm runoff from farm fields. Matching funds from the Florida Department of Environmental Protection (FDEP) provided by Section 319 of the Clean Water Act provided the support needed to monitor the effectiveness of the wet-detention pond to reduce pollutant loads and collect ambient data in the watershed.

Agricultural runoff is excess water from rainfall or irrigation that runs off the land. Uncontrolled, agricultural runoff removes topsoil, nutrients, pesticides, and organic materials and carries them to water bodies where they become pollutants. Nutrients and pesticides present in agricultural runoff can cause serious problems. Nutrients derived from soil, commercial fertilizers or animal manure promote excessive algal growth that filter out and absorb sunlight while releasing offensive odors and toxicants in the receiving waters. Also the effects of pesticides are as toxic in the water as they are on the fields and affect a wide variety of aquatic organisms.

There are generally two types of Best Management Practices (BMPs) used to reduce the impact of agricultural runoff -- source reduction and end-of-the-pipe treatment. Common source reduction methods, such as conservation tillage, tailwater recover, and cover crops, were not observed at this site, but plastic mulch was a common technique employed during the growing season. Plastic mulch with raised beds is a conservative irrigation technique that reduces the need for herbicides and fertilizers, thus reducing contamination by these chemicals. However, farmers must still use biocides to control fungi, bacteria, and insects and there is still runoff – increased runoff, in fact, due to the impermeable plastic and compacted soil between the rows. The most damaging plasticulture runoff entering nearby waterways is the copper-based products applied to plants to prevent disease. Farmers have used several end-of-the-pipe treatments to reduce the impact of runoff from plastic mulch such as ponds and grass strips. Grassed waterways can slow down runoff water and help diminish the water's force, anchor the soil, and filter out sediments. Wet-detention ponds can store runoff in a controlled manner and treat runoff through natural processes between storm events.

Although studies have demonstrated that wet-detention ponds attenuate pollutants such as nutrients and metals in residential and urban settings (Rushton and Dye 1993, Rushton *et al.* 1997, Van Buren 1996, Wu 1996, Harper 1995 and others), no in-depth studies on the effects of a wet-detention pond in an agricultural setting could be found in the literature. A survey study of effluent water quality from detention ponds in agriculture (Bahk and Kehoe 1997) demonstrated good water quality discharging from the ponds, but did not document stormwater treatment since flows were not measured and only ambient grab samples were taken. Actually much of the discharge water in that agricultural runoff study (Bahk and Kehoe 1997) measured concentrations in irrigation water not stormwater.

This paper presents the results from over four years of data collection. Although sampling began in June of 1997, most of the data presented here represent storms from January 1998 to January 2002. Also included are ambient water quality concentrations in the pre-treatment ditch, sediment samples for the entire stormwater system, ground water levels in shallow wells around the pond, and ground water quality in the wells.

The project was designed to characterize an agricultural storm water treatment system by: (1) measuring the reduction (or increase) of pollutants in storm runoff treated by a wet-detention pond, (2) determining water quality concentrations in a pre-treatment ditch, (3) comparing sediment samples for different years, (4) measuring ground water quality and (5) analyzing processes taking place in the stormwater system.

Methods

Site Description

The stormwater project is located in southern Hillsborough County near Ruskin, Florida and adjacent to Cockroach Bay, a part of the Tampa Bay estuary (Figure 1). The 85 hectare (210 acre) drainage basin consists entirely of active and fallow row crop agricultural fields (Figure 2). The fields are irrigated using ground water and most of the crops are winter vegetables that include tomatoes, lettuce, spinach, squash and peppers. The fields are usually left fallow during the summer rainy season, but during 2002, the fields were in production for the entire year (see cover picture taken May 2000). Runoff from the basin flows into a ditch along Cockroach Bay road and enters the detention pond through a submerged culvert (Figure 2). Pond parameters calculated from the design plans are listed in Table 1. The control water level elevation (i.e. when water starts discharging over the outflow weir) is 0.76 meters (2.5 feet) above mean sea level (NGVD). At the control elevation the detention pond has an area of approximately 5.8 hectares (14.3 acres). This makes a pond to drainage area of 6.8 percent, slightly greater than the five percent minimum recommended by Southwest Florida Water Management District rules. Approximately 2.4 hectares (5.9 acres) of the pond area is a shallow littoral shelf (a wetland), which surrounded the deeper aquatic zone. The littoral zone was planted in 1997 with wetland plants such as *Sagittaria lancifolia*, *Bacopa monnieri* and *Pontederia cordata*. Although these plants are still present, by 2000 the littoral shelf was dominated by T*ypha* sp. (Cattail). The outflow from the detention pond empties into a constructed salt marsh before it exits to Cockroach Bay.

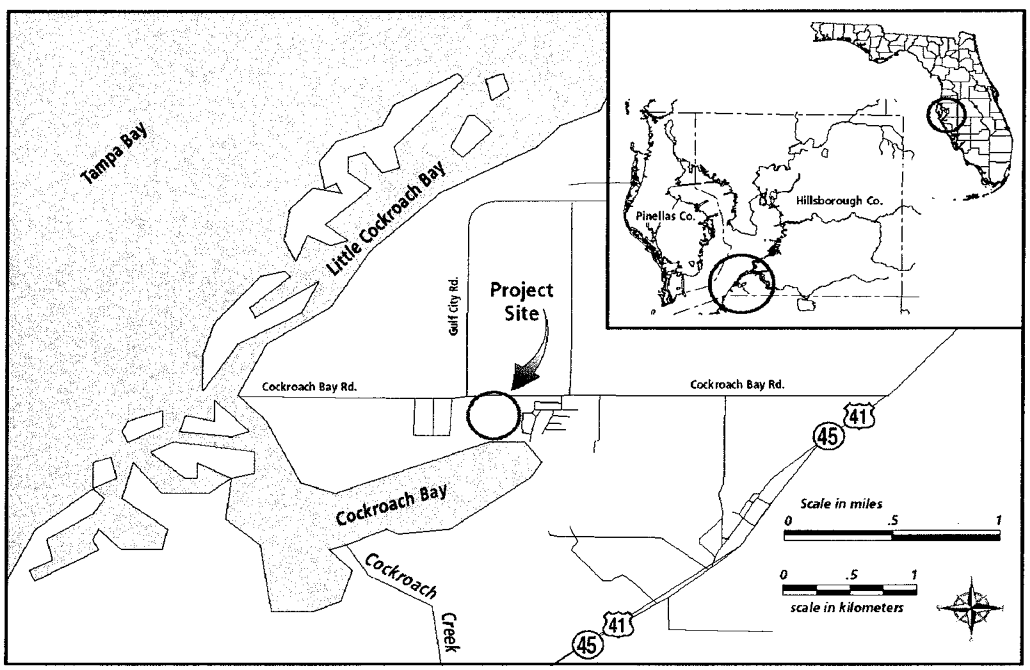


Figure 1. Site location

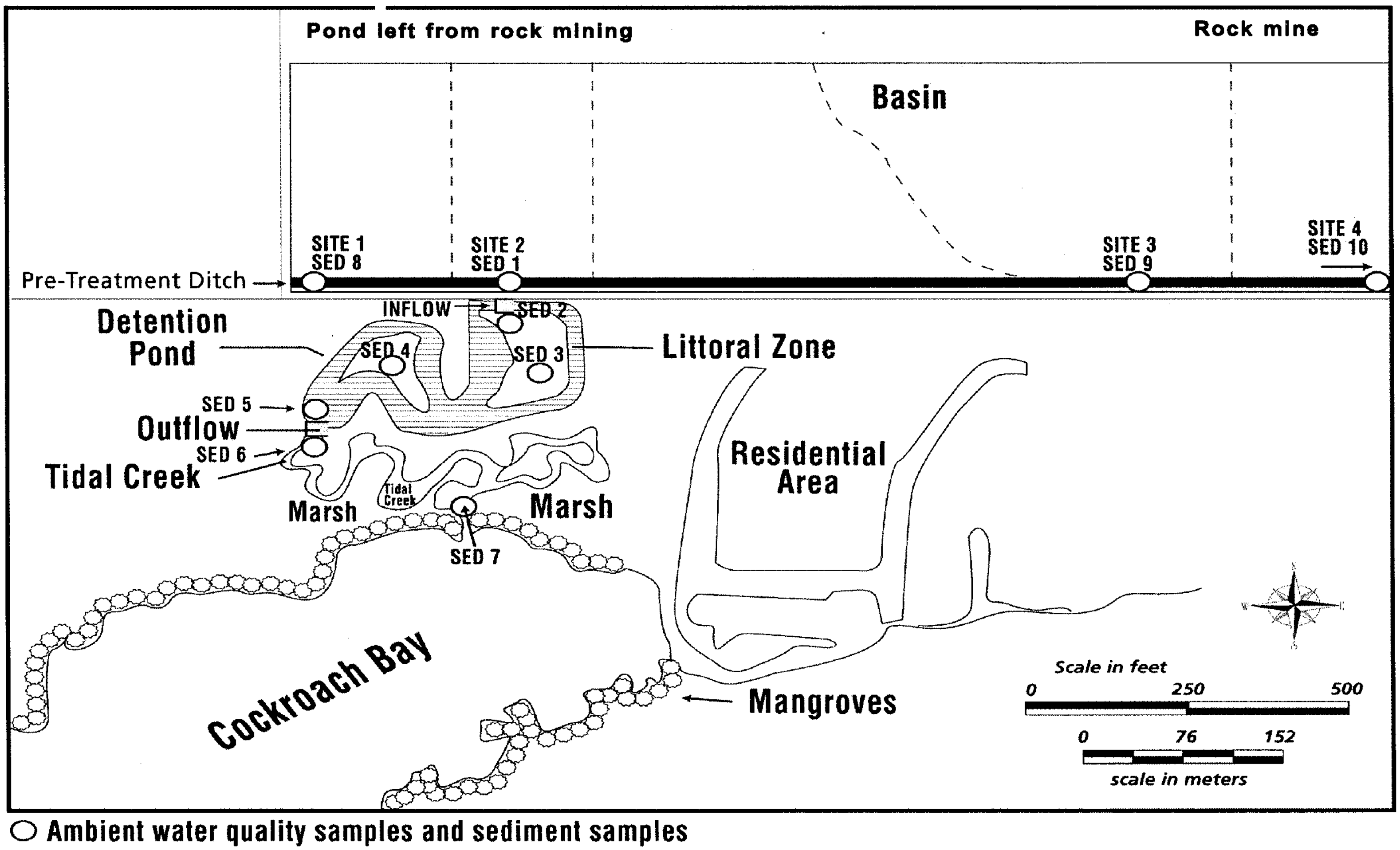


Figure 2. Site plan with water quality and sediment sampling sites identified.

The detention pond is actually two ponds (cells) in series that are not connected until the pond level is above 0.61 meters NGVD (2.0 feet) and only solidly connected when the pond level reaches the control elevation of 0.76 meters NGVD (2.5 ft), and water levels are high enough to discharge at the outflow (Table 1). Land use adjacent to, but not contributing runoff to the drainage basin includes a residential development to the East, an extensive rock mining operation to the North, fallow fields to the West and a constructed salt-water marsh to the South.

Table 1. Pond parameters at different water levels.

Location	NGVD* m (ft)	Area m^2 (ft^2)	Length m (ft)	Volume m^3 (ft^3)
West Pond	-0.305 (-1.0)	7,356 (79,179)	223.7 (733.9)	
	0.457 (1.5)	10,845 (116,732)	254.1 (833.6)	20,800 (734,519)
	0.610 (2.0)	16,043 (172,676)	317.3 (1041.4)	21,592 (762,510)
East Pond	-0.305 (-1.0)	14,213 (152,987)	262.0 (859.7)	
	0.457 (1.5)	22,732 (244,681)	309.3 (1014.9)	34,759 (1,262,782)
Both Ponds**	0.762 (2.5)	57,878 (622,969)	657.2 (2156.3)	74,199 (2,620,270)

* NGVD National Geodetic Vertical Datum = approximate level compared to mean sea level
** Control elevation where water begins to flow out of pond.

Hydrology Measurements

The hydrology of the basin was characterized by recording rainfall at 15-minute intervals and measuring surface and groundwater levels. Rainfall amount was calculated using a tipping bucket rain gauge and surface water was recorded with float and pulley water level sensors. Sensors at both the inflow and outflow sampling stations were connected to Campbell Scientific CR10™ data loggers that stored the data and averaged the measurements at fifteen minute intervals. These measurements allowed interpretation of the hydrological interaction between various elements of the watershed.

Rainfall was characterized by calculating total rainfall, duration, inter-event dry period, rainfall intensity and runoff coefficient using the following formulas.

Rainfall (cm, in)	rainfall amounts for each event >0.40 cm (0.15 in)
Inter-event dry period (hr)	time period since previous rain event (> 6 hours separates storms).
Duration (hr)	period of active rainfall
Intensity (cm/hr, in/hr)	total event rainfall / duration
Maximum intensity	a 15-minute period during the storm with the highest average maximum intensity (cm/hr, in/hr)

Runoff coefficient inflow(m^3, ft^3) / (rain amount(m,ft) * basin area (m^2, ft^2))

Rainfall amounts less than 0.40 cm (0.16 in) were not included in the calculations because these small events produced no runoff from the fields. The selection of 0.40 cm was chosen because storms larger than this amount produced a perceptible change in pond water levels.

Storm Flow Measurements

Flow-weighted composite water quality samples were collected at the inflow and outflow of the detention pond and also for rainfall directly on the pond. Flow was calculated by the following methods:

Outflow Samples - At the outflow, water level was measured with an ISCO™ bubbler flow meter and flow-weighted samples were collected using an ISCO™ refrigerated sampler. Water level measurements were converted to flow using a two-part weir formula. A diagram of the outflow weir is shown in the Appendix. A V-notch formula was used for low flows and a rectangular weir with end contractions formula was used once flows over-topped the V-notch.

Formula for outflow V-notch weir

$$Q = KH^{2.5}$$

Where:
Q = Flow (m^3/sec, ft^3 /sec)
$K = 2.5 \tan(x/2) = 16.7279$
where: x = V-notch angle (163^o)
H = Height of water from V invert (ft)

Formula for rectangular weir above the V-notch

$$Q = 3.33*(L-(0.2*H))*H^{1.5}$$

Where:
Q = flow (m^3/sec, ft^3 /sec)
L = Length of rectangular weir = 9.14 m (30 feet)
H = Height of water above rectangular weir section (m, ft)

Inflow Samples - As reliable flow data at the time of sampling was not available at the inflow, a different technique was devised to collect representative samples. The inflow samples were based on rainfall intensity using the following routine: Rainfall of 0.635 cm (0.25 inches) within 45 minutes was required to trigger the sampler to collect time based samples initiated by the tipping bucket rain gauge. Once triggered, the sampler collected an aliquot every ten minutes for four hours and pumped these into one composite bottle inside the refrigerator. Initial reservations about the ability of the sampling method to collect storm flow were alleviated when the results obtained clearly indicated that representative samples were collected.

The technical problems with the inflow meters presented a challenge for estimating flow. Complete water quality data were collected for about 85 storm events during the four-year period discussed in this report. Of these only a few storm events have reasonable flow measurements from any of the three inflow velocity meters installed at the site. The AFFRA™ acoustic flow meter is actually designed to measure river flow and had difficulty measuring submerged pipe flow with a large area and low flows. It performed best at high flows and provided data for nine storm events. A Marsh-McBirney FLO-MATE™ Model 2000 portable flowmeter was installed by September 1998 and provided point velocity measurements for nine storm events. These measurements were used to validate flow estimates using pond levels and a water budget to estimate flow. In June 2000 a SonTek point velocity meter was installed which was effective for identifying flow movement, but often grossly under estimated actual flow. One problem was the large size of the pipe 1.86 m^2 (20 ft^2) and the low velocity in the pipe. An alligator living in the pipe also created problems.

The formula to estimate inflow is:

*Inflow = (((Max Level Change) - (Rain on Pond)) * Pond Area) + (Amount Discharged)*

Max level is the maximum change in pond level for the storm (meters or feet)
Area is the area of the pond at that level (square meters or feet) from Table 1.
Rain amount on pond is the change in height caused by rainfall on the pond (m^3 or ft^3)
Amount of discharge is the measured discharge from the pond at the outflow (m^3 or ft^3) until inflow stopped (this was estimated to be about 60% of outflow unless storms occurred close together).

To evaluate the results further, a complete water budget was estimated for each storm event.

The Water Budget Method includes:

Precipitation + Inflow - Outflow - Evapotranspiration +/- Seepage = Change in Storage

Precipitation is the amount of rain falling directly on the pond converted to m^3 or ft^3.
Inflow is calculated by the method described above.
Outflow is measured using the method in the previous section.
Evapotranspiration is calculated from evaporation pan data using a coefficient of 0.7
Change in Storage is the difference in water levels in the pond, before the storm began until the last sample was collected, converted to m^3 or ft^3.
Seepage is the error term plus seepage. Large seepage numbers were measured at the beginning of the project, which corresponded to a leak in the outflow weir. Positive seepage is seepage into the pond usually caused by irrigation water. Negative seepage was seepage out of the pond caused by a weir leak before October 1998 and by an obvious seepage area that occurred during all measurements when water levels are high (>2.0 ft NGVD) and the two ponds are connected.

Water Quality Samples

Water quality samples were analyzed by the chemistry laboratory of the Southwest Florida Water Management District according to the guidelines published in their Quality Assurance Plan (SWFWMD 1998). Duplicate samples and blanks were periodically collected for quality assurance. Samples for the analysis of total nitrogen, ammonia, nitrate-nitrite, ortho-phosphorus and total phosphorus were stored in 500 ml polyethylene bottles and preserved with the addition of sufficient concentrated sulfuric acid to lower the sample pH below 2.0. Samples for the analysis of metals were collected in 250 ml EPA approved pre-washed bottles and preserved with the addition of sufficient nitric acid to lower the sample pH below 2.0. Samples for the analysis of chlorophyll were grab samples and were collected in opaque, brown polyethylene 1 liter bottles. Samples for the analysis of total suspended solids, chloride, and hardness were collected in 1-liter polyethylene bottles. All samples were placed on ice in coolers and transported to the SWFWMD Laboratory for analysis using standard methods (Table 2). Pesticide and priority pollutants were sent to the Department of Environmental Protection Laboratory in Tallahassee for analysis using their Quality Assurance Plan (FDEP 1996). Pre-washed bottles and coolers were sent from FDEP for each of their sampling events.

In addition to the quality assurance samples tested in the laboratory, field samples were collected to test the accuracy of our field techniques. Duplicate samples were collected to determine how closely samples collected from the same five gallon composite bottle matched each other (1st sample and 2nd sample). Since it was not always possible to collect water quality samples immediately after a storm event, a 3rd sample was held in the refrigerator and not fixed with preservatives or taken to the lab until several days later. Usually results matched each other, but nitrogen concentrations were sometimes affected. For example, nitrogen showed no consistent pattern when not collected immediately, concentrations were sometimes higher and sometimes lower. It was also noted that when the lab detected particles in the turbidity sample, concentrations of metals and to a certain extent nitrogen were also elevated. All of the duplicate sample data are in the Quality Assurance (QA) Appendix.

Storm Event Samples

Composite storm event samples were collected using the methods described in previous sections and stored in ISCO™ automatic refrigerated samplers until retrieved, preserved with acid and transported to the SWFWMD Laboratory. Sample containers in the refrigerators were acid washed in the lab on a regular basis and the bottles were field washed with de-ionized water after every storm event. De-ionized water blanks were run through the equipment when the tubing was changed to check for possible equipment contamination. Results show that the tubing sometimes contaminated the sample in this worse case scenario, but sample concentrations were still much lower than the average values measured during storm events. (See QA Appendix).

Table 2. Description of laboratory analyses for parameters measured in stormwater study. References refer to sections in Standard Methods (APHA 1992) or (US EPA 1983) where more detailed descriptions can be found. When values were below the laboratory detection limit, one-half the detection limit was substituted for statistical analysis.

Parameter	Method	Det. Limit	Reference.
Total Suspended Solids	**Total filterable residue dried at 103-105° C**	**0.05 mg/l**	**SM 2540**
Total lead	**Electrothermal atomic absorption spectrometry**	**0.001 mg/l**	**SM 3113 B**
Total copper	**Electrothermal atomic absorption spectrometry**	**0.001 mg/l**	**SM 3113 B**
Total cadmium	**Electrothermal atomic absorption spectrometry**	**0.0003 mg/l**	**SM 3113 B**
Total chromium	**Electrothermal atomic absorption spectrometry**	**0.002 mg/l**	**SM 3113 B**
Total zinc	**Direct aspiration into air-acetylene flame**	**0.015 mg/l**	**SM 3111 B**
Total iron	**Direct aspiration into air-acetylene flame**	**0.025 mg/l**	**SM 3111 B**
Ammonia-N	**Automated phenate**	**0.1 mg/l**	**SM4500**
Organic nitrogen	**Semi Automatic Block Digestor**	**0.01 mg/l**	**EPA 351.2**
Nitrate-nitrite-N	**Cadmium reduction**	**0.01 mg/l**	**EPA 353.2**
Total Phosphorus	**Colorimetric automated block digester**	**0.01 mg/l**	**EPA 365.1**
Ortho-phosphorus		**0.01 mg/l**	**SM 4500-P**
Chlorophyll	**Spectrophotometric**	**1.0 ug/l**	**SM 10002G**
Biochemical Oxygen demand	**Standard**	**1.0 mg/l**	**SM 5210 B**
Bacteria	**Membrane Filtration**	**1.0 cfu/100ml**	
Priority Pollutants	**Standard**	**variable**	

Rainfall water quality was collected using an Aerochem Metrics™ model 301 wet/dry precipitation collector. A sensor detected precipitation, which activated a motor that removed the lid from the wet bucket and transferred it to the dry bucket. When the rain stopped the cycle was reversed. A small refrigerator was mounted under the collector to immediately store the sample until it could be fixed with the appropriate preservatives and transported to the laboratory. Dryfall was not measured

Background Samples

Ambient water quality grab samples were collected to document the constituent concentrations in various components of the stormwater system. The sampling sites included: (1) four locations in the inflow ditch, (2) the network of groundwater wells, and (3) locations in the pond. The sampling station identifiers are listed in Table 3.

Pre-treatment Ditch - Pesticide, bacteria, nutrients, metals and chlorophyll grab samples were collected several times a year in the pre-treatment ditch to quantify conditions between storm events. These samples allow comparison of pollutant concentrations measured directly from the different agricultural fields. In addition a Minisonde Surveyor IV Hydrolab™ measured pH, temperature, oxidation-reduction potential (Redox), dissolved oxygen (DO) and conductivity at the same time the samples were collected. Sampling sites are identified as sites 1 through 4 in Figure 2. For most of the study, site 1 was dry and samples were not collected.

Sediment samples - Sediment samples for nutrients, metals and pesticides were collected in July 1997 at seven locations in the ditch, pond and marsh and again in July 1998 for 10 locations. In July 2000 and July 2002, pesticide samples were analyzed for 10 sites, but nutrients and metals were not analyzed. See Figure 2 for sediment sampling sites, which are identified with the prefix "SED". Samples were extracted intact from the sediments with a two-inch diameter hand driven corer. For each sample, four to six replicate cores were taken in close proximity and composited using the four corner mixing method. Samples were placed in EPA approved glass jars supplied by the Florida Department of Environmental Protection (FDEP) laboratory, covered with ice in insulated coolers and transported to Tallahassee for analysis using the FDEP approved quality assurance protocol (FDEP 1996).

Well Samples - a network of 12 water table wells located around the perimeter of the pond were installed to evaluate surface/groundwater interactions. Wells are 2.44 m (8 ft) deep, constructed from two-inch diameter slotted PVC pipe, and backfilled with the material taken from the hole with soil packed tightly around the top.

The well levels were monitored bi-weekly with a Solinst™ meter that activates an audible buzzer when the probe enters a liquid. Markings along the tape-line attached to the sensor allow for measurement of water level depth. The tops of the well casings were surveyed in order to relate ground water levels to NGVD (mean sea level) by subtracting the distance from the top of the well to the level measured with the meter. Well locations are plotted in Figure 3. Some of the well data were analyzed using the Surfer™ software package (v6) to create contour maps of water level elevations to and estimate subsurface flow.

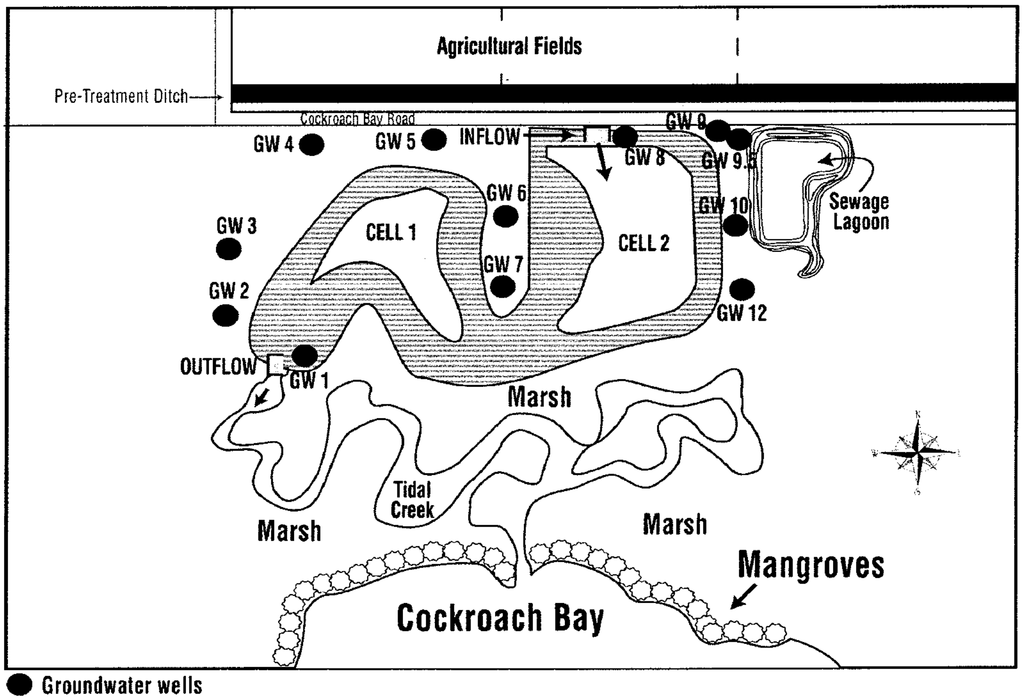


Figure 3. Location of groundwater wells.

Well water was sampled for water quality. Before the samples were collected, the well was purged with a submersible pump until the water became clear and free of sand particles. Samples were preserved and transported on ice to the SWFWMD laboratory and analyzed by the methods described in the previous section.

Field Parameters - Dissolved oxygen (DO), conductivity, oxidation-reduction potential (Redox), pH, temperature and salinity were measured at the inflow and outflow of the wet-detention pond. The fully submersible automated Hydrolab™ Datasonde III units were deployed about once a month and programmed to record data at one hour intervals for a week at a time. Measurements were summarized in graphs for each of the weekly measurements and averages of each week were calculated to compare field parameter characteristics between stations.

Water Quality Standards

Metals and pesticides were compared to State of Florida water quality Standards for Class II and Class III marine waters (Ch 62-302 FAC) to determine how well the concentrations met water

Table 3. Site names and the laboratory UID numbers. Locations are identified in Figures 2 and 3.

Site Description	Water Quality Sites	Laboratory Identifier	Sediment Sites
Inflow of pond	inflow	STA 819	SED 2
Outflow of pond	outflow	STA 820	SED 5
Background ditch #1	site 1	STA 821	SED 8
Background ditch #2	site 2	STA 822	SED 1
Background ditch #3	site 3	STA 823	SED 9
Background ditch #4	site 4	STA 824	SED 10
Middle of east pond		STA 714	SED 3
Middle of west pond		STA 715	SED 4
Marsh inflow at weir		STA 719	SED 6
Marsh at Cockroach Bay		STA 718	SED 7
Rainfall	rain	RNF 468	
Groundwater well #1	gw1	WEL 13093	
Groundwater well #2	gw2	WEL 13095	
Groundwater well #3	gw3	WEL 13100	
Groundwater well #4	gw4	WEL 13096	
Groundwater well #5	gw5	WEL 13097	
Groundwater well #6	gw6	WEL 13098	
Groundwater well #7	gw7	WEL 13099	
Groundwater well #8	gw8	WEL 13094	
Groundwater well #9	gw9	WEL 13089	
Groundwater well #9.5	gw9.5	WEL 13090	
Groundwater well #10	gw10	WEL 13091	
Groundwater well #12	gw12	WEL 13092	

quality goals set by the state to protect fish and wildlife in marine environments (Table 4a). Class II water quality standards protect shellfish propagation or harvesting and Class III marine water standards provide for safe recreational use as well as the maintenance of a healthy, well-balanced population of fish and wildlife. Nutrients were tested against standards recently published (April 2000) by the Environmental Protection Agency for lakes and streams in ecoregion XII, which includes most of Florida (US EPA 2000). The more appropriate manual for estuaries/coastal waters has not been posted on their web site yet. The method used reference conditions that reflect pristine or minimally impacted water for the region. The values presented are estimated to be nutrient levels that protect against the adverse effects of nutrient over-enrichment for total nitrogen, total phosphorus and nitrate+nitrite (Table 4b).

Sediment Standards

As sediments tend to integrate contaminant concentrations over time they may represent a better method for determining when conditions are toxic to organisms. For this reason several government agencies are working on guidelines to assess possible toxic levels detrimental to aquatic organisms. Some of these evolving guidelines are listed in Table 4c. Also compared in Table 4c are standards used to determine safe levels in soils. Soils are considered non-toxic (clean) in Florida (Chapter 62-775 FAC) as long as concentrations do not exceed those listed in column (a). Informal sediment contamination guidelines have been published for freshwater sediments in Canada that identify potentially adverse biological effects (Persuad et al. 1990). Possible effects (Low) listed in column (b) represent the boundary between the level at which no toxic effects have been observed and the lowest level showing the concentrations that can be tolerated by the majority of benthic organisms. The probable (Prob.) effect indicates the level at which a pronounced disturbance to the benthic community occurs. Guidelines for estuarine sediments, column (c), have been established for Florida (MacDonald *et al.* 1993). The lower boundary of the range of concentrations that could potentially be associated with biological effects is the possible (Low) effect level while the probable (Prob) effect level represents concentrations shown to be toxic to some organisms.

Theoretical reasons exist for doubting that any of these chemical-based guidelines reflect sediment toxicity. For example, co-occurrence of other conditions such as low dissolved oxygen, organic chemicals, a combination of chemicals or other stressors might have caused organism mortality (O'Connor *et al.* 1998). Using a large data set of 1,508 samples from an EPA and NOAA coastal and estuary monitoring study the guidelines were investigated further (O'Conner et al. 1998) and the results were compared to the effect range guidelines of Long *et al* (1995), column (d). Sediments were considered toxic if fewer than 80 percent of the amphipods, relative to controls, survived the exposure. Of the 481 samples below the probable exceedance level only 5 percent were toxic and agreed with the prediction. On the other hand, of the 239 samples that had at least one concentration greater than the probably toxic level, only 38 percent were actually toxic (O'Conner *et al.* 1998). These researchers concluded that the probable toxic exceedances should only be taken to indicate that further analysis is in order. The National Oceanic and Atmospheric Agency (NOAA 1999) has also conducted testing and found the guidelines used by Long et al (1995) to be predictive for samples tested below the probably toxic level, but that caution, common sense, and further tests should be used before declaring a sediment toxic.

Table 4a. Criteria for Marine Surface Water Quality Classification (Ch 62-302 F.S.)

Parameter	Class II	Class III
Aluminum (mg/L)	≤ 1.5	≤ 1.5
Fecal coliform (MPN or MF) MF used in this study	a median value of ≤ 14 with not more than 10% of samples > 43 or > 800/day	≤ 200 avg or < 400 in 10% of monthly samples or ≤800 any day
Total coliform (MPN or MF) MF used in this study	a median value of ≤ 70 and not more than 10% > 230	≤ 1,000 as a monthly average or < 1,000 in 20% of samples or < 24,000 any day
Cadmium (ug/L)	≤ 9.3 average	≤ 9.3 average
Chromium (hexavalent)(ug/L)	≤ 50 average	≤ 50 average
Copper (ug/L)	≤ 2.9 average	≤ 2.9 average
Iron (mg/L)	≤ 0.3 average	≤ 0.3 average
Lead (ug/L)	≤ 5.6 average	≤ 5.6 average
Manganese (mg/L)	≤ 0.1 average	no standard
Nickel (ug/L)	≤ 8.3 average	≤ 8.3 average
Chlordane (ug/L)	≤ 0.00059 annual average; 0.004 maximum	≤ 0.00059 annual average; 0.004 maximum
DDT (ug/L)	≤ 0.00059 annual average; 0.001 maximum	≤ 0.00059 annual average; 0.001 maximum
Dieldrin (ug/L)	≤ 0.00014 annual average; 0.0019 maximum	≤ 0.00014 annual average; 0.0019 maximum
Endosulfan (ug/L)	≤ 0.0087	≤ 0.0067
pH (standard units (SU)	Depends on natural conditions usually > 6.5 SU and < 8.5 SU	Depends on natural conditions usually > 6.5 SU and < 8.5 SU
Zinc (ug/L)	≤ 86	≤ 86

Table 4b. Ambient Water Quality Criteria Recommendations for nutrients in ecoregion XII (US EPA 2000).

Parameter	Lakes & Reservoirs	Rivers & Streams
Nitrate+Nitrite (mg/L)	na	0.02 annual average median
Total Nitrogen (mg/L)	0.52 annual average median	0.90 annual average median
Total Phosphorus (mg/L)	0.01 annual average median	0.04 annual average median

Table 4c. Sediment quality criteria giving threshold concentrations (mg/kg) where constituents have the possible effect level (Low) and the limit of tolerance level (Prob). See text for a more complete explanation.

	Soil (a)	Freshwater (b)		Estuarine (c)		Estuarine (d)	
		Sediments		Sediments		Sediments	
Constituent	**Toxic**	**Low**	**Prob**	**Low**	**Prob**	**Low**	**Prob**
Cadmium	37	1	10	1	8	1.2	9.6
Lead	108	31	250	21	160	47	220
Zinc	na	110	800	68	300	150	410
Copper	na	25	114	28	170	34	270
Chromium	50	31	111	33	240	81	370
Mercury	na	na	na	na	na	0.15	0.17
DDE	na	na	na	na	na	0.0022	0.027
DDT	na	na	na	na	na	0.0016	0.046

(a) Soil Thermal treatment Facilities, Chapter 62-775 FAC
(b) Development of Sediment quality Guidelines (Persud et al. 1990)
(c) Sediment Quality in Florida Coastal Waters (MacDonald 1993)
(d) Magnitude and Extent of Sediment Toxicity in Tampa Bay, FL (Long *et al.* 1995)

Treatment Efficiency Calculations

Efficiency of the system (i.e. the pollutant reduction from the inflow to the outflow) was calculated by two methods (concentrations and loads) using composite samples for each storm. Concentration efficiency provides insight into the processes taking place in the pond and indicates whether pollutants are being transformed and reduced. For these calculations both small and large storms are treated equally. Load efficiency puts more emphasis on larger storms and takes into account the amount of water lost by infiltration and evaporation as well as pollution removal.

The Event Mean Concentration (EMC) efficiency was calculated by averaging the inflow and outflow concentrations for each storm for a designated time period (in this case yearly) by using the following formula:

*EMC efficiency (%) = ((conc. in - conc. out) / conc. in) * 100*

where: EMC = Average Event Mean Concentration from flow weighted samples
Conc. in = average of EMC at the inflow
Conc. out = average of EMC at the outflow
Concentrations have the units of mg/L or ug/L.

Load efficiency was calculated by adding the individual storm events together for a given time period (in this case yearly) by the following formula.

*Load efficiency (%) = ((SOL in - SOL out) / SOL in) * 100*

Where: SOL in = the sum of loads at the inflow for a given time period
SOL out = the sum of loads measured at the outfall for a given time period

Loads are calculated by using EMC (mg/L or ug/L) * flow volumes (m^3 or ft^3) * conversions factors. These were calculated for each storm event and added together for SOL and usually have units of kg/yr or lbs/yr. Data in this study are reported on a yearly basis.

Statistical Analysis

Statistical computations were performed using the SAS system, version 8.1, to determine significant differences and to analyze relationships between variables. Most statistical tests assume the variables are from an independent and normally distributed population and that the variances are homogeneous. This is rarely the case for water quality data, therefore, the data were log transformed or non-parametric procedures were used. The Duncan Multiple Range Test and the Kruskal-Wallis test and the Wilcoxon Rank Sum Test were run to determine statistical differences. The non-parametric Spearman method was used to compute correlation coefficients.

Results and Discussion

A wet-detention pond built to treat runoff from agricultural fields was studied to evaluate its ability for removing pollutants and to better understand the dynamics of the system. Most of the data in this final report cover the period between January 1998 and January 2002, but some data before 1998 are also included for comparison purposes. The final ambient samples were collected in July 2002, six months after the storm event sampling was completed, to coincide with the same time of year as the other sediment samples. For storm event samples, hydrology and water quality were analyzed for each year separately and the averaged values compared to each other.

Hydrology of the System

Detailed graphs of water levels and rainfall were made to visually analyze relationships and identify problems (Appendix A). Continuous monitoring sensors recorded rainfall amounts and water levels. Biweekly well readings are also included on the graphs as large dots and show the close relationship between surface and ground water. Once the SonTek velocity meter was installed (June 2000) those readings were also included on the graphs

Rainfall

Rainfall amounts for the four years of data covered both drought and flood conditions caused by the El Niño phenomenon. El Niño produced above average rainfall from September 1997 through March 1998 and La Niña was implicated in the below average rainfall for the following year. Although record droughts continued through 2001, several large summer storms in June and July helped make up the deficit at this site. Several hurricanes contributed to above average rainfall amounts in September of 1997, 1998, 2000 and 2001 (Figure 4).

Florida normally has wet and dry seasons with about 60 percent of rainfall occurring during four summer months (June through September). Instead, the El Niño storms began in September 1997 and continued through March 1998, the normal dry season, and also a time when the agricultural fields were in full production. In addition, the El Niño storms produced over twice as much rainfall (139 cm, 55 inches) than the long-term average for those months (55 cm, 24 in). As a comparison, the same winter months during the following years measured 43 cm (17 in) in 1998-99 and 31 cm (12 in) in 1999-00. During 2000 and 2001 the rainy season precipitation was nearly normal, while most of the rainfall deficit occurred during the dry season.

Rainfall characteristics are relevant not only to water quantity issues where they affect flooding and peak discharge, but also to water pollution where they influence constituent concentrations, removal efficiency, and pollutant loads. Rainfall characteristics for each storm greater than 0.40 cm (0.15 in) are presented in Appendix B and a summary for each year are shown in Table 5, which for 1998, includes the final three months of the El Niño storms.

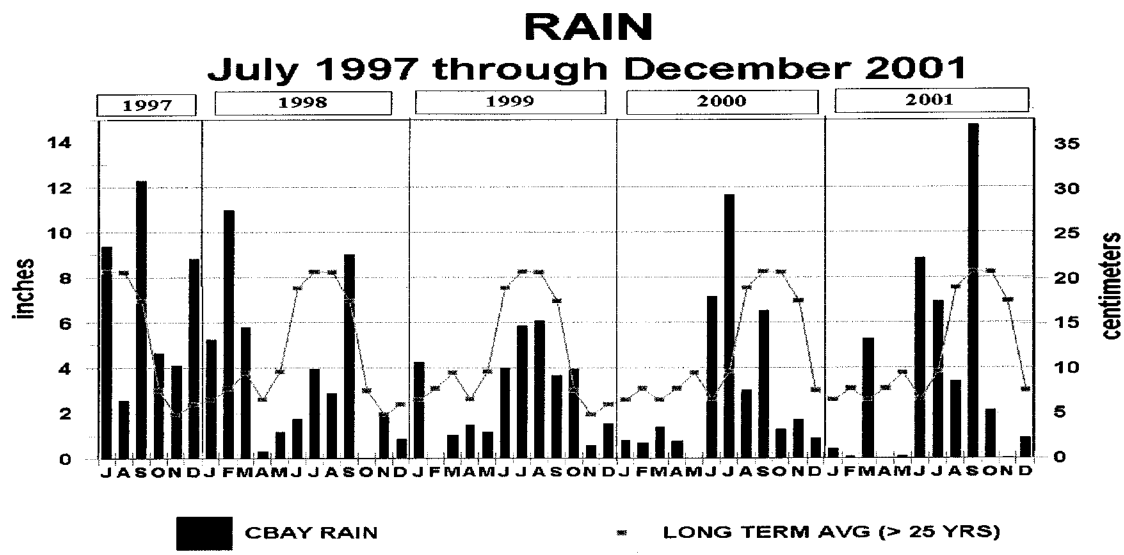


Figure 4. Rainfall amounts measured during the study compared to the long term average (> 25 years) for the area.

When comparing rainfall characteristics between years (Table 5), the most obvious differences are the larger storms and longer average storm durations in 1998, while 1999, 2000 and 2001 had the longest maximum period between storms (inter-event dry period) and lower average rainfall amounts. These results reflect the impact of the few large El Niño storms as indicated by the median values, which are similar for all years. These few large storms, however, can affect Tampa Bay for quite a few years as will be discussed later. It should be noted that only about half the storms greater than 0.40 cm (0.15 in) produced enough flow to take water quality samples in the pond. At this flat, sandy, pervious site with a pre-treatment ditch it took at least 1.27 cm (0.50 in) of rain to produce enough runoff to collect samples unless the ground was already saturated with water from irrigation or previous storm events.

Rainfall characteristics influence pollutant concentrations and removal efficiencies in several ways. Antecedent conditions (inter-event dry period) and rainfall intensity increase pollutant concentrations by providing time for accumulation on land surfaces as well as the rain energy to dislodge soil particles and other pollutants from the watershed. Also wet and dry years affect input and output concentrations by changing subsurface flow and evapotranspiration. Rainfall also has the ability to flush out the system with a few large storms, this is especially true for reducing floating algae mats, phytoplankton and other organic matter in wet-detention ponds. Some researchers have found that precipitation tends to contain contaminants at higher concentrations in short storms and when precipitation is infrequent (Mitsch and Gosselink 1993). This suggests that the wash-out effect, with rainfall purifying the air, is prevalent in short storms, while longer rainfall events dilute samples with better quality water. Some of these relationships were tested with statistical analysis and are discussed later.

Table 5. A summary of rainfall amounts and characteristics measured for storms > 0.40 cm (0.15 in) for each year. All the data are reported in Appendix B.

Statistic	Duration (hr)	Event Rain (cm)	Event Rain (in)	Inter-event (hr)	Intensity (cm/hr)	Intensity (in/hr)	Max Intensity (15 min avg) (cm/ 15min)	Max Intensity (15 min avg) (in/ 15min
1998								
No. Obs.	49	49	49	49	49	49	49	49
Mean	5.17	2.37	0.93	170	0.82	0.32	0.69	0.27
Median	2.75	1.42	0.56	80	0.46	0.18	0.51	0.20
max	45.00	13.01	5.12	940	4.61	1.81	2.57	1.01
min	0.50	0.41	0.16	6.25	0.07	0.03	0.08	0.03
Std.Dev.	7.49	2.64	1.04	231	0.91	0.36	0.59	0.23
c.v	1.45	1.12	1.12	1.36	1.11	1.11	0.86	0.86
Total Rain for Storms		**111.23**	**43.79**					
1999								
No. Obs.	46	46	46	46	46	46	46	46
Mean	4.38	1.85	0.74	223	1.04	0.41	0.79	0.31
Median	2.75	1.37	0.54	94	0.47	0.19	0.66	0.26
max	23.50	8.99	3.54	1542	6.40	2.52	2.46	0.97
min	0.25	0.41	0.16	7.00	0.08	0.03	0.05	0.02
Std.Dev.	4.93	1.66	0.65	323	1.47	0.58	0.64	0.25
c.v	1.13	0.90	0.88	1.45	1.41	1.41	0.81	0.81
Total Rain for Storms		**84.93**	**34.66**					
2000								
No. Obs.	45	45	45	45	45	45	45	45
Mean	4.16	1.88	0.74	149	0.82	0.32	0.73	0.29
Median	3.00	1.24	0.49	74	0.50	0.20	0.66	0.26
max	17.25	10.82	4.26	1369	3.15	1.24	2.72	1.07
min	0.25	0.33	0.13	4.50	0.08	0.03	0.10	0.04
Std.Dev.	3.84	1.96	0.77	229	0.78	0.31	0.60	0.24
c.v	0.92	1.04	1.04	1.54	0.95	0.95	0.82	0.82
Total Rain for Storms		**84.51**	**33.27**					
2001								
No. Obs.	42	42	42	42	42	42	42	42
Mean	4.48	2.31	0.91	159	0.73	0.29	0.66	0.26
Median	2.50	1.22	0.48	81	0.60	0.24	0.52	0.21
max	41.50	25.17	9.91	1540	3.52	1.39	1.93	0.76
min	0.50	0.25	0.10	2.50	0.10	0.04	0.05	0.02
Std.Dev.	6.98	4.03	1.59	297	0.72	0.28	0.53	0.21
c.v	1.56	1.75	1.75	1.87	0.99	0.99	0.80	0.80
Total Rain for Storms		**93.27**	**38.16**					

* C. V. = Coefficient of variation (standard deviation/mean)

Water Budget

The difficulty measuring the inflow to the pond complicated quantifying the hydrology of the system. Although a method was devised that appeared to provide a good estimate of inflow when compared to the few times when the velocity meters were operable, a complete water budget was constructed to make certain the numbers were reasonable. The water budget for the numbered rain events (those with water quality data) are shown in Table 6a and a more complete record can be found in Appendix C. Some of the hydrographs are also included in Appendix C.

Calculations in Table 6 include the period of time from the beginning of the storm flow and continued until flow ceased at the outflow or until the next storm began. Much more agricultural activity in the fields was evident in late 2000 and early 2001 and the irrigation from this activity increased the amount of flow measured at both the inflow and outflow. The more saturated soils caused by irrigation also increased the average runoff coefficient measured during those years from an average of 0.10 to 0.25. During field irrigation, when the pond continually discharged, the length of the storm flow was assumed to end after five days. Although irrigation water did account for some seepage or low flow into the ponds during the winter months, irrigation inflow could not be directly measured since our inflow meter was not sensitive enough to quantify this low flow in a large pipe. Irrigation water did have an impact on the stormwater study and during the winter and spring when the pond discharged constantly it was impossible to separate the effect of irrigation water from stormwater. The water budget method tried to minimize the impact of the effect of irrigation, but the increased amount of inflow and outflow in 2000 and 2001 when agricultural activity increased while rain amount decreased is an artifact of the irrigation practices

An explanation of the water budget terms are described in the method section, the analysis here sheds some insight into the hydrology of the system.

Rainfall directly on the pond is a significant source and accounts for 17 to 29 per cent of the hydrologic input to the pond. This is often not considered in stormwater studies but it accounts for much of the pollutant load measured for inorganic nitrogen and zinc as will be discussed in a later section. Rainfall input is a significant hydrologic input to this pond because of the pervious characteristics at this agricultural site with pre-treatment storage causing low runoff volumes except during extreme rain events.

Inflow from storm events contributed from 70 to 80 percent of the hydrologic input to the pond each year. Additional sources of water are attributed to rainfall, seepage from excessive irrigation and other unmeasured flow.

Outflow from the pond was about 11 to 25 percent less than estimated for the inflow, and 26 to 45 percent less if rainfall is considered an input. According to the estimated water budget for storm events, between 70 and 97 percent of the outflow was discharged over the control structure, but the

Table 6a. Water budget calculations for storm events (See also Appendix C).

STORM #	STORM DATE START	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	ET (CU FT)	RESIDS SEEPAGE (CU FT)	RUNOFF COEF.
1	01/06/98	1.36	70,603 [illegible]						
2	01/15/98	1.07	55,548	176,351	(95,000)	15,574	(21,804)	(99,521)	0.22
3	01/23/98	2.27	117,845	444,865	(362,500)	44,231	(15,346)	(140,633)	0.26
4	02/02/98	1.16	60,220	182,550	(99,300)	24,919	(2,907)	(115,644)	0.21
5	02/15/98	3.84	199,350	795,651	(631,930)	348,863	(1,381)	(12,828)	0.28
6	02/17/98	0.31	16,093	101,235	(172,360)	(255,417)	(16,041)	(184,344)	
7	02/19/98	3.58	185,852	1,001,698	(1,004,570)	24,919	(29,072)	(128,990)	0.35
8	02/22/98	0.27	14,017	27,486	(8,250)	(62,297)	(10,102)	(85,448)	
9	02/28/98	1.48	76,833	343,896	(206,030)	(12,459)	(57,469)	(169,690)	0.30
10	03/08/98	0.68	35,302	56,349	(8,870)	(49,838)	(66,450)	(66,168)	0.11
11	03/18/98	5.12	265,800	1,023,261	(1,099,770)	31,148	(77,871)	(80,271)	0.26
12	04/20/98	0.30	12,934	2,587	0	15,521	(15,210)	15,210	0.01
13	05/28/98	0.88	37,940	8,623	0	46562	(1,992)	1,992	0.07
14	05/30/98	0.29	12,503	49,580	0	56909	(1,328)	(3,846)	
15	06/23/98	1.02	43,976	12,933	0	56,909	0	0	0.02
16	07/06/98	0.39	11,746	2,711	0	7,228	(9,198)	1,970	0.01
17	07/10/98	0.65	19,577	12,951	0	28,913	(9,613)	5,999	0.03
18	07/14/98	2.11	63,548	37,647	0	97,582	(16,618)	13,004	0.02
19	07/21/98	0.41	12,348	2,108	0	10,842	(12,312)	8,698	0.01
20	08/16/98	0.82	24,697	4,216	0	28,913	(11,637)	11,637	0.01
21	08/17/98	0.74	22,287	10,240	0	3,614	(9,535)	(19,378)	0.02
22	09/02/98	1.41	73,199	9,486	0	393,940	(9,127)	320,382	
23	09/06/98	2.92	151,589	123,469	(9,540)	112,134	(29,457)	(123,926)	0.06
24	09/18/98	1.70	88,254	86,865	(5,180)	37,378	(5,788)	(126,773)	0.07
25	09/19/98	1.72	89,292	344,953	(128,160)	142,037	(7,420)	(156,629)	0.38
26	09/20/98	0.35	18,170	252,864	(97,580)	na	(18,476)	na	
27	12/13/98	0.58	20,172	5,287	0	21,703	(2,626)	(1,130)	0.01
TOTALS 1998*		**37.43**	**1,799,695**	**5,119,862**	**(3,929,040)**	**1,169,828**	**(458,781)**	**(1.136,327)**	**0.14**
1	01/02/99	1.38	47,996	81,385	0	66,064	(13,293)	(50,023)	0.08
2	01/23/99	2.69	139,649	399,878	(78,530)	411,160	(5,259)	(44,579)	0.20
3	03/14/99	1.01	52,433	117,029	(33,250)	(6,230)	(35,976)	(106,466)	0.15
4	04/30/99	1.10	33,130	14,577	0	(723)	(9,867)	(38,563)	0.02
5	05/30/99	1.02	20,798	15,904	0	(7,830)	(14,216)	(30,316)	0.02
6	06/02/99	0.92	27,709	5,542	0	29,636	(9,529)	5,915	0.01
7	06/05/99	0.63	18,974	2,711	0	16,264	(10,752)	5,331	0.01
8	06/16/99	1.83	55,116	70,476	0	97,582	(39,467)	11,457	0.05
9	07/01/99	1.09	32,829	28,251	0	57,827	(5,903)	2,650	0.03
10	07/02/99	0.39	11,746	9,939	0	23,000	(3,584)	4,899	0.03
11	07/09/99	0.55	16,565	12,047	0	25,299	(8,770)	5,457	0.03
12	07/26/99	0.75	38,936	15,263	0	38,001	(7,801)	(8,397)	0.03
13	08/06/99	0.66	34,263	5,607	0	29,903	(5,000)	(4,968)	0.01
14	08/12/99	0.32	16,613	2,077	0	11,213	(3,373)	(4,103)	0.01
15	08/14/99	0.18	9,345	4,984	0	(8,722)	(4,217)	(18,833)	0.04
16	08/16/99	1.18	61,259	45,869	(600)	99,675	(3,373)	(3,480)	0.05
17	08/18/99	1.37	71,122	203,250	(171,760)	67,281	(16,868)	(18,464)	0.19
18	08/22/99	1.71	88,773	350,176	(383,430)	(13,705)	(21,355)	(47,869)	0.27
19	08/28/99	0.51	26,476	7,397	(11,810)	(11,213)	(12,651)	(20,626)	0.02
20	09/06/99	1.94	100,713	218,066	(240,580)	92,822	(36,359)	50,982	0.15
21	09/11/99	0.34	17,651	20,023	(38,910)	(41,739)	(20,294)	(20,209)	0.08
22	09/19/99	1.62	84,101	265,687	(238,270)	89,085	(13,476)	(8,957)	0.22
23	10/04/99	3.95	205,061	1,098,728	(880,170)	179,415	(27,602)	(216,602)	0.37
24	10/01/99	1.22	63,335	114,069	(147,200)	(2,492)	(9,738)	(22,958)	0.12
25	11/22/99	0.55	28,553	98,307	(112,100)	0	(17,286)	2,526	0.23
	12/17/99	0.85	44,127	86,278	(91,710)	46,100	(4,025)	11,429	0.13
TOTAL 1999*		**28.38**	**1,299,275**	**3,212,136**	**(2,428,320)**	**1,221,608**	**(346,740)**	**(514,741)**	**0.10**

Table 6a (con't). Water budget calculations for storm events (See also Appendix C).

STORM #	STORM DATE START	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	ET (CU FT)	RESIDS SEEPAGE (CU FT)	RUNOFF COEF.
1	02/14/00	0.46	23,880	80,986	(48,520)	0	(68,988)	12,642	0.23
2	03/27/00	0.79	34,059	103,471	0	96,746	(6,832)	(33,953)	0.17
3	04/13/00	0.73	37,897	24,400	0	62,297	(7,257)	7,257	0.04
4	06/25/00	1.46	29,770	41,188	0	70,957	(3,400)	3,400	0.04
5	06/26/00	1.38	28,138	101,543	0	106,436	(17,069)	(6,176)	0.10
6	07/01/00	1.04	53,991	149,097	0	158,110	(7,801)	(37,178)	0.19
7	07/06/00	0.57	29,591	43,504	0	12,459	(17,312)	(43,324)	0.10
8	07/08/00	0.25	12,979	8,622	(1,197)	(623)	(3,200)	(17,827)	0.05
9	07/09/00	2.55	132,381	427,547	(354,890)	193,120	(15,000)	3,083	0.22
10	07/15/00	4.26	221,154	1,515,606	(1,525,656)	174,431	(5,903)	(30,769)	0.47
	07/23/00	1.46	75,795	116,597	(102,613)	28,034	(16,321)	(45,424)	0.10
11	07/31/00	0.76	39,455	43,177	(60,886)	(8,722)	(24,122)	(6,345)	0.07
12	08/12/00	1.33	69,046	86,811	(82,718)	0	(16,741)	(56,397)	0.09
13	08/22/00	0.51	26,476	33,216	(30,961)	(623)	(8,521)	(20,833)	0.09
14	08/26/00	0.63	32,706	69,640	(44,945)	13,705	(19,056)	(24,640)	0.15
15	09/06/00	1.53	79,429	220,517	(171,905)	113,380	(17,870)	3,210	0.19
16	09/07/00	0.85	44,127	172,341	(76,400)	107,151	(3,400)	(29,517)	0.27
17	09/16/00	3.58	183,257	1,805,398	(1,627,400)	24,919	(19,147)	(317,189)	0.66
18	09/27/00	1.35	70,084	349,009	(231,261)	149,516	(6,000)	(32,316)	0.34
19	10/06/00	1.19	61,778	114,785	(65,850)	52,329	(14,432)	(43,952)	0.13
20	11/25/00	1.31	68,007	291,400	(264,685)	109,020	(11,685)	(5,358)	0.29
22	12/17/00	0.37	19,208	87,158	(68,302)	21,804	(1,341)	(14,919)	0.31
TOTALS 2000 *		**28.36**	**1,373,206**	**5,886,011**	**(4,758,189)**	**1,484,447**	**(311,398)**	**(736,524)**	**0.19**
1	03/04/01	1.62	84,101	205,544	(94,800)	189,383	(5,386)	(77)	0.17
2	03/29/01	4.25	220,635	756,779	(345,100)	591,198	(3,693)	(37,423)	0.23
3	06/23/01	2.91	151,070	682,936	(115,100)	680,282	(30,350)	(8,274)	0.31
4	06/30/01	1.16	60,220	245,606	(226,400)	44,231	(24,215)	(10,980)	0.28
5	07/04/01	0.23	11,940	20,826	(19,800)	(5,607)	(6,107)	(12,466)	0.12
6	07/16/01	0.74	38,416	15,862	(16,900)	34,263	(12,100)	8,985	0.03
7	07/21/01	0.82	42,570	100,137	(44,900)	95,314	(8,219)	5,727	0.16
8	07/23/01	1.85	96,041	1,114,331	(1,173,000)	50,460	(21,317)	34,405	0.79
9	07/26/01	0.69	35,821	189,847	(226,600)	(34,886)	(27,200)	(6,754)	0.36
10	08/05/01	0.47	24,400	140,974	(57,600)	100,298	(10,300)	(17,776)	0.39
11	09/11/01	1.08	56,067	58,435	(1,122)	109,020	(6,430)	2,069	0.07
12	09/13/01	9.91	514,469	3,425,799	(3,891,466)	30,525	(27,611)	9,335	0.45
13	09/28/01	1.00	51,914	58,994	(56,300)	59,182	(7,900)	12,474	0.08
14	10/21/01	1.89	98,118	103,962	(66,700)	127,086	(20,933)	12,639	0.07
TOTALS 2001 *		**28.62**	**1,485,781**	**7,120,032**	**(6,335,788)**	**2,070,749**	**(211,761)**	**(8,115)**	**0.25**

* Runoff coefficient is the average of all measured storms for the year

Table 6b. Summary Table for Water Budget

	TOTAL RAIN AM'T	TOTAL RAIN AM'T	TOTAL INFLOW	RESIDS SEEPAGE IN	TOTAL OUTFLOW	TOTAL ET	RESIDS SEEPAGE OUT	TOTAL STORAGE MEASURED	AVG. RUNOFF COEF.
	IN	INFLOW (CU FT)			OUTFLOW (CU FT)			(CU FT)	
1998	37.43	1,799,695	5,119,862	58,509	(3,929,040)	(458,781)	(1,194,836)	1,169,828	0.14
1999	28.38	1,299,275	3,212,136	49,666	(2,428,320)	(346,740)	(564,407)	1,221,608	0.10
2000	28.36	1,373,206	5,886,011	51,395	(4,758,189)	(311,398)	(736,524)	1,484,447	0.19
2001	28.62	1,485,781	7,120,032	85,638	(6,335,788)	(211,761)	(93,750)	2,070,749	0.25
	CM	INFLOW (CU METERS)			OUTFLOW (CU METERS)			(CU M)	
1998	95.07	50,931	144,892	1,656	(111,192)	(12,983)	(33,814)	33,106	0.14
1999	72.09	36,769	90,903	1,406	(68,721)	(9,813)	(15,973)	34,572	0.10
2000	72.03	38,862	166,574	1,454	(134,657)	(8,813)	(20,844)	42,010	0.19
2001	72.69	42,073	201,621	2,425	(179,413)	(5,997)	(1,359)	58,638	0.25
		PERCENTAGE INFLOW			PERCENTAGE OUTFLOW				
1998		25.79%	73.37%	0.84%	70.38%	8.22%	20.95%		
1999		28.49%	70.42%	1.09%	72.72%	10.38%	16.90%		
2000		18.78%	80.51%	0.70%	81.95%	5.36%	12.69%		
2001		17.09%	81.92%	0.98%	96.06%	3.21%	7.27%		

increased outflow in 2000 and 2001 was definitely caused by the increased amount of irrigation water that resulted in the pond discharging continuously during the winter vegetable growing season. Except for 2001, the pond experienced long periods with no discharge until it filled up after six to twelve storms at the beginning of the rainy season, as can be noted by the string of zero discharges recorded in Table 6a.

Storage is the difference in the volume of water in the pond after the storm is over compared to the volume before the storm began. It suggests the amount of storm flow that is lost between rain events and accounts for the loss of water by evapotranspiration and seepage between storm events. The ability of a wet-detention pond to store stormwater runoff is one of the major mechanisms for reducing peak flows and pollutant loads. For this reason, the Southwest Florida Water Management District's surface water rules require ponds to retain and slowly release stormwater over a five day period. The quiescent period between storms provides time for natural processes and transformations to take place. This is why ponds with a longer residence time, ideally about 14 days, have been shown to have the best treatment for stormwater runoff (Rushton *et al.* 1997).

Evapotranspiration (ET) in Table 6a accounts for only a small amount of the total water lost from the pond by ET, since the time period calculated for storms was usually short (1 to 7 days). During measured storm events only 3 to 9 percent of the water lost by the pond was through evapotranspiration.

Resids are the residuals or errors that unfortunately are a part of almost any water budget calculation. Since no field instruments measuring flow, rainfall or evapotranspiration are 100 percent accurate, an error term is introduced into the water budget equation. It is almost always included with one of the other terms and that term is usually also difficult to measure, in this case, it is the seepage term.

Net Seepage into the pond (positive numbers) and out of the pond (negative numbers) also includes the error term as discussed above. The seepage into the pond during June and July, when the pond level was low, is only a small amount and can probably be attributed to calculation error. The large amount of seepage out of the pond during the first nine months of 1998 was caused by a leak in the outflow weir. The continued seepage out of the pond after the weir was repaired (October 1998) is the result of an obvious seepage area that only occurs when the ponds are connected and the water level is above the control elevation (0.76 NGVD meters or 2.50 feet). It was estimated that during storm events between 7 and 21% percent of the outflow from the pond was by net seepage. It should be noted, net seepage is subsurface flow into the pond minus subsurface flow out of the pond and total ground water inflows and outflows are probably much greater than this. Ground water/surface water interactions are difficult to quantify.

Runoff coefficients were calculated for each storm event to analyze processes in the pond and to check to see if the water budget estimates were reasonable (Table 6a). Missing values usually represent storms that occurred too close together to separate and in that case two storms were combined. The runoff coefficient accounts for the integrated effect of rainfall interception, infiltration, depression storage, and temporary storage in transit from the fields. If all of the rain falling on a drainage basin ran off the coefficient would be 1.0 or 100 percent. During the period when ample moisture was available as seen when storms occur close together and the pond is discharging, a runoff coefficient showed that 20 to 30 percent of the rainfall ran off the fields, through the ditch and into the pond. During dry periods only 1 to 10 percent of rainfall ran off. More intensive agriculture and irrigation took place in 2000 and 2001 and the unmeasured flow and saturated soils account for the higher runoff coefficients reported for those years. The highest coefficients calculated usually occurred during the summer for storms greater than two inches and only occurred during 2000 and 2001 when more irrigation water had kept the pond at a higher level. These two years also had a higher percentage of water discharging from the pond.

Storm Event Water Quality

Pollutant Concentrations

Concentrations of constituents measured for about 85 storm events during the four years of data analyzed in this report show considerable differences between years (Tables 7a-b). Since more water flows into the pond than out of the pond as discussed above, fewer storm events were sampled at the outflow station. An exception is 2001 when the level in the pond was continually elevated because of more irrigation on the fields keeping the pond level high and making the pond discharge for all storms sampled. The most striking difference between years is the lower concentrations of almost all constituents measured at the inflow during 1999 compared to the other three years. The fact that the El Niño storms, the year before, washed out the system may have contributed to this effect. Further investigation of the pollutant concentrations at the inflow and outflow are helpful in determining processes taking place in the pond (Table 7a-b) and also how well the pond is meeting water quality goals. Nutrients have been identified as the second leading cause of impairments reported by the States in their 1998 lists of impaired waters (US EPA 2000). In addition, over-enrichment by metals create toxic conditions for the biota .

Nitrogen contributes to the eutrophication (over-enrichment) of rivers, lakes and estuaries and is considered a limiting factor for Tampa Bay because of the naturally high levels of phosphorus present in the region. The most biologically important inorganic forms of nitrogen are nitrate, nitrite and ammonia. In addition to eutrophication, excessive inorganic nitrogen causes other water quality problems. Dissolved ammonia at concentrations above 0.2 mg/L may be toxic to fish, especially trout (US EPA 2002). Median concentrations for ammonia at our site (Table 7b) are all below this 0.20 threshold.

During 1998 and 1999 in this study, inorganic nitrogen (ammonia and nitrate) was at its highest concentrations in rainfall, but even with this atmospheric input, inorganic nitrogen is measured at relatively low concentrations at the outflow (Table 7a-b). Nitrate-nitrogen is highly mobile and can readily migrate through sandy soils into the groundwater. Ammonia, on the other hand, can be adsorbed to soil particles. Both forms can be deposited in the sediments where they are sequestered or released back to the atmosphere. Organic nitrogen is usually the dominant form of nitrogen measured in natural systems and, although not readily available as an energy source for plants and animals, it can be converted to available forms at a rate of 2 to 3 percent per year (US EPA 2002). In the Cockroach Bay wet-detention pond, organic nitrogen sometimes increased as water traveled through the pond (years 1999 and 2000), probably as a result of nitrogen transformations taking place.

The United States Environmental Protection Agency has recently developed standards for nitrate, total nitrogen and total phosphorus for rivers and streams (US EPA 2000). These are based on median concentration for pristine conditions in our region. The standard, 0.02 mg/L for nitrate+nitrite was almost always met at the outflow of the pond except for the El Niño year (Table 7b). But standards for total nitrogen (0.90 mg/L) and total phosphorus (0.04 mg/L) were seldom met when water was discharged from the pond after storm events. This pattern reflected the nutrient balance at the site where high concentrations of phosphorus make the system nitrogen limiting for inorganic N as exhibited in the many values of nitrate measured below the laboratory detection limit. This made total nitrogen difficult to reduce in the pond as inorganic nitrogen was converted to organic nitrogen by biological processes.

Phosphorus can also contribute to the eutrophication of both freshwater and estuarine systems. Algae utilize dissolved inorganic phosphorus and convert it to the organic form. In this study inorganic phosphorus was measured as ortho-phosphorus and total phosphorus included both ortho- and organic forms. Fertilizers applied to increase crop production have caused many agriculture soils to contain higher phosphorus concentrations than plants need, causing elevated levels in storm runoff.

Table 7a. Average concentrations in storm water are calculated for each year. Numbers with asterisk exceed Marine Water Quality Standards (std). The entire data set is in Appendix D.

Constituent	unit	std	Rainfall				Inflow				Outflow			
			1998	**1999**	**2000**	**2001**	**1998**	**1999**	**2000**	**2001**	**1998**	**1999**	**2000**	**2001**
# Samples			25	25	20	12	25	25	22	13	9	17	18	14
Ammonia	mg/L	na	0.366	0.159	0.095	0.116	0.100	0.053	0.177	0.231	0.066	0.038	0.086	0.076
Nitrate+Nitrite	mg/L	na	0.406	0.189	0.211	0.183	0.427	0.131	0.478	0.741	0.144	0.006	0.042	0.076
Organic- N	mg/L	na	0.657	0.152	0.248	0.230	1.110	0.902	1.640	1.991	0.828	1.132	2.066	1.468
Ortho-Phos.	mg/L	na	0.060	0.014	0.008	0.007	0.945	0.796	0.805	1.407	0.623	0.223	0.361	0.888
Tot. Phos.	mg/L	na	0.094	0.023	0.018	0.012	1.842	0.957	1.420	2.068	0.807	0.367	0.626	1.044
Aluminum	mg/L	1.5	0.168	0.141	0.081	0.073	***3.47**	0.322	***2.059**	**2.25**	1.30	1.36	1.48	0.55
Chromium	ug/L	50	BD	BD	BD	BD	***55.07**	2.42	17.65	11.69	4.70	6.49	4.62	1.40
Cadmium	ug/L	9.3	0.35	0.19	0.14	0.15	1.340	0.180	0.44	0.34	0.157	0.150	0.13	0.15
Copper	ug/L	2.9	***4.0**	1.51	1.9	1.5	***117.0**	***8.24**	***64.3**	**"42.2**	***17.0**	***3.6**	***6.2**	**"4.3**
Iron	mg/L	0.3	0.034	0.037	0.060	0.062	***2.225**	0.246	***0.891**	**1.335**	***0.472**	***0.57**	***0.66**	0.178
Lead	ug/L	5.6	BD	BD	BD	BD	***16.6**	1.07	5.24	3.54	1.60	1.67	1.96	BD
Manganese	mg/L	0.1	BD	BD	BD	BD	***0.255**	**0.175**	***0.237**	**0.34**	0.054	0.088	0.083	0.105
Zinc	ug/L	86	69.4	46.0	28.0	37.5	***98.6**	BD	36.0	39.4	BD	BD	BD	BD
TSS	mg/L	na	na	na	na	na	155	11	43	67	20	35	49	7.1

Abbreviations: BD=Average values below the laboratory detection limit, NA=Not measured. Organic-N=organic nitrogen, Otho-Phos.=Ortho-phosphoru Tot. Phos.=Total Phosphorus, Susp. Solids=Total Suspended Solids. Std=marine water quality standards for Class II and Class III waters (Chp 62-302 F.S.). Both classes have almost the same standards, and the only difference in the constituents presented here are for manganese, which has no Class III standard. (See method section for more detail).

Table 7b. Median concentrations in storm water are calculated for each year. Numbers in bold exceed Marine Water Quality Standards (std). The entire data set is in Appendix D.

Constituent	unit	std	Rainfall				Inflow				Outflow			
			1998	**1999**	**2000**	**2001**	**1998**	**1999**	**2000**	**2001**	**1998**	**1999**	**2000**	**2001**
# Samples			25	25	20	12	25	25	22	13	9	17	18	14
Ammonia	mg/L	na	0.209	0.126	0.057	0.095	0.105	0.035	0.119	0.151	0.057	0.033	0.067	0.037
Nitrate+Nitrite	mg/L	0.020	0.238	0.113	0.072	0.163	**0.150**	0.013	**0.295**	0.017	**0.139**	0.005	**0.028**	0.005
Tot. Nitrogen	mg/L	0.900	0.810	0.401	0.429	0.470	**1.200**	**0.960**	**2.500**	**2.400**	**0.870**	**1.150**	**1.790**	**1.350**
Ortho-Phos.	mg/L	na	0.022	0.005	0.005	0.005	0.717	0.860	0.749	1.500	0.687	0.237	0.335	0.861
Tot. Phos.	mg/L	0.040	0.028	0.015	0.014	0.010	**1.200**	**1.008**	**1.310**	**1.805**	**0.760**	**0.368**	**0.628**	**0.971**
Aluminum	mg/L	na	0.231	0.105	0.069	0.051	3.474	0.182	1.100	1.040	1.094	0.948	0.764	0.305
Chromium	ug/L	na	BD	BD	BD	BD	BD	BD	10.50	5.50	3.98	4.80	4.19	1.00
Cadmium	ug/L	na	0.30	0.19	BD	BD	BD	BD	0.35	BD	BD	BD	BD	BD
Copper	ug/L	na	**3.0**	BD	BD	BD	15.0	4.2	39.0	23.9	7.0	3.10	5.0	2.1
Iron	mg/L	na	BD	BD	0.050	BD	2.10	0.180	0.735	0.480	0.520	0.355	0.445	0.105
Lead	ug/L	na	BD	BD	BD	BD	BD	BD	2.70	1.70	BD	BD	1.76	BD
Manganese	mg/L	na	BD	BD	BD	BD	0.065	0.158	0.211	0.272	0.108	0.074	0.069	0.085
Zinc	ug/L	na	90.0	40.0	BD	32.6	BD	BD	30.0	24.2	BD	BD	BD	BD
TSS	mg/L	na	na	na	na	na	12.0	8.0	28.0	27.8	47.0	22.0	36.0	4.30

Abbreviations: BD=Median values below the laboratory detection limit, NA=Not measured. Organic-N=organic nitrogen, Otho-Phos.=Ortho-phosphorus, Tot. Phos.=Total Phosphorus, Susp. Solids=Total Suspended Solids. Std=marine water quality standards for Class II and Class III waters (Chp 62-302 F.S.). Both classes have almost the same standards, and the only difference in the constituents presented here are for manganese, which has no Class III standard. Nitrogen and phosphorus standards were based on EPA criteria for streams (See method section).

Phosphorus was measured at relatively high levels in the Cockroach Bay wet-detention pond with average concentrations of total phosphorus at the inflow often over 1 mg/L (Table 7a). It may not be surprising that phosphorus concentrations are much higher at the inflow than measured in urban development where untreated runoff usually ranges between 0.1 and 0.6 mg/L (Harper 1994, Rushton *et al.* 1997 and others), but phosphorus concentrations are even higher than other agricultural studies. Other studies measured average total phosphorus concentrations of 0.48 mg/L discharging from pastures, 0.14 mg/L from citrus and 0.40 mg/L from row crops (Harper 1994). Although phosphorus concentrations were reduced by over 50 percent in the Cockroach Bay wet-detention pond, concentrations were still much higher at the outflow than measured in other stormwater studies.

Some standards suggest an upper limit of 0.1 mg/L for phosphorus (US EPA 1986) and even 0.01 mg/L for sensitive systems such as the Everglades. It should be remembered that phosphorus concentrations in this part of Florida are higher than most regions because of our native phosphate deposits, but even with the natural enrichment, the concentrations of ortho-phosphate at the outflow were still high compared to average concentrations measured discharging from other wet-detention ponds in the region. The average concentrations measured between 0.22 and 0.89 mg/L in this study were much greater than the average concentrations between 0.03 and 0.17 mg/L in other studies (Carr and Rushton 1995, Rushton *et al.* 1997, Carr and Kehoe 1997, Bahk and Kehoe 1997). In addition, when the yearly median concentrations of phosphorus at the outflow were compared to the EPA goal of 0.04 mg/L for rivers and streams in Florida (US EPA 2000) the concentrations were 9 to 24 times greater than measured in pristine environments (Table 7b). Also, phosphorus at both the inflow and outflow appear to be increasing with time.

Metal average concentrations exhibited a pattern between years (Table 7a). In 1998, the year of the El Niño storms, metals had the highest concentrations of all years measured and also had the greatest percent reduction in concentrations from the inflow to the outflow, often over 80 percent. Since higher concentrations are more easily reduced, this is not a surprising result. In 1999, inflow metal concentrations were measured at their lowest levels during any of the four years. Since low concentrations are more difficult to reduce to even lower concentrations, 1999 showed low percent reduction or concentrations actually increased between the inflow and outflow. Other problems encountered in analyzing low concentrations, and especially prevalent for cadmium and lead, were the values near the laboratory detection limit, or even below the detection limit, making percent reduction calculations inaccurate. Another process that might explain the result of poor reduction of concentrations in 1999 is the delayed removal of metals deposited during the previous year caused by re-suspension of bottom sediments or changes in water chemistry. In 2000 and 2001, yearly average concentrations were measured at intermediate values; and metal concentrations were usually decreased by at least 50 percent in the pond. (See Appendix D for the average reduction in constituent concentrations between the inflow and outflow).

Of some concern are the copper and iron samples that were consistently measured above concentrations considered toxic to marine organisms. One explanation for the higher copper concentrations may be the plastic mulch used to conserve moisture and provide weed control in the fields, since farmers use a copper-based biocide on plants to prevent disease. Research conducted by

Dietrich and Gallagher (2000) showed that a sedimentation basin does reduce copper concentrations (by up to 90 percent), but it does not reduce the copper concentrations sufficiently to eliminate mortality to fish and shrimp. In fact, they found most of the copper exported is in a form that is bioavailable to aquatic organisms.

Total suspended solids (TSS) in runoff waters reduce the amount of sunlight available to aquatic plants, cover fish spawning areas, clog fish gills and cause other changes, such as anaerobic conditions, in the aquatic environment. Other pollutants such as metals, phosphorus and ammonia are transported with sediments in an adsorbed state and changes in the aquatic environment can cause these chemicals to be released. Two types of suspended solids are measured in stormwater ponds: at the inflow TSS is usually measured as mineral soil particles dislodged and transported by erosion, while at the outflow TSS is more often measured as phytoplankton and organic material. The poor removal of suspended solids for most years in this study may be the result of these processes (Table 7b). The organic nitrogen concentrations measured in our stormwater samples support this hypothesis, but the ambient chlorophyll concentrations do not, as will be seen later.

Major ions and water hardness were measured and are not shown in Table 7, but are reported in Appendix D. Results were similar for all four years and showed no apparent salt buildup, which is often caused by irrigation practices in other sections of the country. Major ion concentrations were measured at higher concentrations at the outflow of the wet-detention pond caused by occasional backflow from the brackish marsh during storms and periods of higher than normal tides.

Inflow Comparisons - To emphasize the impact caused by the El Niño storms, constituent concentrations at the inflow for over four years were graphed and compared for metals and nutrients (Figures 5 and 6). Metal concentrations were orders of magnitude greater during the El Niño storms than concentrations measured for other rain events. The same pattern of increased concentrations was also seen for phosphorus. Nitrogen was not necessarily increased in comparison with other years.

Infrequent large storms may be a significant impact for stormwater ponds and the receiving waters since most of the pollutants are flushed into and out of the system by these extreme events. This is compounded by the fact that these storms also produced the most flow as will be discussed in the next section. These large storms may explain why concentrations remained low for 1999, but then steadily increased in late 2000 and early 2001, a trend that was especially noticeable for organic nitrogen, phosphorus, zinc, copper and lead. With the exception of the El Niño storms, the highest concentrations of these five constituents were measured between July 2000 and July 2001, the time when the fields were in production for the entire year. Nitrogen and phosphorus spikes may have been caused by fertilizer applications, and, since these represent extreme values of 1 to 4 mg/L, more emphasis for treating stormwater should be placed on good farming practices.

Pollutant Loads

An analysis of pollutant concentrations is valuable for understanding processes taking place in the pond, but pollutant loads, which include both concentrations and water volumes, are a better measure for predicting impacts to the receiving waters. All of the data calculations for loads are reported in Appendix E and summary data are discussed below.

Differences between years were affected by: 1) the unseasonable amount of rainfall and pollutant concentrations induced by the El Niño rains in 1998, 2) the lower flows and pollutant concentrations measured in 1999, and 3) the increased flow and concentrations caused, in part, by more intensive agricultural activity in 2000 and 2001 (Figure 7). A comparison of the hydrology is shown in the first figure to demonstrate how much greater the impact of pollutant loads are than can be attributed to increased flow alone. The greater amount of rainfall in 1998 increased loads at both the inflow and outflow. Another point of interest is the large percentage of nitrogen that enters the pond directly in rainfall. For ammonia, it is often a greater load than is discharged at the outflow. This may be one reason it is difficult to remove total nitrogen from stormwater ponds.

The increase in agricultural activity including irrigation contributed to the increased nitrogen and phosphorus loads in 2000 and 2001. The unseasonable rainfall caused by El Niño during the growing season contributed to the total suspended solids load during 1998. The results show the pond is especially effective in reducing high loads before discharge to Cockroach Bay, but as discussed in the previous section, the pond still did not decrease median total nitrogen and phosphorous concentrations at the outflow to anywhere close to pristine concentrations.

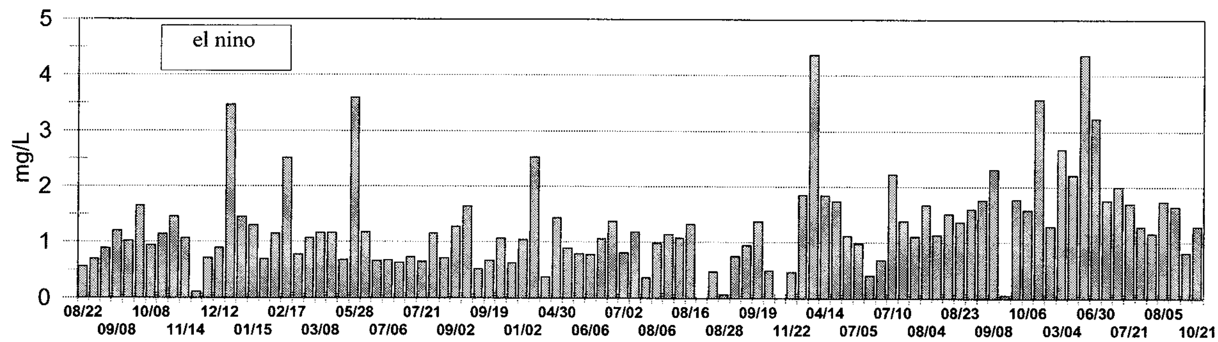
The impact of extreme events was further explored by comparing five storms in 1998 with the rest of the data set (Table 8). For metals of concern, greater than 90 percent of the loads from all storm events for the next two years entered the pond during five El Niño storms. Even after four years about 40 percent of loads entering the wet-detention pond were accounted for by those same five storms.

Table 8. Percent of loads contributed by five El Niño storms compared to the total loads for all storms entering and leaving the pond compared to time since El Niño.

Constituents	Two Years 1998-1999		Three years 1998-2000		Four Years 1998-2001	
	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
Cadmium	93%	44%	74 %	27 %	44%	16%
Copper	89%	69%	66 %	54 %	40%	24%
Iron	91%	46%	73 %	26 %	40%	22%
Lead	93%	57%	76 %	36 %	44%	25%
Manganese	71%	24%	50 %	12 %	27%	10%
Zinc	90%	49%	70 %	31 %	41%	19%
Suspended Solids	96%	34%	82 %	16 %	60%	18%

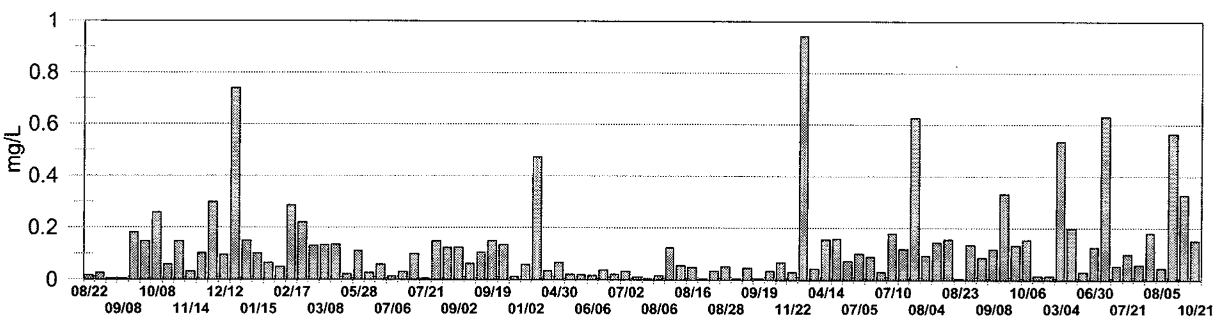
TOTAL ORGANIC NITROGEN (mg/L)

August 1997 to January 2002



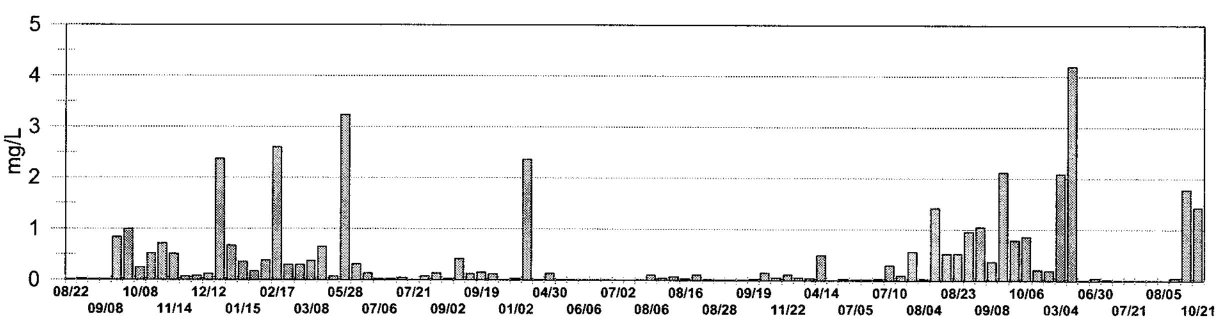
AMMONIA AS N (mg/L)

August 1997 to January 2002



NITRATE + NITRITE AS N (mg/L)

August 1997 to January 2002



TOTAL PHOSPHORUS (mg/L)

August 1997 to January 2002

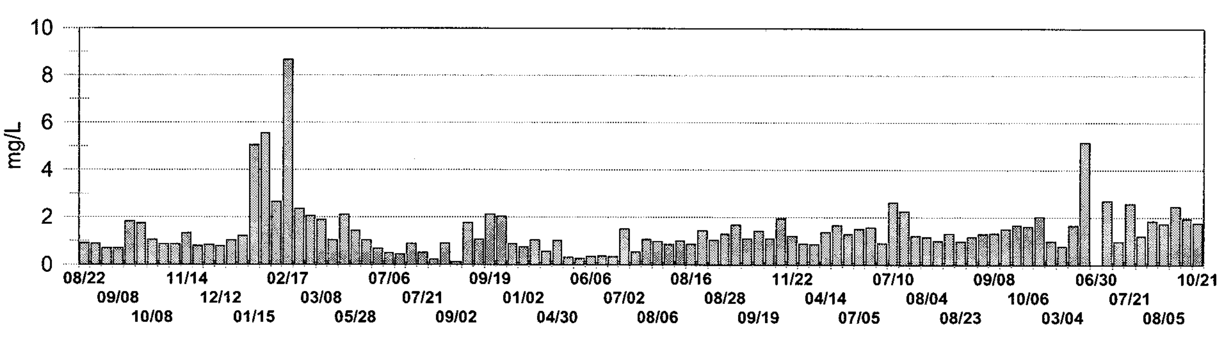


Figure 6. Comparison of nutrient concentrations over time from August 1997 to January 2002.

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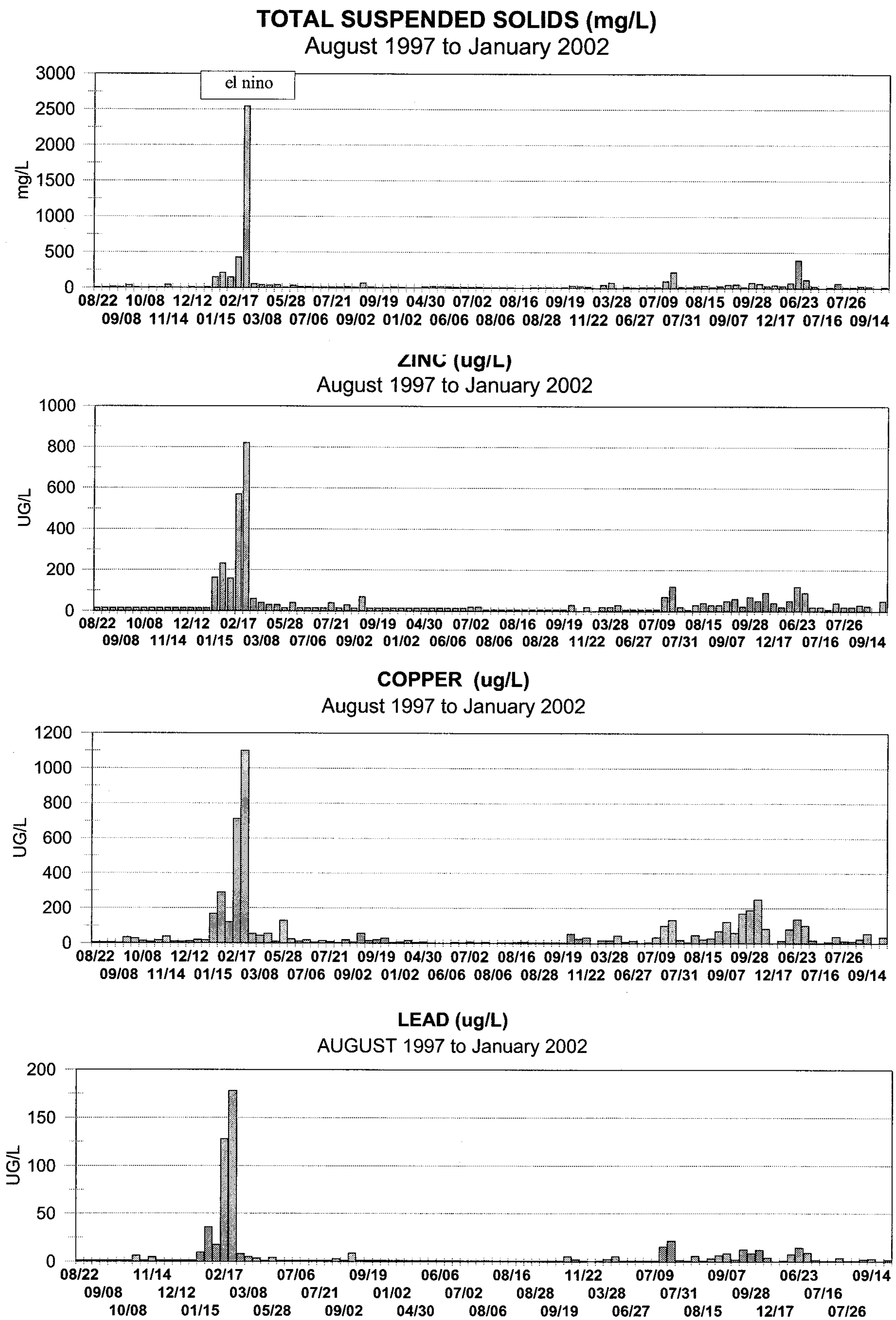

Figure 5. Comparison of metal and suspended solids concentrations from June 1997 to Jan 2002.

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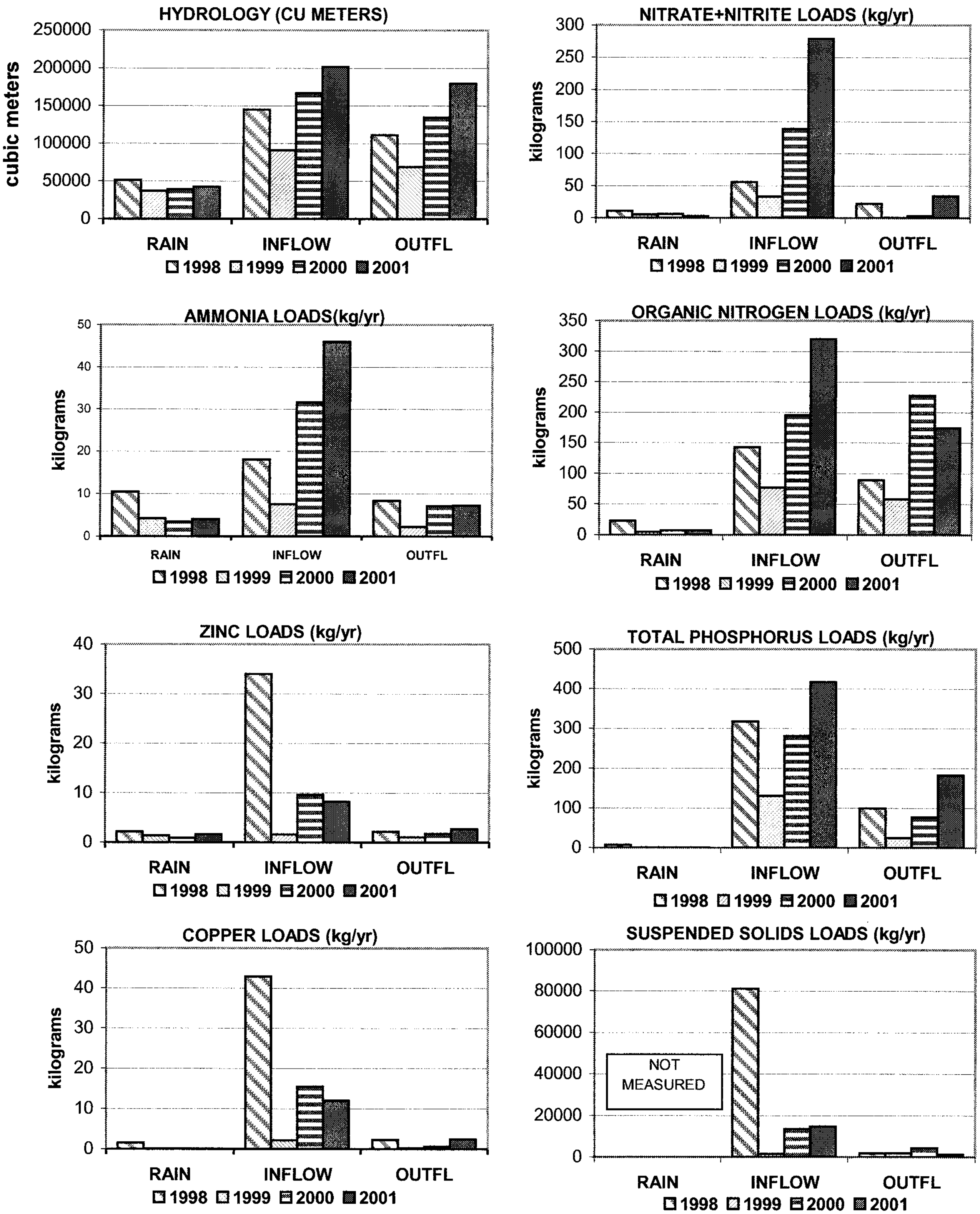

Figure 7. Comparison of pollutant loads for different years. Rain is the rainfall on the pond.

These large events can flush out the system and contribute the majority of pollutant loads measured for several years. The impact is evident in the receiving waters. For example, the Tampa Bay Estuary Program (TBEP 2000) reported the total nitrogen (TN) loadings for Tampa Bay were highest in 1995, 1997 and 1998 and during those three years the target TN loads were higher than the goal established for the Bay. Explanations for the increase in TN loadings suggest that much of the increase could be explained by the higher than average rainfall and the resultant hydrologic loadings experienced during those years. The report further explained that increases in non-point source loading were the primary contributors to the increased annual loadings. These same years of higher TN loadings also saw a decline in sea grass beds in the main stem segments of Tampa Bay. Sea grasses are affected by the lower light penetration in the water column caused by the increased suspended solids flushed into the bay by the storms.

The efficiency of the system is characterized by the reduction of pollutant loads from the inflow to the outflow (Figure 8). A negative efficiency indicates a load increase. One of the goals of the State of Florida Water Policy (Chp. 17-40 FAC) is an 80 percent removal of pollutant loads by stormwater systems, especially of total suspended solids. This goal of 80 percent reduction is met for

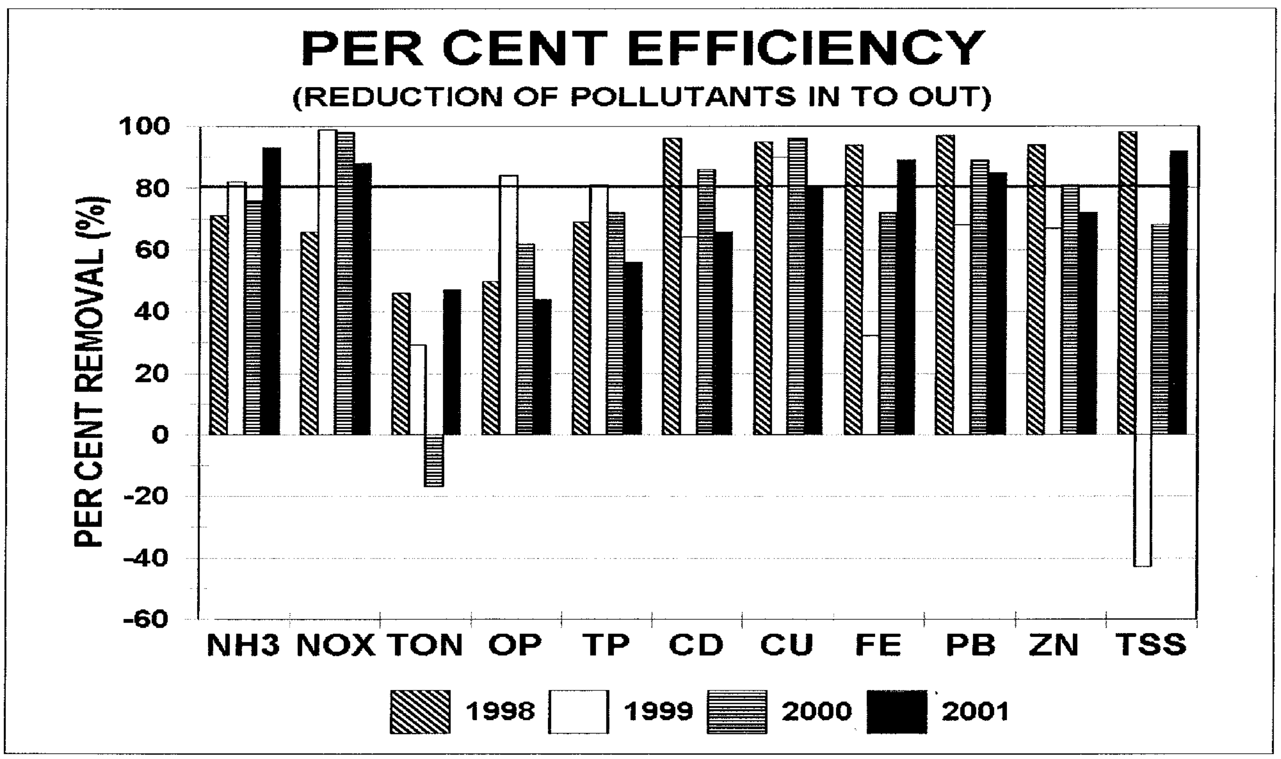

Figure 8. Reduction of pollutant loads from the inflow to outflow of the wet-detention pond. A negative percent removal indicates an actual increase in loads from the inflow to the outflow. (Key: ammonia, nitrate+nitrite, total organic nitrogen, ortho-phosphorus, total phosphorus, cadmium, copper, iron, lead, zinc and total suspended solids).

many metals in 1998, 2000 and 2001 and nearly so for inorganic nitrogen. However, organic nitrogen shows poor efficiency and phosphorus only meets the 80% goal for 1999, the year of reduced agricultural activity. Copper meets the goal for all years, but also fails to meet the water quality standard for all years (see Table 7a). None of the years show consistent results and the wide variation in pollution removal demonstrates the differences that can occur in wet-detention ponds between years as hydrologic, agricultural practices and other conditions change.

Efficiency is affected by rainfall characteristics and runoff amounts as well as pollutant concentrations. For example, the exceptionally high loads during 1998 also greatly increased the efficiency of the pond for metals and suspended solids. It should be noted that ammonia and nitrate nitrogen had good removal during the dry year, which may be explained by the high concentrations that usually enter the pond directly in rainfall. Another factor that may have increased metal efficiency in 1998 was the fact that the pond was recently excavated and the soil particles had available surface area to adsorb metal ions. The better efficiency for nitrates and ammonia in later years may have been the result of more mature vegetation in the planted littoral zone.

Except for total suspended solids and organic nitrogen, the wet-detention pond at Cockroach Bay had better removal rates than other wet-detention ponds reported in the literature (60 to 98 percent efficiency in this study compared to 50 to 65 percent for median efficiencies in other studies) (Winer 2000). However, median concentrations in this study were not necessarily lower.

Ambient Samples in the Pond

Water quality samples were collected between storm events about four times a year to test conditions in the pond and in the pre-treatment ditch under ambient conditions.

Field Parameters

Field conditions (pH, dissolved oxygen, temperature and specific conductivity) affect the chemical and biological cycling and transformations that take place in a pond. Graphs of all the actual field measurement taken at one-hour intervals while deployed in the pond can be found in Appendix F. In the following section, an example of daily fluctuations and storm effects on field parameters is presented first and then averaged values for individual parameters are discussed.

Daily fluctuations show the diurnal cycles that track the progress of light, temperature, respiration and related processes (Figure 9). The cycle for pH and dissolved oxygen is usually quite pronounced at the inflow and less so at the outflow. Greater diurnal fluctuations reflect the increased biological activity associated with productive (eutrophic) systems. The smoother, more dampened fluctuations that usually occur at the outflow indicate the pond has moderated the effects of storm runoff. This pattern may be interrupted during the rainy season when storms occur close together or when the instrument malfunctions as happened in February 2000. Specific conductivity is much lower at the inflow because backflow from the brackish marsh introduced higher salinity water on several occasions. Rainfall changes the measurements for all parameters.

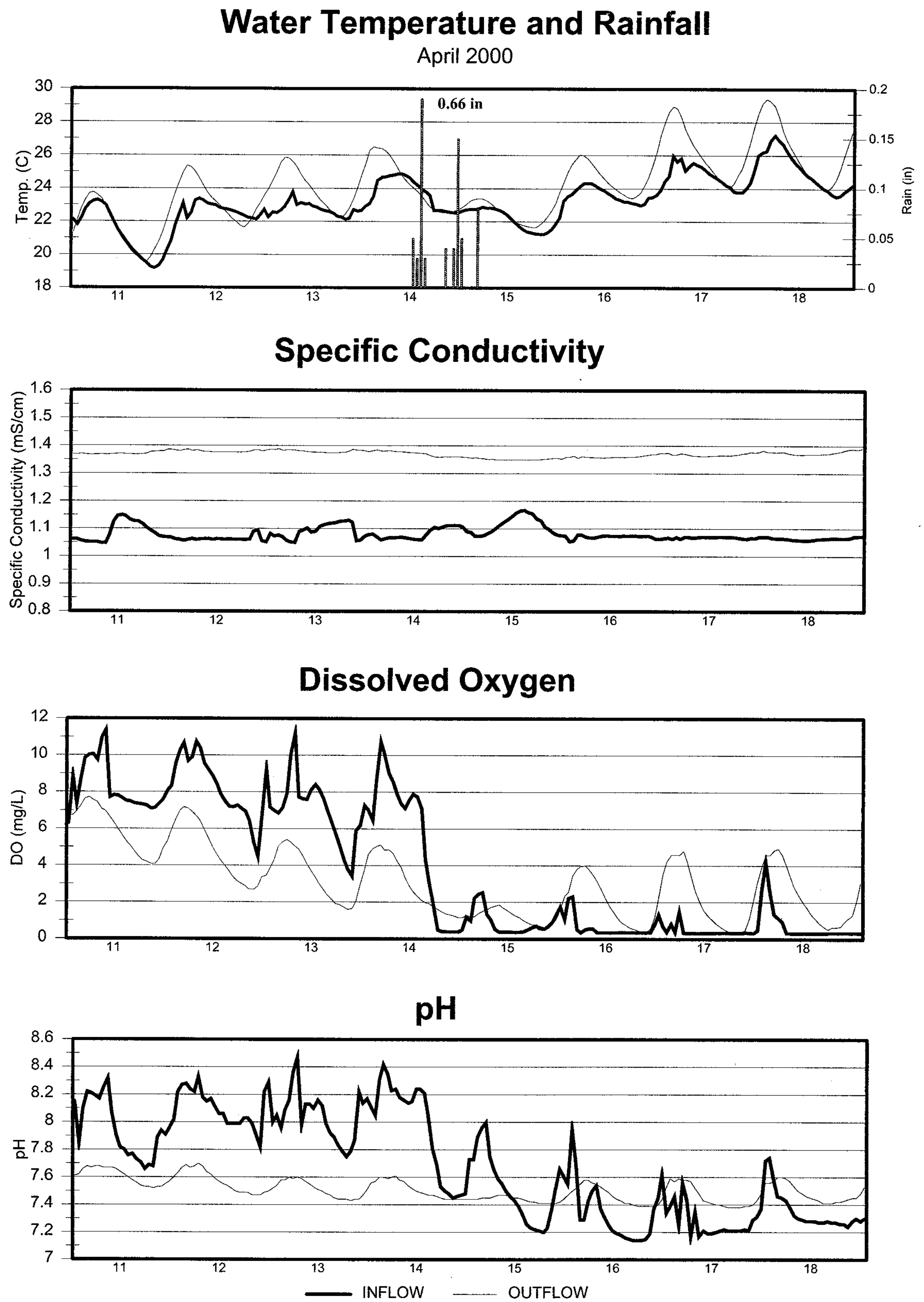

Figure 9. Example of hydrolab readings taken at one hour intervals at the inflow and outflow of the Cockroach Bay wet-detention pond.

Rainfall effects moderate the fluctuations at both the inflow and outflow, but the fluctuations are more pronounced at the inflow. This is caused by a greater amount of actual rainwater runoff being measured at the inflow and the dilution and mixing of this water in the pond before it reaches the outflow. Conductivity usually decreases with freshwater input from rainfall and then slowly increases between storms as evapotranspiration increases ion concentrations. The increase in conductivity noted at the inflow immediately following rainfall is the result of the storm flushing stagnant water from the ditch into the pond. Dissolved oxygen and pH exhibit a sharp decrease with rainfall, especially at the inflow. Quite a few of the graphs in Appendix F at the outflow show a double peak in the diurnal cycle for pH and dissolved oxygen. This appears to be related to the tidal cycle and is another indication of the interaction between the pond and the surrounding landscape.

Average values of the weekly field parameter measurements plotted over time provided an indication of conditions in the wet-detention pond (Figure 10). Temperature followed a seasonal pattern (i.e. higher in the summer and lower in the winter) and was fairly consistent for the inflow and outflow. Dissolved oxygen (DO) showed only weak seasonal patterns because of two processes. Normally DO is increased in winter because oxygen is more soluble in colder water, but at this site, it is also sometimes increased in summer because of algae photosynthesis that can raise DO during the day to very high supersaturated conditions (>14 mg/L), and then fall to low levels at night. In general, average dissolved oxygen is measured higher at the inflow than the outflow and is lowest in August and September. Since low dissolved oxygen levels are detrimental to a healthy well-balanced ecosystem, state standards for all waters set the minimum level for any 24-hour period at 5.0 mg/L with 4.0 mg/L as the absolute minimum. The wet-detention pond fails to meet these standards more than half the time. Other studies have also documented the difficulty of wet-detention ponds in meeting the dissolved oxygen standard especially in vegetated ponds and wetlands (Kehoe 1992, Carr and Kehoe 1997, Rushton *et al.* 1997). The lower average dissolved oxygen levels in late 2000 and 2001 were the result of the units being deployed in the vegetation that had encroached into the pond at both the inflow and outflow. Other processes that affected the readings in June 2001 and early July 2001 were stagnant conditions making the water black and turbid.

The pH showed the pond as an alkaline system with pH values greater than 7.4 until the final year of the study. Since the pond is built on mineral soils and receives much of its input from alkaline irrigation water pumped from deep wells, this condition is not surprising. Irrigation water probably accounts for the slightly higher levels at the inflow compared to the outflow, but higher dissolved oxygen at the inflow could also raise pH. Because of its influences on other chemistry, pH is an important regulatory parameter, therefore, state standards require pH in a neutral range between 6.5 and 8.5 standard units for most waters. The wet-detention pond in this study had values higher than 8.5 at the inflow during the summer (Appendix F), probably the result of high biological production increasing both pH and DO during daylight hours. One of the rationales behind the standard comes from the constraints of many treatment bacteria, which are not able to exist outside the range $4.0 < pH < 9.5$ (Kadlec and Knight 1996).

Specific conductance is a measure of the total concentrations of ionized materials at the sampling site and was measured at high values in this system, which was caused by backflow from the brackish marsh and higher concentrations typical of agricultural runoff and irrigation water from deep wells. The specific conductance of most natural, inland surface waters is between 0.01 and 0.3 mS/cm (Kadlec and Knight 1996), compared to 0.5 to 1.5 mS/cm in the wet-detention pond at this site. The specific conductance is shown on a log scale in Figure 10 to emphasize the higher concentrations caused by occasional backflow from the marsh into the pond. The most obvious is the averaged value of almost 1000 mS/cm when backwater from Hurricane Earl filled the pond.

Pesticides

Grab water quality samples taken of organochlorine and organophosphorous pesticides at the inflow and outflow indicated lower concentrations at the outflow than inflow for most samples (Table 9). Concentrations of ten pesticides and pesticide residues were detected at the inflow while only four pesticides were detected at the outflow. Concentrations were usually lower or not detected at the outflow, but one exception existed for the Endosulfan series on September 29, 1997. These samples were collected right after one of the largest storms measured during the entire four-year period (25.15 cm, 9.90 in). This demonstrated how pollutants are sometimes flushed directly through the system with large storms.

Although the quantity of pesticides detected in this study was usually below the detection limit, it is still a cause for concern. This is especially true for chlordane and endosulfan, which failed to meet Water Quality Standards (see Table 4a). Lower concentrations of fewer pesticides were detected in samples at the outflow, which indicated this newly constructed wet-detention pond was attenuating pesticides from agricultural runoff. The breakdown of pesticides in surface waters may alter the chemical structure of the compound by converting the constituents to carbon dioxide, water, and chloride ions (Larson *et al.* 1997). Breakdown processes include both biotic and abiotic hydrolysis and oxidation-reduction reactions. Photolysis, alteration of the chemical by sunlight, is a chemical reaction that can alter the compound. Unfortunately, transformed compounds of original pesticides linger in the environment and may be harmful such as DDE - p,p' (transformation of DDT) banned in 1972 by the US EPA, and endosulfan sulfate (transformation of endosulfan) which is now on the EPA list to be phased out (December 2000). This detention pond, however, with its aquatic and wetland landscape apparently promoted conditions that favored both chemical and biological breakdown of pesticides.

Bacteria

Bacteria concentrations exhibited widely fluctuating values and there was no consistent pattern from the inflow to the outflow (Table 10). A few exceptionally high counts skew the data as is obvious from the enormous differences between the average and median values. The pond does not appear to be a sink for bacteria with concentrations usually higher at the outflow. One source of bacteria could be migration in the groundwater or atmospheric deposition from the adjacent sewage treatment lagoon (see Figure 3). Another possibility is contamination from wildlife. It should be noted that only about half of the samples taken at the inflow detected coliform bacteria while almost all the samples at the outflow were contaminated. Although samples were not taken so that they can be easily compared to the State of Florida Water Quality Standards (see Table 4a), they do indicate concentrations may not always meet state goals. The standards use monthly averages or medians, but when all of our samples are lumped together they provide an estimate of what more intensive sampling might show. The samples are compared to marine standards since the pond discharges to a productive estuary. Class II standards

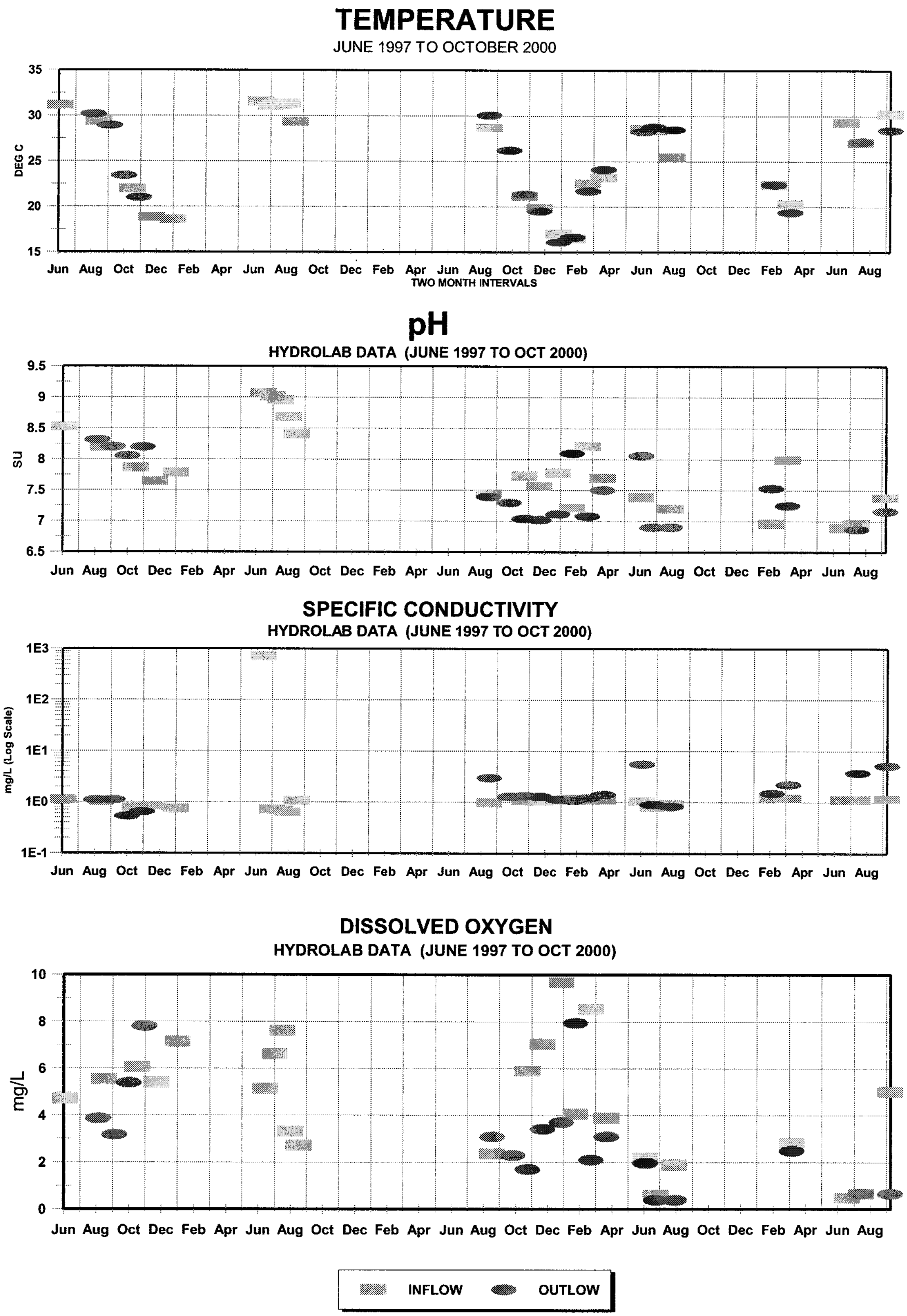

Figure 10. Average values of the field parameter data. Hourly data in Appendix G

Table 9. Pesticide data from inflow and outflow pond. Abbreviations: U=nont detected, i=value between lab detection limit and practical quantification limit, J=estimated value, T=trace, NM=not analyzed for.

Pesticides	Units	09/29/97		01/24/98		02/15/98		03/01/98		03/19/98		09/22/98		03/16/99		09/08/99		11/09/99		01/12/99		03/08/01		04/24/01	
		in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out
PCB																									
PCB - 1016	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PCB - 1221	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PCB - 1232	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PCB - 1242	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PCB - 1248	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PCB - 1254	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PCB - 1260	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorinated Pesticides																									
Aldrin	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Alpha - BHC	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Beta - BHC	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Delta - BHC	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Gamma - BHC	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlordane	ug/L	U	U	**0.78i**	U	**0.32i**	U	**0.15i**	U	**0.13i**	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorothalonil	ug/L	NM	NM	**0.049i**	U	U	U	NM	NM	NM	NM	NM	NM	NM	NM	U	U	U	U	U	U	U	U	U	U
DDD - p,p'	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DDE - p,p'	ug/L	U	U	**0.12**	U	**0.044i**	U	**0.027i**	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DDT - p,p'	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Dieldrin	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan I	ug/L	**0.023 i**	**0.034 i**	**0.068i**	U	**0.011i**	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan II	ug/L	**0.064 i**	**0.044 i**	**0.12**	U	**0.036i**	U	U	U	**0.012i**	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan Sulfa	ug/L	**0.093 i**	**0.12 J**	**0.23**	U	**0.094i**	**0.038i**	U	**0.030i**	**0.089i**	U	**0.028i**	U	U	U	U	U	U	U	U	U	U	**0.035i**	U	U
Endrin	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endrin Aldehyde	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Heptachlor	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Heptachlor Epoxi	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Methoxychlor	ug/L	U	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Permethrin	ug/L	NM	NM	U	U	U	U	NM	NM	NM	NM	NM	NM	NM	NM	U	U	U	U	U	U	U	U	U	U
Toxaphene	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Organonitrogen - phosphorus																									
Alachlor	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Ametryn	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Atrazine	ug/L	U	U	U	U	U	**0.10i**	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Azinphos Methyl	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Bromacil	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Butylate	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Ethyl	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Meth	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Diazinon	ug/L	**0.13 i**	U	U	U	U	U	U	U	U	U	**0.5**	U	U	U	U	U	U	U	U	U	U	U	**0.19**	U
Ethion	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Ethoprop	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fenaminphos	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fonofos	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Malathion	ug/L	U	U	U	U	U	U	U	U	U	U	1.1	U	U	U	U	U	U	U	U	U	U	U	U	U
Metalaxyl	ug/L	**0.21 T**	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metolachlor	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metribuzin	ug/L	U	U	U	U	U	U	U	U	U	U	**0.48i**	U	U	U	U	U	U	U	U	U	U	U	U	U
Mevinphos	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Naled	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Parathion Ethyl	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Parathion Methyl	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Phorate	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Prometryn	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Simazine	ug/L	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

protect shellfish propagation or harvesting and Class III marine waters are set to protect public recreation uses and maintain a healthy, well-balanced population of fish and wildlife.

Fecal Coliform Bacteria - According to the standards for class II marine waters using membrane filtration (MF) in units of cfu's/100 mL, fecal coliform counts shall not exceed a median value of 14 with no more than 10 percent of the samples exceeding 43. The median value for fecal coliform at our site was 25 at the inflow; and 20 at the outflow, which was slightly above the standard of 14. Another stipulation to meet the standard is that no more than 10 percent of the samples should exceed 43. Thirty percent of the samples at the inflow and 32 percent, at the outflow exceed this limit. For Class III marine waters, the number of fecal coliform shall not exceed a monthly average of 200, or exceed 800 on any one-day. Three sampling dates at both the inflow and outflow exceeded the daily standard.

Total Coliform Bacteria -The standards were also exceeded for total coliform bacteria. The Class II total coliform standard states that the median shall not exceed 70 cfu=s/100 mL and not more than 10 percent of samples shall exceed 230. The median value at the inflow was 245 and did not meet standards, but at the outflow the median was 230 right at the standard. The Class III standards are more lenient with monthly averages less than 1000 cfu=s/100 mL considered safe. Eight samples at the inflow and eleven samples at the outflow failed to meet this standard. As mentioned above, one reason coliform bacteria may be elevated at this site is the close proximity of a sewage treatment lagoon (see Figure 3). It should be noted that higher concentrations were measured in 2000 and 2001 than in the early years.

Chlorophyll

Clorophyll is a photosynthetic pigment used extensively to estimate phytoplankton biomass. All green plants contain chlorophyll *a*. Other pigments that occur in phytoplankton include chlorophylls *b* and *c*. The degradation product, pheophytin, is a measure of algal remains (Kadlec and Knight 1996). Chlorophyll *a* concentrations are strongly associated with other water quality parameters, such as, transparency, turbidity, total phosphorus and total suspended solids. This relationship is one of the most often used parameters to develop trophic state indicies for water bodies. Chlorophyll measurements are useful indicators of the phytoplankton population and provide valuable insight into the primary productivity and ecology of lakes, rivers and estuaries. Phytoplanktons are usually single-celled microscopic organisms and live suspended in the water column. They are essential to life and form the basis of the food chain.

Chlorophyll was measured at the inflow and outflow of the pond, and although there are some notable exceptions, the pond reduced all species of Chlorophyll by a significant amount (Table 11). Although the mechanism is complicated, in general, the rate of growth of phytoplankton is related to the nutrient supply in the water, as discussed above, and since inorganic nitrogen and phosphorus concentrations are reduced by the wet-detention pond, it should come as no surprise that chlorophyll is also reduced. Another process that may have helped reduce chlorophyll in the pond was the robust littoral shelf that was established around the fringe of the lake, and especially the littoral zone between the two lobes of the pond and in front of the outfall skimmer. Canfield and Hoyer (1992) tested the theory that macrophytes have a significant negative effect on chlorophyll *a* concentrations and found

Table 10. Bacteria concentrations at the inflow and outflow.

	INFLOW		OUTFLOW	
	Fecal Coliform	Total Coliform	Fecal Coliform	Total Coliform
Units	cfu's/100 mL	cfu's/100 mL	cfu's/100 mL	cfu's/100 mL
11/10/97	10	40	0	300
12/01/97	10	40	80	150
01/06/98	30	600	30	600
02/02/98	40	270	30	90
03/03/98	160	3,000	20	230
03/31/98	0	60	20	800
04/27/98	0	110	0	100
06/01/98	70	310	3,200	21,700
06/29/98	60	140	0	0
08/03/98	0	460	1,100	1,400
09/01/98	0	0	10	300
10/06/98	40	610	0	150
12/01/98	10	120	190	340
01/06/99	40	180	120	290
02/01/99	0	620	40	110
03/02/99	0	160	180	180
04/07/99	0	200	0	200
05/11/99	0	10	20	60
06/02/99	100	220	0	0
07/07/99	0	140	0	1,200
09/09/99	100	300	0	670
10/05/99	14,400	23,200	60	2,000
11/09/99	0	200	20	180
01/02/00	0	400	20	180
01/12/00	0	120	0	80
02/15/00	400	2,300	0	1,000
03/08/00	0	460	0	100
04/10/00	40	120	0	40
05/09/00	0	320	160	160
06/13/00	20	100	60	80
07/24/00	100	11,600	700	3,300
08/23/00	100	220	9,800	143,000
09/06/00	0	60	220	2,200
10/09/00	600	700	0	600
04/24/01	300	2,200	200	1,700
07/18/01	900	1,780	40	210
09/20/01	2,460	3,200	240	1,320
07/16/02	440	2,000	0	1,040
Average	538	1,489	436	4,896
Median	25	245	20	230

Table 11. Chlorophyll measured about once a month at the inflow and outflow of the wet-detention pond.

Date	Chlorophyll A (monochro.)		Pheatophytin (monochro.)		Chlorophyll A (trichro.)		Chlorophyll B (trichro.)		Chlorophyll C (trichro.)	
	inflow	outflow	inflow	outflow	inflow	outflow	inflow	outflow	inflow	outflow
Unit	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
08/03/98	83.0	108.0	21.4	14.5	99.0	121.0	*0.5*	*0.5*	6.1	6.8
09/01/98	151.0	77.4	19.8	7.5	169.0	85.0	*0.5*	*0.5*	4.2	3.1
09/11/98	52.7	6.2	11.6	3.1	60.8	8.3	11.0	*0.5*	3.4	1.5
10/01/98	34.0	17.4	10.9	5.5	41.6	21.3	2.0	*0.5*	3.7	*0.5*
12/01/98	29.3	30.9	9.9	1.7	36.2	33.0	2.8	*0.5*	1.2	1.5
01/06/99	28.7	2.3	10.9	*0.5*	36.1	2.3	3.6	*0.5*	5.9	1.0
02/01/99	84.2	10.0	30.4	5.1	106.0	13.4	*0.5*	*0.5*	7.8	2.3
03/02/99	46.3	21.8	12.2	2.8	55.3	24.4	1.9	*0.5*	3.4	3.4
04/07/99	13.0	6.7	3.1	3.4	15.3	9.0	*0.5*	*0.5*	*0.5*	*0.5*
05/05/99	21.0	5.7	3.1	3.8	23.7	8.1	*0.5*	*0.5*	1.2	*0.5*
06/02/99	78.8	16.4	30.1	3.4	96.5	19.0	45.8	*0.5*	2.2	1.9
07/07/99	37.6	5.8	8.5	3.7	44.1	8.3	1.0	*0.5*	2.1	*0.5*
09/09/99	24.4	3.4	20.1	2.9	37.1	5.1	6.2	1.8	4.4	2.3
10/05/99	11.6	74.4	3.3	21.0	13.8	87.4	3.1	33.6	2.4	4.8
11/09/99	28.1	1.5	23.3	3.3	43.0	3.6	5.2	*0.5*	3.9	*0.5*
12/09/99	32.9	1.9	17.9	1.9	44.5	3.1	5.9	*0.5*	3.0	*0.5*
01/12/00	25.2	1.4	17.3	1.4	36.6	2.2	2.0	*0.5*	4.3	*0.5*
02/15/00	30.3	3.5	17.9	2.0	42.4	4.7	*0.5*	*0.5*	2.5	*0.5*
03/08/00	133.0	6.4	70.4	3.0	181.0	8.4	*0.5*	*0.5*	7.5	1.0
04/10/00	66.7	4.5	4.9	2.4	72.4	9.8	*0.5*	*0.5*	2.8	1.0
05/09/00	30.6	27.9	8.5	10.3	36.8	35.0	1.5	2.8	1.9	1.1
06/13/00	66.2	561.0	13.2	17.6	76.8	593.0	*0.5*	*0.5*	2.5	5.9
08/23/00	62.7	29.7	36.1	*0.5*	84.9	31.3	28.2	*0.5*	6.2	2.1
09/06/00	68.0	24.3	28.3	7.0	86.9	29.7	10.7	*0.5*	5.0	*0.5*
10/09/00	59.3	8.3	53.6	4.7	93.7	11.5	5.1	*0.5*	14.1	*0.5*
04/24/01	1730	16.7	227	11.1	1940	23.8	0.5	3.23	86.8	3.19
07/18/01	25.2	56.6	4.84	33.6	28.8	78.9	3.58	4.26	4.08	5.31
09/20/01	47.5	2.07	74.8	6.7	93.3	5.6	20.5	5.7	6.5	13.2
07/16/02	40.3	4.47	41.3	1.3	66.5	5.46	6.77	0.5	2.92	1.77
# Samples	29	29	29	29	29	29	29	29	29	29
Average	108.3	39.2	28.8	6.4	129.7	44.5	5.9	2.2	7.0	2.6
Median	40.3	8.25	17.9	3.42	55.3	11.5	2.04	0.5	3.74	1.77

the approach valid for many Florida lakes. However, the regression coefficient for all lakes in their study was small (-0.003) and the results indicated that phosphorus and nitrogen concentrations are the primary determinants of chlorophyll *a* concentrations in open-water and that vegetation does not have a significant effect on whole-lake chlorophyll *a* concentrations until high levels of vegetation occur (30% to 50%). The Cockroach Bay wet-detention pond littoral zone vegetation falls within this range and the percent coverage is increasing with time.

Even though chlorophyll *a* concentrations were reduced in the pond, the average concentration at the outflow classifies the pond as hypereutrophic (TN>1,500. TP>100 and Chlorophyll *a* >40 ug/L)(Canfield and Hoyer 1992), however, the median values indicate it is only in the eutrophic category. When the data are compared to the annual average chlorophyll *a* concentrations in Tampa Bay, the concentrations indicate that the pond is as bad or worse than Hillsborough Bay (Boler 1998). There appears to be no seasonal pattern to phytoplankton abundance and no relationship between chlorophyll spikes between the inflow and outflow.

Ambient Conditions in the Watershed

Besides studying conditions in the pond, monitoring was conducted in the pre-treatment roadside ditch that collected stormwater from the fields and also in shallow wells surrounding the pond. In addition, sediment samples were collected from the entire system including the ditch, the marsh and the pond several times during the study including at the beginning and the end.

Pre-Treatment Roadside Ditch

A roadside ditch collects runoff from the fields before water is discharged into the wet-detention pond. This section describes the ambient water quality samples collected at three stations in the ditch about four times a year. Site 1 was usually dry and is not included. Several years of background sampling at site 2 is also discussed.

Pre- and Post Construction Samples - Background water quality grab samples were collected at one station (Site 2) in the pre-treatment ditch both before and after construction to evaluate the effects of excavating and re-sodding the ditch and to characterize water quality discharged from agricultural fields. Occasional spikes in constituent concentrations are the most obvious features seen when inspecting the graphs (Figures 11 and 12). The September 1995 data stand out because they show the highest concentrations measured for almost all constituents. Although no supporting data exist for the conditions that may have caused these results, it did occur during the height of the rainy season and the beginning of the planting season. Also the Tampa Bay Estuary Program reported 1995 as a year with reduced sea grasses in the bay (TBEP 2000).

In general, concentrations were much more erratic before the ditch was re-contoured and since few samples were collected, especially for metals, there is probably no way to make a valid comparison. For most constituents, concentrations were measured at low levels for about a year after the ditch was excavated, but for metals there appears to be a gradual increase in concentrations. Since many metal concentrations correlate to other constituents, as will be discussed later, it is not surprising that the graphs show similar patterns. It appears that excavating the ditch reduced concentrations for about a year. For the remainder of the study, annual maintenance activity in the ditch chopped down the vegetation and left it to rot in the ditch. This maintenance as well as fertilizer applications may have caused the rather dramatic spikes in nutrient concentrations.

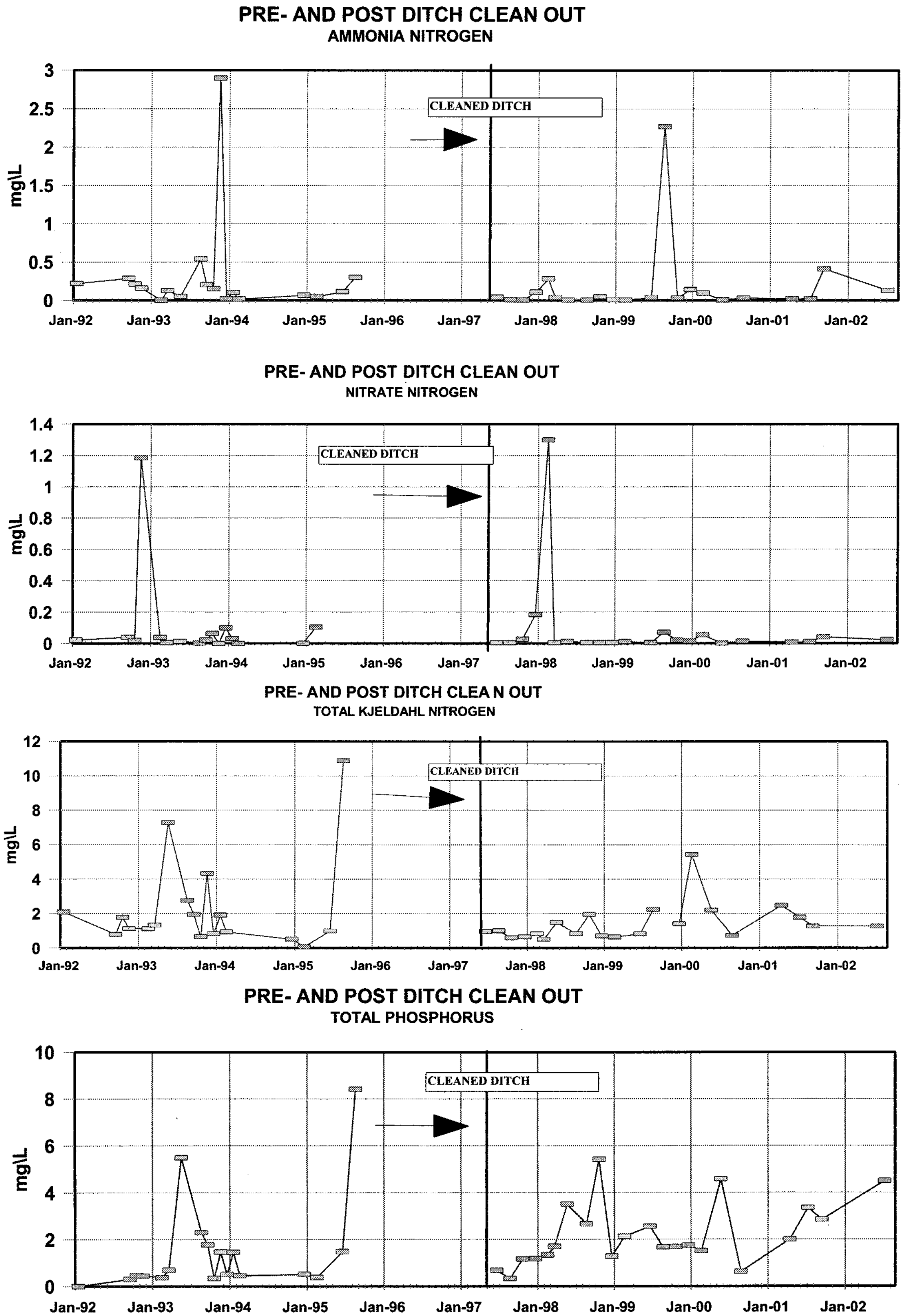

Figure 11 A comparison of nutrient concentrations measured in the pre-treatment ditch before and after restoration of the ditch.

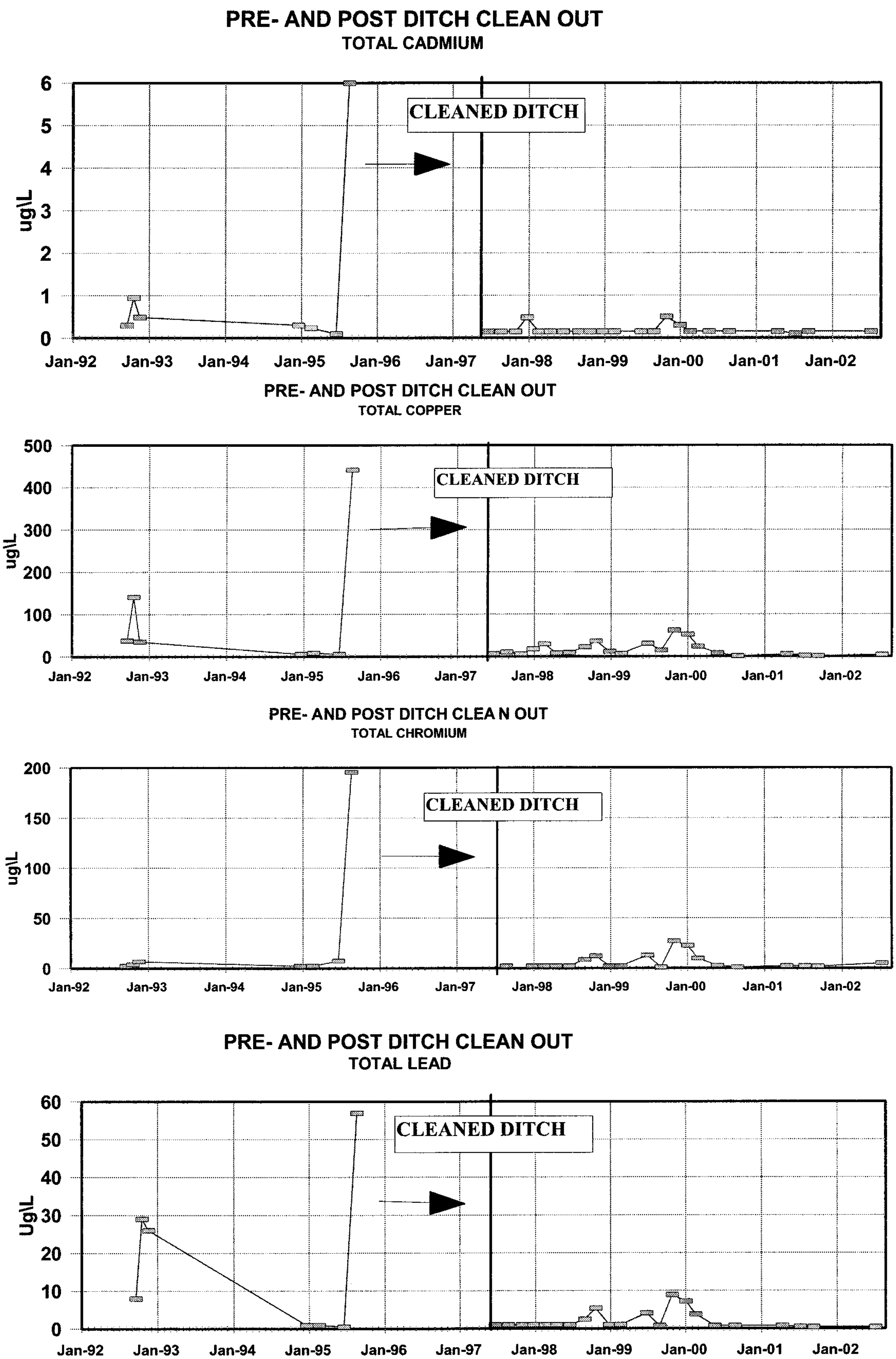

Figure 12. A comparison of metal concentrations measured in the pre-treatment ditch before and after restoration of the ditch.

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Ambient Grab Samples in the Pre-Treatment Ditch exhibit some differences between sites. Sampling locations are identified in Figure 2, and the summary data are in Tables 12a and 12b. All the data as well as comparison graphs are presented in Appendix G. In general, median values of phosphorus, ammonia, copper, manganese and zinc are highest at site 4 and lowest at site 2. This is caused by the low flow, low dissolved oxygen and low oxidation-reduction potential (redox) at site 4 (Tables 13). Low dissolved oxygen and redox create reduced conditions that release these constituents from the sediments and low flow fails to flush the system. Site 2 has an open water area before runoff is discharged into the pond, and therefore, the water is usually more oxygenated. As is typical of water quality concentrations, the data are log normally distributed and strongly skewed to the left. A few extreme values make nitrogen and most metal averages much higher than concentrations usually measured in freshwater aquatic systems.

The much lower median concentrations show that lower than average concentrations are more often measured at these sites. In fact, nitrate nitrogen is often measured below the laboratory detection limit. The phosphorus levels are much higher than normal and these results are much higher than the phosphorus concentrations measured at the inflow and outflow of the pond. Phosphorus concentrations were almost twice as high in samples collected in the pre-treatment ditch than samples collected during rain events at the inflow to the pond. The higher phosphorus levels in the ditch were typical of all sampling events as can be deduced by the almost equal average and median concentrations. Some extreme values for metals measured in 2000 can probably be attributed to the shallow water levels in the ditch that made collecting samples without also including some of the bottom fluff difficult.

The concentration of some nutrients measured in the ditch between storm events is often many times greater than the event mean concentrations measured at the inflow to the pond during storm events. For example, average concentrations in the ditch for ammonia are 0.26 mg/L compared to 0.14 mg/L in the pond, and ortho-phosphorus is 2.04 mg/L in the ditch versus 0.99 mg/L in the pond. In contrast, nitrate was most often measured below the laboratory detection limit in the ditch with an average of 0.10 mg/L compared to 0.44 mg/L in the pond. These results can probably be explained by the low dissolved oxygen concentrations causing anaerobic conditions in the ditch, which favors ammonia, and the application of fertilizers on the fields increasing ammonia and phosphorus. Metal concentrations were usually measured much lower for ambient concentrations in the ditch than for storm event samples in the pond. Average iron concentrations were 0.857 mg/L in the ditch compared to 1.17 mg/L in the pond, lead was 3.92 mg/L in the ditch versus 6.61 mg/L in the pond, and total suspended solid levels were measured as 27 mg/L in the ditch versus 69 mg/L in the pond. These values for metals and suspended solids represent what might be expected for ambient conditions as measured in the ditch between storm events. For ambient samples, pollutants have had time to settle to the bottom or to be treated by vegetation and microbes compared to samples taken during storm events in the pond where soil particles and associated pollutants are being transported by rain energy. Average copper concentrations were almost the same for the ditch and the pond at 58 mg/L and the higher than expected concentrations in the ditch may represent copper fungicide applied on the fields. These average concentrations were calculated from Table 7a, 12a and 12b.

Table 12a. Summary statistics for the ambient nutrient samples collected in the pre-treatment ditch. All the data are in Appendix G.

Nutrients Units	Ammon mg/L-N	Nitrite mg/L-N	Nitrate mg/L-N	TKN mg/L-N	TN mg/L-N	Ortho P mg/L-P	Total P mg/L-P	TSS mg/L
Station 2 -STA822								
No Obs	22	21	22	21	21	22	22	21
Mean	0.168	0.028	0.081	1.45	1.59	1.74	2.18	15.39
Median	0.035	0.005	0.009	1.00	1.42	1.54	1.73	5.02
max	2.270	0.266	1.300	5.44	5.51	3.98	5.42	95.60
min	0.005	0.003	0.002	0.51	0.51	0.21	0.33	0.70
Std.Dev	0.469	0.066	0.269	1.08	1.10	1.03	1.28	22.68
c.v.	2.788	2.329	3.313	0.74	0.69	0.59	0.59	1.47
Station 3- STA823								
No Obs	21	20	21	19	20	21	21	20
Mean	0.257	0.045	0.156	2.89	3.07	2.01	2.75	25.20
Median	0.066	0.005	0.013	1.30	1.40	2.26	2.67	7.49
max	1.440	0.516	2.650	28.90	28.93	3.82	6.27	150.33
min	0.005	0.003	0.005	0.37	0.45	0.26	0.31	0.68
Std.Dev	0.413	0.116	0.560	6.17	6.04	0.92	1.56	41.94
c.v.	1.608	2.597	3.585	2.13	1.97	0.46	0.57	1.66
Station 4- STA824								
No Obs	22	21	22	21	21	22	22	19
Mean	0.354	0.036	0.055	2.38	2.53	2.38	3.02	40.54
Median	0.187	0.007	0.005	1.28	1.50	2.42	2.88	12.70
max	1.980	0.220	0.417	12.00	12.01	5.43	6.40	414.70
min	0.005	0.002	0.004	0.15	0.16	0.01	0.02	2.94
Std.Dev	0.437	0.065	0.105	2.91	2.87	1.55	2.02	91.32
c.v.	1.234	1.801	1.921	1.22	1.13	0.65	0.67	2.25

Abbreviations: TKN=Total keldahl nitrogen, ortho-p=orthophosphorus, TSS=total suspended solids.
c.v. Coefficient of variation (standard deviation/mean)

Table 12b. Summary Statistics for the ambient metal samples collected in the pre-treatment ditch. All the data are in Appendix G.

Metals Units	AL ug/L	CD ug/L	CR ug/L	CU ug/L	FE ug/L	PB ug/L	NI ug/L	MN ug/L	ZN ug/L
Station 2 -STA822									
No Obs	20	22	20	22	22	22	19	22	22
Mean	690	0.18	6.20	16.7	760	2.07	3.89	672	22
Median	215	0.15	2.35	10.0	381	1.00	2.15	345	15
max	3780	0.50	27.20	61.5	2450	8.90	30.10	4410	60
min	1	0.00	1.00	1.0	80	0.40	1.25	32	8
Std.Dev	981	0.11	7.24	16.2	763	2.29	6.22	964	13
c.v.	1.42	0.61	1.17	0.97	1.00	1.11	1.60	1.43	0.61
Station 3- STA823									
No Obs	19	21	19	21	21	21	19	21	21
Mean	696	0.34	8.98	51.9	693	3.45	2.81	313.4	31
Median	219	0.15	2.90	15.3	260	0.75	2.15	254.0	15
max	3390	1.40	44.00	278.0	3190	16.50	7.40	884.0	120
min	14	0.10	1.00	1.0	40	0.60	1.25	28.5	8
Std.Dev	983	0.36	12.76	76.7	874	4.38	1.60	252.4	30
c.v.	1.41	1.07	1.42	1.5	1	1.27	0.57	0.8	1
Station 4- STA824									
No Obs	21	22	21	22	22	22	21	22	22
Mean	1624	0.47	18.28	106.5	1118	6.25	3.65	379.4	68
Median	375	0.15	3.00	28.0	450	2.45	2.15	298.0	30
max	22700	3.10	200.00	1180.0	10400	56.80	16.70	2060.0	350
min	21	0.10	0.40	1.0	50	0.30	1.25	0.8	8
Std.Dev	4760	0.69	42.40	247.8	2159	11.97	3.49	429.6	88
c.v.	3	1.46	2.32	2.3	2	1.91	0.96	1.1	1

Abbreviations: AL=Aluminum, CD=cadmium. CR=chromium, CU=copper, FE=iron, PB=lead, NI=nickel, MN=manganese, ZN=zinc.

c.v. Coefficient of variation (standard deviation/mean)

Field parameters shed insight into the concentrations of many constituents (Table 13). Since reduced conditions (low DO and redox) change the chemical properties of many constituents making them more soluble, these conditions cause their release from the sediments. The low dissolved oxygen and redox levels measured in the ditch once the dense vegetation was established (about six to eight months after the ditch was excavated) probably caused increases in some of the pollutants

Table 13. Average values for field parameters for the ambient samples collected in the pre-treatment ditch. All data are in Appendix G.

Params. Units	Cond. mS/cm	DO mg/L	Redox volts	pH SU
site 2				
n	19	19	13	20
mean	1.10	2.44	215.54	7.22
median	1.19	2.12	321.00	7.16
std d	0.29	2.14	267.82	0.20
max	1.32	6.61	464.00	7.56
min	0.01	0.11	-319.00	6.95
site 3				
n	19	18	12	19
mean	1.26	1.39	111.42	7.01
median	1.16	0.79	292.50	7.02
std d	0.37	2.06	359.11	0.30
max	2.29	7.85	632.00	7.57
min	0.77	0.04	-336.00	6.18
site 4				
n	20	19	14	20
mean	0.90	1.63	-63.93	7.03
median	1.02	0.75	-116.50	7.06
std d	0.37	2.20	339.96	0.33
max	1.30	7.15	376.00	7.99
min	0.11	0.11	-427.00	6.60

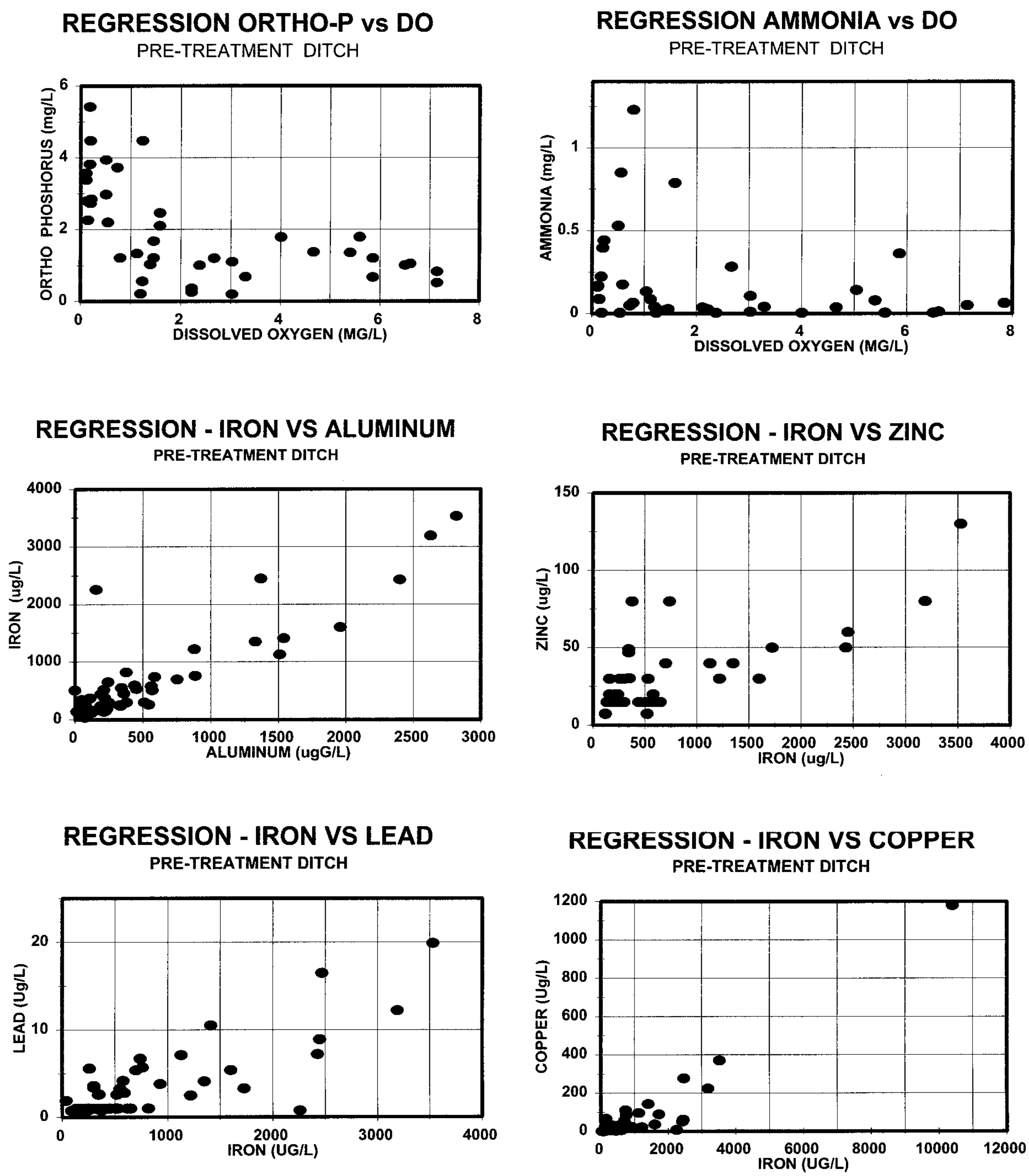

Figure 13. Relationships between variables measured at three stations in the ditch. Some constituents vary together. Others are higher at dissolved oxygen levels less then 1 mg/L.

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Some of these relationships were evaluated with regression analysis (Figure 13). A fairly consistent result was observed with phosphorus, which almost always shows concentrations greater then 2 mg/L when dissolved oxygen is measured at less than 1 mg/L. The same tendency is seen for ammonia, but since inorganic nitrogen concentrations were usually measured at relatively low levels in the ditch, concentrations were not high enough to increase ammonia concentrations during all the sampling events that also exhibited reduced conditions (low DO).

Also many metal concentrations vary together since similar conditions of low dissolved oxygen and redox potential tend to release them from the sediments and into the water column. The process by which anaerobic conditions convert metals from the oxidized to the reduced state makes them much more soluble. Some of the best relationships for demonstrating metal associations were found with iron concentrations. Although iron is of little direct toxicologic significance, it often controls the concentration of other elements, including toxic heavy metals in surface water. Surface water iron concentrations usually range from 50 to 200 ug/L in aerated aquatic systems (Hutchinson 1975). In the pre-treatment ditch in this study that often had dissolved oxygen levels near zero, iron concentrations were much higher than the usual range with average values between 600 and 800 ug/L. A common process that causes the relationship between iron and other metals is their affinity to be adsorbed and co-precipitated with the ferric hydroxide particle (Wetzel 1975).

Coliform in the ditch - Both total and fecal coliform were measured at high concentrations in the ditch and those concentrations were from 102 to 210 times greater than at the inflow of the pond (Table 14 and see Table 10). The most likely explanation for this tremendous difference in concentrations is the stagnant condition and low water level in the ditch between storm events when the samples were collected. These conditions are conducive to bacterial growth. Fecal microorganisms accumulate in sediments where survival is extended for weeks to months (Burton et al. 1987). Sediment bacteriological analyses conducted in Birmingham (AL) lakes found elevated pore water concentrations (several hundred to several thousand oranisms/100ml) extending to at least 0.1 m into the sediments (Burton and Pitt 2002). It was further explained that when gently disturbed, the water layer over the sediments also caused a significant increase in microorganism concentrations.

Investigations of sources of coliform bacteria in rural areas identified farm animals and wildlife as probable sources (Geldreich and Kenner 1969). Since no farm animals were present at the Cockroach Bay site, it would appear wildlife might contribute bacteria. Vegetation has also been studied as a source of bacteria, and it was found that most of the bacteria on vegetation is of insect origin (Geldreich 1965). Another possibility at Cockroach Bay may be aerial deposition from the sewage lagoon adjacent to the site.

The high bacteria counts may help explain the findings of the Hillsborough County Environmental Protection Commission (1996) that reported elevated total and fecal concentrations often exceed state standards for shellfish harvesting and recreational exposure. Based on state water quality standards, 45 percent of the tributaries in the region did not meet their intended use for recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

Table 14. Concentrations of total and fecal coliform measured in the pre-treatment ditch (cfu's/100ml). See Figure 2 for sampling locations.

	Station 2 - STA822		Station 3 - STA823		Station 4 - STA824	
	total	fecal	total	fecal	total	fecal
09/24/99	9800	1300	3800	600	8600	300
09/25/99	2100	1000	4000	420	1600	300
09/18/99	1650	230	1510	30	1420	0
09/23/99	1280	100	16100	150	340	10
08/31/99	4500	1300	3000	300	800	10
08/31/99	11200	7300	dry	dry	7400	1600
10/01/99	2600	500	1070	80	400	180
09/17/99	4200	300	3800	40	2800	90
09/23/99	6800	4840	4880	3600	1020	0
07/07/99	48000	9000	11300	180	5100	500
09/09/99	15400	2500	13400	11600	21600	16300
11/09/99	11600	200	10500	1100	18400	800
01/12/00	13000	1000	na	na	5800	100
03/08/00	1980	200	42000	240	1240	60
05/09/00	dry	dry	dry	dry	26800	140
09/06/00	1420	560	3000	940	1320	160
04/24/01	500	0	39400	2500	3800	100
07/18/01	2580	6880	3400	6640	2040	4400
09/20/01	na	na	380	1880	1460	2940
07/16/02	2100	1480	10100	9600	5900	2500
no obs	18	18	17	17	20	20
mean	7817	2149	10096	2347	5892	1525
median	3400	1000	4000	600	2420	170
max	48000	9000	42000	11600	26800	16300
min	500	0	380	30	340	0

Chlorophyll measured in the ditch - Chlorophyll concentrations exhibited considerable variation between locations in the ditch (Table 15). Station 2, which is the location immediately before water empties into the pond, had concentrations much lower than the inflow of the pond. Station four that has the most stagnant conditions had the highest values, with median concentrations over two and a half times greater than the inflow to the pond. Station 3 measured intermediate concentrations. See Figure 2 for site locations and Table 11 for the concentrations measured in the pond.

Table 15. Chlorophyll measured in the pre-treatment ditch.

Date	Chlorophyll A Monochro ug/L	Pheaophytin Monochro ug/L	Chlorophyll A Tricho ug/L	Chlorophyll B Tricho ug/L	Chlorophyll C Tricho ug/L
STATION 2- STA 822					
07/07/99	8.6	6.35	12.79	*0.50*	1.24
09/09/99	61.3	132.00	145.00	*0.50*	*0.50*
11/09/99	2.3	3.46	4.35	1.04	1.92
01/12/00	13.2	16.20	22.70	9.08	14.40
03/08/00	204.0	66.90	253.00	*0.50*	9.02
05/09/00	dry	dry	dry	dry	dry
07/24/00	8.4	5.84	12.40	0.05	0.05
09/06/00	5.6	2.37	7.19	*0.50*	*0.50*
04/24/01	130.0	23.80	149.00	*0.50*	9.59
07/18/01	9.1	2.33	10.50	3.51	3.64
09/20/01	4.7	6.36	8.29	4.80	9.47
07/16/02	6.00	1.49	7.02	1.26	1.28
#samples	**11**	**11**	**11**	**11**	**11**
Average	**41.19**	**24.28**	**57.20**	**2.06**	**4.73**
Median	**8.61**	**6.35**	**12.40**	**0.5**	**1.92**
STATION 3- STA823					
07/07/99	77.4	*0.5*	82.8	*0.5*	8.35
09/09/99	13.9	6.03	17.9	1.23	3.61
11/09/99	386	154	502	*0.5*	*0.5*
01/12/00	dry	dry	dry	dry	dry
03/08/00	dry	dry	dry	dry	dry
05/09/00	dry	dry	dry	dry	dry
07/24/00	8.4	5.84	12.4	0.05	0.05
09/06/00	20.2	15.1	30.6	*0.5*	*0.5*
04/24/01	207	210	344	*0.5*	*0.5*
07/18/01	25.3	8.61	31.2	3.33	2.6
09/20/01	6.99	11.19	13.63	4.71	7.7
07/16/02	39.3	7.56	45.5	.5	1.77
#samples	**9**	**9**	**9**	**9**	**9**
Average	**87.17**	**46.54**	**120.00**	**1.31**	**2.84**
Median	**25.3**	**8.61**	**31.2**	**0.5**	**1.77**
STATION 4- STA824					
07/07/99	29.5	3.9	33	*0.5*	3.12
09/09/99	1.62	1.48	2.54	*0.5*	*0.5*
11/09/99	792	125	920	*0.5*	*0.5*
01/12/00	93.1	53.1	130	*0.5*	2.37
03/08/00	dry	dry	dry	dry	dry
05/09/00	605	*0.5*	647	*0.5*	*0.5*
07/24/00	2.46	0.05	3.16	0.05	0.05
09/06/00	156	23	179	*0.5*	7.22
04/24/01	213	70.6	266	*0.5*	*0.5*
07/18/01	25.6	4.86	29.2	3.29	4.44
09/20/01	16.02	19.38	27.14	13.2	25.36
#samples	**11**	**11**	**11**	**11**	**11**
Average	**205.21**	**33.92**	**238.46**	**1.87**	**4.10**
Median	**93.1**	**19.38**	**130**	**0.5**	**0.5**

Pesticides in the ditch - Of the 45 pesticides tested in the water column only the ten in Table 16 were detected and five were above the laboratory quantification limit. Most of the Endosulfan was measured at site 2, the station in the ditch that flows directly into the pond. Most of these detections were the result of the El Niño storms in 1998 and endosulfans were not detected again until the growing season in 2000. Three samples at site 2 exceeded the standard (0.056 ug/L for fresh water) with values between 0.057 and 0.48 ug/L. No endosulfan species were measured at sites 3 and 4 during 1998, but all three sampling stations had detectable amounts in 2000. Chlordane was measured at all sites, except site 2, during March 1998 and again in March 2000. Chlordane was identified in measurable quantities at site 2 in May 2000. Diazinon was detected at almost all sites during January of 1999 and January 2000, which is during the growing season for winter vegetables. Diazinon was measured during January 2000 at concentrations well above the detection limit with values of 0.66 and 1.6 ug/L. Chlordane was detected again in April 2001 at site 3. PCBs and PAHs were tested for but were not detected. All the data for each sampling event are listed in Appendix H.

Table 16. Frequency of pesticides detected in water in the ditch during background sampling conducted at two-month intervals. 20 samples (All the data are in Appendix H)

Constituents	**Units**	**Site 2**	**Site 3**	**Site 4**
Chloronated Pesticides				
DDD - p,p'	ug/L	5 %	0 %	0 %
DDE - p,p'	ug/L	5 %	0 %	0 %
DDT - p,p'	ug/L	5 %	5 %	0 %
Endosulfan I	ug/L	10 %	0 %	0 %
Endosulfan II	ug/L	20 %	0 %	0 %
Endosulfan Sulfate	ug/L	55 %	16 %	15 %
Chlordane	ug/L	5 %	10 %	10 %
Organophosphorus and Nitrogen Pesticides				
Metalaxyl	ug/L	0%	5 %	5 %
Bromacil	ug/L	0 %	5 %	0 %
Diazinon	ug/L	10 %	16 %	10 %

Information about the priority pollutants that were detected at the site indicates these pesticides are a national problem, even though many of these pollutants have been banned for years.

Although DDT has not been used in this country since 1972, once introduced into the environment, it lasts for a long time. Some studies show that half the DDT in soil breaks down within 2 years, but other researchers have found that it takes more than 15 years (US PHS 1994). DDT may attach to small particles and be carried by the wind, or bind to suspended particles in surface water and settle in the sediments. DDT in soil usually breaks down to form DDE or DDD, while DDT in surface water may evaporate into the air, or be broken down by the sun or microorganisms. Other parts of the world continue to use DDT, therefore, atmospheric deposition is the current source of new DDT contamination in the United States (US EPA 2001). DDT, and its break-down products DDE and DDD, are persistent toxic pollutants targeted by EPA (2001).

Endosulfan is an insecticide, used primarily on food crops, which does not easily dissolve in water, but sticks to soil particles readily. In soil, the half-life for the alpha isomer is 35 days and for the beta isomer 150 days under neutral conditions (Sax and Lewis 1989). The breakdown product, endosulfan sulfate, is more persistent than the parent compound, accounting for 90% of the residue after 11 weeks (Extoxnet 2001). Endosulfan is rapidly degraded and eliminated in mammals with very little absorption in the gastrointestinal tract, but birds and several fish species are quite susceptible to endosulfan poisoning (Extoxnet 2001).

Chlordane was used in the United States as a pesticide and fumigating agent from 1948 to 1978. In 1988, all approved uses of chlordane in the United States were terminated; however, manufacture for export still continues. Because chlordane is bioaccumulative, it becomes more concentrated as it works its way up the food chain creating a threat to wildlife and humans. Chlordane is a persistent toxic pollutant targeted by US EPA (2001). Chlordane remains in our food supply because it was commonly used on crops in the 1960s and 1970s.

Diazinon was the most frequently detected insecticide in surface water analyzed by the US Geological Survey's National water Quality Assessment program from both agricultural and non-agricultural sites (US EPA 1999). In Florida, the use by professional lawn care applicators is higher than anywhere else in the United States. In December 2000, the Environmental Protection Agency reached a voluntary agreement with the chief manufacturer of diazinon to phase out/eliminate certain uses of the pesticide (US EPA 2000).

Bromacil is practically nontoxic in dry form and only moderately toxic in the liquid form. It is used for selective weed control and works by interfering with photosynthesis (EXTOXNET 2000). Bromacil does not bind to soil particles, but is soluble in water and moderately to highly persistent in soil. Its half-life is about 60 days and it is estimated to have a 2-month half-life in water (EXTOXNET 2000). Bromacil is slightly to practically nontoxic to fish, birds and invertebrates.

Sediment Concentrations

Sediment samples provided insight into processes taking place in the system. Samples were collected in July 1997 right after the pond was constructed and one year later in July 1998. Sediment samples were also collected for pesticides but not for nutrients and metals in July 2000 and again one year later in July 2001. Sampling sites included not only the inflow, outflow and ditch stations that were discussed in the water quality sections, but also stations in the center of the two cells of the pond and two stations in the marsh (See Figure 2 for site locations). All the sediment data for nutrients and metals are presented in Appendix I. The same pesticides measured in the water column were also found in the sediments (chlordane, endosulfate, DDT and bromacil).

Nutrients were measured in the sediments as ammonia, organic nitrogen, ortho-phosphorus and total phosphorus and the data help explain some of the concentrations found in the water quality samples as well as processes taking place in the system. Only the ammonia and ortho-phosphorus data are shown here (Figure 14), but all of the nutrient data are in Appendix G-2.

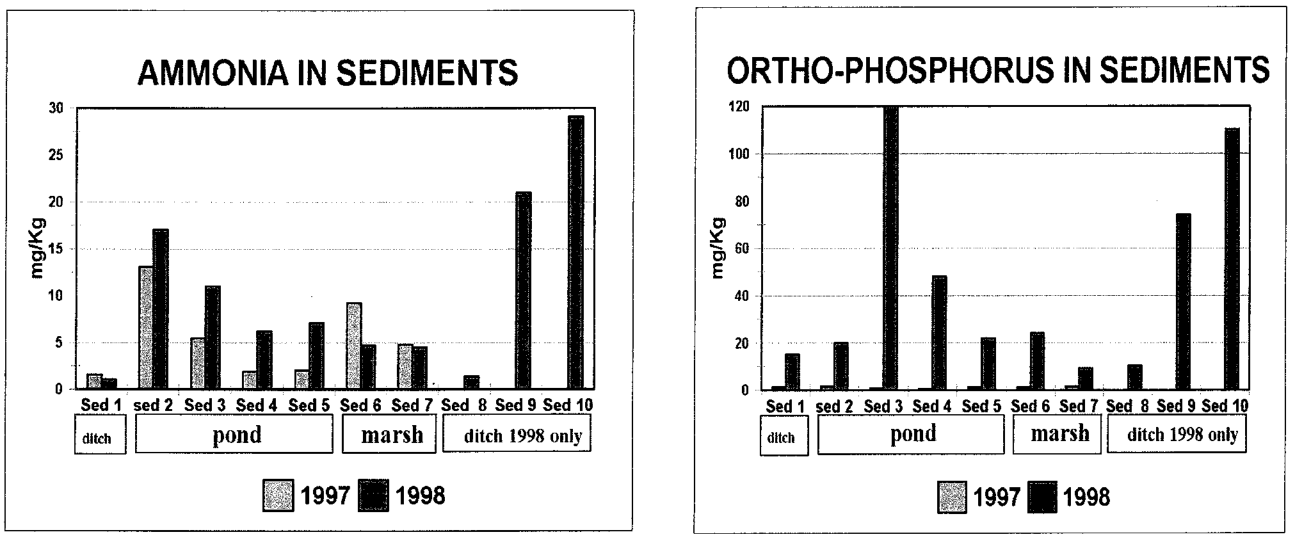

Figure 14. Ammonia and ortho-phosphorus measured in the sediments in July of 1997 right after the pond was constructed and again in July of 1998.

All of the nutrients tended to have high concentrations in the ditch at sediment stations 9 and 10 during 1998. This was also the pattern seen with the water quality samples where sites 3 and 4 in the ditch correspond to sediment stations 9 and 10. It should be noted that stations 8, 9 and 10 were not measured in 1997. The greater concentrations in the sediments combined with the lower dissolved oxygen readings at these locations probably explain these results. Total organic nitrogen and total phosphorus concentrations (not shown) were also much higher at these ditch sites. These values are typical of wetlands with dense emergent vegetation, especially cattails. The other two ditch sites (Sed 1 and Sed 8) had the lowest concentrations of all sites, but Sed 1 also had more open water where the samples were collected and sediment site 8 seldom had standing water or runoff input since it represented the western boundary of the drainage basin. Ortho-phosphorus was measured at higher values in the center of the two cells of the wet-detention pond (sed 3 and sed 4). This was also true of total phosphorus. These could be residual concentrations left from its previous use as an agricultural field, but since concentrations of phosphorus increased dramatically in the sediments between the two years, some other process is probably responsible, such as migration of small grain particles to the deepest part of the pond or anaerobic conditions in the bottom waters. Average ortho-phosphorus increased from barely detectible (1 mg/kg) in 1997 to an average of 37 mg/kg in 1998.

Metals exhibited almost the same pattern as nutrients for the majority of constituents analyzed and most values were highest in the ditch stations Sed 9 and Sed 10 (Figure 15). Aluminum is shown first because it is sometimes used to normalize sediment metal concentrations, and therefore, identifies anthropogenically enriched sediments (Livingston *et al.* 1995). Since most of the metals do not exhibit the same pattern as aluminum, all the high concentrations appear to be caused by man and our modern technology, with the possible exception of arsenic. Also for many metals, the concentrations were below the laboratory quantification limit in 1997 but well above it in 1998 indicating the rapid increase of metal concentrations in the sediments once the ponds had been used to treat agricultural runoff for a year.

The elevated metal concentrations measured in the ditch can be partially explained by the poor flushing of water through the ditch, the use of plastic mulch in the fields, and the use of pesticides to increase yield. The metals in the ditch that were measured above the possible toxicity level are copper, mercury, cadmium, and zinc, but none of these concentrations was above the probably toxic levels except for copper. Copper exceeded the possible toxicity level for both ditch sites and was well above the probable toxicity level at Sed station 9 (See Table 4c).

The processes responsible for the increase in metals as water leaves the fields include the use of plastic mulch. Growing winter vegetables using plastic mulch with raised beds controls soil moisture, reduces the need for herbicides, and prevents weeds. But farmers must still use biocides to control fungi, bacteria, and insects, and there is still runoff — increased runoff, in fact, due to the impermeable plastic and compacted soil between the rows (Dietrich and Gallagher 2000). They further explain that the plasticulture runoff is the copper-based bactericide and fungicide used on the plants to prevent disease. In a study (Hapeman 1999) that measured the consitituents in runoff from two agricultural fields, it was found that since the plastic-mulched field had less exposed soil, which can bind pollutants, runoff had chemical concentrations 19 times higher than the vetch-covered fields. Fortunately, at the Cockroach Bay agricultural site this runoff is treated by the ditch, which reduced most of these high concentrations. Vegetated waterways such as ditches can provide for the controlled release of runoff water along natural drainage ways where plants diminish the water's force, anchor and protect the soil, and filter out sediments. This describes the processes taking place in the pre-treatment ditch in this study. The ability of the ditch to remove pollutants could be improved by installing swale blocks and employing maintenance practices that remove the accumulated sediments when the soil particle attachment sites become saturated.

Copper, zinc and lead were slightly elevated compared to the other pond sites when the fresh water from the pond was discharged into the marsh (Sed 6). The process responsible for the increase in metal sediment concentration at this location is probably the response to estuarine mixing. This is similar to the salt-water wedge that occurs in rivers where constituents in fresh water may precipitate or release material when it encounters salt-water conditions.

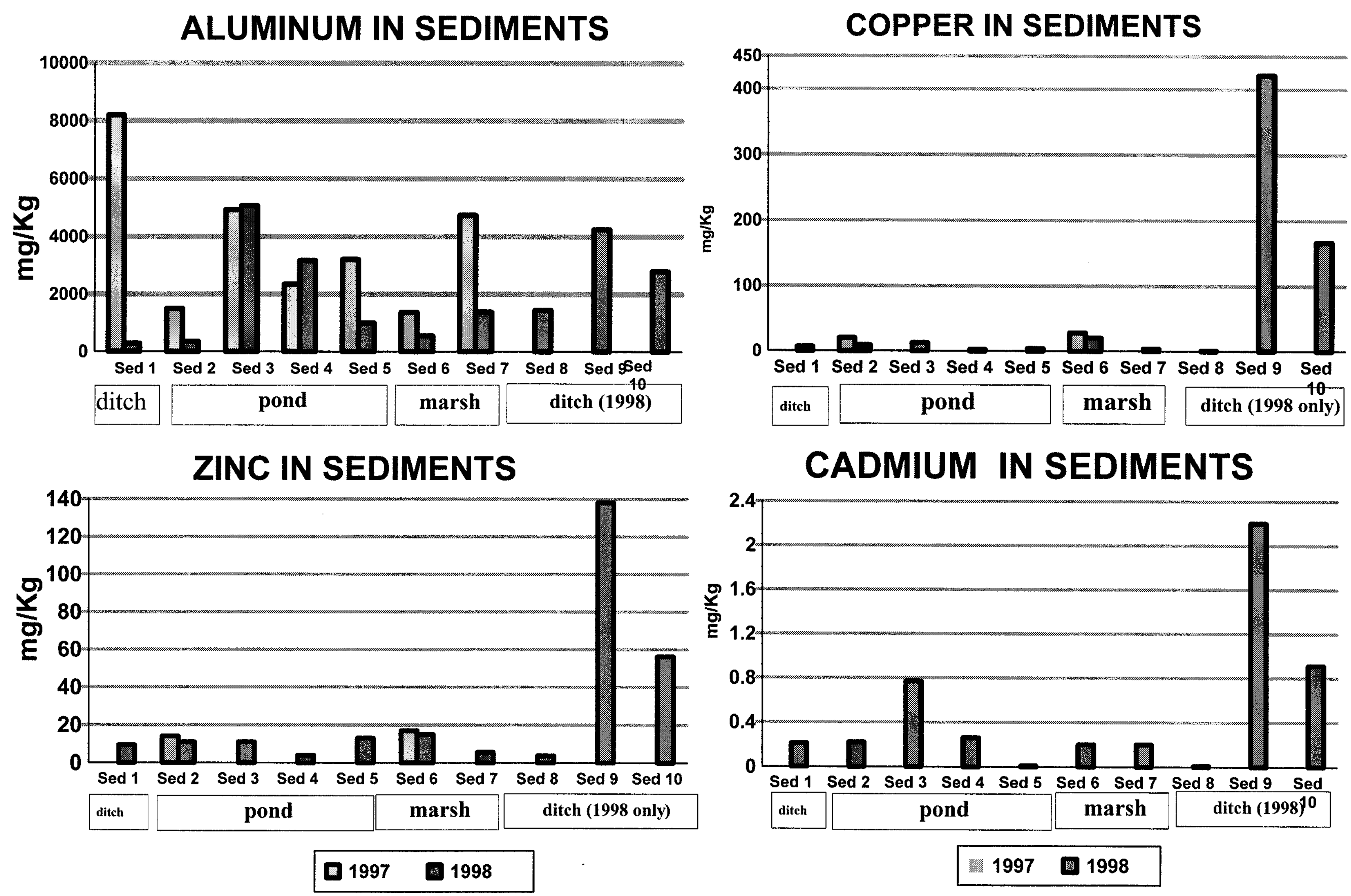

Figure 15. Concentration (mg/Kg) of metals in sediments from the roadside ditch, in the pond, and in the tidal marsh that the pond discharges to. Generally sites are ranged from headwaters to bay except the ditch sites 8,9,10 which were not sampled in 1997.

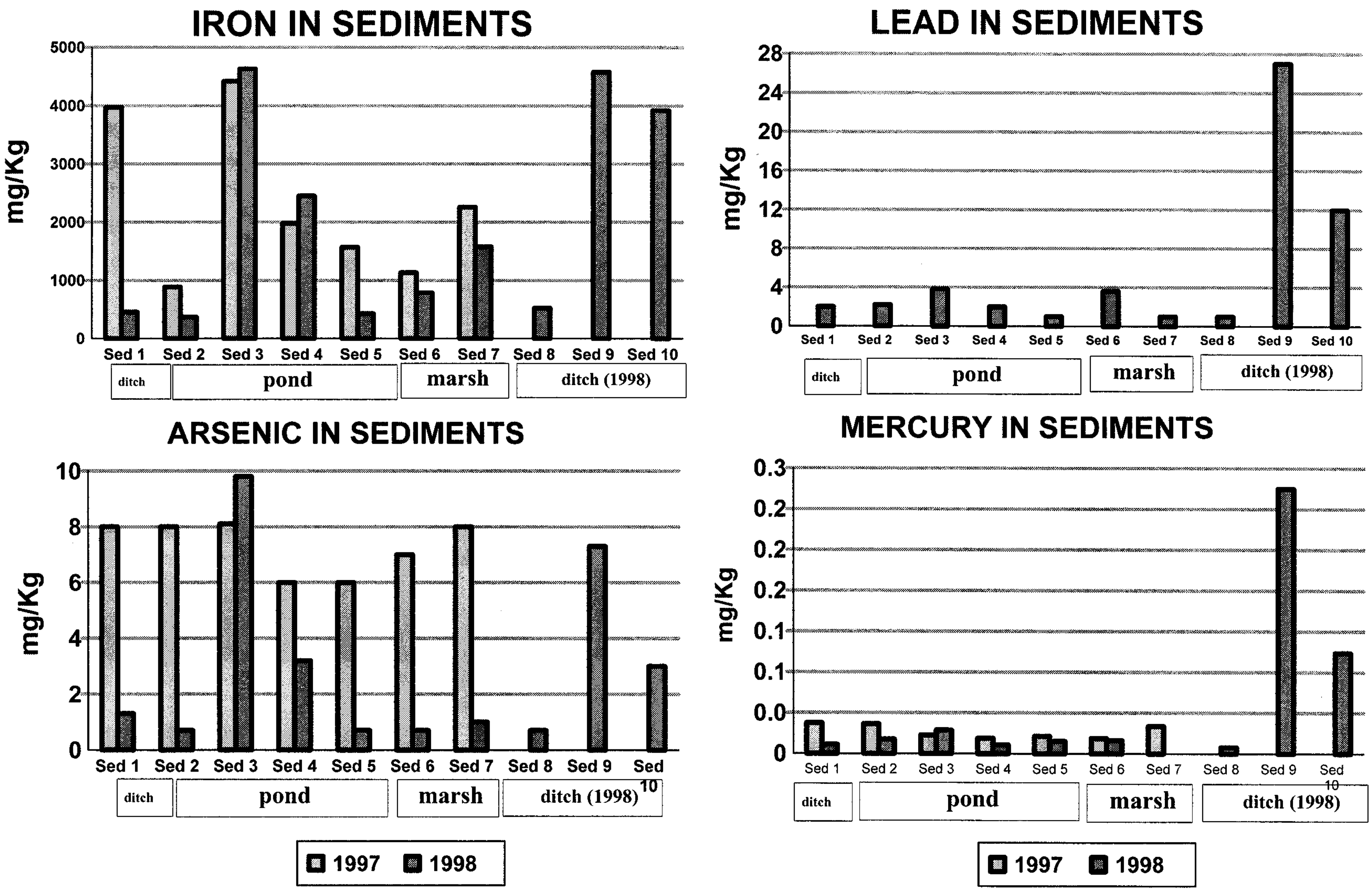

Figure 15 (con't) . Concentration (mg/Kg) of metals in sediments from the roadside ditch, in the pond, and in the tidal marsh that the pond discharges to. Generally sites are ranged from headwaters to bay except the ditch sites 8,9,10 which were not sampled in 1997.

Pesticides measurements in the sediments identified chlordane and DDT derivatives as present in almost all the soil samples (Table 17). Some of the pesticides measured reflect the same pollutants as those in the water samples (see Table 16) except they were detected much more often. Most of the pesticides found are no longer in use in this country, but once they have been introduced into the environment they last for a long time. They are of concern since they are persistent and bioaccumulate up the food chain. Chlordane is of special concern since many of the concentrations were present in measurable quantities. In addition, DDE was measured in concentrations in the sediments that are toxic to estuarine organisms (see Table 4c), although none of these probably toxic levels were measured in the marsh. The stormwater system appears to protect the bay from these toxic sediments since most of the higher concentrations were measured in the ditch and inflow to the pond and not at the outflow or in the marsh.

Table 17. Frequency of pesticides detected in the sediments for each year sampled at 10 locations throughout the site. All the data are in Appendix I-2.

Constituent	units	1997	1998	2000	2002
Chlordane	ug/kg	100 %	90 %	100 %	70 %
DDD – p; p'	ug/kg	28 %	50 %	30 %	60 %
DDE – p, p'	ug/kg	100 %	60 %	70 %	60 %
DDT – p, p'	ug/kg	28 %	30 %	30 %	20 %
Endosulfan II	ug/kg	14 %	30 %	10 %	0
Endosulfan Sulfate	ug/kg	0	0	10 %	0
Dieldrin	ug/kg	0	10 %	20 %	10 %
Bromacil	ug/kg	0	0	10 %	10 %

Ground water

Twelve shallow wells located around the perimeter of the pond were monitored about every two weeks for water levels and on seven occasions for water quality (see Figure 3 for well locations). All of the bi-weekly levels including some water level contours are shown in Appendix J and the water quality data are in Appendix K.

Well levels are related to NGVD (approximate mean sea level measured in feet) and exhibited similar annual average levels for all four years with less than a six-inch difference between years (Figure 16). Well 1 is next to the outflow weir and has the lowest average water level of all the wells. Well 1 was the only well monitored on the marsh side of the pond because the other wells installed in the marsh were too greatly influenced by the tidal cycle to be meaningful. Besides well 1, wells 2 and 12 were also close to the marsh and have average levels lower than most of the other wells indicating the ground water gradient is from the uplands toward the marsh. Wells 3, 4, and 9 were located in the most upland areas and are usually measured with higher water levels. Wells 6, 7, and 8 are near the pond and respond closely to pond levels. Well 10 is located between the pond and a sewage treatment lagoon and the higher levels measured in this well may reflect ground water seepage from that source as well as its upland location. Wells 5 and 11 were mowed over during maintenance activities and since their record is incomplete, they are not included in this analysis. Seasonal differences in pond levels further refine some of the groundwater interactions taking place by comparing the driest month of the year (May) with the wettest (September) (Figure 17). The dry season in May when compared to the end of the wet season shows greater variation between years than levels in September.

Well 1 is tidally influenced and is not as consistent as the other wells. The dry season data show the effect of the El Niño storms in 1997-98, which kept the water table higher even through an exceptionally dry spring. For the wet season in September, the uplands show the greatest differences between years (wells 2, 3, and 4) while those wells closest to the pond (wells 6, 7, and 9) are measured at almost the same level as the pond and close to the control elevation of the outflow weir (2.5 NGVD in feet).

Some interesting observations are evident from the water table contour graphs in Appendix J-3. The heavy line represents the outline of the two cells of the pond. The inflow is at well number 8 and the outflow is well number 1. More graphs show a steeper gradient on the north side of the pond, but a gradient exists on three sides under normal conditions. When pond levels are high, as September 3, 1997, the gradient is out of the pond. During the winter months of 1997 a strong gradient exists (> 1 ft) which can possibly be explained by the El Niño storms. Yearly comparisons for each month are graphed in Appendix J-2 and they also suggest interactions between the uplands and the pond and also the positive gradient from the fields to the marsh and the differences between wet and dry seasons and wet and dry years.

Water quality was measured in the groundwater wells on several occasions (Figures 18 - 21). Blank spaces in the figures indicate samples were not collected for that well on that day. Ammonia (Figure 18) was consistently measured at high levels (7 to 16 mg/L) in well 10, closest to the sewage lagoon. Nitrate-nitrogen was usually found below the laboratory detection limit of 0.01 mg/L, except in July 2000 when concentrations exceeded 1 mg/L at wells 6, 7, and 9.

Like ammonia, total phosphorus was measured in higher concentrations (1.5 mg/L) in well 10, the one closest to the sewage lagoon, but spikes in concentrations occurred in other wells also (Figure 20). Higher concentrations of phosphorus were also measured in wells closest to the fields (wells 4 and 9). But average concentrations are lower in these wells (< 1.0 mg/L) compared to the 2 to 3 mg/L measured in the ditch, suggesting soil processes are reducing phosphorus concentrations. Soil processes cause phosphorus to adsorb to soil minerals and to precipitate with calcium, iron and aluminum (Pitt et al 1996) accounting for lower phosphorus concentrations as water passes through soils. Potassium, used in fertilizers, was measured at the highest concentrations in the wells on the.

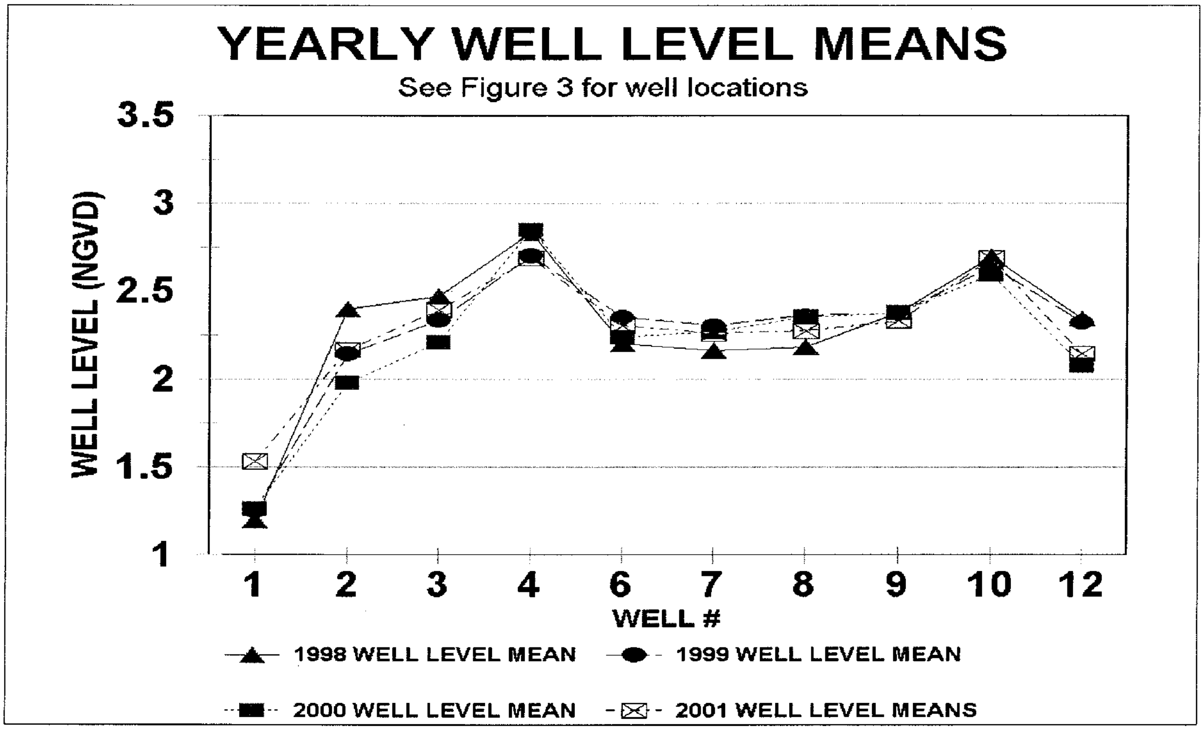

Figure 16. Average well levels for each year.

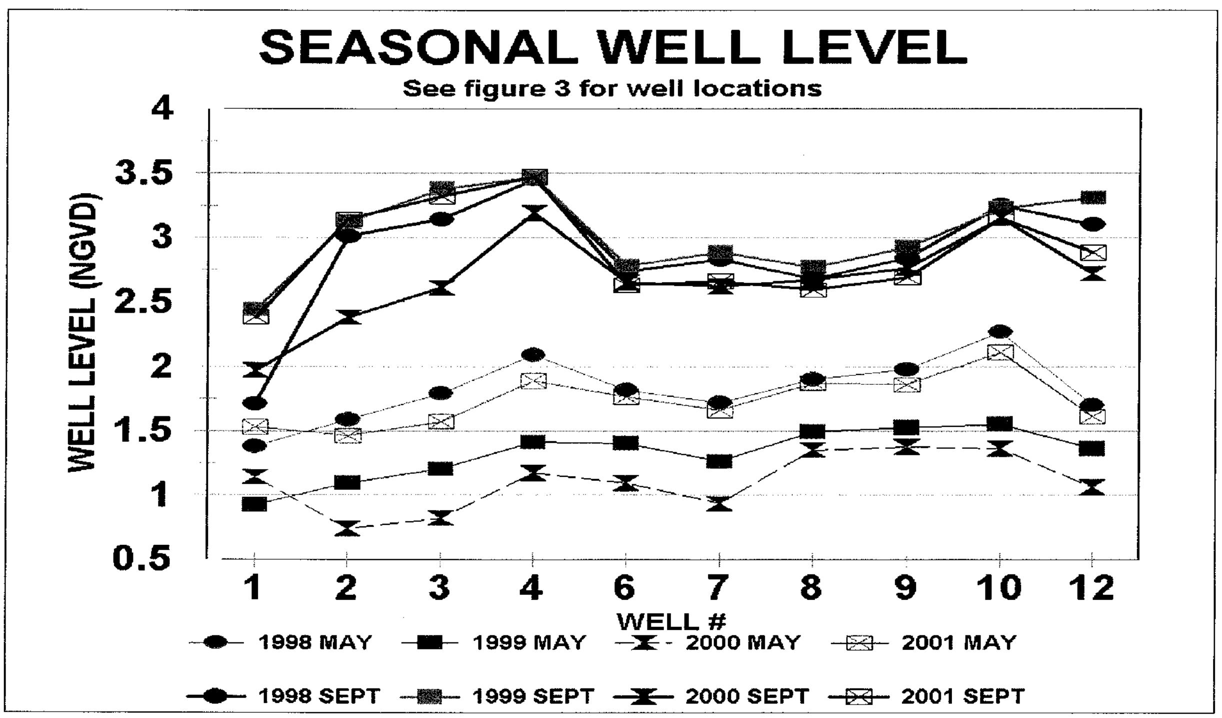

Figure 17. Differences in well levels during the dry season (May) compared to the wet season September) of each year.

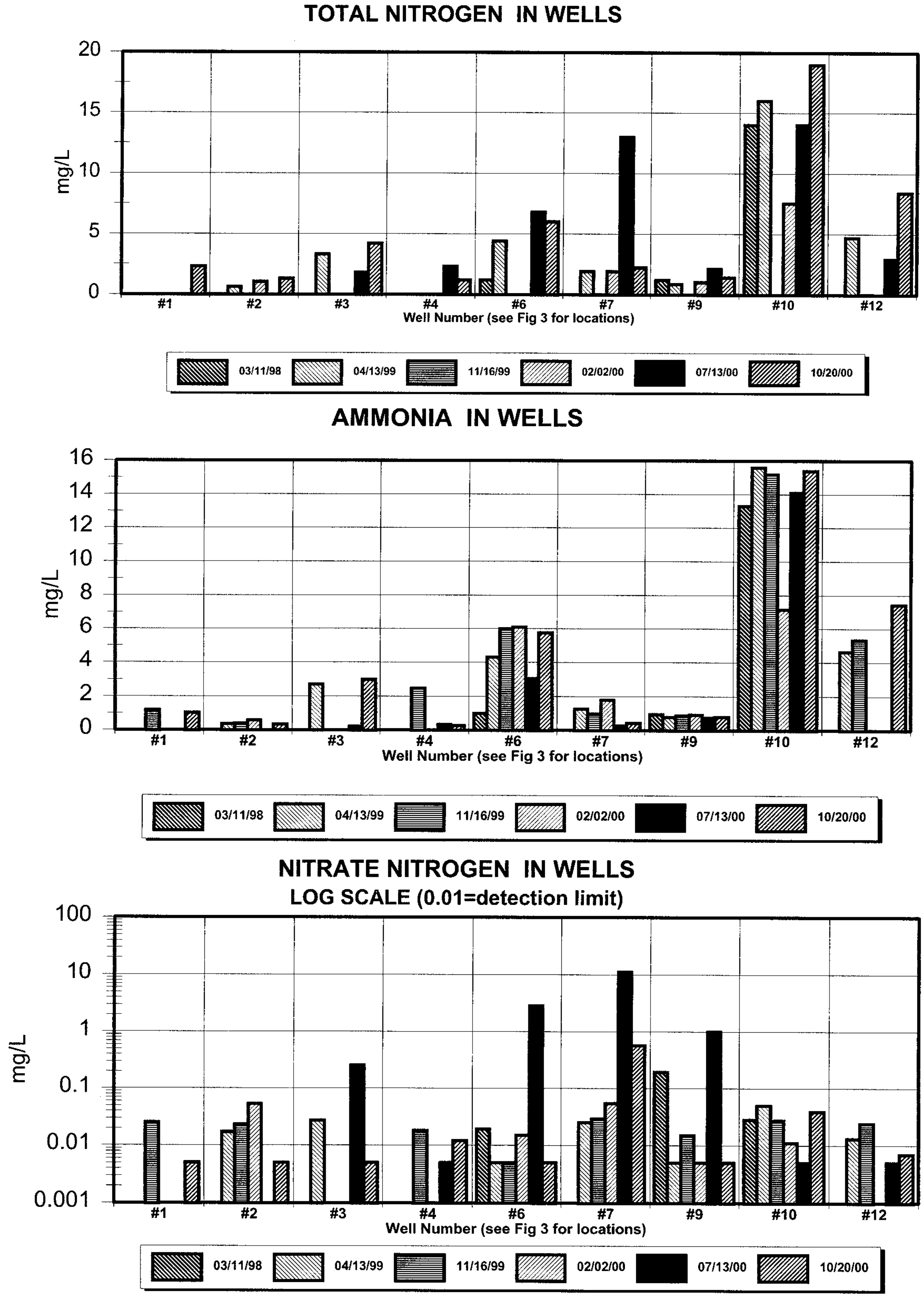

Figure 18. Nitrogen measured in water table wells. Empty spaces indicate no water quality data collected on that date.

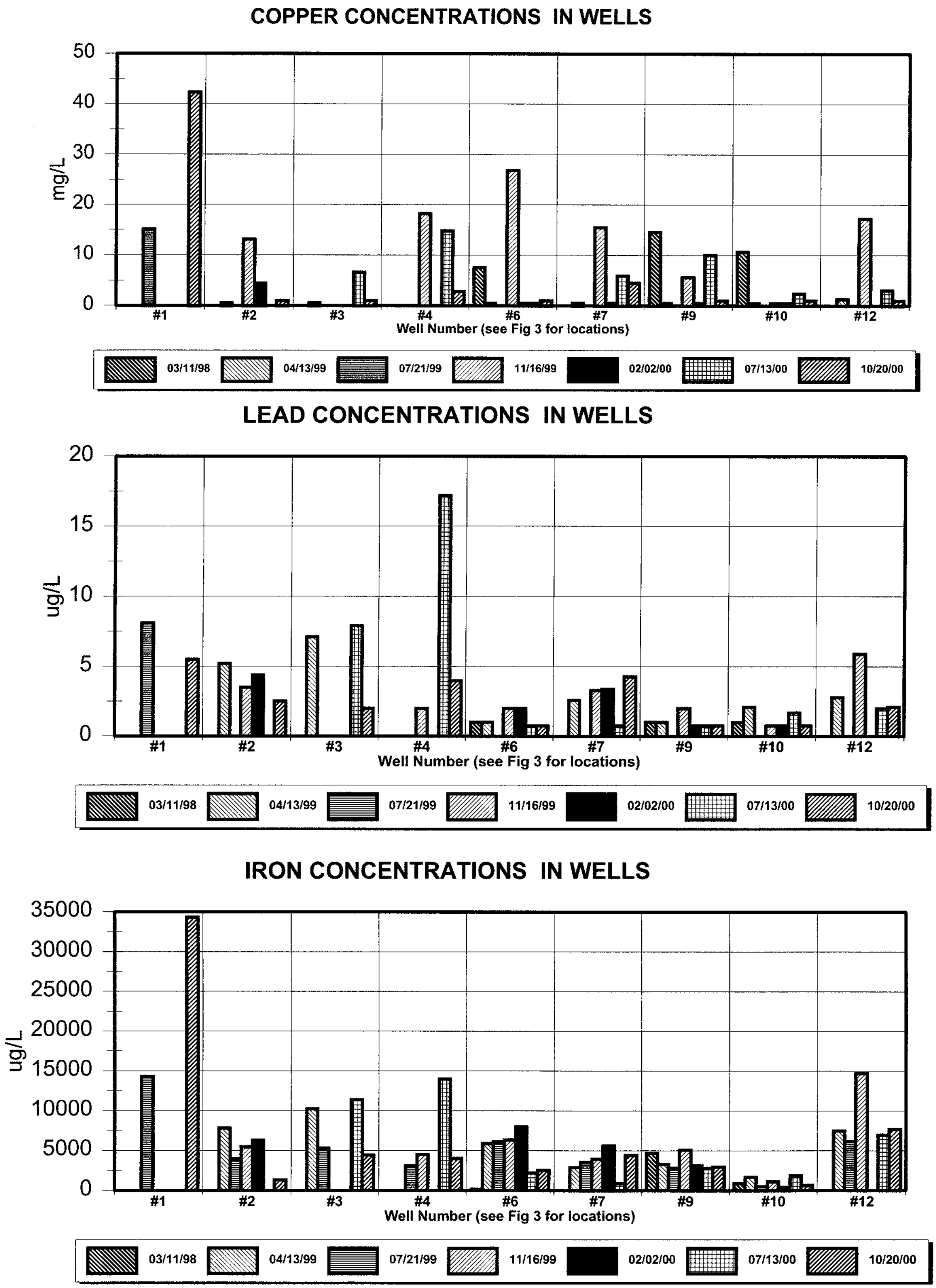

Figure 19. Metals measured in water table wells. Empty spaces indicate no water quality data collected on that date.

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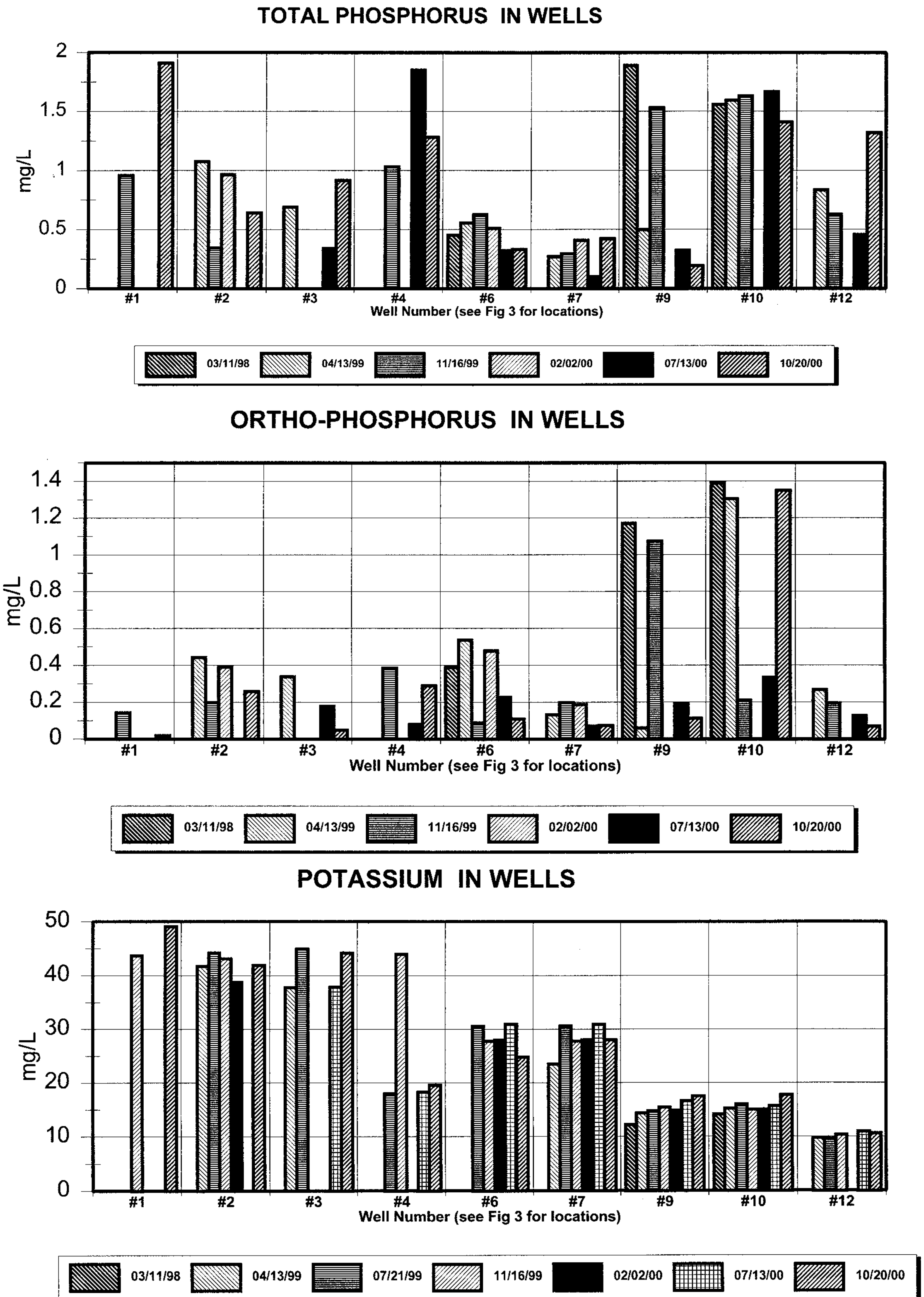


Figure 20. Nutrients measured in water table wells. Empty spaces indicate no water quality data collected on that date.

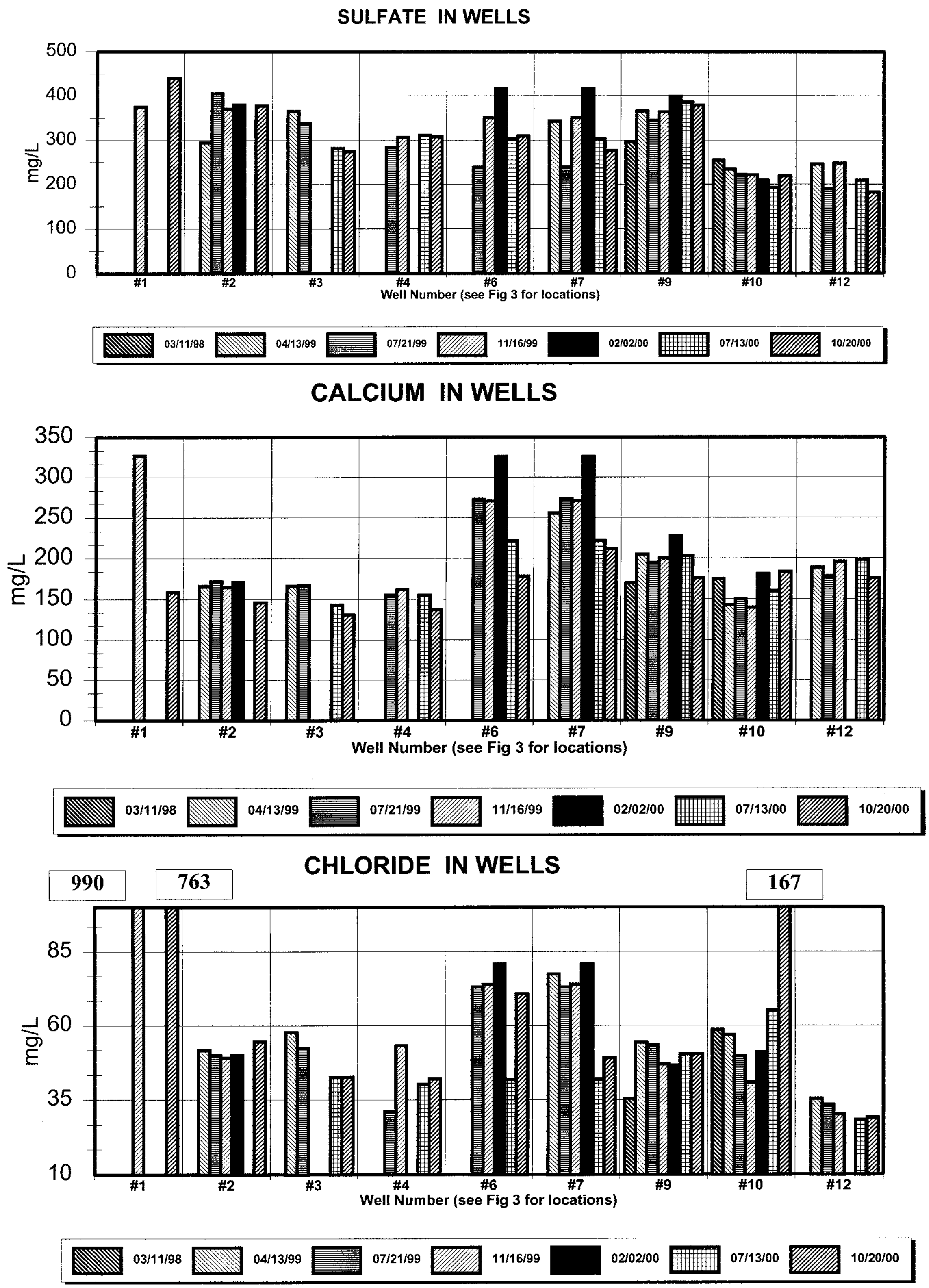


Figure 21. Major ions measured in water table wells. Empty spaces indicate no water quality data collected on that date.

west side of the ponds and furthest from the fields (wells 2, 3, and 4), but these wells were lowest in other nutrient concentrations indicating no potassium contamination from recent agriculture. Some of the other ions are graphed (Figure 21), and in contrast to potassium, are usually found at their lowest concentrations in wells 2, 3 and 4. Well 1 is influenced by water in the brackish marsh as can be seen by its chloride concentration of 990 mg/L and to a lesser extent by some of the other sea salts. In general, sulfate is measured at about the same concentrations in all wells, but average concentrations are lowest in wells 10 and 12.

Metal concentrations (Figure 19) exhibited no consistent pattern although iron and lead tended to measure higher concentrations in the uplands (wells 2, 3, 4, and 12). Iron consistently exceeded all standards for marine waters (300 ug/L) and fresh water (1000 ug/L). Copper frequently exceeded the marine standard of 4 ug/L but never exceeded the fresh water standard, which ranges between 50 and 92 ug/L at this site. (A range is given because the fresh water standard is calculated with a formula that includes the water hardness measured for the sample). Lead exceeded the marine standard of 5.6 ug/L for a few samples, but never exceeded the fresh water standard that ranged between 30 and 70 ug/L calculated for each sample. The fate of the metals once groundwater seeps into the marsh was not measured.

Statistical Analysis for Storm Event Samples

Statistical analyses were performed for the entire storm event data set to further verify some of our conclusions. The stations analyzed included the pond inflow, outflow and rainfall. A few storms with questionable data from the original data set were omitted and some storms occurring close together were combined, otherwise all storms for the four years of data collection were included and the data are the same as discussed in the previous sections for storm events. The SAS system (SAS 8.2 2001) was used for the statistical analyses and includes: summary statistics, tests for normality, significant differences between years and some correlation analysis and regressions.

Tests for Normality - A summary of all the storm event data with descriptive statistics is shown in Table 17 and all the data are summarized by year (Appendix L-1) and in tabular form (Appendix L-2). The summary data are identified by their abbreviation and also with a descriptive name. Hydrology data include the amount of rainfall for each event, the inter-event dry period, and the average intensity of the storm event. The hydrologic inputs and outputs to the pond are identified as the rain falling directly on the pond (RAPD), the runoff amount measured in the pipe entering the pond (INFL), and the water discharged from the pond over the outfall weir (OUFL). The remaining parameters describe the water quality data for the inflow, the outflow and in rainfall. The abbreviations in the column headings represent N for the number of observations used in the computation and NMISS for the number of observations with missing values. Many missed values are shown for the outflow because it usually took six to twelve storm events at the beginning of the rainy season each year before the pond filled with enough water to discharge. MIN represents the lowest value for the data while MAX is the maximum value. The Coefficient of Variation (CV) in SAS is multiplied by 100 and presented as a percentage. The CV is a useful measure for evaluating results from data collected by different experimenters, but to know if a particular CV is unusually large or small requires experience with similar data (Steel and Torrie 1960). The CV for the water

Table 17 . Summary statistics for the hydrology and water quality data used for statistical analysis*

Variable	Label	Units	N	N Miss	Mean	Std Error	Min	Max	Coeff of Variation	Skew-ness	Kurtosis
RAIN	Rain Amount	in	85	0	1.418	0.152	0.180	9.910	98.75	3.296	15.790
AVGI	Average Rain Intensity	in/hr	84	1	0.479	0.053	0.040	2.520	101.12	2.419	6.741
ANTE	Inter-event dry period	hours	85	0	198	27	0.7	1316.5	124.23	2.677	8.133
RAPD	Rain on Pond	cu ft	85	0	68429	8057	9344.5	514468.6	108.56	3.255	15.167
INFL	Inflow	cu ft	85	0	249488	52957	2076.6	3425798.9	195.70	4.176	22.156
OUFL	Outflow	cu ft	85	0	200935	56249	0.0	3891466.0	258.09	5.043	31.365
RANH	Ammonia in rain	mg/l	83	2	0.199	0.028	0.005	1.410	126.32	2.660	8.064
INNH	Ammonia at inflow	mg/l	84	1	0.124	0.018	0.005	0.943	130.47	2.878	9.486
OUNH	Ammonia at outflow	mg/l	54	31	0.067	0.010	0.005	0.453	114.88	3.087	12.284
RANOX	Nitrate+ in rain	mg/l	83	2	0.257	0.035	0.005	2.450	125.77	4.307	25.763
INNOX	Nitrate + at inflow	mg/l	84	1	0.385	0.083	0.005	4.190	198.43	3.018	9.743
OUNOX	Nitrate + at outflow	mg/l	54	31	0.068	0.020	0.005	0.672	213.09	2.811	7.505
RAON	Organic nitrogen in rai	mg/l	80	5	0.346	0.053	-0.224	2.888	137.87	3.017	11.487
INON	Organic nitrogen at in	mg/l	83	2	1.325	0.094	-0.083	4.366	64.73	1.573	3.229
OUON	Organic nitrogen at out	mg/l	53	32	1.487	0.117	0.016	4.727	57.52	1.429	3.236
RATN	Total nitrogen in rain	mg/l	80	5	0.702	0.080	0.050	3.900	101.82	2.770	9.093
INTN	Total nitrogen at inflow	mg/l	83	2	1.679	0.129	0.080	6.600	70.08	1.647	3.557
OUTN	Total nitrogen at outflo	mg/l	53	32	1.586	0.124	0.110	4.850	56.77	1.364	2.507
RAOP	Ortho-phos in rain	mg/l	82	3	0.025	0.008	0.005	0.510	271.11	5.954	37.409
INOP	Ortho-phos at inflow	mg/l	83	2	0.937	0.067	0.005	3.380	65.40	1.529	3.625
OUOP	Ortho-phos at outflow	mg/l	53	32	0.504	0.052	0.005	2.140	75.16	1.853	5.750
RATP	Total phosphorus rain	mg/l	83	2	0.042	0.011	0.001	0.681	244.73	4.993	26.153
INTP	Total phos at inflow	mg/l	82	3	1.509	0.140	0.005	8.650	83.84	3.165	13.729
OUTP	Total phos at outflow	mg/l	54	31	0.689	0.058	0.043	2.370	62.09	1.273	3.542
RAAL	Aluminum in rain	ug/l	81	4	119.4	12.3	10.5	528.0	93.08	1.859	3.443
INAL	Aluminum at inflow	ug/l	84	1	2010.1	518.7	86.1	30000.0	236.48	4.176	18.984
OUAL	Aluminum at outflow	ug/l	54	31	1075.3	173.5	0.0	6920.0	118.54	2.555	8.157
RACD	Cadmium in rain	ug/l	81	4	0.217	0.024	0.015	1.600	99.11	4.545	24.226
INCD	Cadmium at inflow	ug/l	84	1	0.619	0.186	0.015	13.300	275.79	6.108	40.894
OUCD	Cadmium at outflow	ug/l	54	31	0.147	0.004	0.000	0.253	21.11	-2.800	17.275
RACR	Chromium in rain	ug/l	81	4	1.507	0.081	0.200	3.800	48.63	0.626	-0.720
INCR	Chromium at inflow	ug/l	83	2	23.519	8.356	1.000	545.000	323.68	5.816	35.506
OUCR	Chromium at outflow	ug/l	54	31	4.400	0.733	1.000	35.200	122.36	3.850	20.071
RACU	Copper in rain	ug/l	81	4	2.297	0.305	0.050	16.000	119.67	2.825	9.301
INCU	Copper at inflow	ug/l	84	1	60.812	16.095	0.500	1100.000	242.58	5.444	33.842
OUCU	Copper at outflow	ug/l	54	31	6.797	0.986	0.716	32.700	106.56	1.864	3.338
RAFE	Iron in rain	ug/l	81	4	44.4	6.0	12.5	340.0	122.45	3.663	15.458
INFE	Iron at inflow	ug/l	84	1	1172.2	317.9	70.0	21500.0	248.56	5.425	33.019
OUFE	Iron at outflow	ug/l	54	31	477.6	77.4	60.0	3480.0	119.11	3.228	14.181
RAPB	Lead in rain	ug/l	81	4	0.860	0.017	0.750	1.700	17.97	2.126	9.035
INPB	Lead at inflow	ug/l	84	1	7.142	2.606	0.750	178.000	334.46	6.129	39.309
OUPB	Lead at ouflow	ug/l	54	31	1.522	0.167	0.750	5.900	80.70	1.828	2.895
RAMG	Magnesium in rain	ug/l	70	15	0.162	0.027	0.000	1.710	140.65	4.835	31.015
INMG	Manesium at inflow	ug/l	84	1	33.758	1.438	5.980	56.200	39.04	-0.379	-0.624
OUMG	Magnesium at outflow	ug/l	53	32	71.711	8.994	11.200	399.000	91.31	2.933	11.591
RAMN	Manganese in rain	ug/l	82	3	2.203	0.217	0.300	13.300	89.33	3.015	12.999
INMN	Manganese at inflow	ug/l	84	1	239.190	26.847	14.300	1570.000	102.87	3.247	13.329
OUMN	Manganese at outflow	ug/l	53	32	87.358	9.198	13.100	396.000	76.66	2.450	8.477
RANI	Nickel in rain	ug/l	82	3	1.954	0.150	1.250	10.000	69.36	4.003	19.062
INNI	Nickel at inflow	ug/l	84	1	3.424	0.495	1.250	33.100	132.50	4.894	27.183
OUNI	Nickel at ouflow	ug/l	53	32	2.458	0.348	1.250	18.300	103.08	4.957	29.988
RAAG	Mercury in rain	ug/l	82	3	0.056	0.002	0.050	0.200	37.99	4.517	25.197
INAG	Mercury at inflow	ug/l	84	1	0.245	0.065	0.050	4.500	243.98	5.735	36.334
OUAG	Mercury at outflow	ug/l	53	32	0.058	0.003	0.033	0.141	34.53	2.443	5.862
RAZN	Zinc in rain	ug/l	81	4	47.748	6.054	7.500	320.000	114.10	3.150	11.383
INZN	Zinc at inflow	ug/l	83	2	49.119	12.167	7.500	820.000	225.68	5.568	34.112
OUZN	Zinc at outflow	ug/l	52	33	18.695	1.739	7.500	53.239	67.09	1.314	1.050
INSS	Suspended solids in	mg/l	80	5	72.856	32.340	2.800	2546.000	397.03	8.152	69.917
OUSS	Suspended solids out	mg/l	53	32	29.466	5.055	1.060	176.000	124.91	2.057	4.315

* For values below the laboratory detection limit one half the detection limit was used in the calculations.

quality in the stormwater samples we collect usually vacillates in a wide range around 1.0 when presented as a ratio or around 100 when given as a percentage. Skewness and Kurtosis indicate whether the data are from a normal (bell-shaped) distribution. For a normal distribution, the skewness is zero, and also, as calculated by SAS, the kurtosis for a normal distribution is zero (Schlotzhauer and Littell 1997). Since the distribution of the data is important in selecting the correct statistical test and both the skewness and the kurtosis values indicated the data were not from a normal distribution, more information was necessary before doing any hypothesis testing. The Univariate procedure in SAS provided a wealth of information for analyzing the pattern of data and it indicated the data were strongly left skewed. Taking the log of the data improved the distribution for most parameters, but others especially those with many values near the detection limit were not improved as much. For the statistical analysis either the log transformed data or non-parametric statistics were used.

Differences Between Years - Since most of the data previously discussed in this report have been divided into yearly data, we wanted to test to see if there were any significant differences between years. Also of interest was the idea that constituent concentrations might increase as the system aged. The Duncan Multiple Range test using log transformed data and the Kruskal-Wallis non-parametric test were run to help determine statistical differences. This information is shown in Tables 16a-c and includes the probability value, the number of samples in the calculation and the sample mean. Means with the same letter are not significantly different.

The hydrology data (Table 18a) tested no significant differences between years except for the inflow data. In 1999 significantly less storm runoff was measured flowing into the pond, while during 2001 more runoff was measured coming into the pond than in any other year. This represents the different agricultural irrigation practices for the two years with less activity in 1999 and more in 2001. Another likely explanation is Hurricane Gabrielle that dumped 40 cm (9.91 in) of rain on the site in 2001. This represented 48 percent of all the rain measured in 2001.

Table 18a. Significant differences between years for the hydrology parameters.

Parameter	Units	P ≤	1998		1999		2000		2001	
Storm event rain	inch	0.62	25	1.44a	25	1.57a	21	1.29a	14	2.04a
Inter-event dry period	hour	0.38	25	218a	25	230a	21	142a	14	187a
Average Intensity	in/hr	0.22	25	0.440a	24	0.668a	21	0.355a	14	0.411a
Rain on pond	cu ft	0.28	25	6.9E4a	25	5.2E4a	21	6.2E4a	14	10.6E4a
Inflow	cu ft	0.016	25	2.0E5bc	25	1.2E5c	21	2.7E5ab	14	5.1E5a
Outflow	cu ft	0.88	25	1.5E5a	25	0.9E5a	21	2.2E5a	14	4.2E5a

The inflow results revealed considerable differences between years (Table 18b). Nutrients (nitrogen and phosphorus) tended to be significantly higher in 2001 and lowest in 1999. This was the same pattern shown by the pond inflow data (Table 18a) and is probably also an artifact of differences in agricultural practices between years. Metals demonstrate a different pattern with significantly higher concentrations in 1998, the El Niño year. Although not significant, metals, nutrients and suspended solids tended to show an increasing trend from 1999 to 2001. The significant results tend to verify the assumptions made during the discussion for Table 7 and Figures 5 and 6.

Table 16b. Significant differences between years for the inflow water quality parameters.

Parameter	Units	P ≤	1998		1999		2000		2001	
Ammonia	mg/l	0.0002	25	0.100a	25	0.053b	21	0.092b	12	0.116b
Nitrate + Nitrite	mg/l	0.007	25	0.427a	25	0.131b	21	0.417a	13	0.741c
Organic Nitrogen	mg/l	0.003	25	1.11bc	25	0.90c	21	1.65ab	13	1.99a
Total Nitrogen	mg/l	0.0001	25	1.21b	24	0.985b	21	2.24a	13	2.96a
Ortho Phosphorus	mg/l	0.064	25	0.95b	24	0.80b	21	0.78ab	13	1.41a
Total Phosphorus	mg/l	0.067	25	1.84ab	24	0.957b	21	1.42ab	12	2.07a
Copper	ug/l	0.0001	25	117b	25	8.24a	21	68.1a	13	41.2a
Iron	ug/l	0.0005	25	2224b	25	245a	21	928a	13	1335a
Zinc	ug/l	0.0001	25	98.6a	24	12.8b	21	37.7a	13	39.4b
Suspended solids	mg/l	0.0007	25	155a	23	11b	20	44a	12	67a

Some of the same patterns as measured at the inflow were also seen for constituents measured at the outflow (Table 18c). Both locations had significantly higher copper concentrations during the El Niño year and significantly lower phosphorus concentrations in 1999. The highest levels of suspended solids and organic nitrogen were measured at the outflow in 2000 and may reflect an increase in most concentrations from July 2001 to July 2002 (see Figures 5 and 6).

Table 18c. Significant differences between years for the outflow water quality parameters.

Parameter	Units	P ≤	1998		1999		2000		2001	
Ammonia	mg/l	0.233	9	0.066a	14	0.034a	17	0.086a	14	0.076a
Nitrate + Nitrite	mg/l	0.001	9	0.194a	14	0.007b	17	0.045b	14	0.076b
Organic Nitrogen	mg/l	0.004	9	0.828b	13	0.828b	17	2.18a	14	1.47ab
Total Nitrogen	mg/l	0.004	9	0.893b	13	1.18b	17	2.24a	14	1.62a
Ortho Phosphorus	mg/l	0.0001	9	0.623ab	13	0.200c	17	0.355b	14	0.888a
Total Phosphorus	mg/l	0.0001	9	0.807ab	14	0.331c	17	0.630b	14	1.044a
Copper	ug/l	0.0001	9	16.79a	14	3.09b	17	6.59b	14	4.33b
Iron	ug/l	0.006	9	472a	14	482a	17	724a	14	178b
Zinc	ug/l	0.421	10	16.9a	13	15.0a	14	23.6a	14	18.1a
Suspended solids	mg/l	0.0001	10	20.3b	14	26.3ab	15	59.3a	14	7.1c

Correlation Analysis - Chemical and physical processes in surface waters influence the concentration of pollutants in stormwater systems causing some constituents to vary together. In addition, rainfall characteristics such as storm intensity and antecedent conditions (inter-event dry period) have sometimes been implicated in the concentrations measured for pollutants. To better identify and understand relationships between variables, the Spearman method was used to compute correlation coefficients (Appendix L-3). The Spearman coefficient was chosen since it makes no assumption of a normal or linear distribution and also gives more reliable information if the data possess a distinct curvilinear relationship (Walpole and Myers 1972).

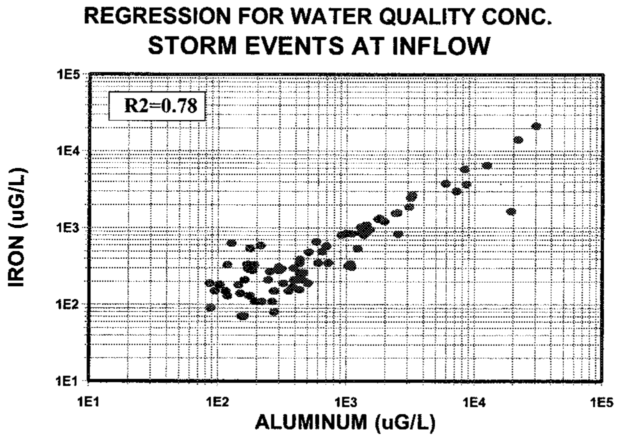
Since the pond was large and the outflow samples were not usually from the same storm event as the inflow samples, no comparisons were made between the inflow and outflow. In a review of the correlation results shown in Appendix L-3, the closest relationships were seen for the inflow data while the outflow and rainfall data demonstrated some weaker associations. Some of the better correlations were not at all surprising, for example, nitrogen species tended to vary together as did ortho- and total phosphorus. Also metals showed a close relationship, especially with iron and aluminum, and sometimes with total suspended solids and phosphorus.

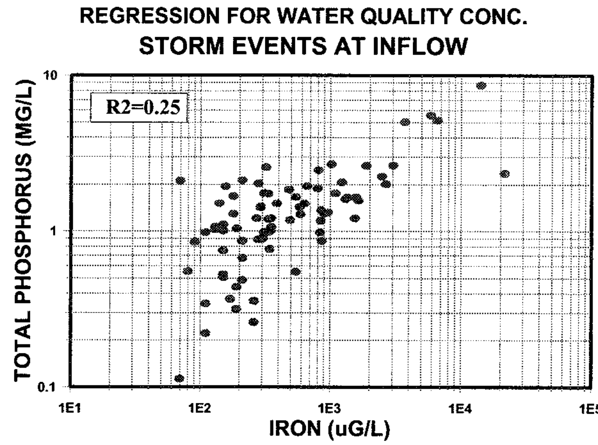
A few of the relationships were investigated further with regression analysis using data converted to a log normal distribution (Figures 22a-b). Metals, suspended solids and total phosphorus often vary together. This can be partially explained by the interaction of iron with other agents. Most iron is present as colloidal particles of ferric hydroxide, which is measured here in part as suspended solids, explaining that relationship. Metals, such as copper, can also be adsorbed by and co-precipitated with the ferric hydroxide precipitate (Wetzel 1975). Manganese is chemically similar to iron in its behavior in surface water and similar conditions cause these two elements to vary together. Fortunately, many toxic metals are readily sorbed by iron thereby reducing their availability for biological uptake (Moore 1991). Although iron interactions with the biota show little adverse effect on acute toxicity, little is know about iron's effect on chronic toxicity. Although iron is only moderately toxic in most water, when the iron redox cycle is broken, as happens with low dissolved oxygen conditions, other pollutants may be mobilized and lead to significant environmental effects (Moore 1991). Although zinc was often measured below the laboratory detection limit, when it was present in measurable amounts at the inflow, 80 percent of its variation could be attributed to an increase in total suspended solids. Other researchers have found that zinc shows variable behavior in binding to suspended particulates, depending on pH and Eh conditions, and the input of anthropogenically derived zinc (Moore 1991).

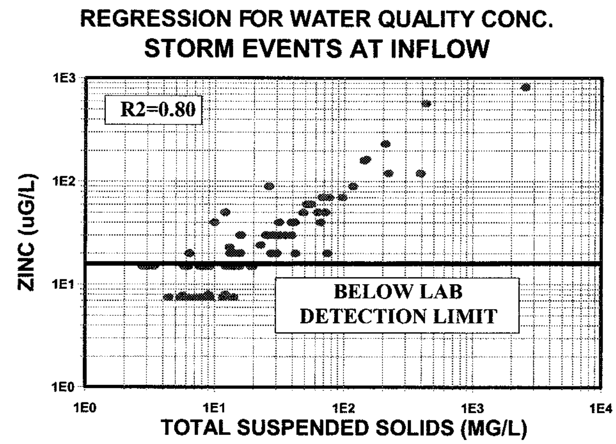
Phosphorus was of special interest in this study since it was measured in elevated concentrations at this site (see Table 7). Under undisturbed natural conditions, phosphorus is in short supply and is soluble only under acidic or anoxic (low oxygen) conditions. In the soil or sediments it becomes immobilized as phosphates of either calcium or iron. Besides its relationship with iron, phosphate species are also known to form complexes, chelates and insoluble salts with other metals (Stumm and Morgan 1970). The correlations of total phosphorus with manganese, iron and copper in this study also support the idea that their aquatic transformations (dissolution, transport, distribution, precipitation and accumulation) are interrelated and are interdependent with other components of natural waters (Stumm and Morgan 1970). Total phosphorus and ortho-phosphorus were also correlated with each other (Figure 22a), which is not surprising since ortho- is a constituent of total phosphorus. Of some interest is the fact that at higher concentrations of phosphorus, ortho-P is a smaller percentage of total P than at lower concentrations. This may be the result of fertilizer application. One researcher studying fish ponds found that when fertilizer is applied there is a rapid increase in total phosphorus concentration in the water column, but that total phosphorus is quickly decreased to pretreatment levels when adsorbed and settled as soil particles (Boyd 1995).

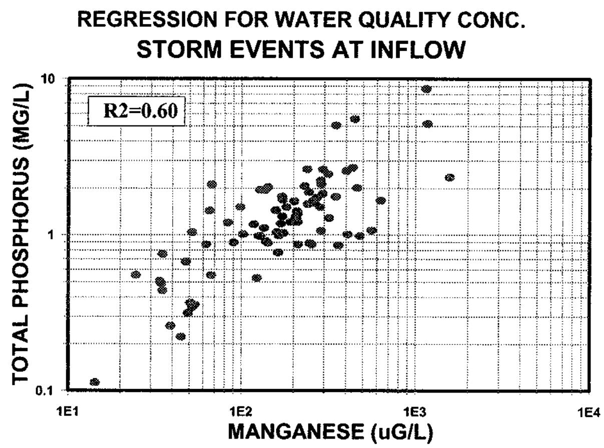
Nitrogen exhibited a few interesting relationships. Nitrogen has been dramatically increased in surface water with the increased use of nitrogen-based fertilizers. Dramatic changes in nitrogen come during rainfall, particularly in the first and second runoff events after a long dry period (Moore 1991). All the forms of nitrogen are interrelated by a complicated series of transformations within the nitrogen cycle. Therefore it was not surprising to find that ammonia and nitrate exhibited a close relationship in rainfall (r=0.64) and at the inflow (r=0.52). Under aerobic conditions ammonia is rapidly oxidized to nitrate (Moore 1991) helping to explain why no relationship was noted between ammonia and nitrate at the outflow. Ammonia and nitrate are usually denitrified in pond waters (Boyd 1995) or converted to organic nitrogen. Another interesting relationship may be the result of farming practices where 46 percent of copper concentrations were related to nitrogen concentrations. Both copper and nitrogen are used in row crop farming that uses plastic sheeting.

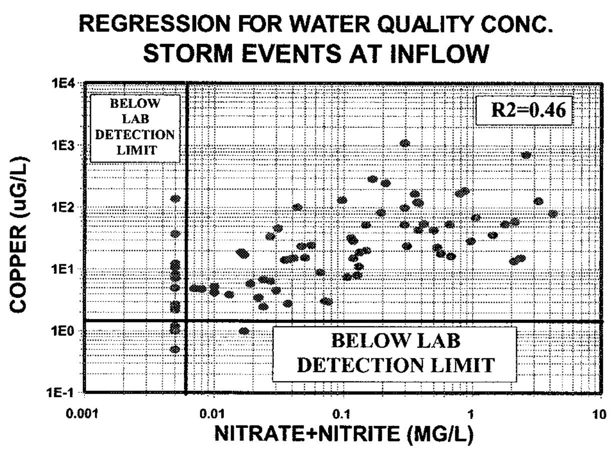
No close correlations were found between constituent concentrations and hydrology (rain amount, intensity, antecedent conditions, inflow and outflow). The closest relationship was a negative correlation calculated for the outflow volume and organic nitrogen concentration where 15 percent of the variation was explained by the association. This result was probably caused by less organic nitrogen measured in large storms which flush out the system and dilute pond water. The results from the correlation analysis do not support the discussion of rainfall characteristics that accompanied Table 5, which indicated that long inter-event dry periods and higher rainfall intensities would increase constituent concentrations. The lack of correlation can probably be attributed to the pervious nature of the site, pre-treatment by the ditch and the over-riding dominance of the agricultural practices.











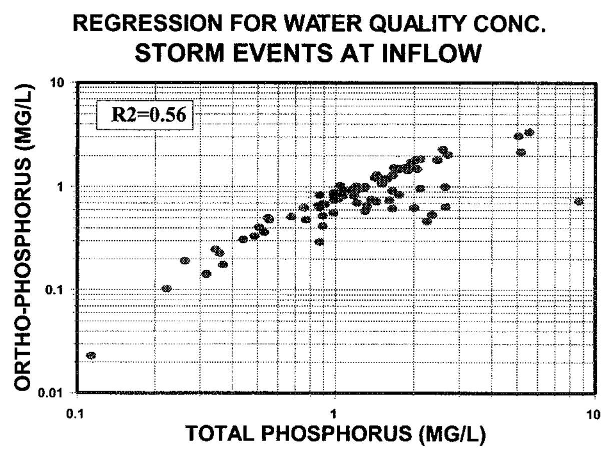


Figure 22a . Regression analysis for water quality parameters measured at the inflow

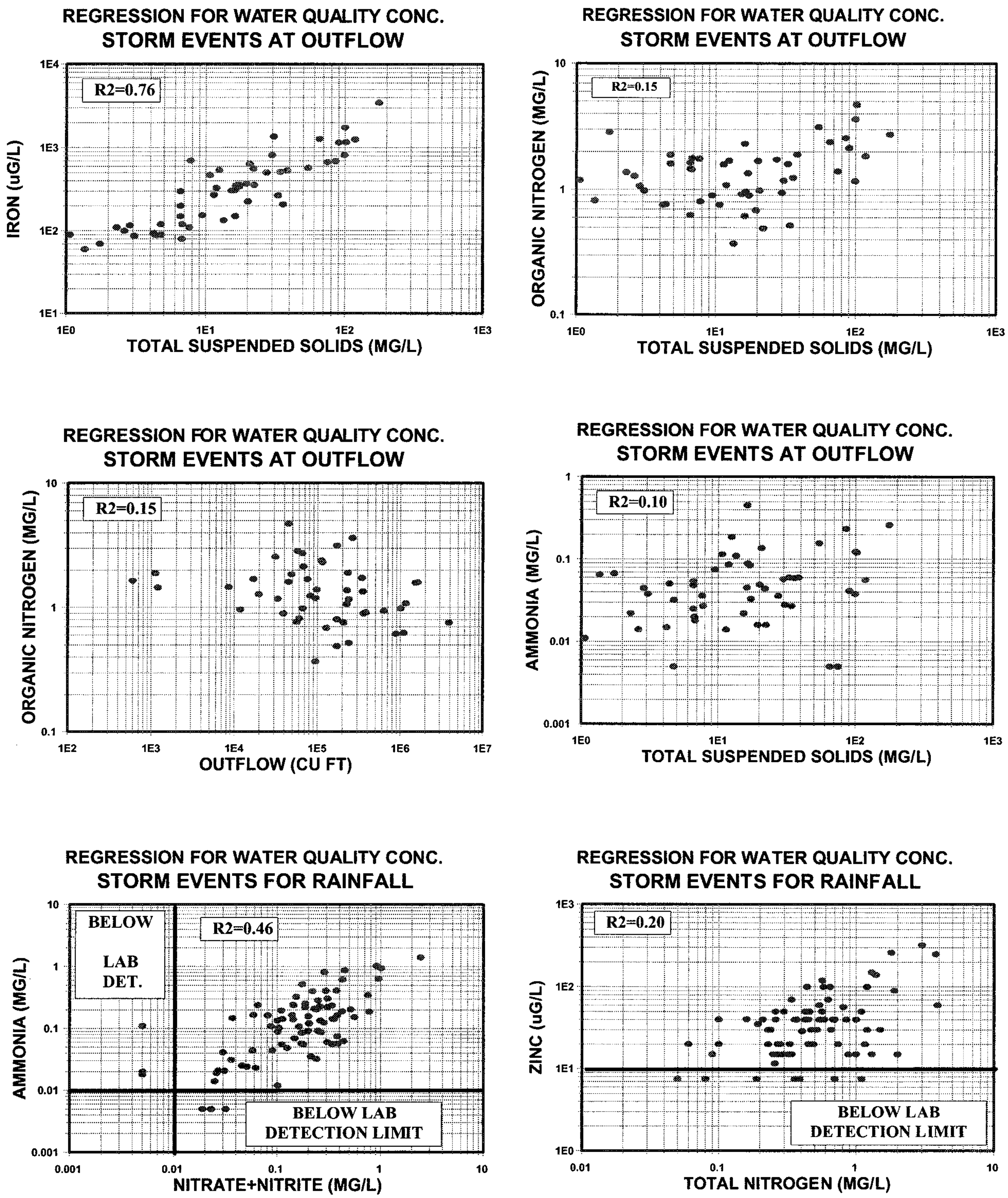


Figure 22b . Regression analysis for water quality parameters measured at the outfl or in rainfall,

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Summary of Results

Hydrology

- Rainfall directly on the pond contributed 17 to 29 percent of the hydrologic input to the pond (Table 6a and 6b).
- The large storage capacity of the pond at the beginning of the rainy season helped reduce the annual volume of runoff that left the pond by 11 to 25 percent (26 to 45 percent when rainfall is considered an input) (Table 6a and 6b).
- The runoff coefficient ranged from 0.20 to 0.30 during the rainy season, 0.00 to 0.10 during the dry season and greater than 0.40 for a few storms greater than 2 inches (Table 6a).
- A complete water budget of the pond estimated about 75 percent of the hydrologic input and output was measured at the control structures, about 20 percent was identified as rainfall directly on the pond and the remainder was lost by evapotranspiration and net seepage (Table 7b and Appendix C).
- Although both drought and flood years were included in the study, there were no significant differences between years for rainfall characteristics except for the inflow into the pond, where inflows were significantly greater during 2000 and 2001 caused in part by more irrigation (Table 18a).

Storm Water Quality

- Significant differences in pollution concentrations were noted between years with extremely high concentrations of metals and pesticides flushed through the system during the El Niño storms and higher concentrations of nutrients and some metals measured with increased agricultural activity in 2000 and 2001 (Table 7, 9 and 18b; Figures 5 and 6; Appendixes D and I).
- Annual averages of copper and iron concentrations failed to meet Class II and III marine water standards at the outflow of the pond during all years (Table 7a and Appendix D).
- Total suspended solids and total organic nitrogen concentrations increased from the inflow to the outflow during the second and third years (Table 7a and Appendix D).
- The nutrient levels for pristine waters determined for total nitrogen (0.90 mg/L) and total phosphorus (0.04 mg/L) for our region by the Environmental Protection Agency were seldom met when water was discharged from the pond after storm events (Table 7b and Appendix D).
- Large storm events flush out the system and often contribute the majority of pollutant loads measured for years. Five storms during El Niño contributed over 65 percent of metal pollutant loads measured during the first three years of the study and 40 percent for the entire four years (Figures 5, 6 and Table 8).

Ambient Water Quality

- The wet-detention pond often failed to meet the state dissolved oxygen standard (> 4 mg/L) especially at the outflow. The pH standard, with an acceptable range between 6.5 and 8.5 SU, was usually met except during the summer at the inflow (Figure 10 and Appendix F).
- Phosphorus concentrations in the water in the ditch were all between 2 and 6 mg/L when

dissolved oxygen levels were below 1 mg/L. All P samples were below 2 mg/L when DO was above 2 mg/L, emphasizing the relationship between aerobic conditions and the release of sequestered pollutants from the sediments (Figure 13).

- The field measurements of pH and dissolved oxygen often demonstrated the dampening effect of the pond when comparing fluctuations between the inflow and the outflow (Figure 9 and Appendix F) and this is also reflected by the lower chlorophyll concentrations measured at the outflow compared to the inflow (Table 11).
- Pesticides in stormwater were detected, and more were found at the inflow (10) than at the outflow (4). Two pesticides exceeded standards (Endosulfan at the inflow and outflow and Chlordane at the inflow) (Table 9). Pesticides were also detected in ambient water quality samples collected in the roadside pre-treatment ditch (at some sites in 55 percent of samples for endosulfan; 10 percent for chlordane; 5 percent for Bromacil; and 16 percent for Diazinon) (Table 16 and Appendix H).
- Concentrations of some nutrients (except nitrate) were reduced as water flowed along the ditch and average ambient concentrations were also higher in the ditch than measured at the inflow of the pond during storm events (Tables 7 and 12).
- Average concentrations in the ditch were over three times greater for fecal coliform and over five times greater for total coliform than measured at the inflow to the pond (Tables 10 and 14).
- Both fecal coliform and total coliform bacteria appear to exceed concentrations considered safe for the propagation and harvesting of shellfish at the outflow. This has implications since the pond water discharges to an estuary that in the past was a prime shellfish harvesting area (Table 10). Still the system greatly reduced bacteria and the median concentrations at the outflow are 14 to 30 times less than the fecal and total coliform bacteria measured in the ditch (Tables 10 and 14).
- The chlorophyll concentrations were reduced as water flowed from the ditch through the pond and over the outflow structure, but the pond still discharged water into the marsh in the eutrophic to hypereutrophic range (Tables 7a and 11).

Sediments

- Concentrations of metals of concern in the sediments usually showed an increase from 1997 to 1998, demonstrating that the sediment metal concentration in this newly constructed pond increased from undetectable amounts in 1997 to much higher concentrations in 1998 (Figures 14 and 15). This may account for the good removal of water quality pollutant loads (about 90%) in 1998 compared to 1999 and 2000 (about 60%) as attachment sites on sediment particles were occupied (Figure 8).
- High concentrations of metals were measured in the sediments in the ditch and some concentrations were possibly toxic (Figures 15 and 16).
- Pesticides measurements in the sediments identified chlordane and DDT derivatives as present in almost all soil samples (Table 17). Some of the pesticides measured reflect the same pollutants as those in the water samples (Table 16) except they were detected much more often in the sediments.

Ground Water

- The dry season in May shows greater variation between years than the wet season in September (Figure 17). This is consistent with the rainfall data that show more below average concentrations during the dry season than the wet season (June, July, August, and September) except for the El Niño Year (Figure 4).
- Ammonia (Figure 18) was consistently measured at high levels (7 to 16 mg/L) in well 10, closest to the sewage lagoon and total phosphorus (Figure 20) was also often measured at higher concentrations (1.5 mg/L) in this well.
- Metal concentrations in the wells (Figure 19) exhibited no consistent pattern although iron and lead tended to be measured at higher concentrations in the uplands (wells 2, 3, 4, and 12). Iron in the wells consistently exceeded all standards for marine waters (300 ug/L) and fresh water (1000 ug/L).

Conclusions

The wet-detention pond moderated the effects of agricultural stormwater runoff and reduced pollutants entering the bay by a significant amount. But even though the pond reduced pollutant loads for most constituents by at least 60 percent, and often over 80 percent, some water quality problems exist. The average annual concentrations for copper and zinc failed to meet the State of Florida Class II and Class III marine water quality standards (Chp 62-302.530) for all years. Thirty-two percent of the samples for fecal coliform bacteria taken at the outflow of the pond failed to meet standards, and the median concentrations at the outflow were barely met for total coliform concentrations. Although the pond frequently failed to meet the standard for dissolved oxygen at the outflow, it is expected that dissolved oxygen concentrations will increase as water is discharged over the weir. The pristine water quality levels identified for nutrient concentrations for our region by the Environmental Protection Agency were not met for total nitrogen and total phosphorus. The 80% reduction goal for total suspended solids recommended in the State Water Policy (Chp 62-40 FAC) was met for only two of the four years of study. Although the concentrations of pesticides measured in this study were usually below the detection limit, they are a cause for concern. This is especially true for chlordane and endosulfan concentrations that exceeded Water Quality Standards in the pond.

Data Needs

- Maintenance guidelines need to be developed for wet-detention ponds. The littoral zone at this study site was transformed from a flag marsh to a cattail marsh that resulted in a shift in bird utilization from flocks of wading birds to black birds.
- The accumulation of metals in the sediments from 1997 to 1998 indicate more long-term studies of wet-detention ponds are needed to quantify the performance of ponds as they age.
- More information is needed about the effect of wet-detention ponds on wild life and whether we are creating toxic conditions for wildlife.
- Ditch maintenance needs to be better quantified and incorporated into county schedules. The ditch in this study appeared to significantly reduce the amount of pollutants reaching the

pond, but anaerobic conditions and vegetation left to rot in the ditch may reduce its effectiveness.

- Best Management Practices (BMPs) such as filter strips and irrigation water reuse need to be encouraged for row crop farming. Also less reliance on pesticides and fertilizers.

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APPENDIX FOR METHOD SECTION

STRUCTURE DESIGNS

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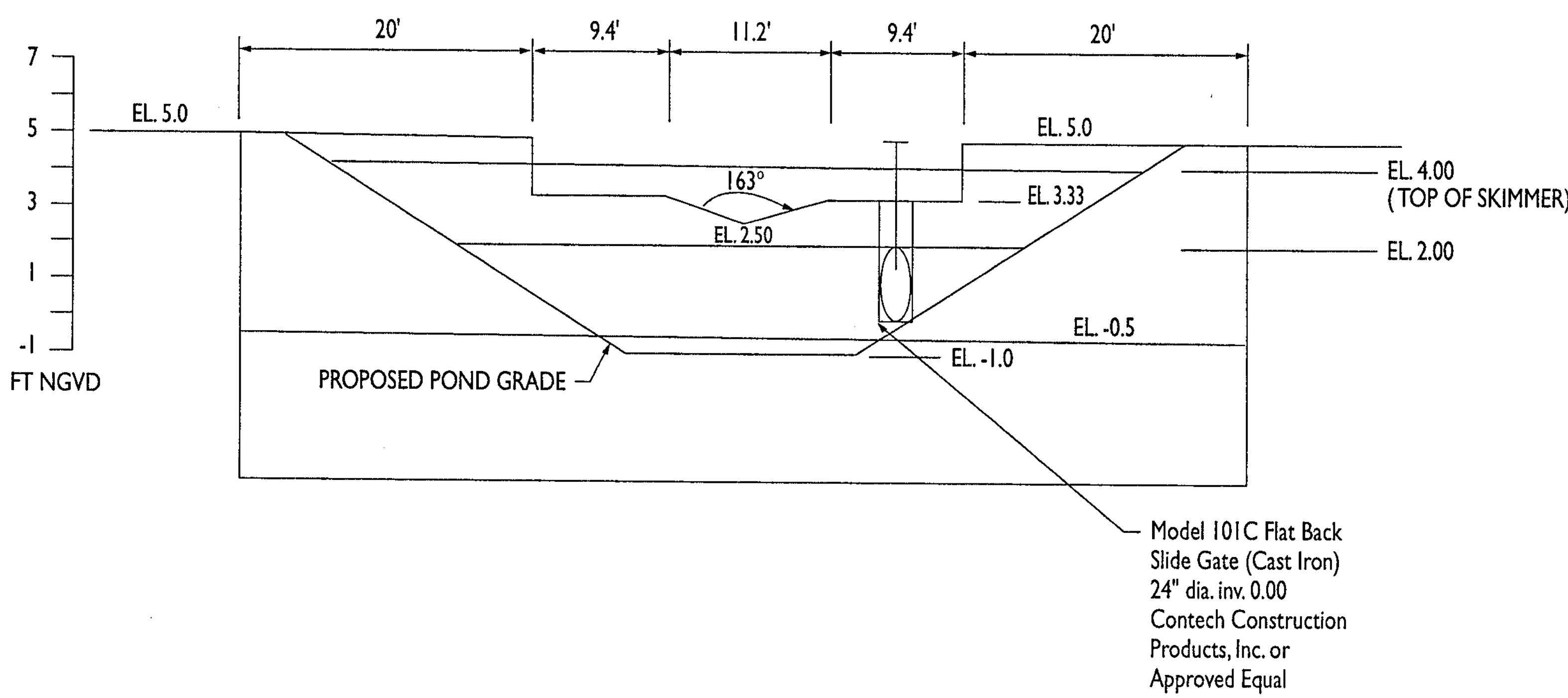
QUALITY ASSURANCE DATA

OUTFLOW WEIR STRUCTURE



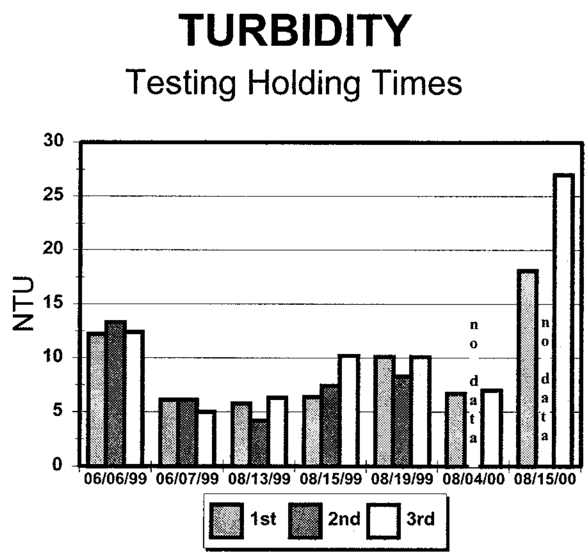
Appendix for quality assurance. Comparison of water quality collected immediately after the storm with water qulity allowed to sit for three days in the refrigerator and then fixed with acid and taken to the lab. Sample 1 and sample 2 tests the variability between duplicate samples. Sample 3 (held) tests the variability between samples allowed to sit in the refrigerator for a couple of days compared to samples collected right away.

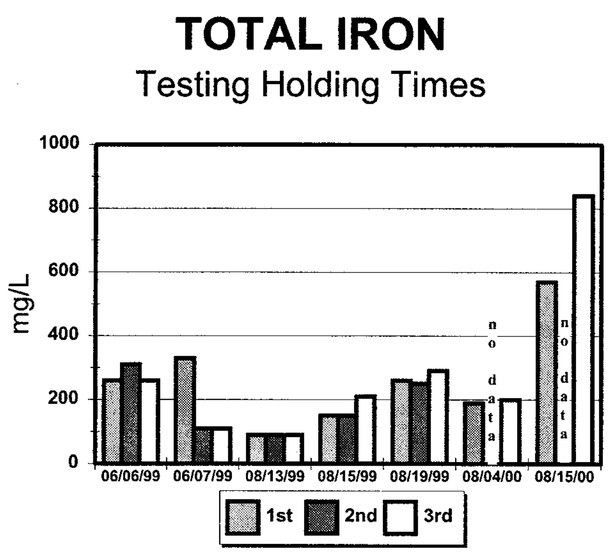
constituent	Units	1st sample	2nd Sample	1st sample	2nd Sample	1st sample	2nd Sample	3rd Sample held	1st sample	2nd Sample	3rd Sample held	1st sample	2nd Sample	3rd Sample held
Date Station		09/19/98 STA 819	09/19/98 STA 819	01/25/99 RNA 468	01/25/99 RNA 468	06/06/99 STA 819	06/06/99 STA 819	06/08/99 STA 819	06/07/99 STA 819	06/07/99 STA 819	06/09/99 STA 819	08/13/99 STA 819	08/13/99 STA 819	08/15/99 STA 819
Aluminum	ug/L	431	461	17.6	15.3	435	541	478	118	111	104	88.2	90.2	97
Cadmium	ug/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.7	<0.3	<0.3	<0.3	<0.3	<0.3
Chloride	mg/L	131	128	0.88	0.68	125	124	123	82.1	79.2	105	129	93	96.3
Chromium	ug/L	7.3	7.2	<4.7	<4.7	<4.7	<4.7	<4.7	<2	<2	<2	<2	<2	<2
Copper	ug/L	15.3	16.1	<1	<1	<1	<1	<1	<2	<2	2.9	2.8	2.5	<2
Iron	ug/L	350	390	<30	<30	260	310	260	330	110	110	90	90	90
Lead	ug/L	<2	<2	<2	<2	<2	<2	<2	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Nickel	ug/L	<4.7	<4.7	<4.7	<4.7	<4.3	<4.3	<4.3	3.1	2.6	2.9	3.2	3.1	2.5
Ortho-Phos	mg/L	0.822	0.822	0.012	<0.01	0.227	0.230	0.234	0.873	0.871	0.850	0.659	0.769	0.774
Total Phos	mg/L	1.067	1.081	0.010	<0.01	0.357	0.368	0.357	0.987	0.923	0.966	0.856	0.870	0.899
Potassium	mg/L	13.8	13.9	0.1	<0.05	17.8	17.7	17.8	20.4	20.2	18.0	17.3	17.5	17.9
Silver	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	mg/L	68.3	68.3	0.67	0.47	63.8	63.8	63.7	46.3	46	47.1	47.8	47.8	48.1
Sulfate	mg/L	203	200	0.47	0.36	307	302	301	266	258	270	304	293	298
Tubidity	NTU	na	20.0	0.3	0.2	12.2	13.3	12.4	6.1	6.1	5.0	5.8	4.2	6.3
Zinc	ug/L	<30	<30	<30	<30	<30	<30	<30	<15	<15	<15	<15	<15	<15
Calcium	mg/L	92.5	92.4	0.2	0.1	118	118	118	147	149	137	151	146	148
Magnesium	mg/L	29.1	29.0	0.1	0.0	54.3	54.3	54.4	49.3	48.8	34.8	33.7	33.1	30.6
Hardness	mg/L	351	350	0.78	0.41	518	518	518	570	573	485	515	500	495
Total Nitrogen	mg/L	0.63	0.64	0.4	0.2	0.8	1.4	1.6	1.1	1.2	0.23	1.3	1.5	1.1
Ammonia-N	mg/L	0.105	0.109	0.030	0.011	0.017	0.021	0.033	0.017	0.015	0.035	0.123	0.166	0.112
Nitrate-N	mg/L	0.101	0.098	0.031	0.032	<0.01	<0.01	0.285	0.091	0.086	0.025	0.026	0.033	0.035
NItrite-N	mg/L	0.018	0.019	<0.01	<0.01	<0.01	<0.01	<0.01	0.007	0.007	0.006	0.011	0.011	<0.005
Manganese	ug/L	287	300	<0.6	<0.6	53.8	57.2	55.1	480	479	531	363	350	345

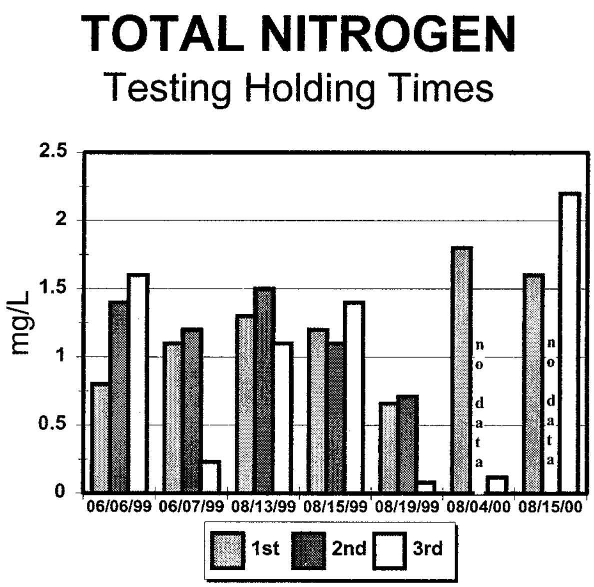
Appendix for QA (continued). Comparison of water quality collected immediately after the storm with water quality allowed to sit for three days in the refrigerator and then fixed with acid and taken to the lab. Sample 1 and sample 2 tests the variability between duplicate samples. Sample 2 or 3 (held) tests the variability between samples allowed to sit in the refrigerator for a couple of days compared to samples collected right away.

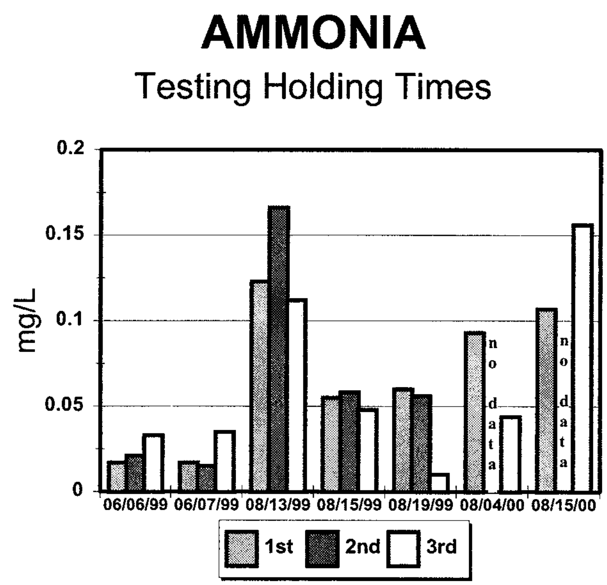
	Units	1st sample	2nd Sample	3rd Sample held	1st sample	2nd Sample	3rd Sample held	1st sample	2nd Sample held	1st sample	2nd Sample held
Date Station		08/15/99 STA 819	08/15/99 STA 819	08/17/99 STA 819	08/19/99 STA 819	08/19/99 STA 819	08/20/99 STA 819	08/04/00 STA 819	08/04/00 STA 820	08/15/00 STA 820	08/17/00 STA 820 ***
Aluminum	ug/L	115	164	161	169	142	182	71.3	74.8	611	1100
Cadmium	ug/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3	0.5
Chloride	mg/L	89.6	89.5	78.8	53.1	53.1	52.9	42.4	42.4	34.7	35.5
Chromium	ug/L	<2	<2	<2	2.4	2.3	2.8	10.4	2.1	10.6	17.1
Copper	ug/L	3.1	4.4	4.6	7.4	7.9	7.6	4.4	4.7	28.9	46.7
Iron	ug/L	150	150	210	260	250	290	190	200	570	840
Lead	ug/L	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	3	5.6
Nickel	ug/L	<2.5	<2.5	2.7	<2.5	<2.5	<2.5	2.5	<2.5	<2.5	2.6
Ortho-Phos	mg/L	0.866	0.877	0.834	1.450	1.470	1.300	0.964	0.957	0.864	0.823
Total Phos	mg/L	1.006	1.022	0.867	1.460	1.480	1.440	1.17	1.17	1.21	1.31
Potassium	mg/L	17.6	17.4	17.9	14.6	14.5	14.5	15.7	15.7	14.1	17.1
Silver	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.2	0.1	0.3
Sodium	mg/L	45.2	45.1	38.9	24.7	24.8	24.6	19.0	18.9	17.4	17.8
Sulfate	mg/L	292	292	263	210	212	211	239	241	228	243
Tubidity	NTU	6.4	7.4	10.2	10.1	8.3	10.1	6.7	7.0	18.1	27.0
Zinc	ug/L	<15	<15	<15	<15	<15	<15	<15	<15	30	40
Calcium	mg/L	147	147	140	131	134	128	119	119	111	117
Magnesium	mg/L	31.6	30.6	35.6	29.9	29.7	30.0	36.7	36.7	34	35.5
Hardness	mg/L	497	493	496	450	456	433	448	448	417	438
Total Nitrogen	mg/L	1.2	1.1	1.4	0.66	0.71	0.08	1.8	0.12	1.6	2.2
Ammonia-N	mg/L	0.055	0.058	0.048	0.060	0.056	<0.01	0.093	0.044	0.107	0.156
Nitrate-N	mg/L	0.072	0.072	0.019	0.089	0.095	0.098	0.031	0.033	0.101	0.531
NItrite-N	mg/L	<0.005	<0.005	0.011	0.01	0.01	0.008	0.013	<0.005	0.016	0.047
Manganese	ug/L	408	422	254	146	144	158	158	161	158	216

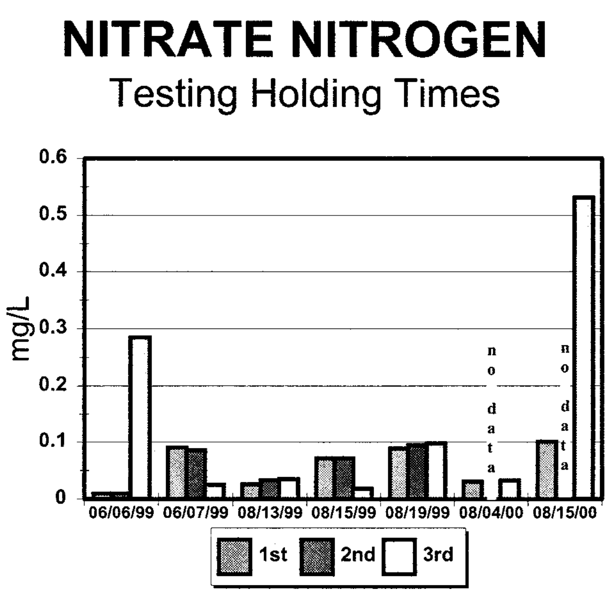
*** Turbidity has a lot of suspended particles. This probably accounts for a lot of the discrepancy between dates

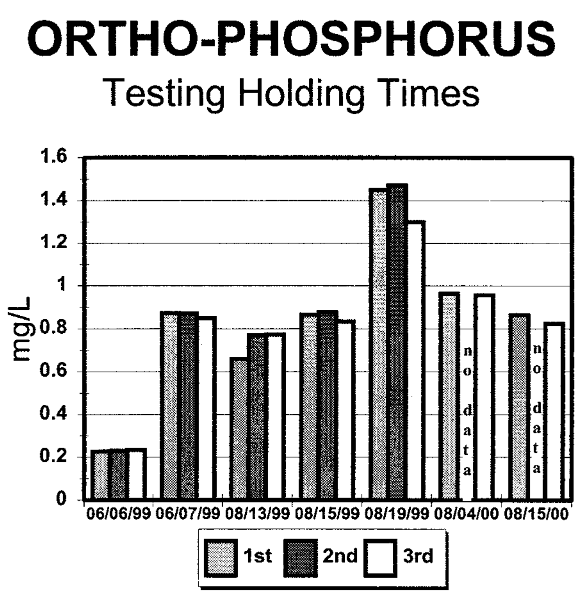






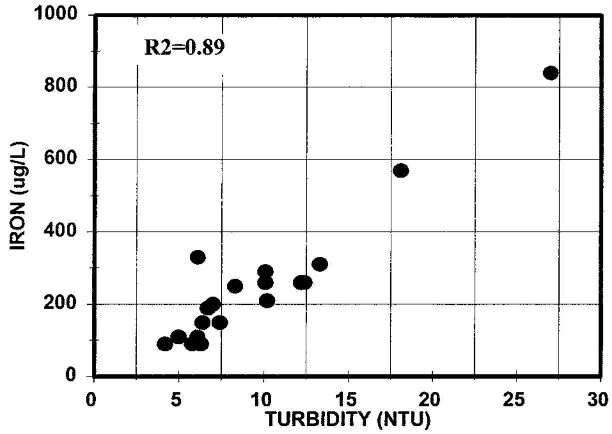




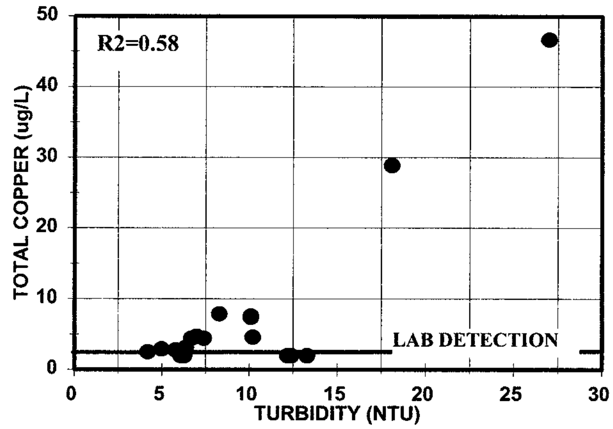


Appendix for quality assurance. The first and second sample were collected to test the variability between samples collected at the same time and treated with perservatives in the same way. The 3rd sample was collected at the same time but held in the refrigerator for two to three days and then preseved and taken to the lab.

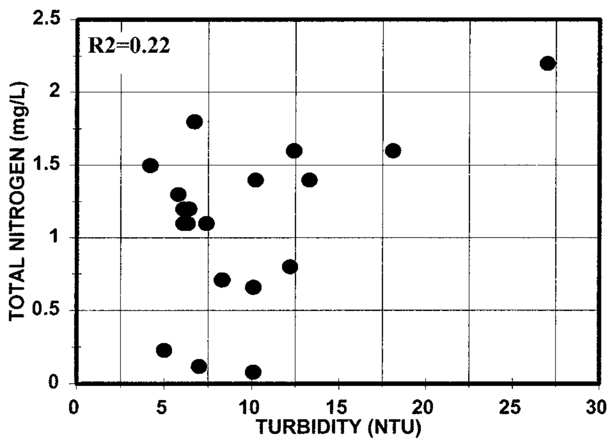
REGRESSION TURBIDITY VS IRON
Cockroach Bay quality Assurance sample



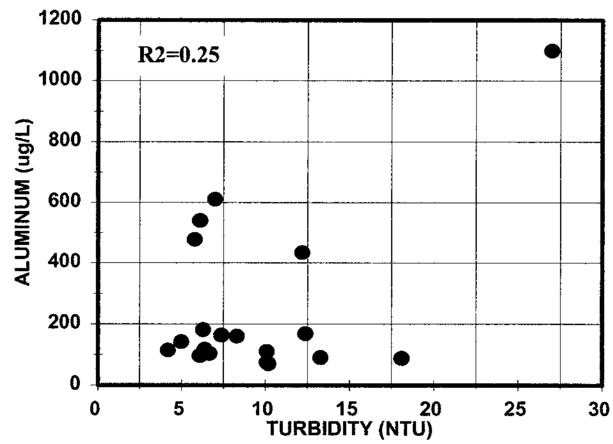
REGRESSION TURBIDITY VS COPPER
Cockroach Bay Quality Assurance sample



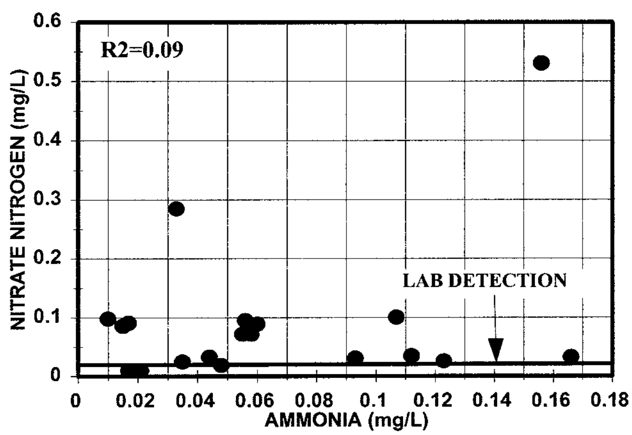
REGRESSION TURBIDITY VS TOTAL-N
Cockroach Bay Quality Assurance sample



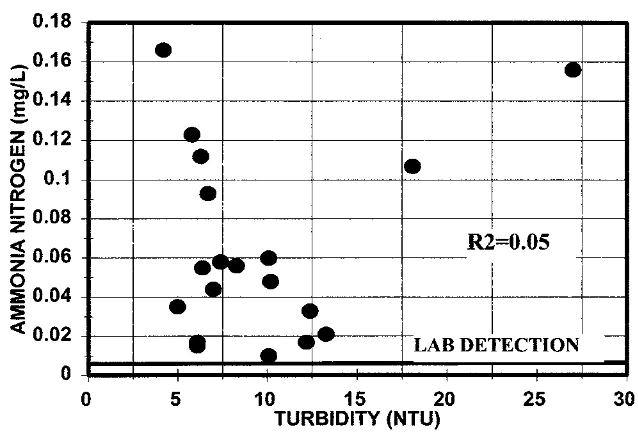
REGRESSION TURBIDITY VS ALUMINUM
Cockroach Bay quality Assurance sample



REGRESSION AMMONIA VS NITRATE
Cockroach Bay Quality Assurance sample



REGRESSION TURBIDITY VS AMMONIA
Cockroach Bay Quality Assurance sample



Appendix for quality assurance. Regression equations testing theories about sample variation and consitituent concentrations. Since sometimes even samples taken at the same time may have different amounts of particle this was found to influence metals and to a minor extent total nitrogen. No relationships were seen with nutrients.

Appendix for quality assurance. Regressions comparing factors other than holding times that affect constituent concentrations.

TURBIDITY VS IRON

Regression Output:		
Constant		-53.6104
Std Err of Y Est		64.00466
R Squared		0.885097
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	31.62889	
Std Err of Coef.	2.763948	

TURBIDITY VS COPPER

Regression Output:		
Constant		-0.07367
Std Err of Y Est		0.081862
R Squared		0.58192
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	0.017196	
Std Err of Coef.	0.003535	

TURBIDITY VS TOTAL NITROGEN

Regression Output:		
Constant		0.644233
Std Err of Y Est		0.516225
R Squared		0.217739
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	0.048492	
Std Err of Coef.	0.022292	

TURBIDITY VS ALUMINUM

Regression Output:		
Constant		20.04831
Std Err of Y Est		236.9088
R Squared		0.251869
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	24.475	
Std Err of Coef.	10.23056	

TURBIDITY VS AMMONIA

Regression Output:		
Constant		0.044519
Std Err of Y Est		0.048053
R Squared		0.055836
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	0.002081	
Std Err of Coef.	0.002075	

AMMONIA VS NITRATE

Regression Output:		
Constant		0.041471
Std Err of Y Est		0.120615
R Squared		0.092396
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	0.778179	
Std Err of Coef.	0.59153	

TOTAL NITROGEN VS AMMONIA

Regression Output:		
Constant		0.011719
Std Err of Y Est		0.040932
R Squared		0.314959
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	0.047551	
Std Err of Coef.	0.017009	

NITRATE VS TOTAL NITROGEN

Regression Output:		
Constant		-0.02147
Std Err of Y Est		0.111768
R Squared		0.22066
No. of Observations		19
Degrees of Freedom		17
X Coefficient(s)	0.101895	
Std Err of Coef.	0.046444	

Appendix for quality assurance. Comparison of water quality of di-ionized water out of the bottle compared to di-ionized water run through the equpment tubing. This is the worst case scenario since the tubing is changed about every three months.

	Units	D.I. WATER ALONE	D.I. WATER THRU TUBING	D.I. WATER ALONE	D.I. WATER THRU TUBING	D.I. WATER ALONE	D.I. WATER THRU TUBING	D.I. WATER ALONE	D.I. WATER THRU TUBING
Date Station		11/03/98 STA 819	11/03/98 STA 819	11/03/98 STA 820	11/03/98 STA 820	11/22/99 STA 819	11/22/99 STA 819	03/15/00 STA 820	03/15/00 STA 820
							***		
Aluminum	ug/L	174	337	173	425	<6	60.5	<6	<6
Cadmium	ug/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chloride	mg/L	<0.05	0.19	<0.05	7.72	<0.4	<0.4	<0.4	<0.4
Chromium	ug/L	<4.7	6.9	<4.7	59.7	<2	123	<2	<2
Copper	ug/L	3.6	3.5	3.0	4.1	<2	na	<2	<2
Iron	ug/L	<30	60	<30	180	<25	130	<25	<25
Lead	ug/L	<2	<2	<2	<2	<1.5	<1.5	<1.5	<1.5
Nickel	ug/L	<4.3	<4.3	<4.3	6.2	<2.5	29.4	<2.5	<2.5
Ortho-Phos	mg/L	<0.01	0.017	<0.01	0.028	na	na	na	<0.01
Total Phos	mg/L	<0.01	0.099	<0.01	0.154	<0.01	0.013	<0.01	<0.01
Potassium	mg/L	<0.05	0.09	<0.05	0.49	<0.04	<0.04	<0.04	<0.04
Silver	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	mg/L	<0.05	0.19	<0.05	5.55	<0.06	0.08	<0.06	0.14
Sulfate	mg/L	<0.05	<0.05	<0.05	1.69	<0.12	<0.12	<0.12	<0.12
Tubidity	NTU	<0.08	2.3	0.2	6.4	0.4	<0.08	<0.08	<0.08
Zinc	ug/L	<30	<30	<30	<30	<15	20	<15	<15
Calcium	mg/L	0.06	0.91	0.05	0.68	1.94	0.79	3.10	0.89
Magnesium	mg/L	0	0.13	0	0.67	0.44	0.15	0.59	0.21
Hardness	mg/L	0.15	2.81	0.12	4.46	6.65	na	10.17	3.03
Total Nitrogen	mg/L	0.35	0.86	0.13	0.70	0	0	0	0
Ammonia-N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate-N	mg/L	<0.01	0.056	0.016	0.012	<0.01	<0.01	<0.01	<0.01
NItrite-N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.008	<0.005	<0.005	<0.005
Manganese	ug/L	<0.6	14.1	<0.6	19.2	<1.0	36.9	<1.0	<1.0

*** Small amount of black particulate found in sample

How long can samples be left in collection bottles?

It is not always convenient to be at the site immediately after storm events. Also as often happens at an ouflow station, it takes several days before the pond stops discharging. To test whether leaving samples in the refrigerator for three days without preservatives affected sample result, statistical tests were run. Duplicate samples were collected within 24-hours after a rain event, fixed with preservatives and taken to the lab to test our sampling technique. No significant differences were detected in the duplicate samples (Mann-Whitney alpha=0.80 and above for most constituents). Although there were no significant differences (alpha=0.10) for samples stored in the refrigerator or even in styrofoam coolers with ice, the probabilities were much greater for errors indicating that we might not be detecting a difference when there actually was a difference. The results are shown in the table below. Although samples held three days in the refrigerator may not be significantly different, they showed a greater probability than the duplicate samples, and samples not refrigerated showed an even greater probability that they were different. The results indicate it is best to collect and preserve samples right away. Nitrates demonstrated the most differences when not collected right away. Since the data were not normally distributed, the Mann-Whitney test is a more appropriate test to use for determining significant differences.

Probability that there is not a significant difference betw een samples held for three day s without presevatives either in refrigerators (n=7) or in a dark cooler w ith not ice (n=10)

Constituent	duplicate samples		electric refrigeration		no ice 3-days	
	Mann Whitney	ttest	Mann Whitney	ttest	Mann Whitney	ttest
Ammonia (mg/l)	0.85	0.94	0.70	0.68	0.68	0.19
Nitrate (mg/l)	0.68	0.35	0.70	0.54	0.57	0.04
Total nitrogen (mg/l)	0.85	0.81	0.60	0.18	0.35	0.05
Ortho-phosphorus (mg/l)	0.88	0.10	0.61	0.87	0.47	0.04
Total phosphorus (mg/l)	1.00	0.74	0.89	0.78	0.68	0.05
Total Iron (ug/l)	1.00	0.63	0.94	0.87	1.00	0.87
Total copper (ug/l)	0.82	0.41	0.70	0.24	0.96	0.52

APPENDIX A

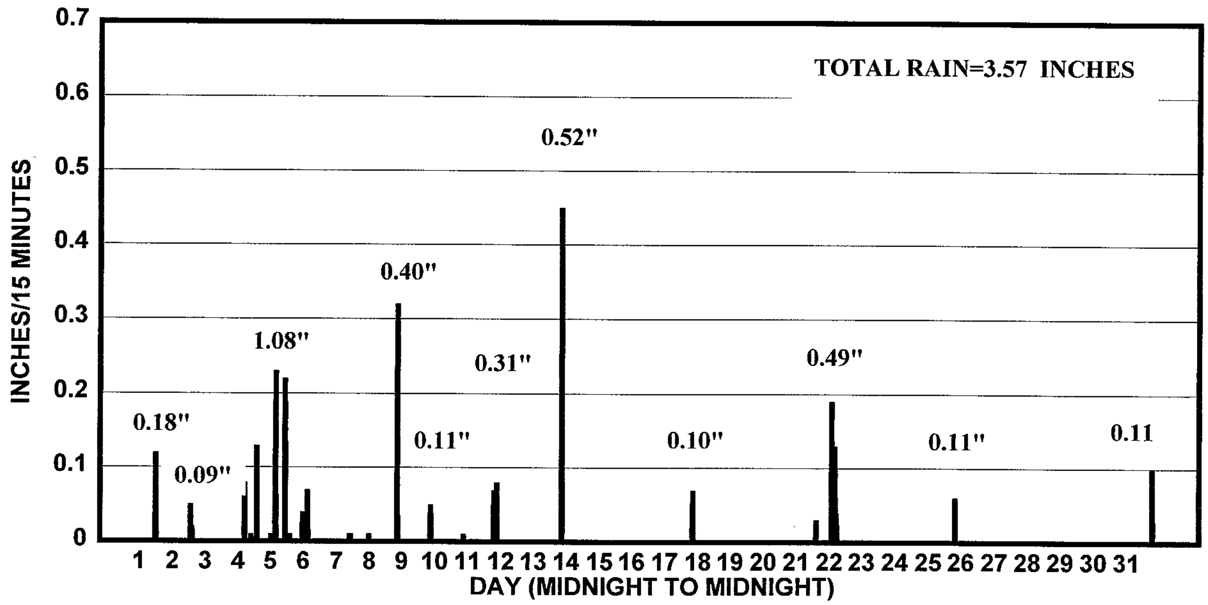
Rainfall and Water Level Measurements

The Contol Elevation where water begins to discharge over the outflow weir is 2.5 feet (NGVD) Since the recording well transducer was not accurate, the biweekly measuremts are also included as big black dots and most of the recording well data have been deleted.

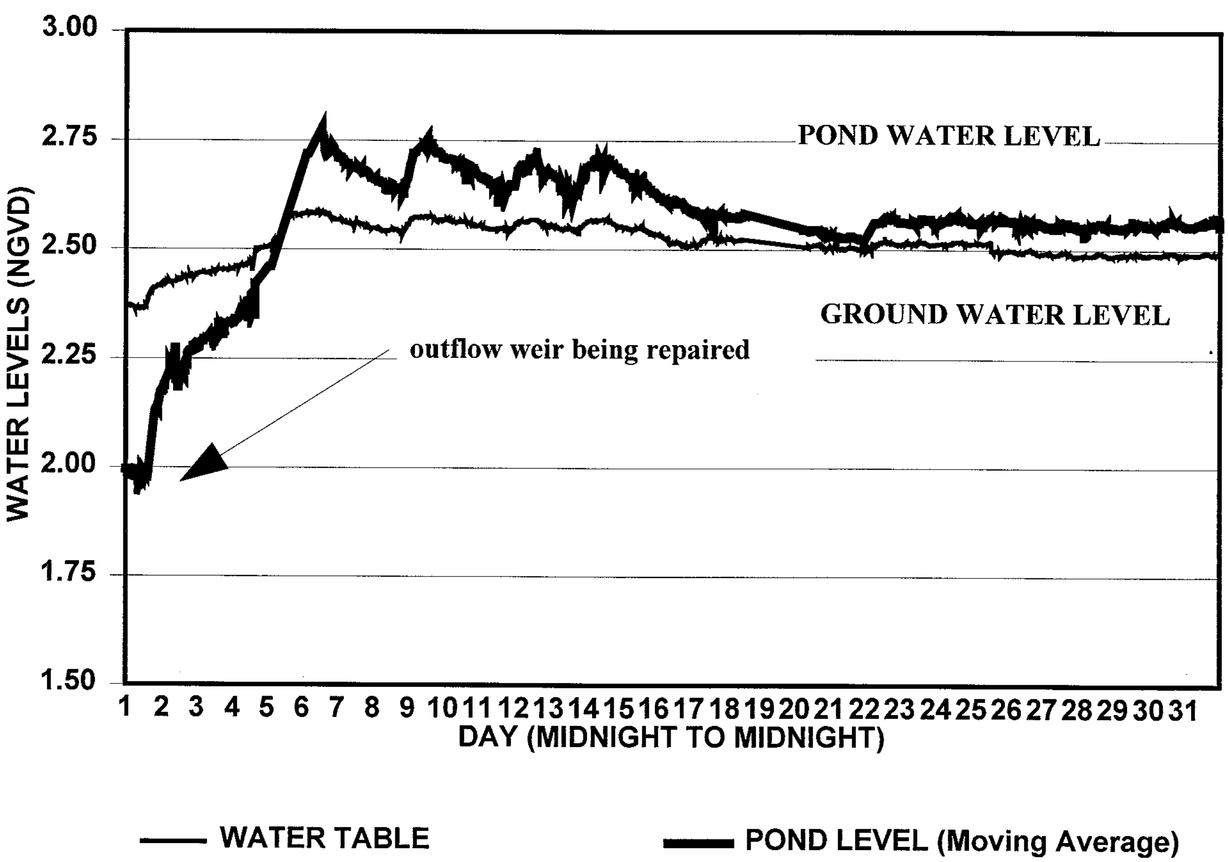
Starting in May 2000, a new velocity meter was installed and these measurements are also included in the graphs.

AUGUST 1997

RAINFALL

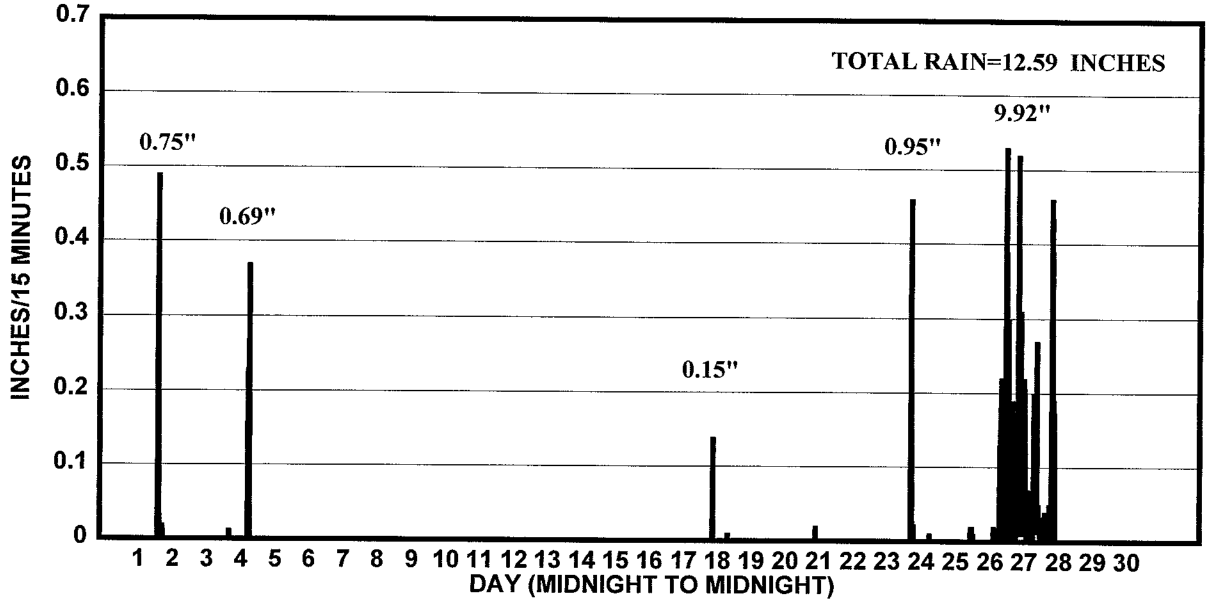


WATER LEVELS

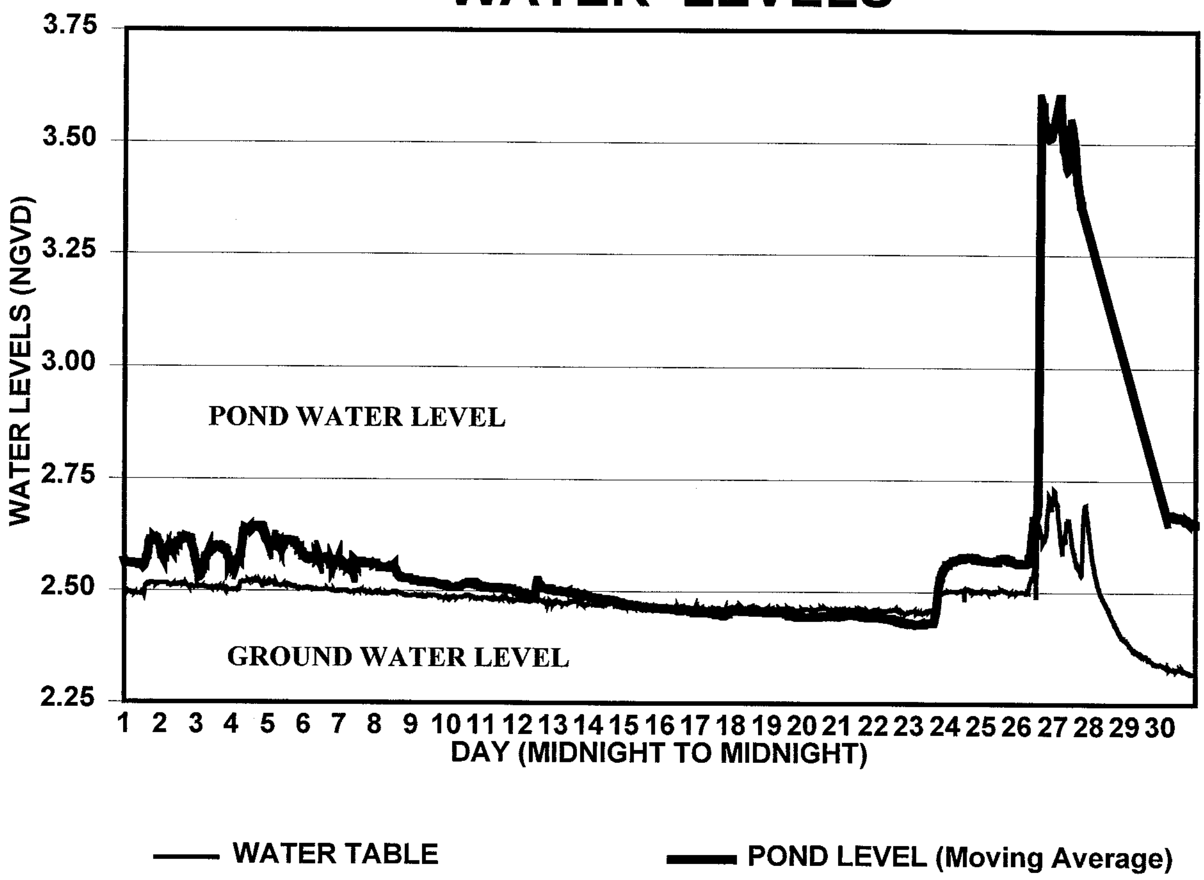


SEPTEMBER 1997

RAINFALL

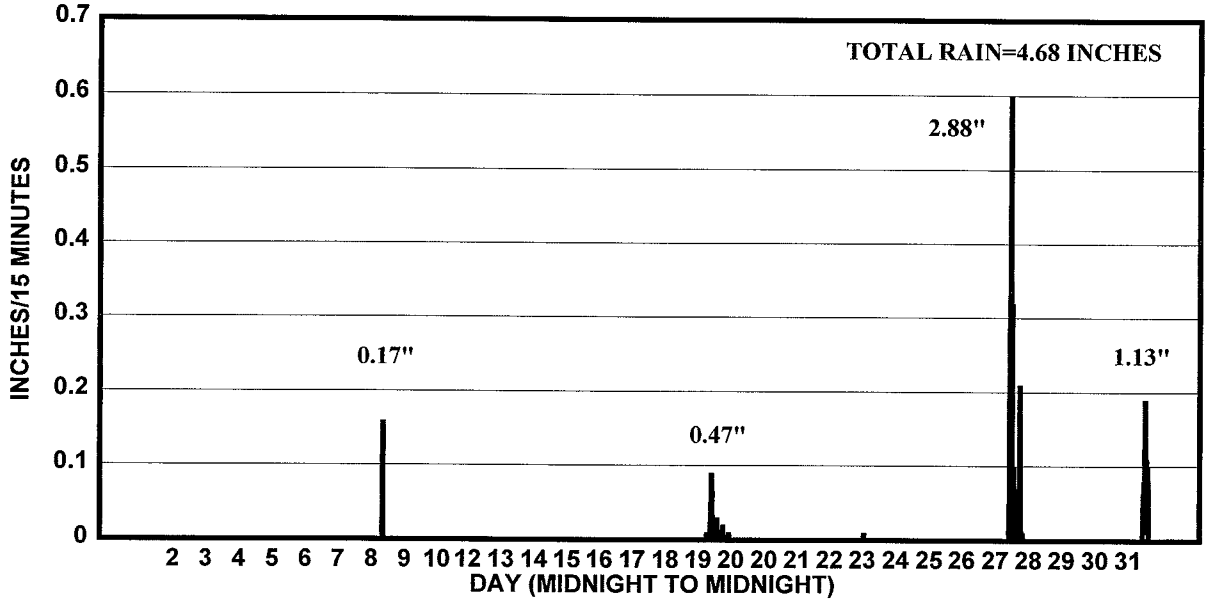


WATER LEVELS

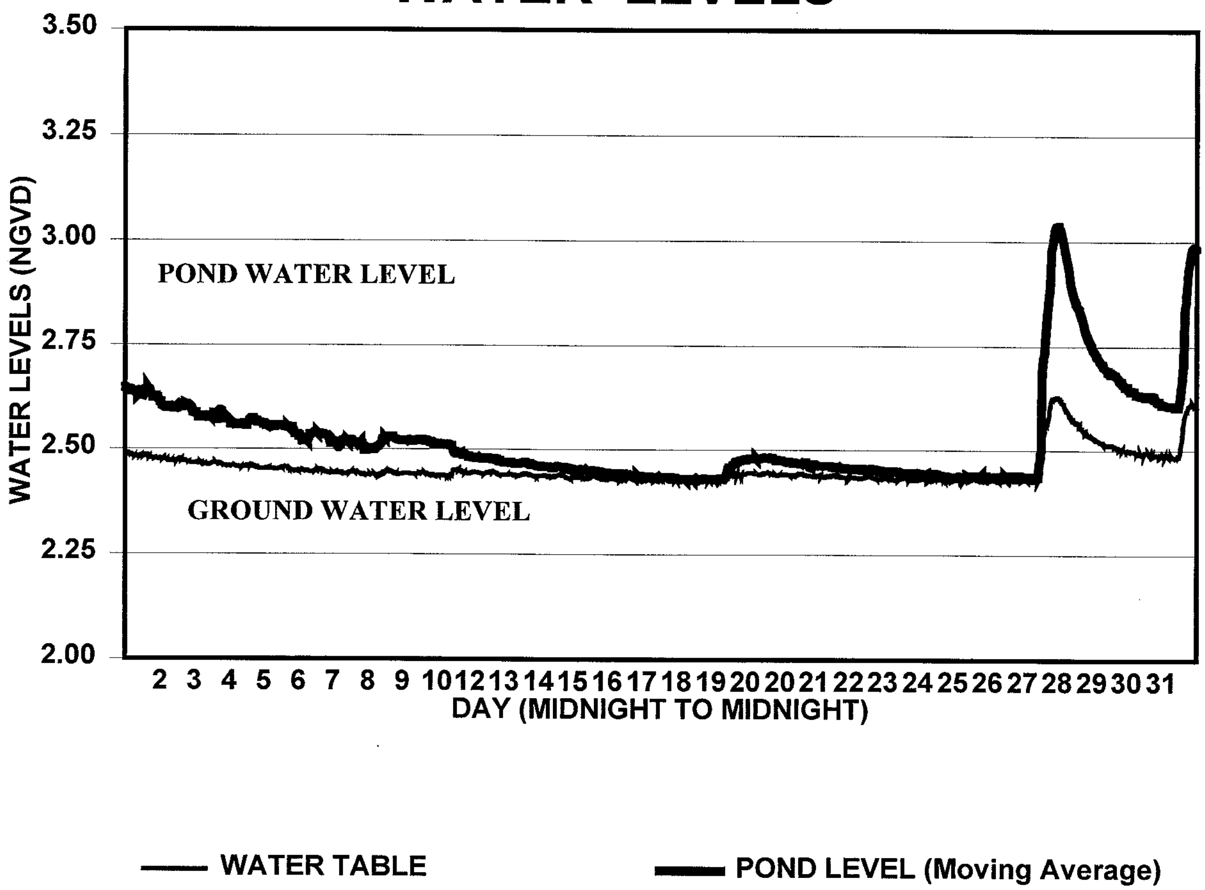


OCTOBER 1997

RAINFALL

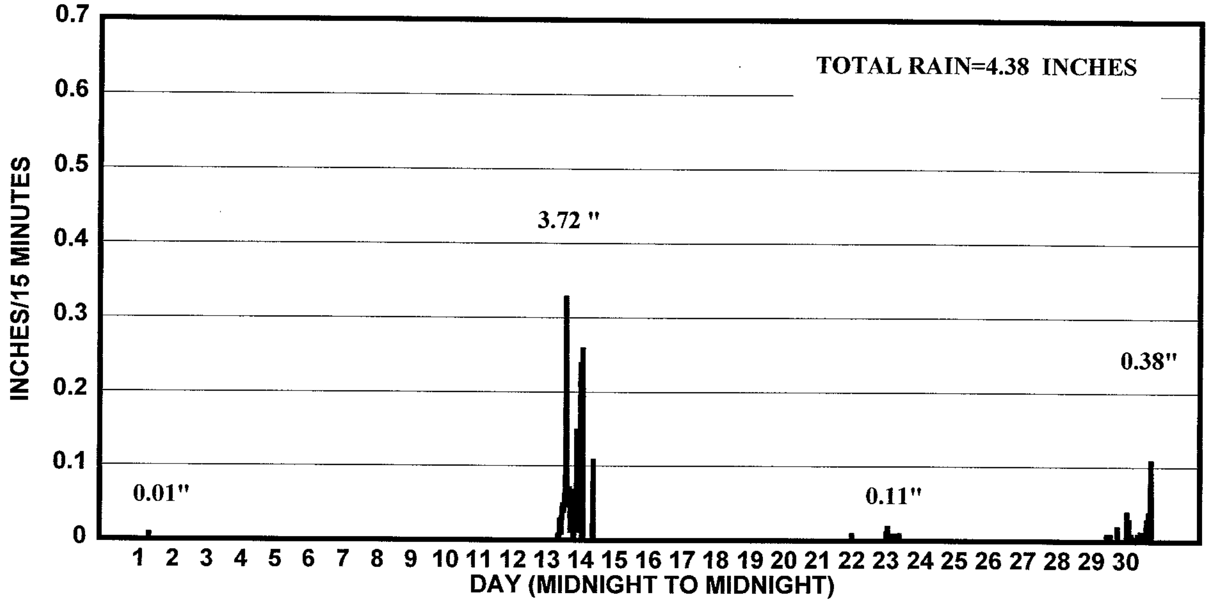


WATER LEVELS

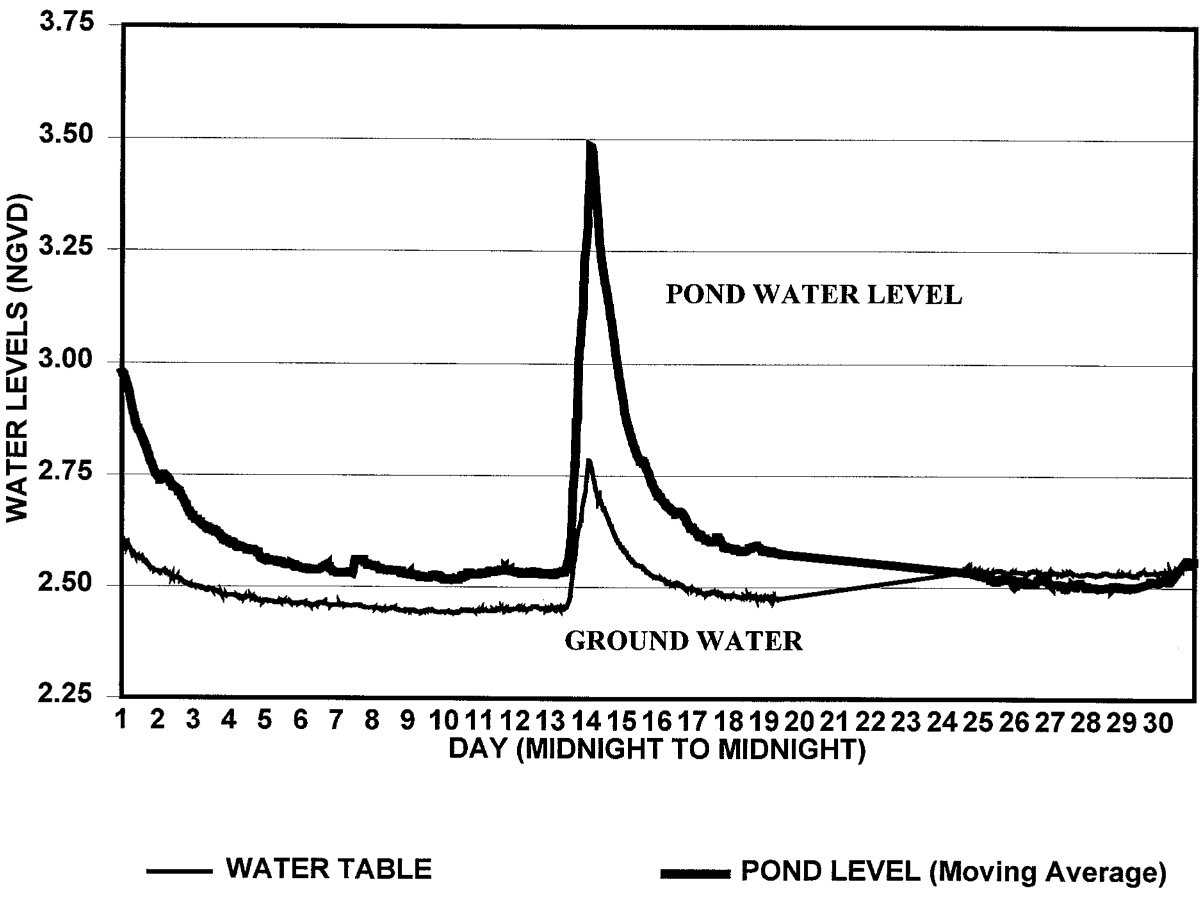


NOVEMBER 1997

RAINFALL



WATER LEVELS



DECEMBER 1997

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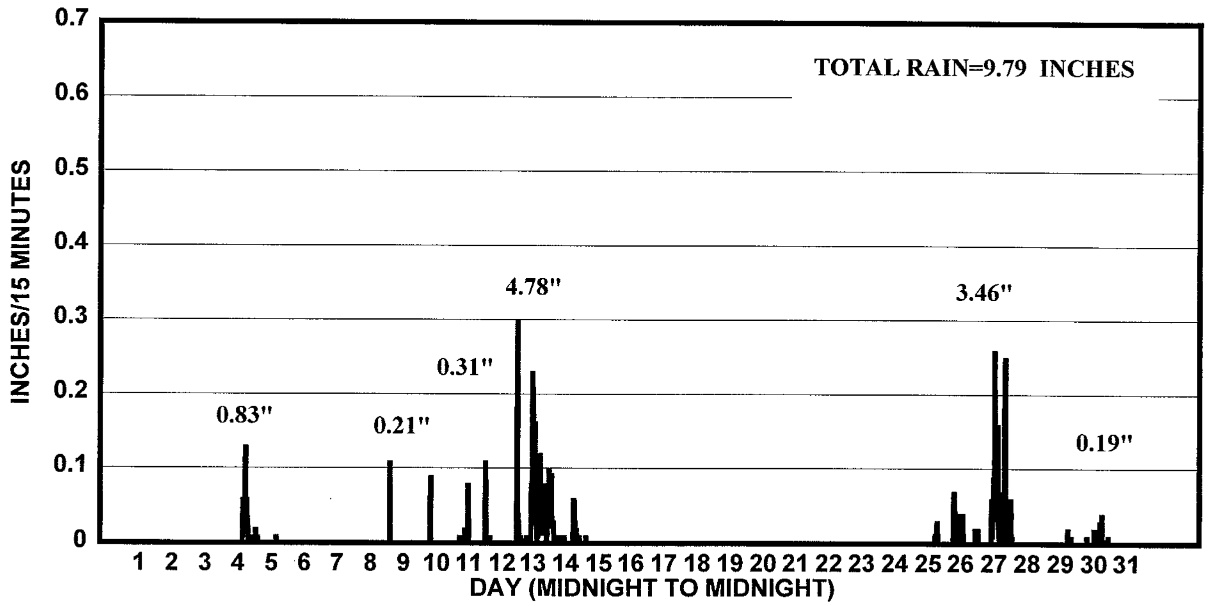

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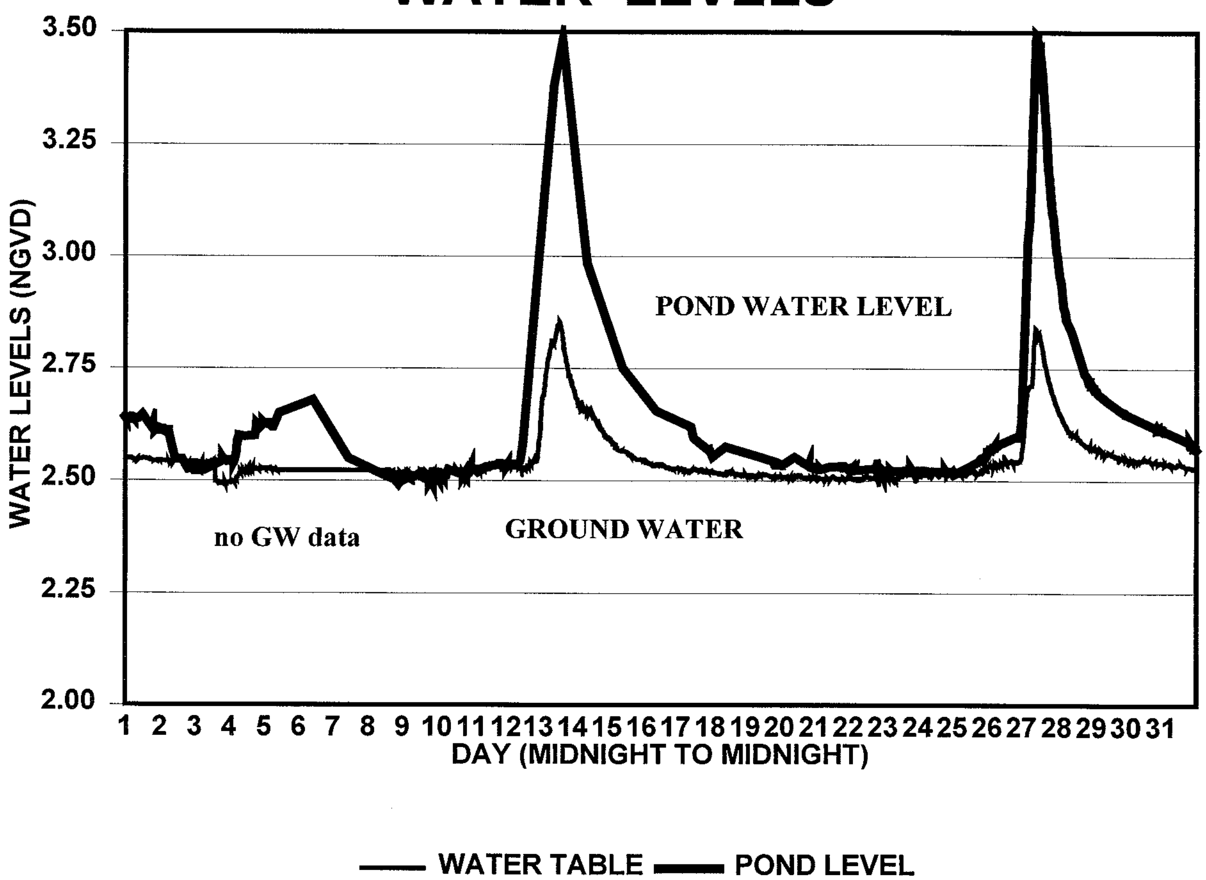
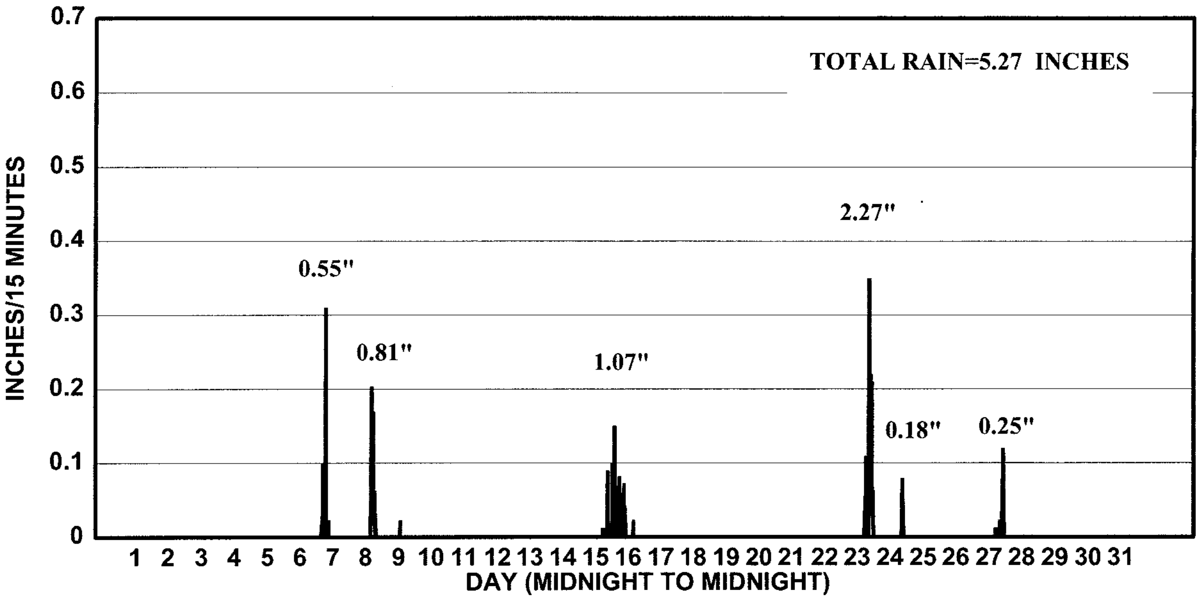
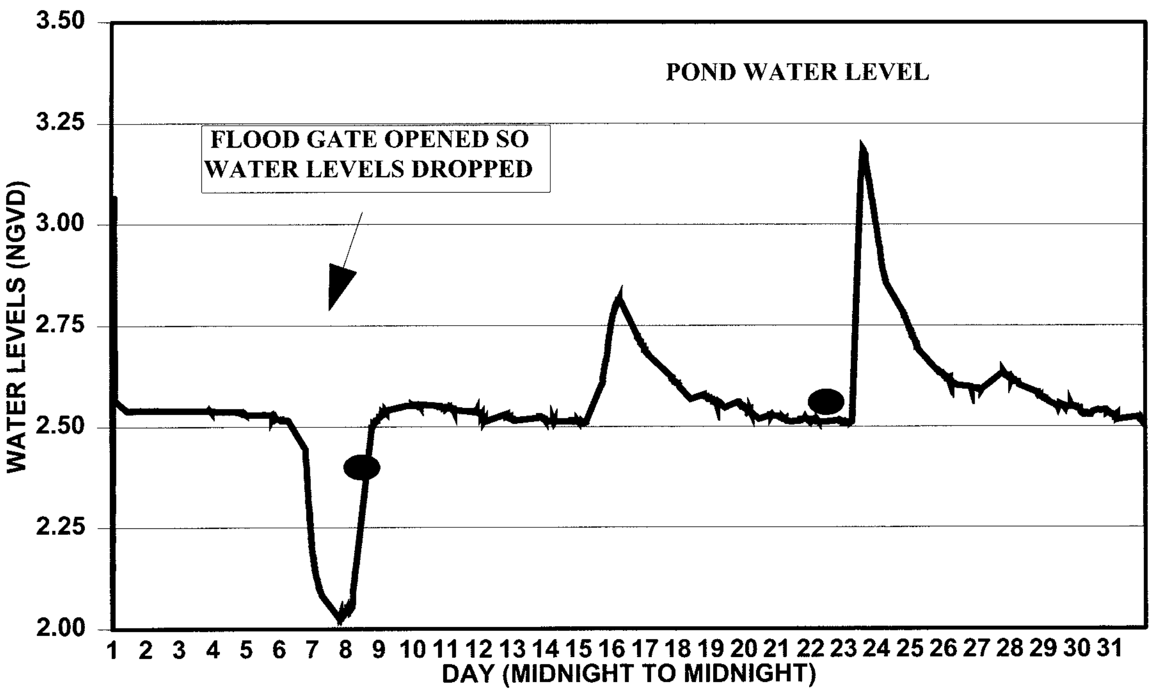


JANUARY 1998

RAINFALL



WATER LEVELS



POND LEVEL (AFFRA STAGE SENSOR) WT MEASURED

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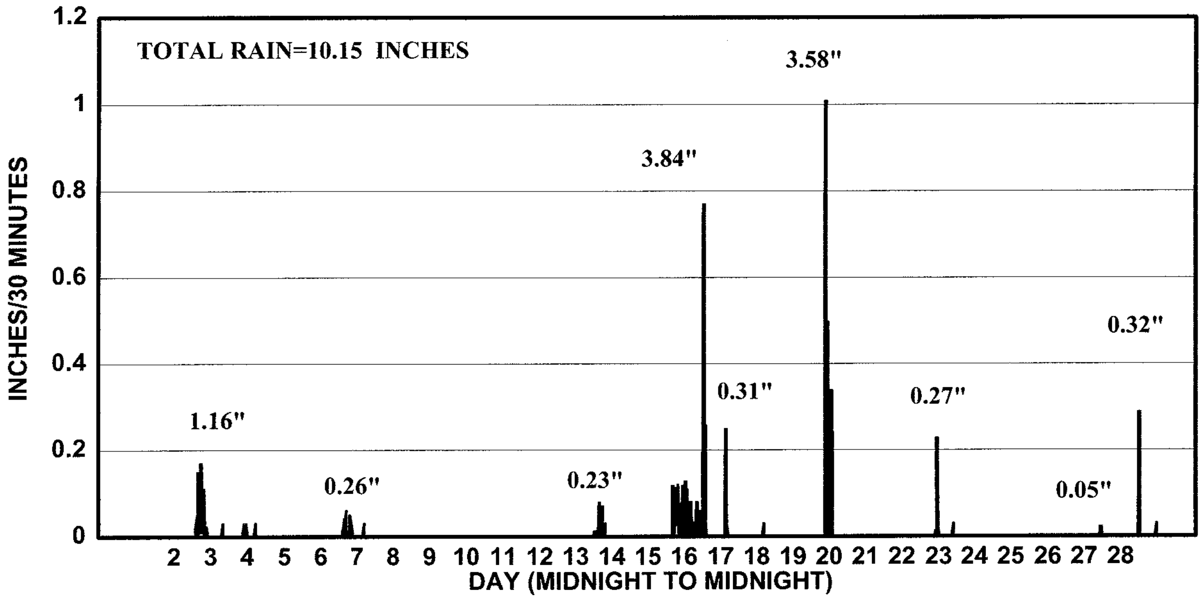
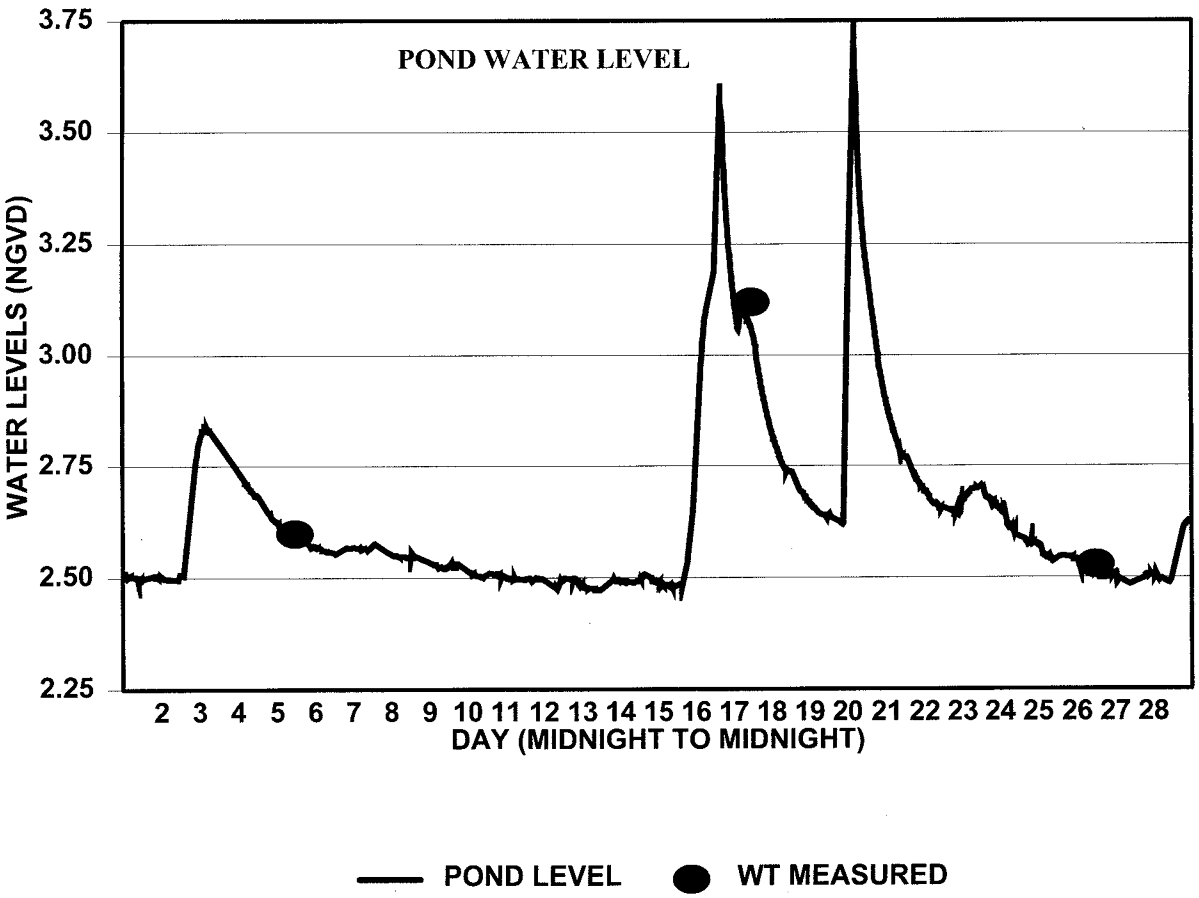
FEBRUARY 1998

RAINFALL

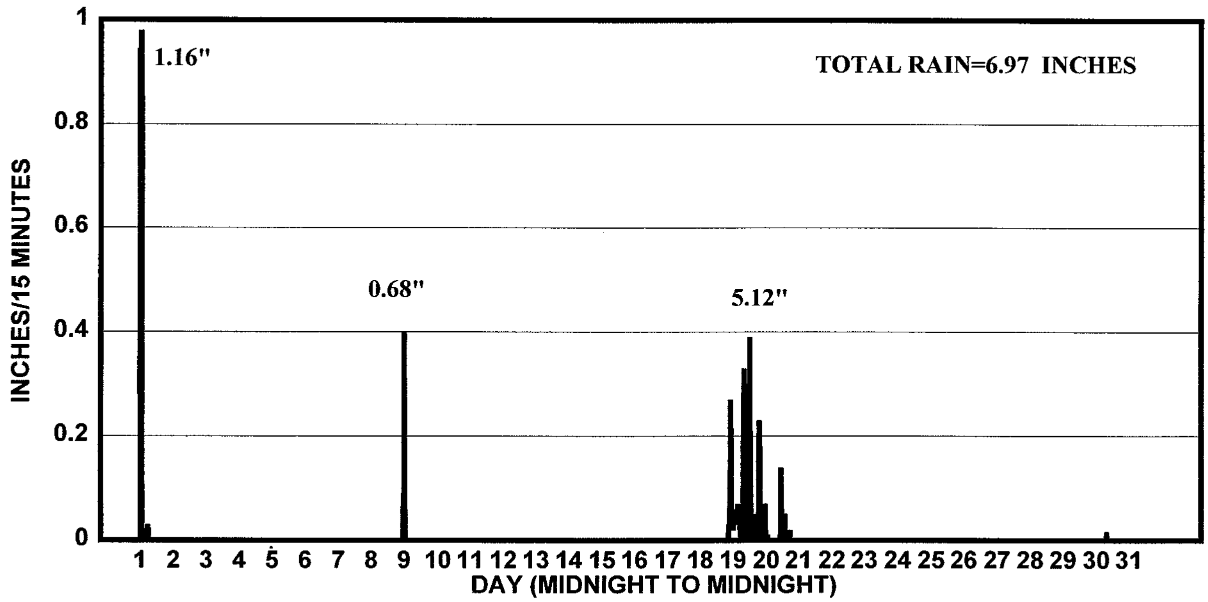


WATER LEVELS

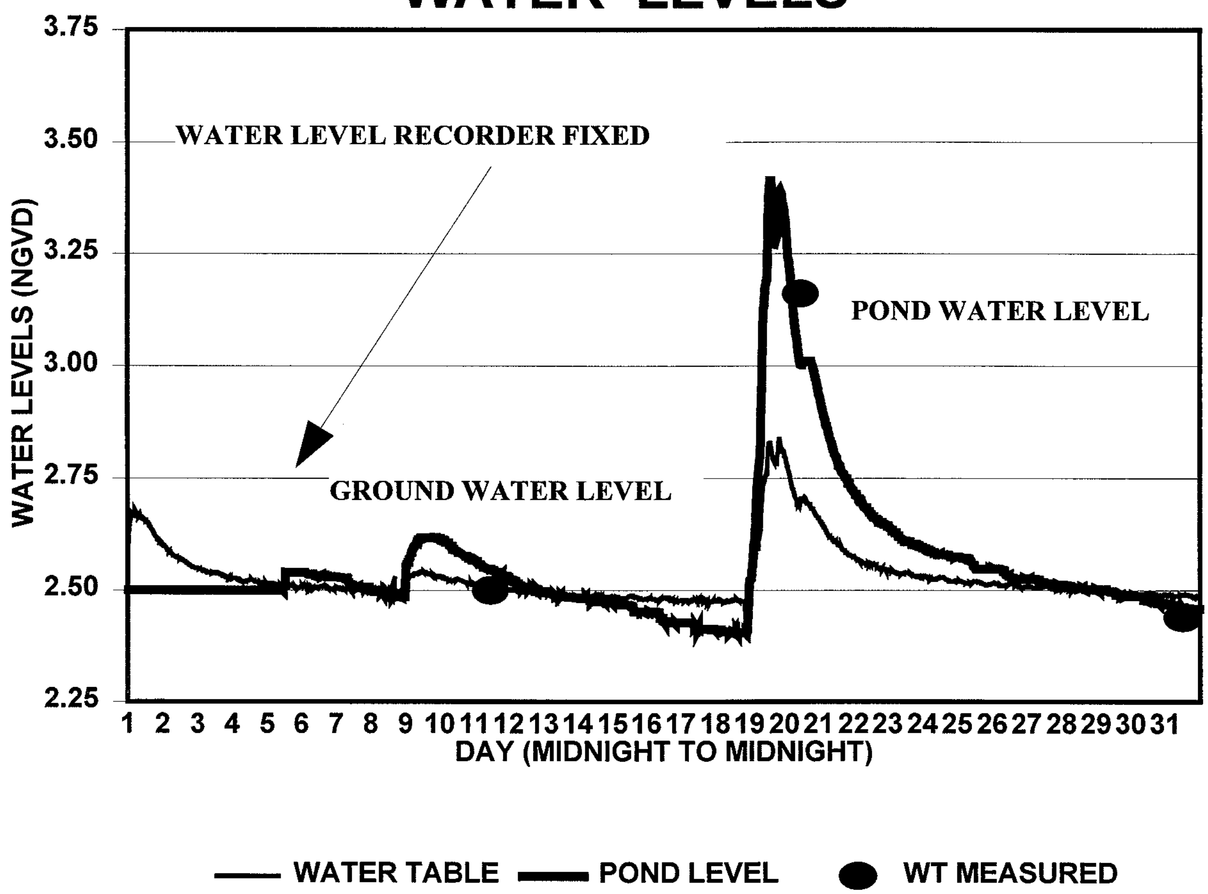


MARCH 1998

RAINFALL



WATER LEVELS



APRIL 1998

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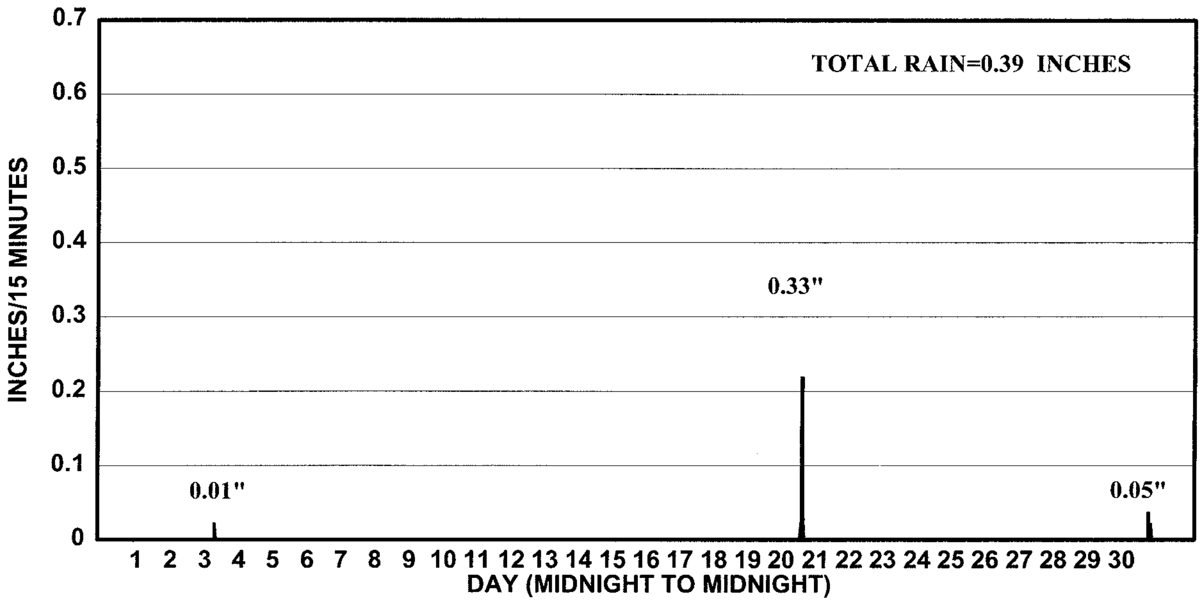
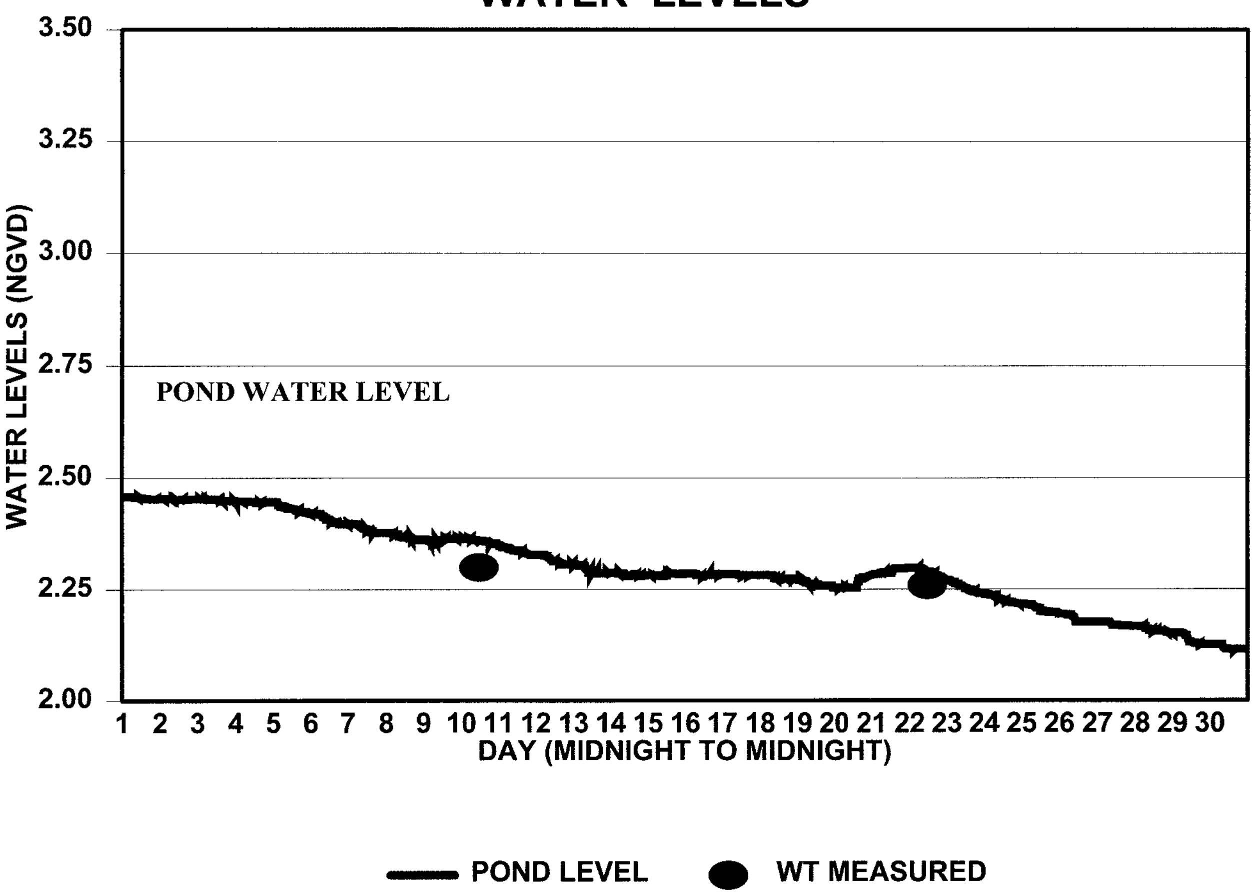
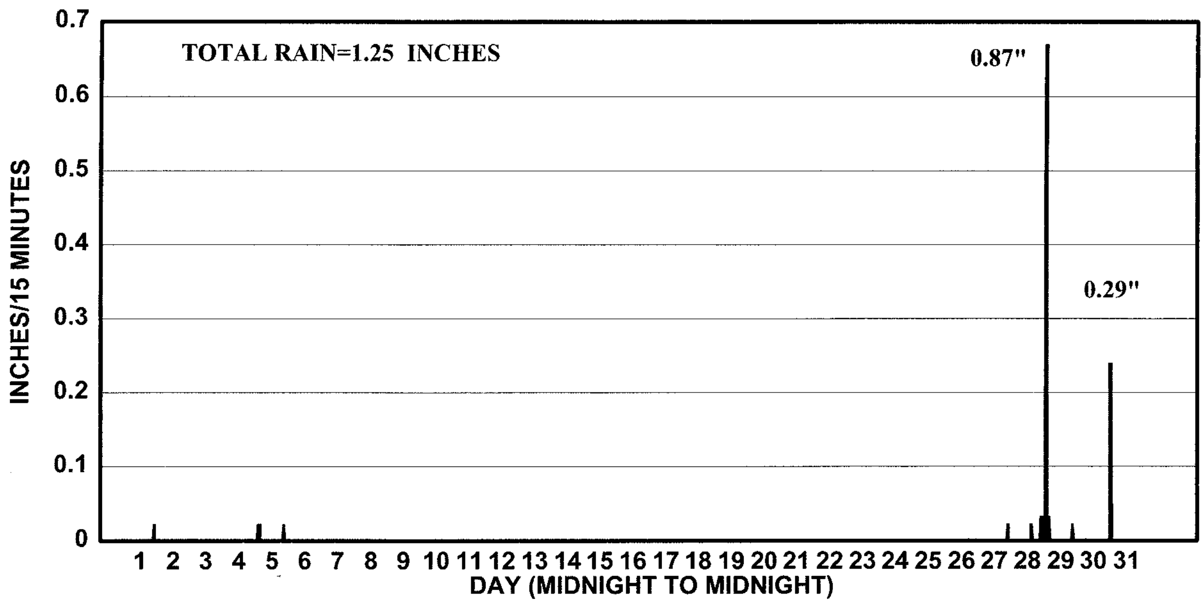


WATER LEVELS

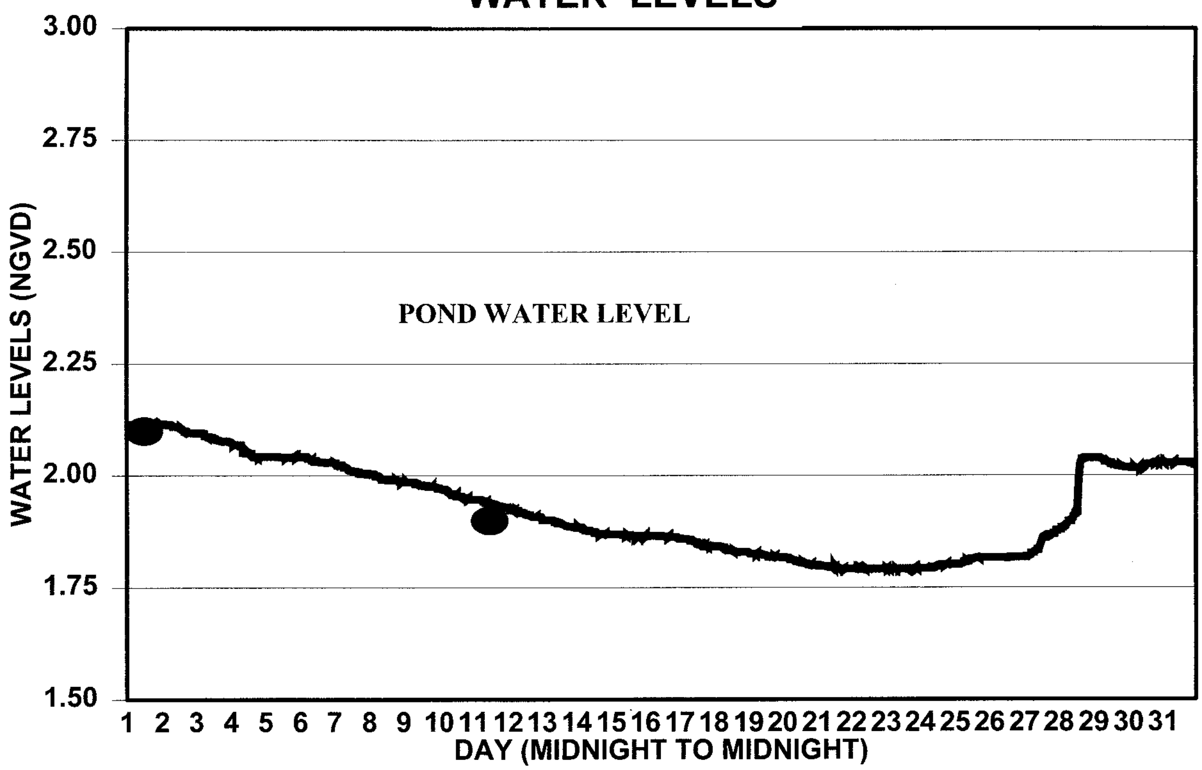


MAY 1998

RAINFALL



WATER LEVELS



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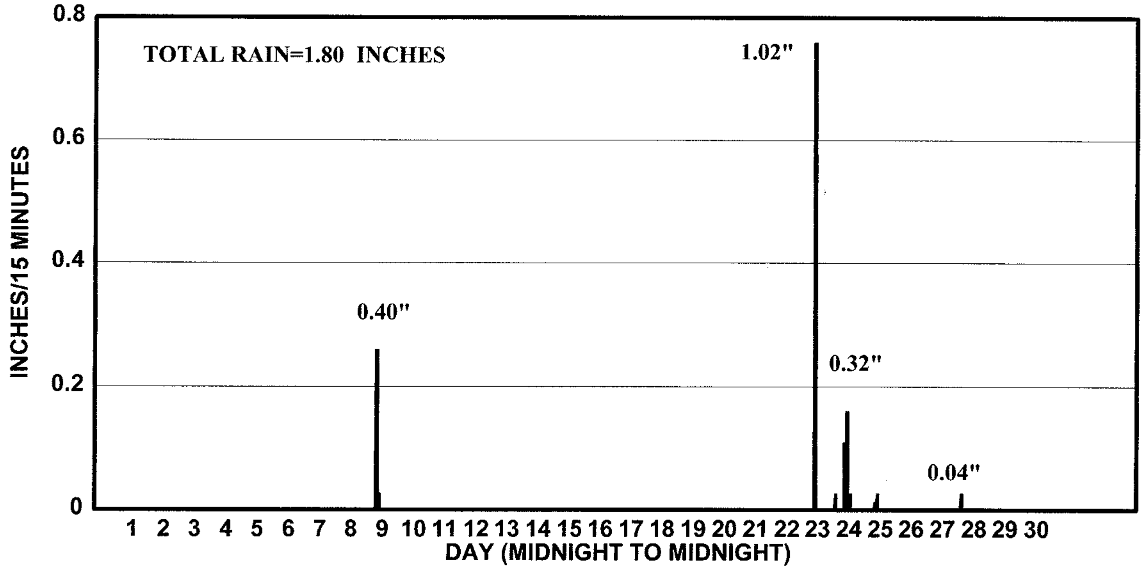
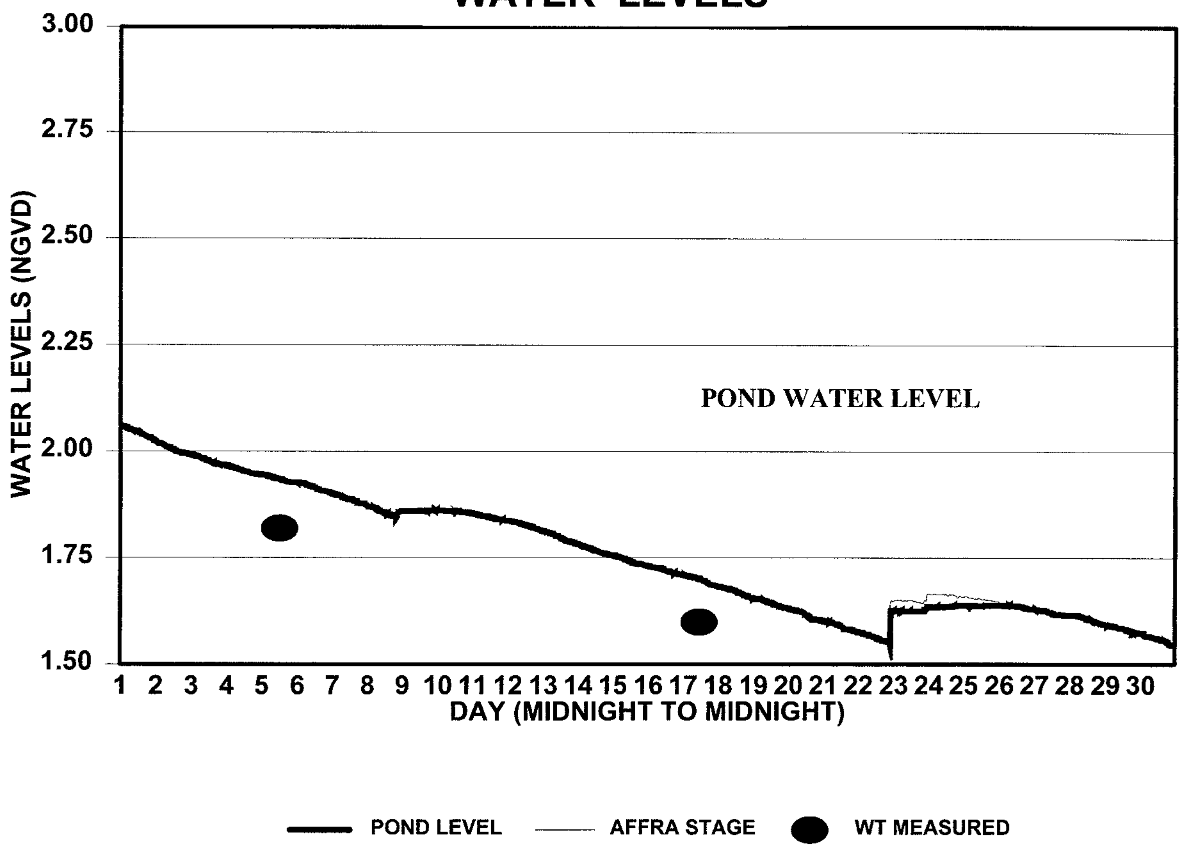
JUNE 1998

RAINFALL



WATER LEVELS



JULY 1998

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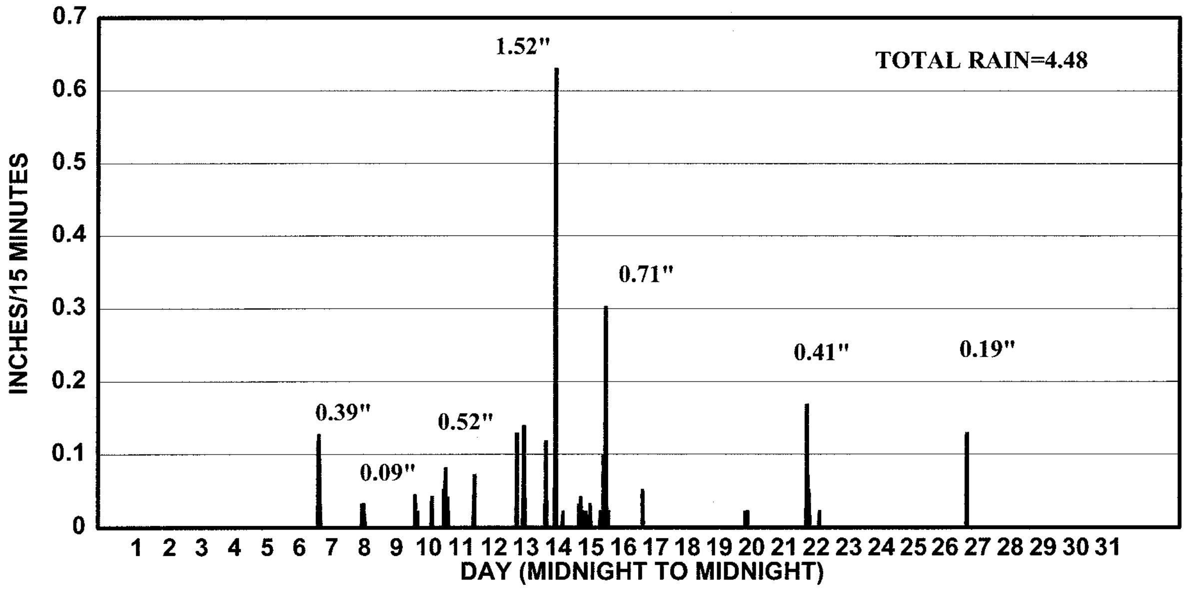
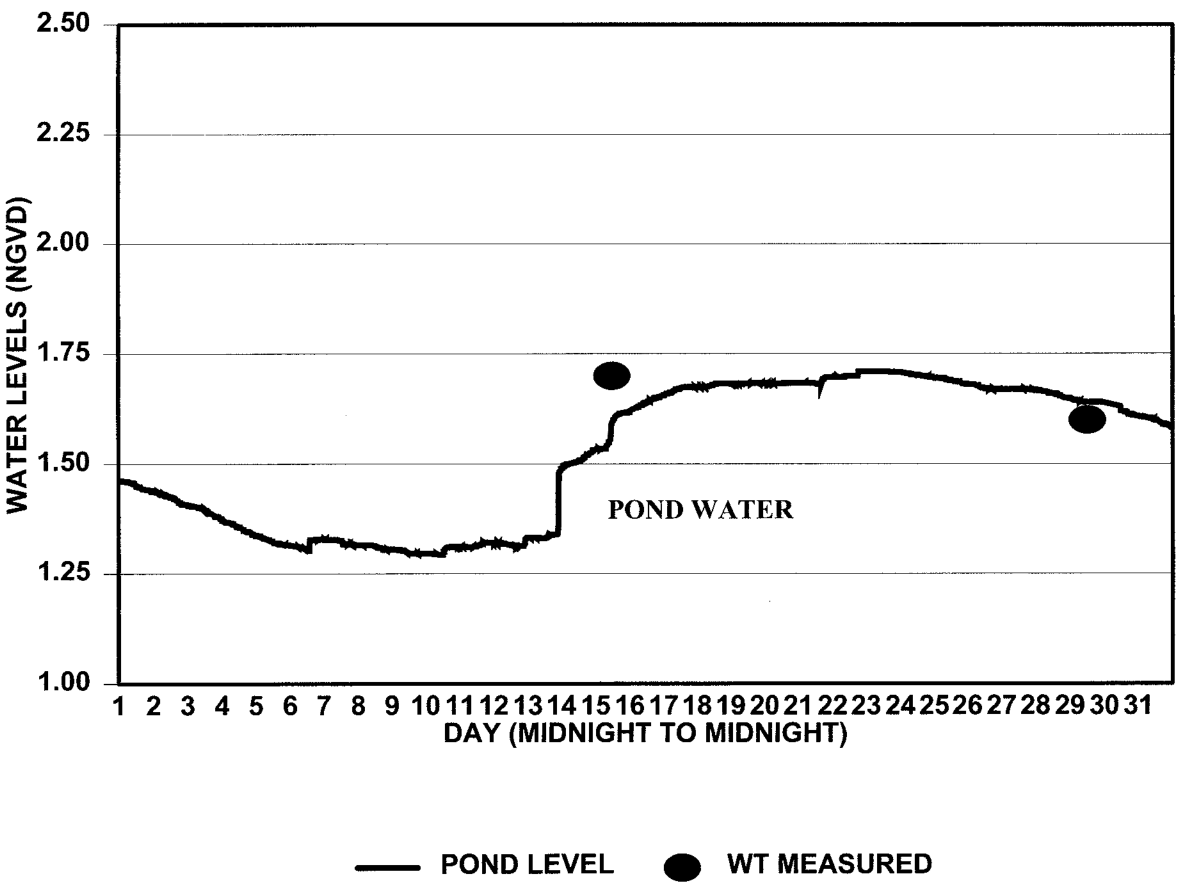
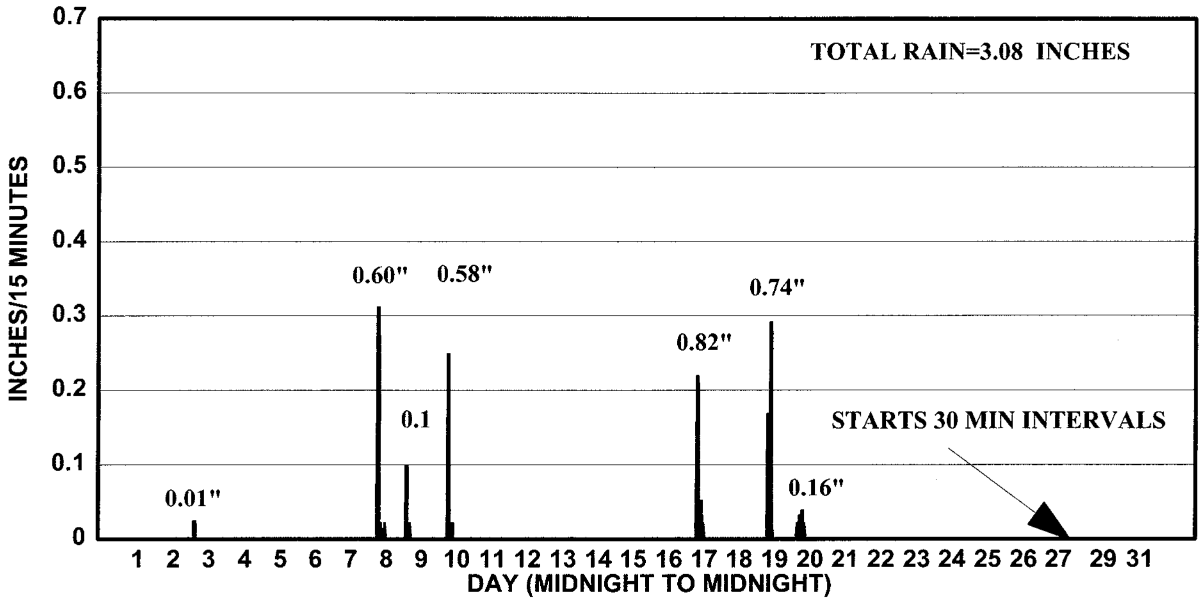


WATER LEVELS

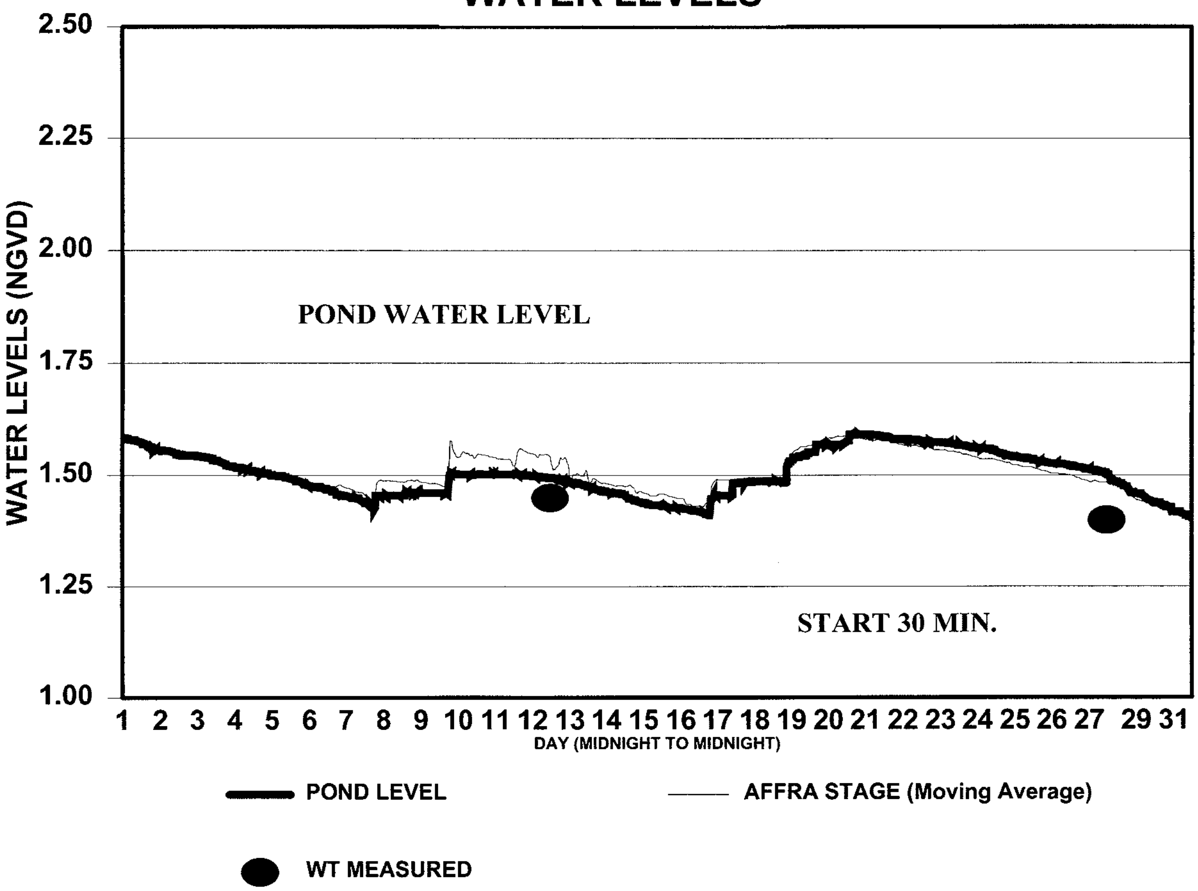


AUGUST 1998

RAINFALL



WATER LEVELS



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SEPTEMBER 1998

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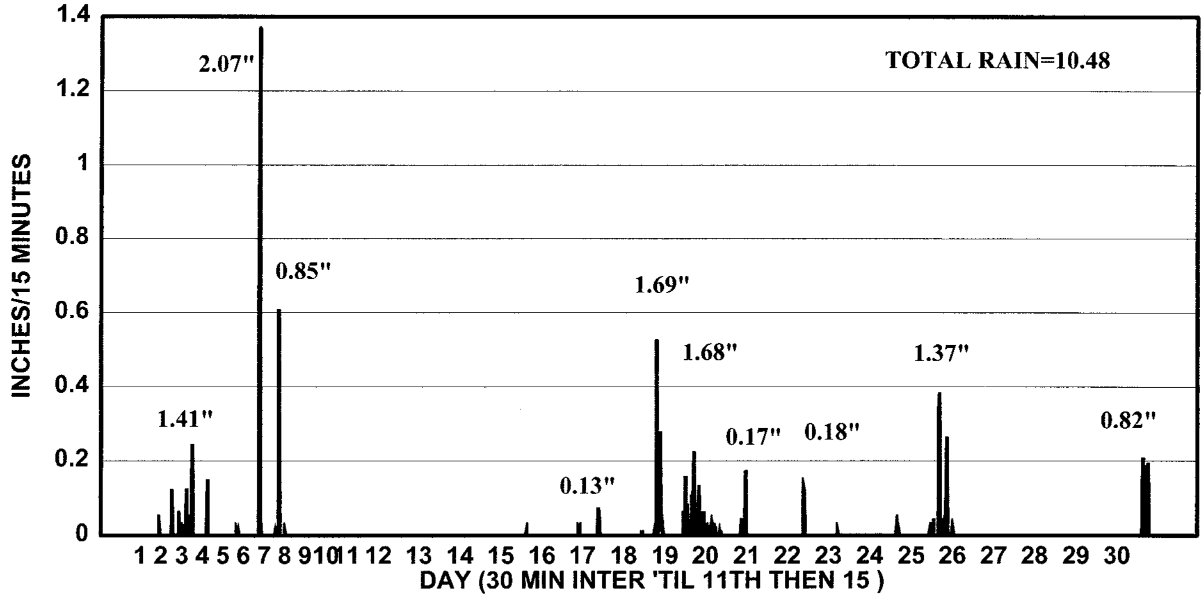
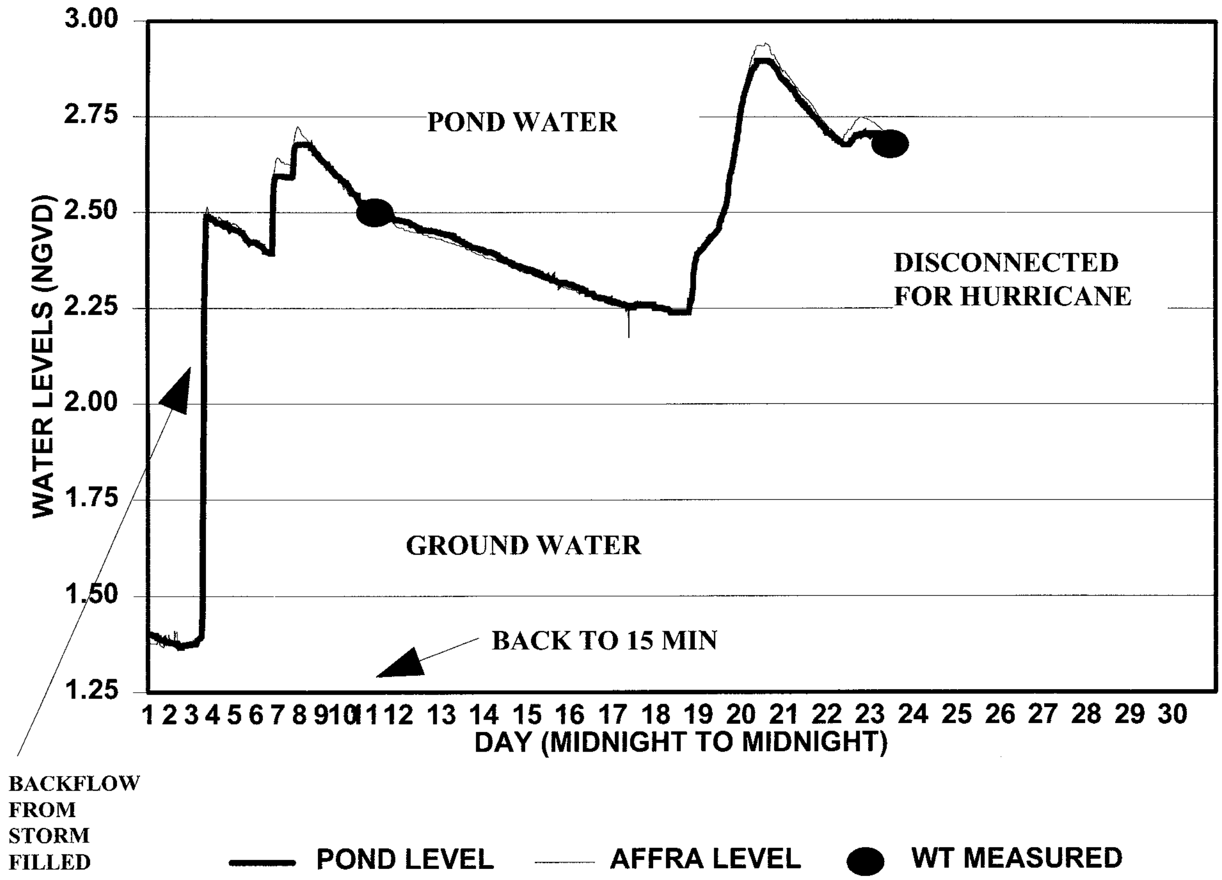


WATER LEVELS



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OCTOBER 1998

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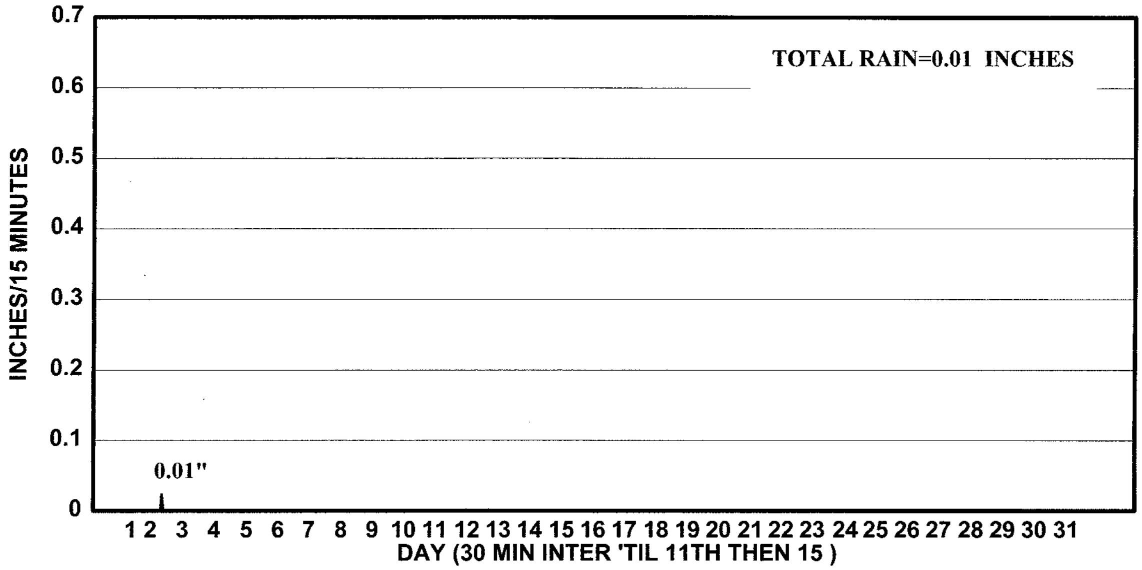
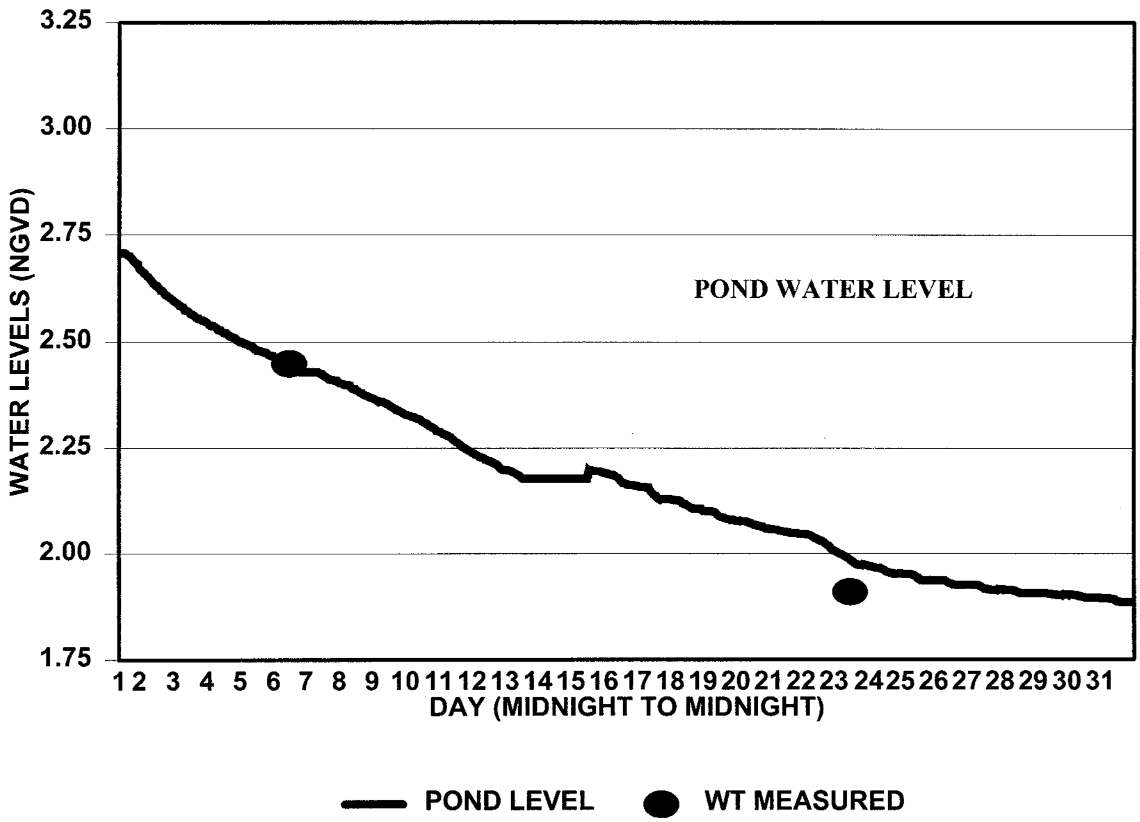


WATER LEVELS



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NOVEMBER 1998

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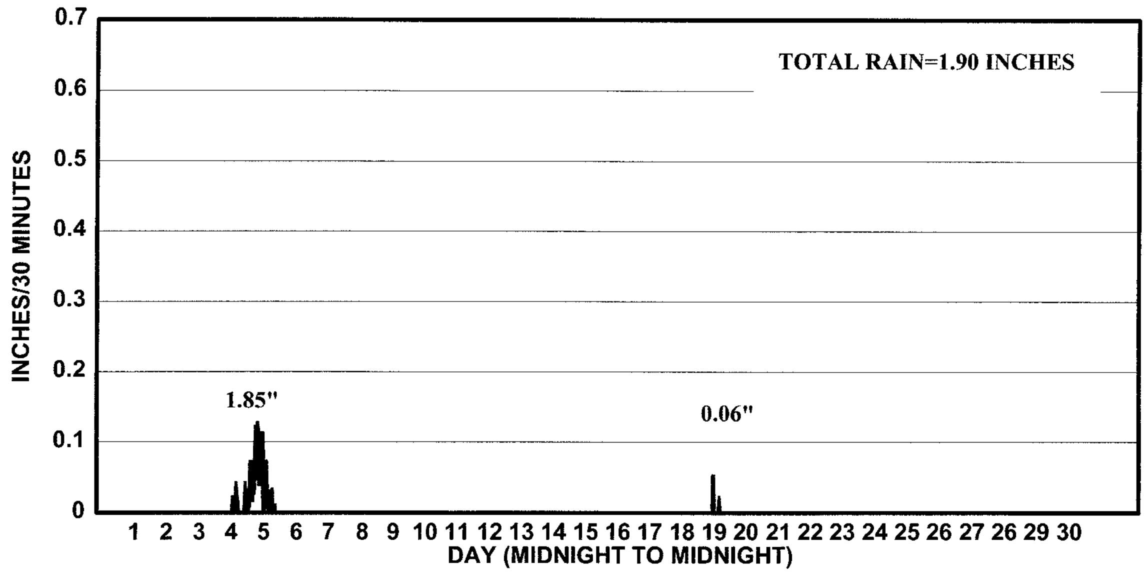

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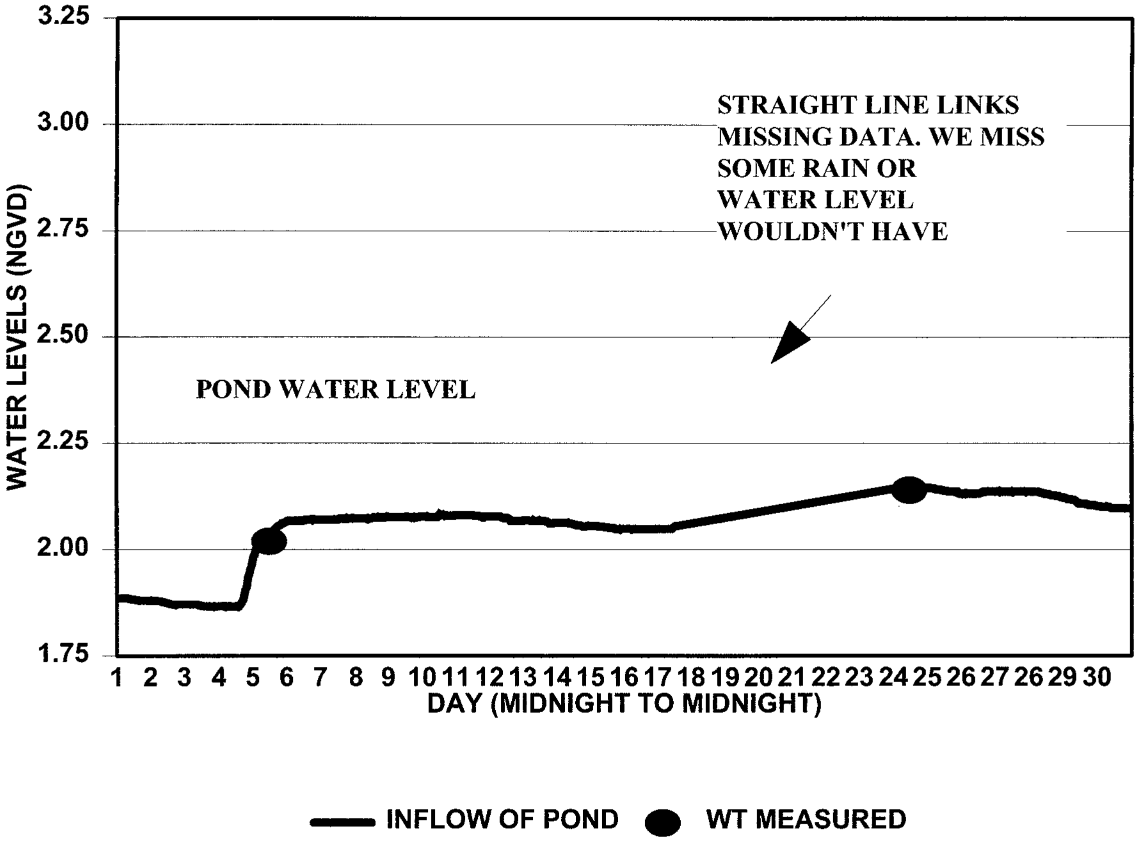

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DECEMBER 1998

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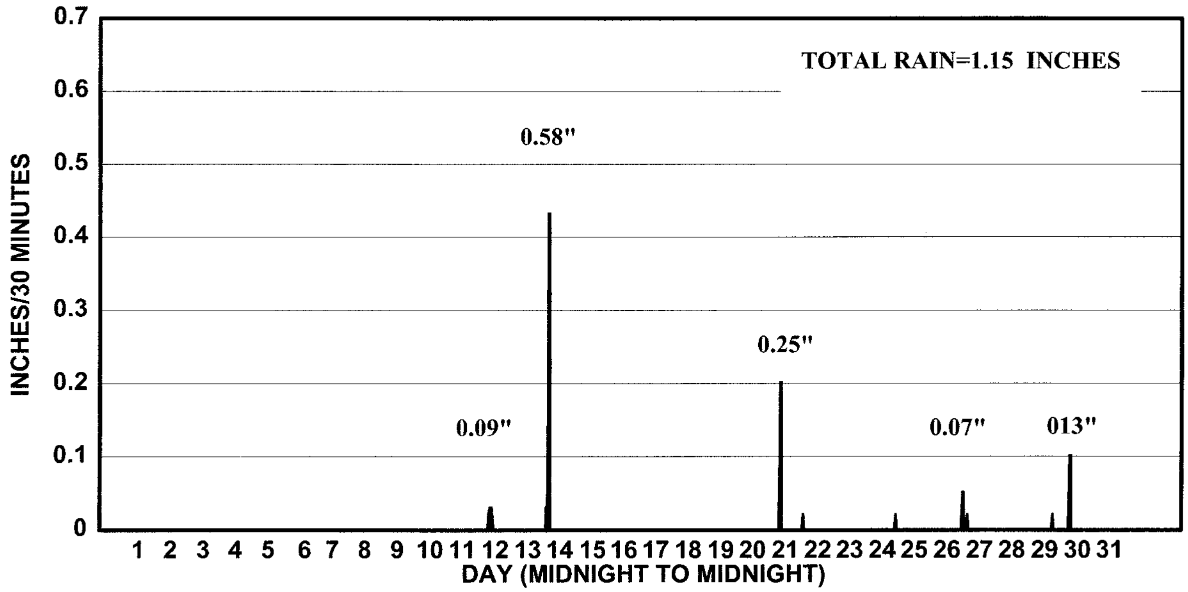
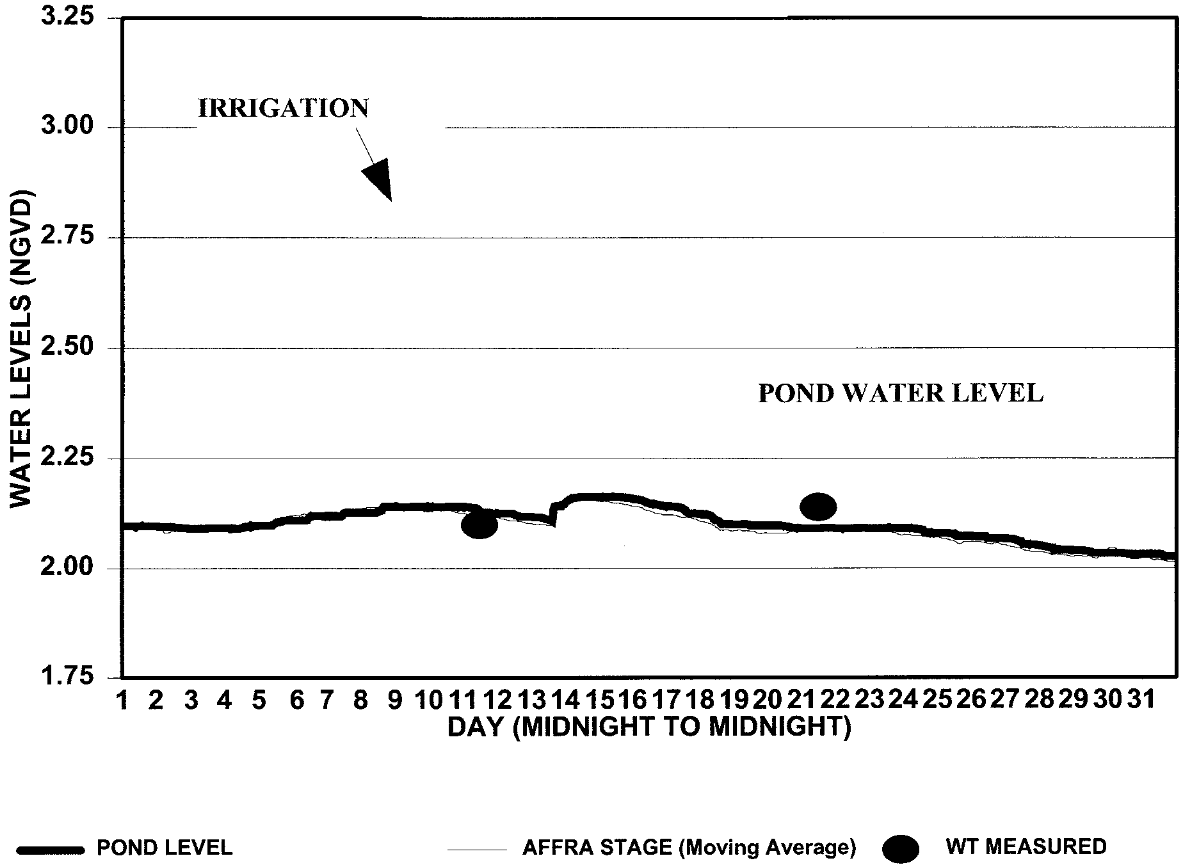


WATER LEVELS



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JANUARY 1999

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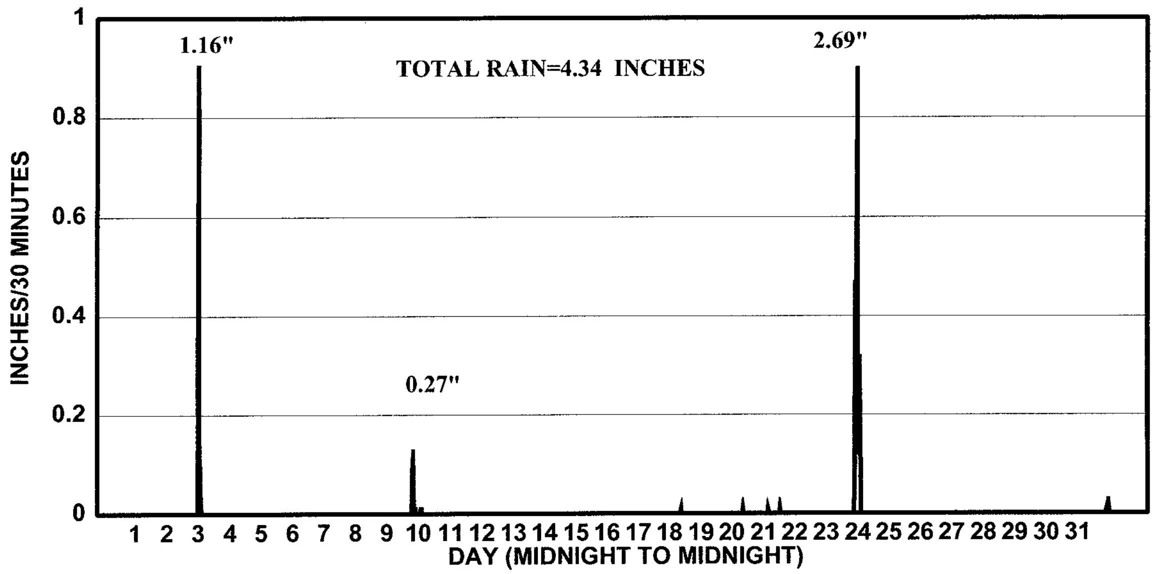

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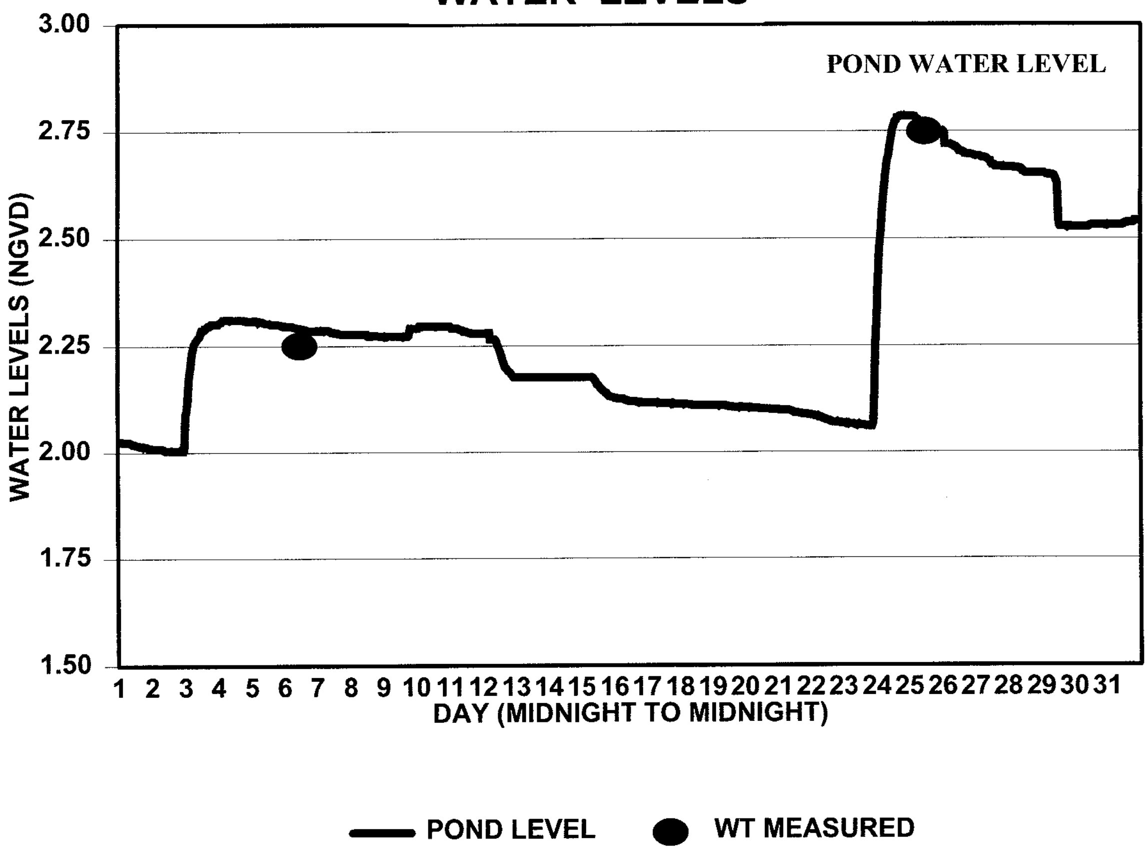

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FEBRUARY 1999

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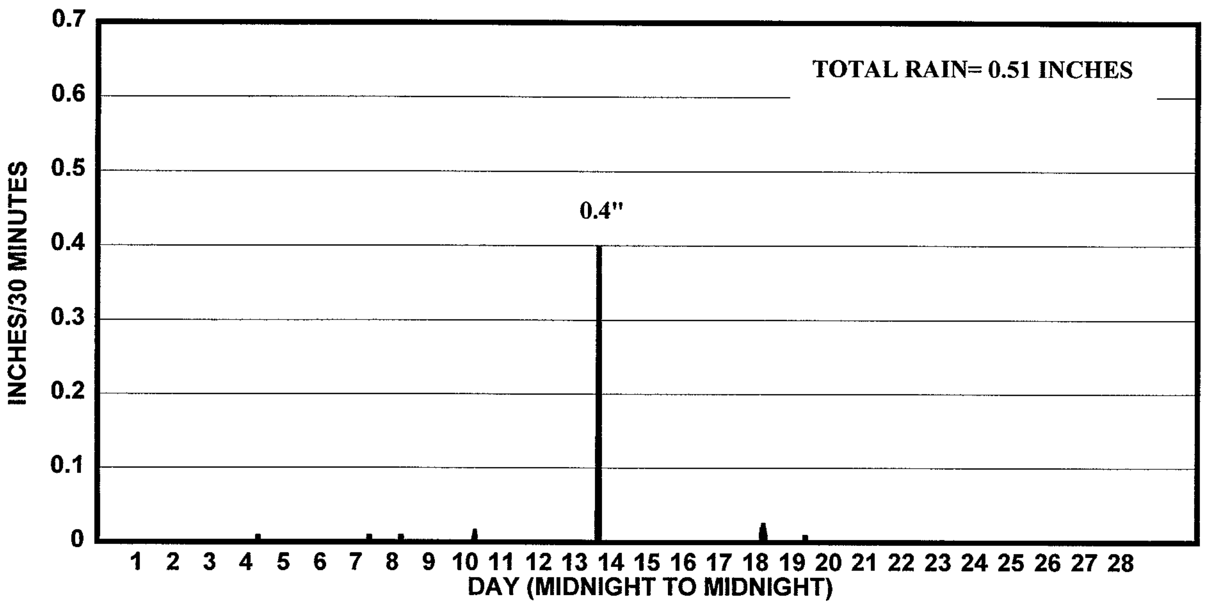
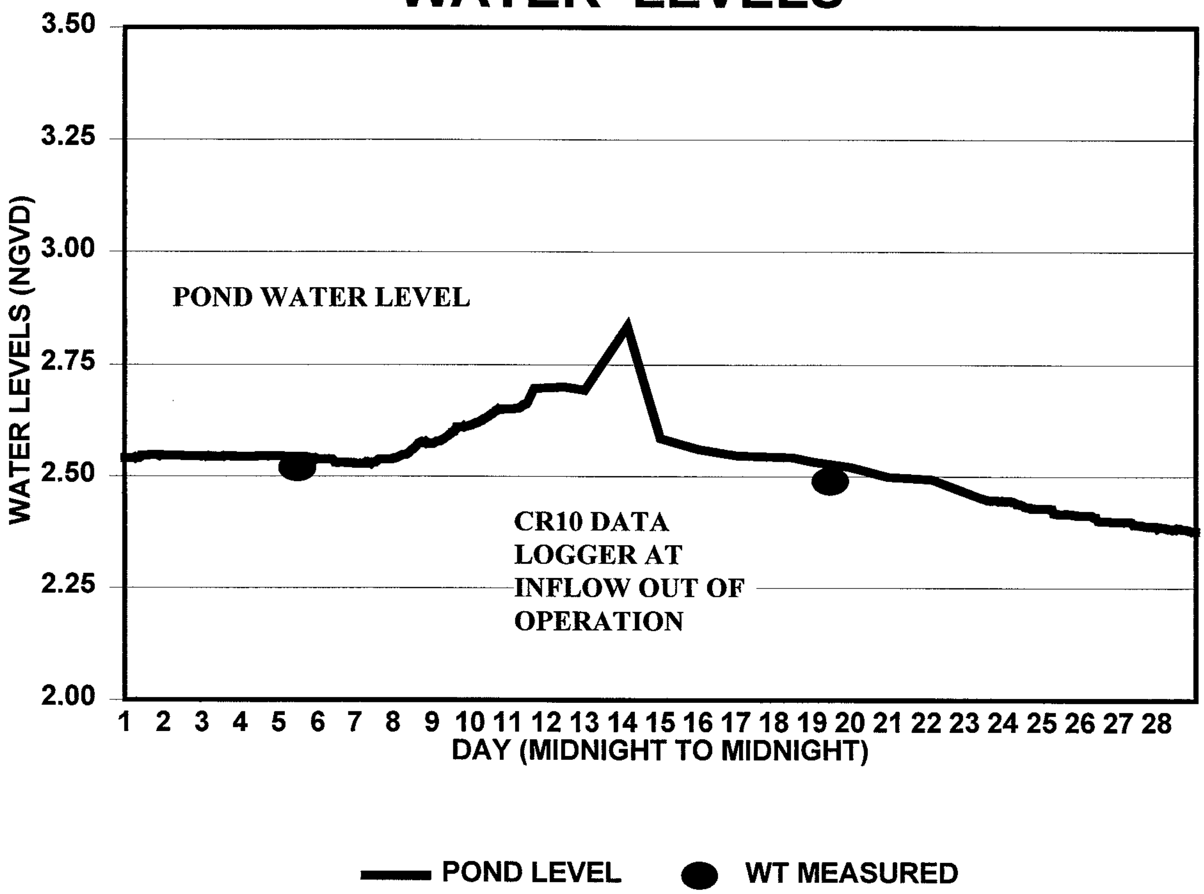
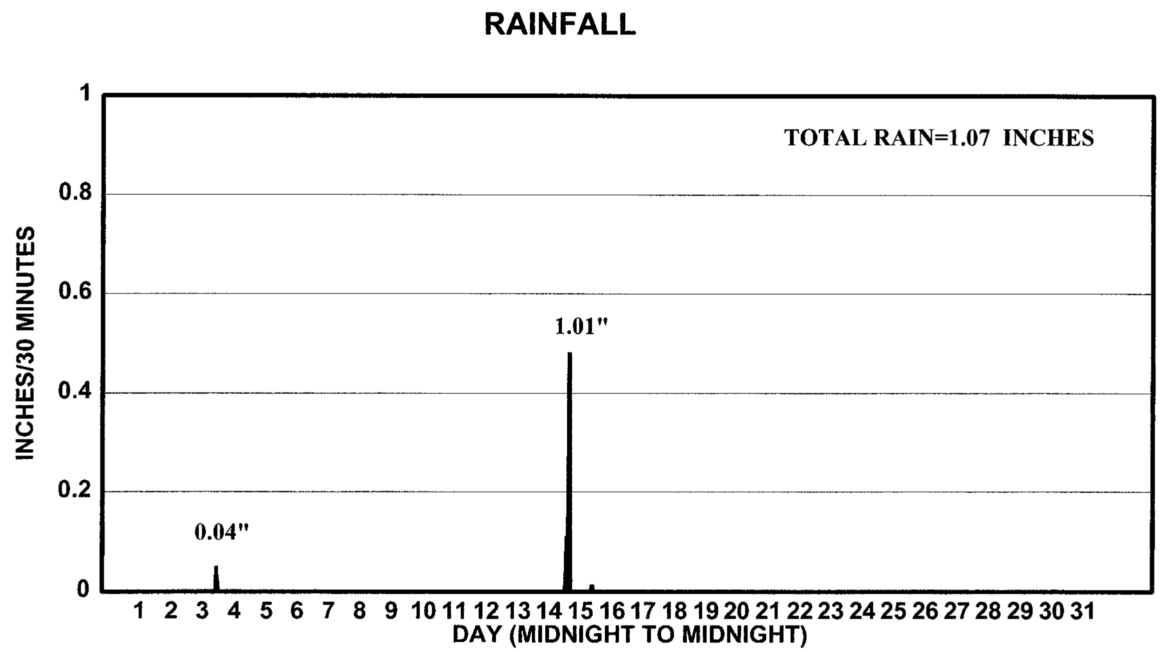
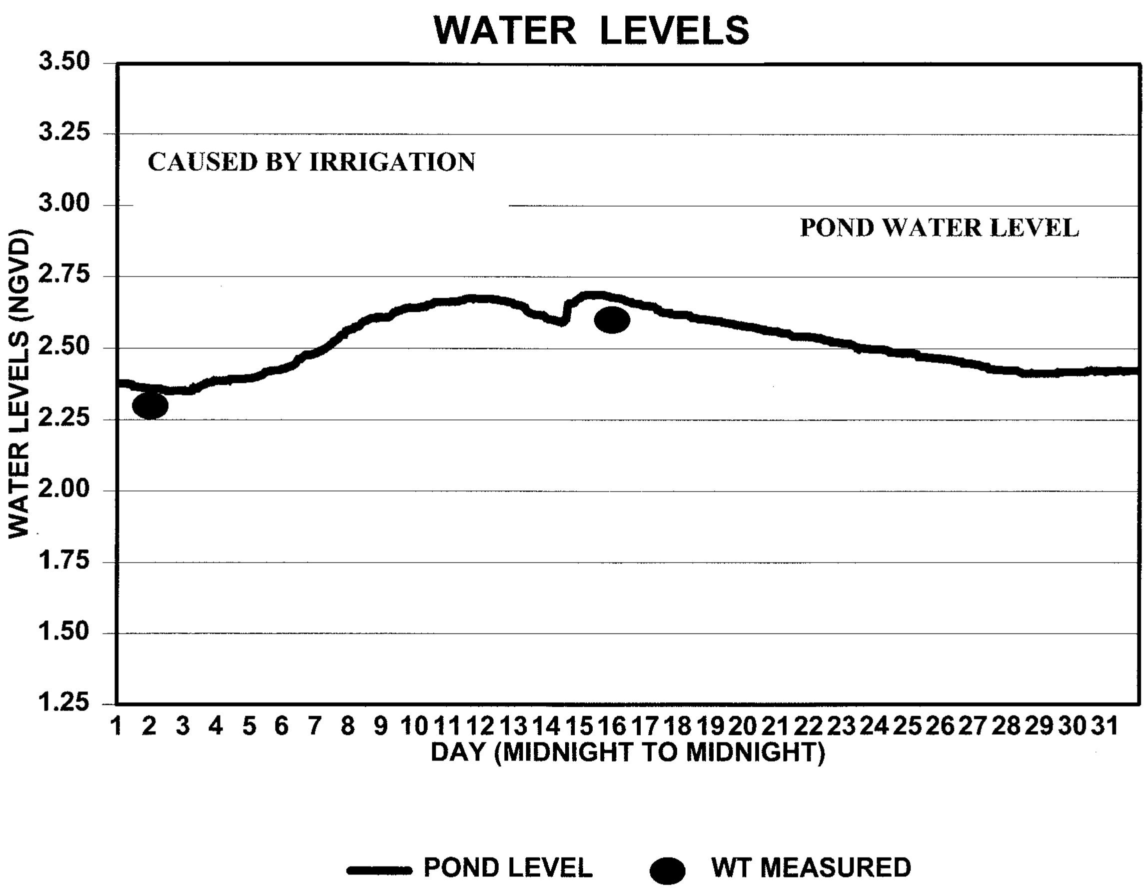


WATER LEVELS



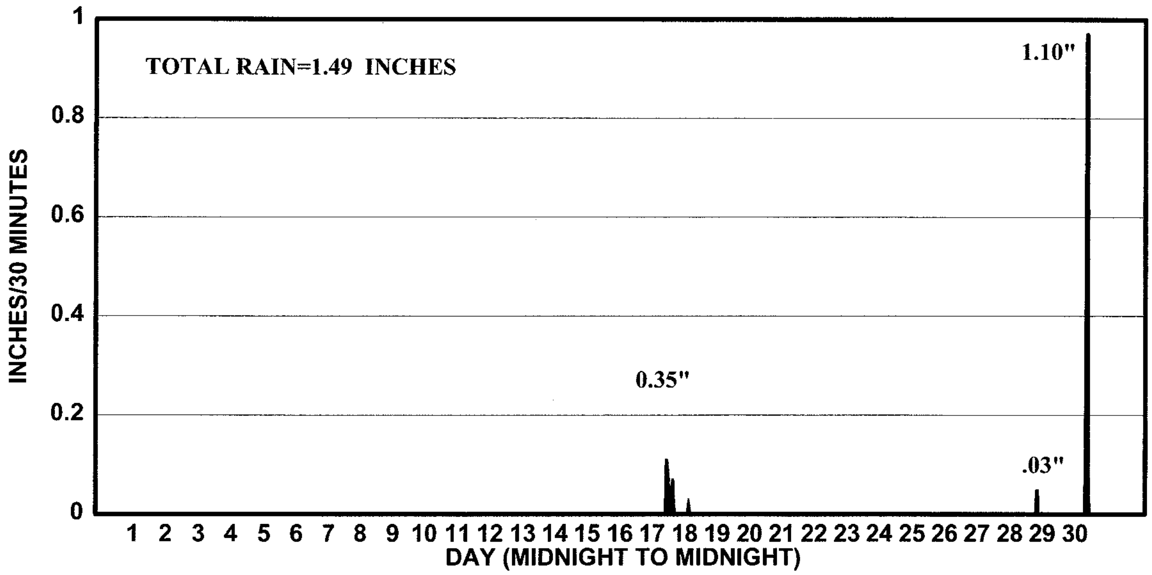
MARCH 1999


RAINFALL
TOTAL RAIN=1.07 INCHES
1.01"
0.04"
INCHES/30 MINUTES
0
0.2
0.4
0.6
0.8
1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DAY (MIDNIGHT TO MIDNIGHT)

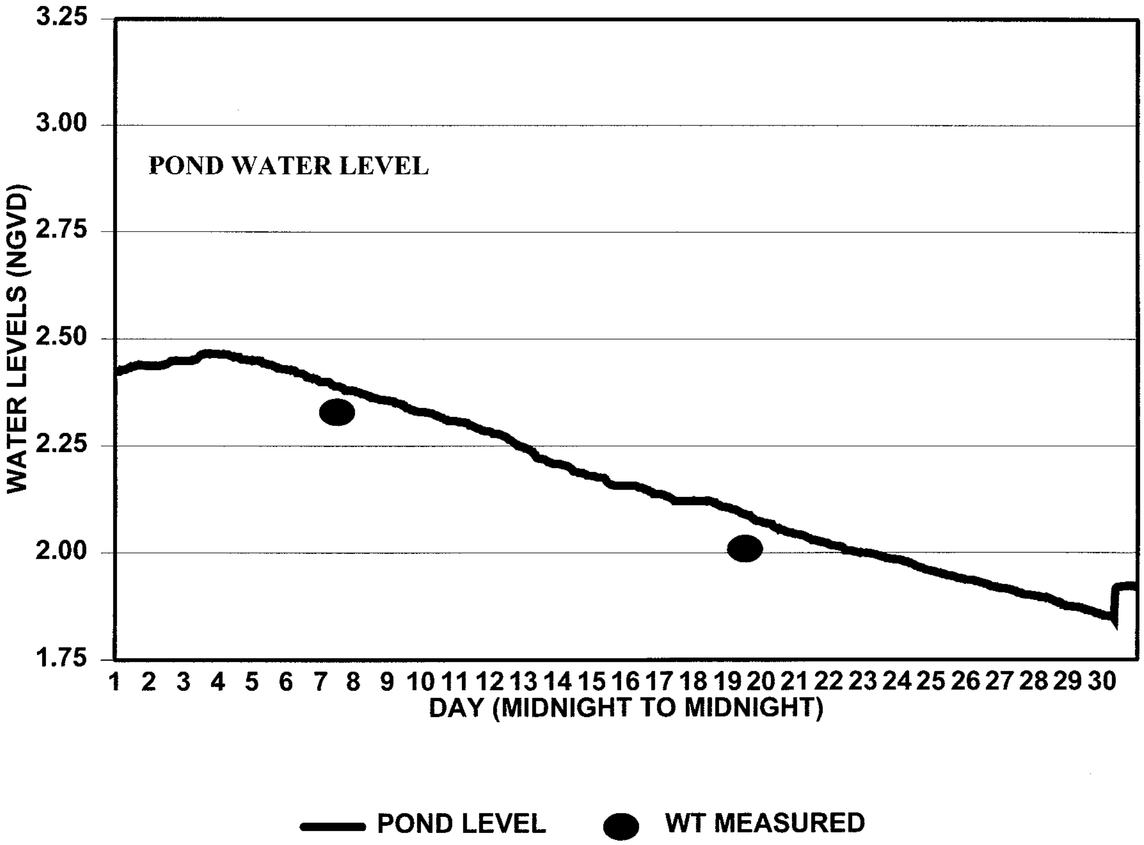

WATER LEVELS
CAUSED BY IRRIGATION
POND WATER LEVEL
WATER LEVELS (NGVD)
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
DAY (MIDNIGHT TO MIDNIGHT)
POND LEVEL
WT MEASURED

APRIL 1999

RAINFALL



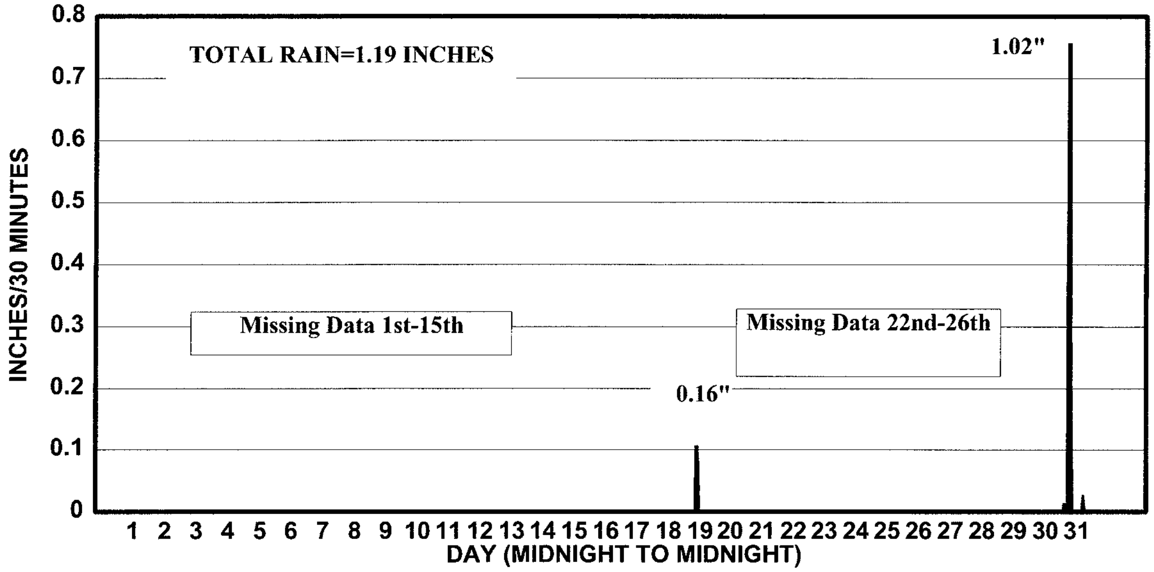
WATER LEVELS



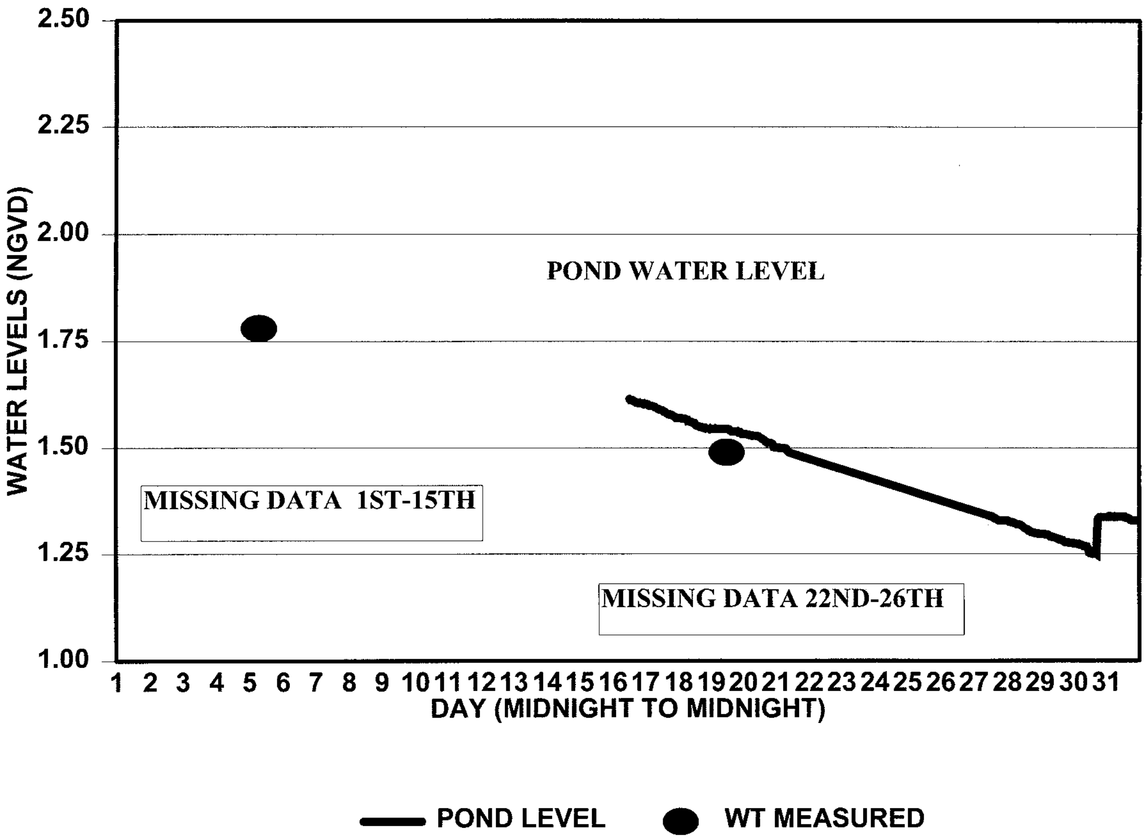
E:\Cockroach Bay\FINLgraphs\APR99.wb2

MAY 1999

RAINFALL



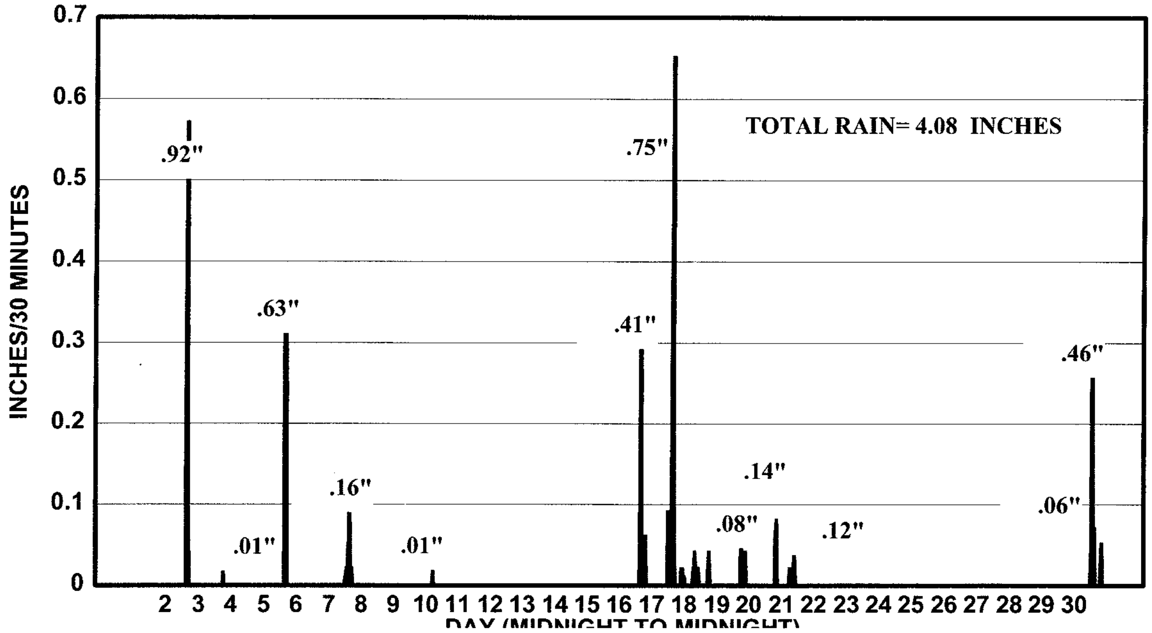
WATER LEVELS



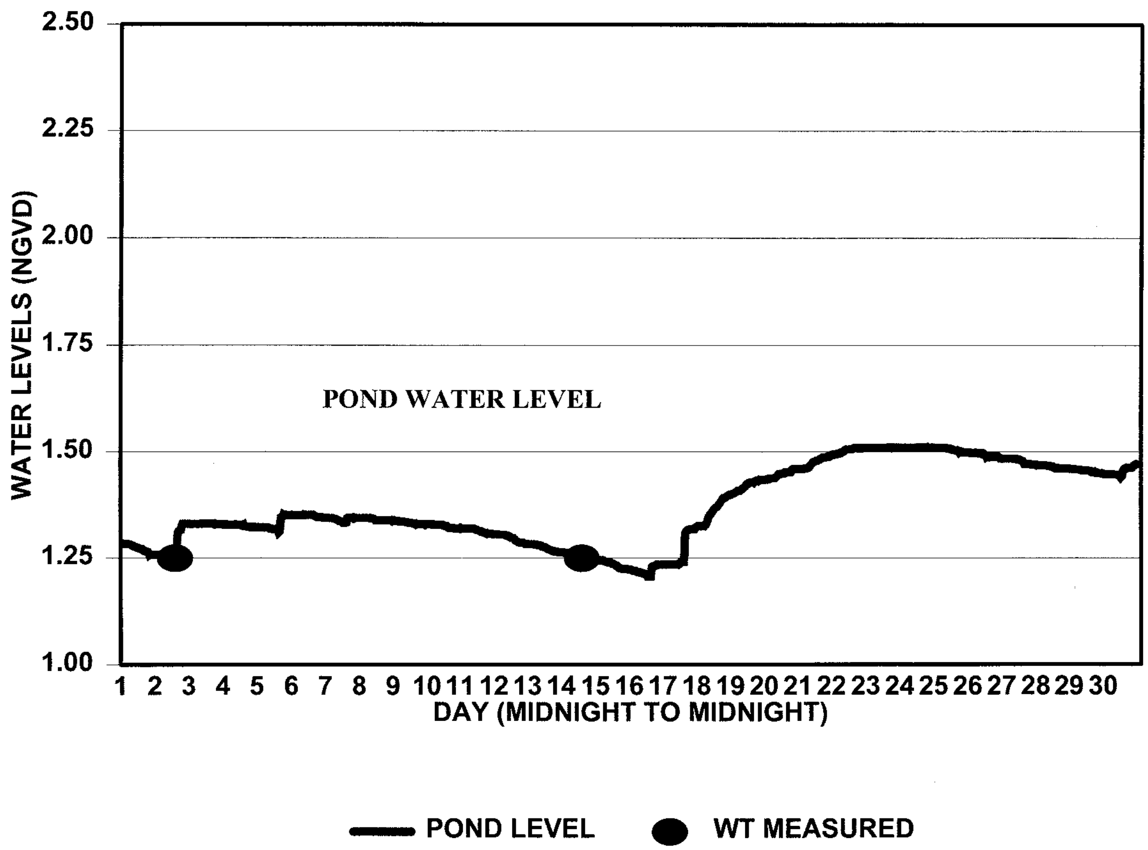
E:\Cockroach Bay\FINLgraphs\MAY99.wb2

JUNE 1999

RAINFALL



WATER LEVELS



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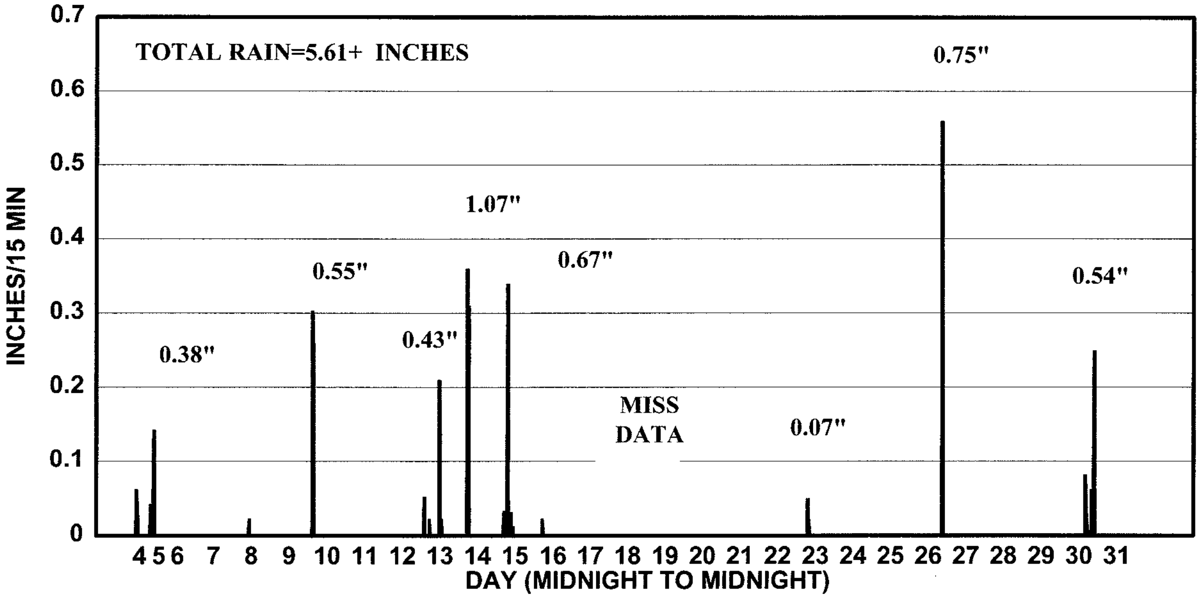
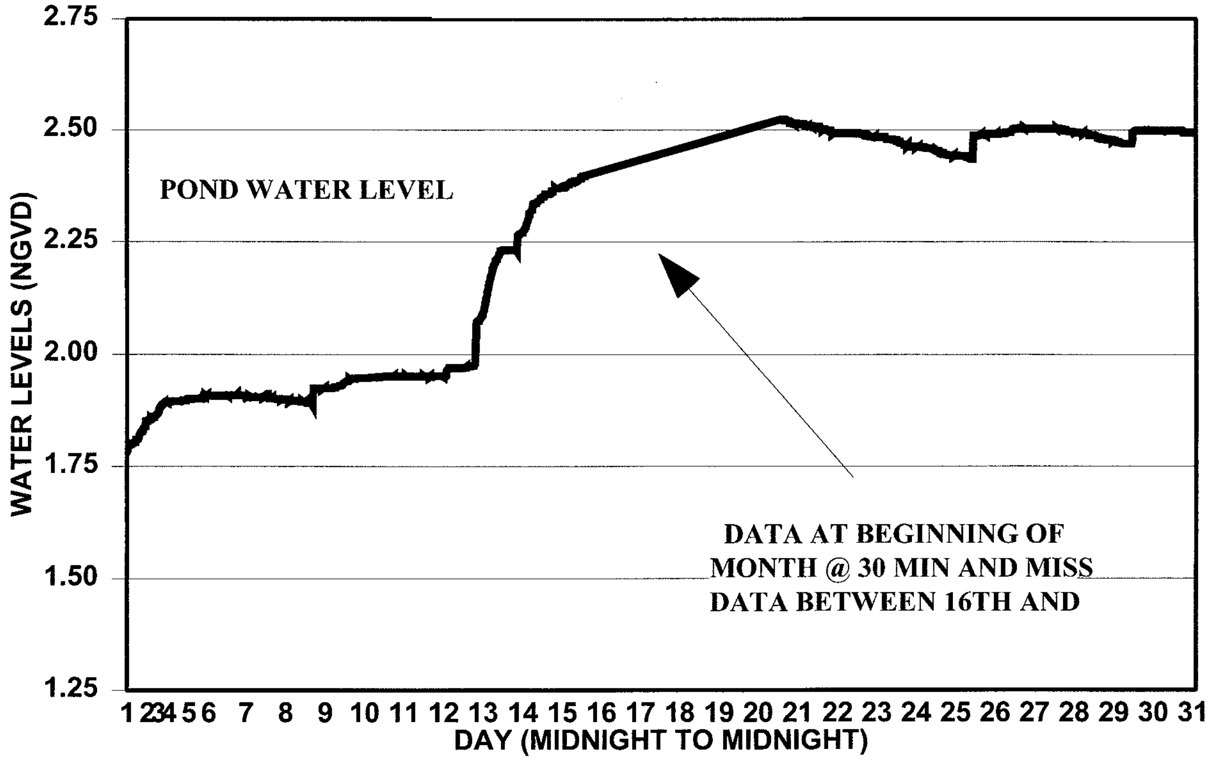
JULY 1999

RAINFALL



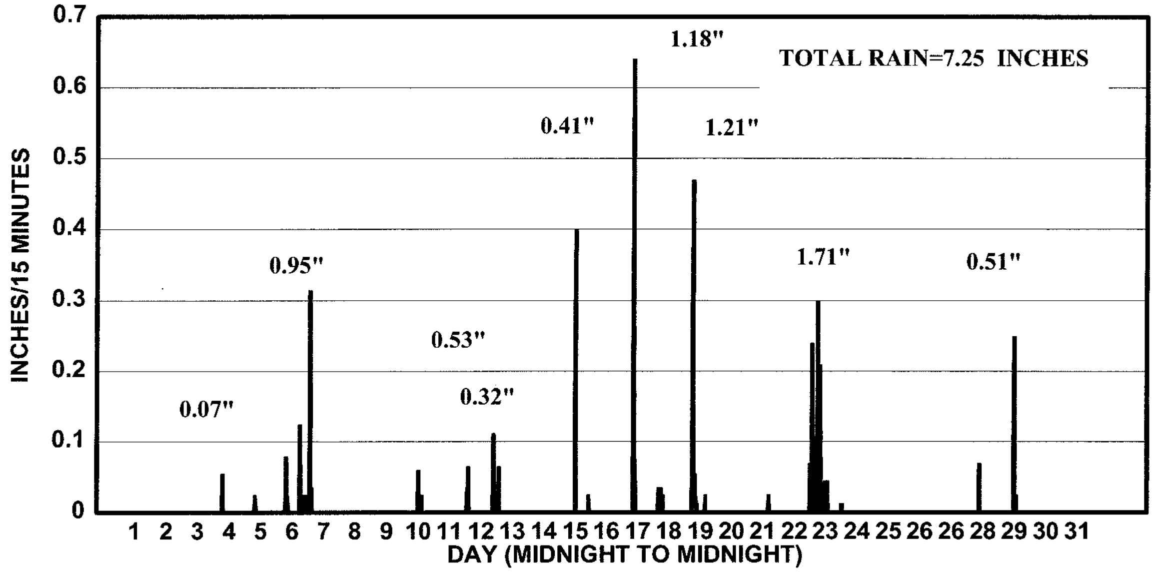
WATER LEVELS



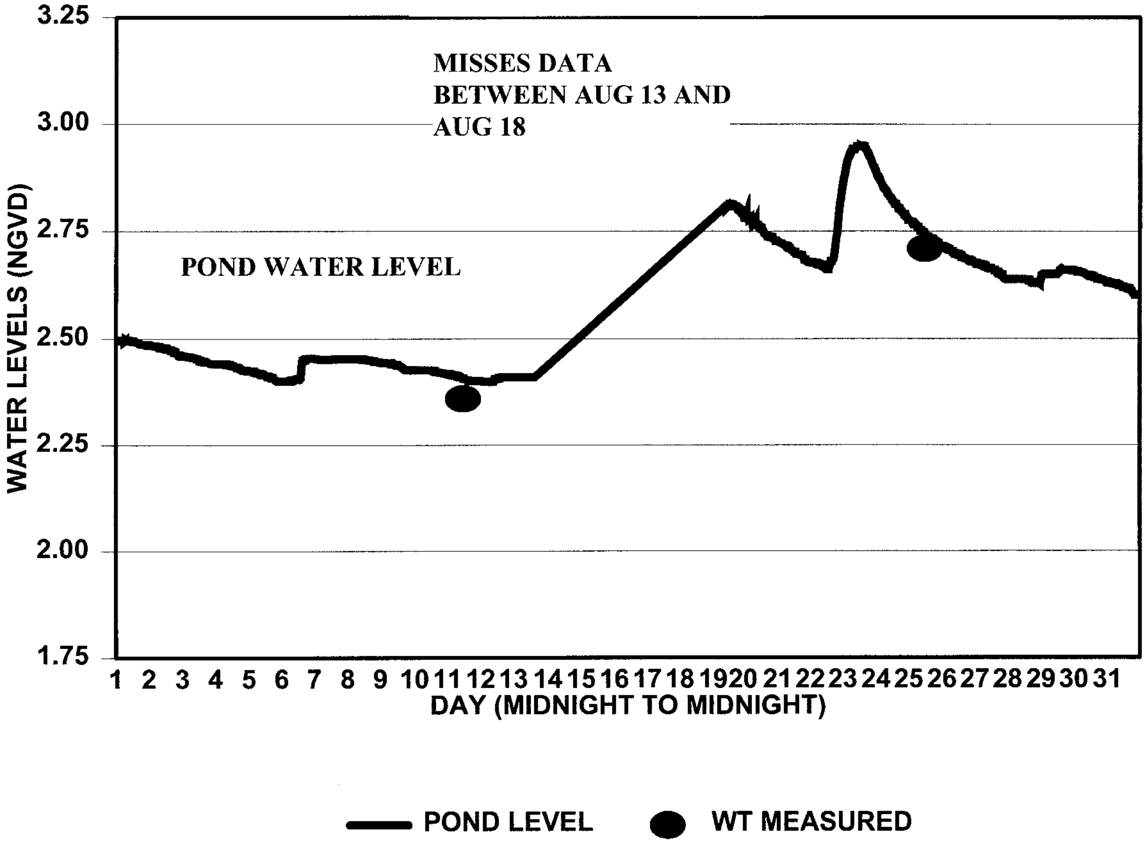
POND LEVEL

AUGUST 1999

RAINFALL



WATER LEVELS



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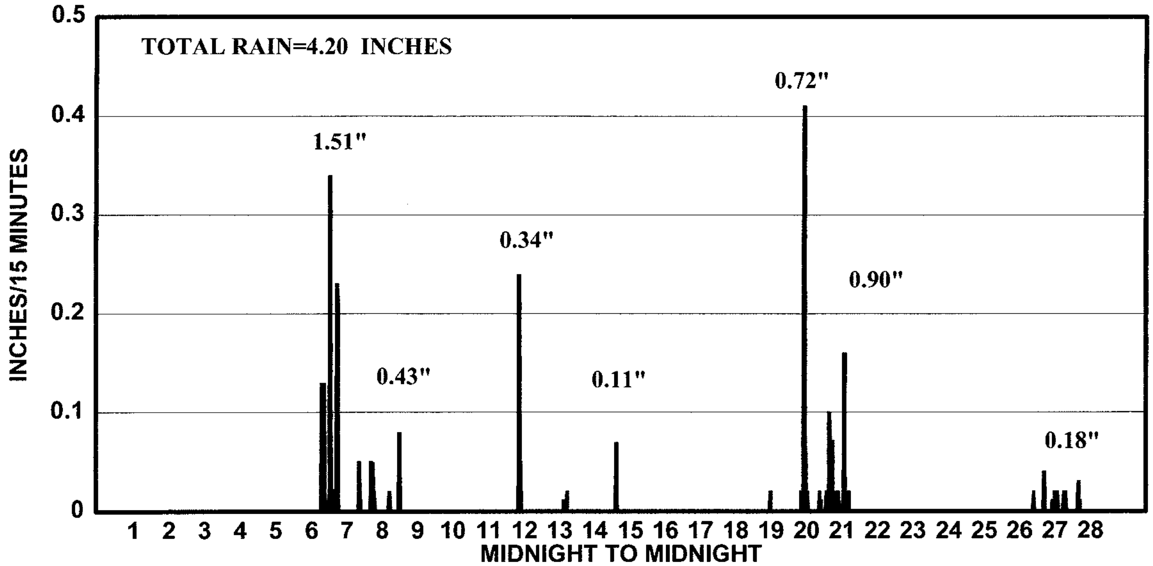
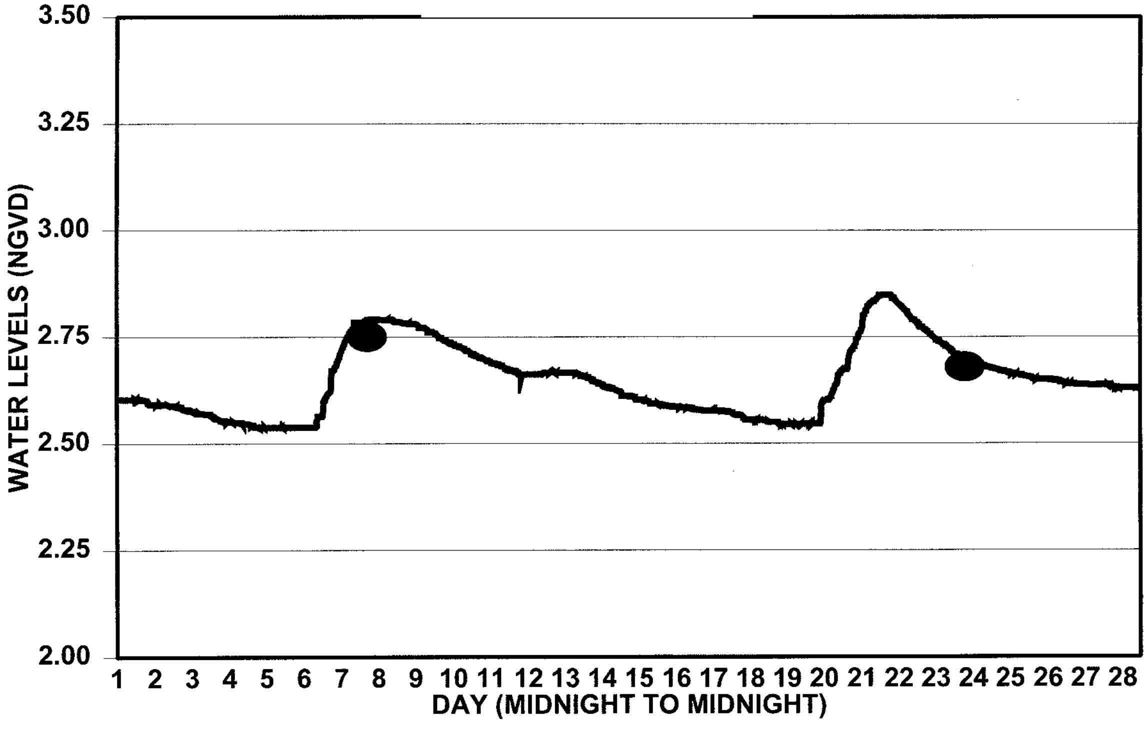
SEPTEMBER 1999

RAINFALL



WATER LEVELS



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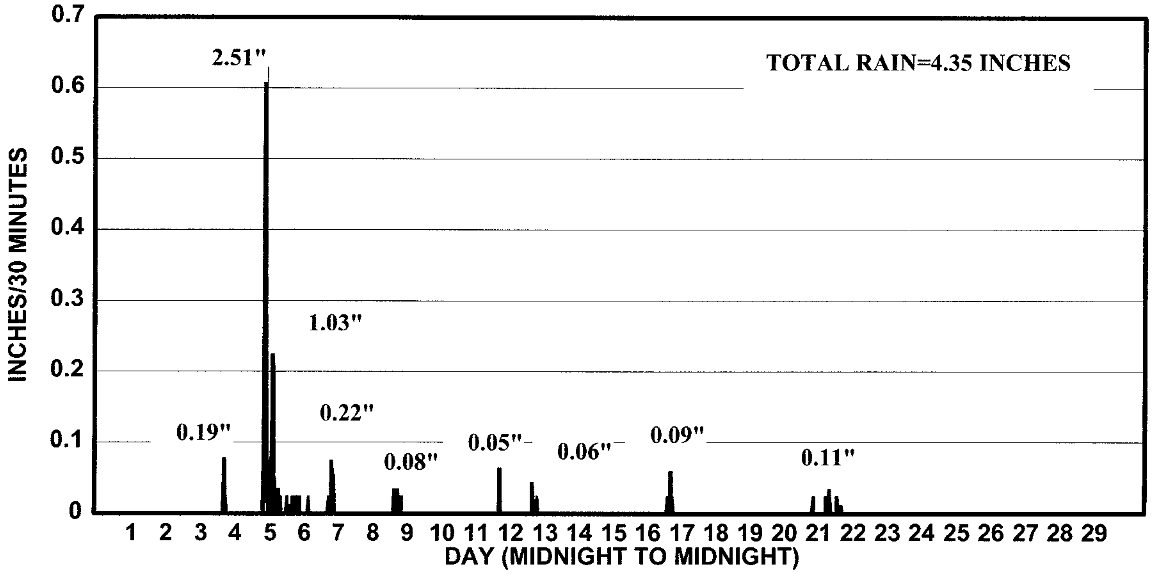
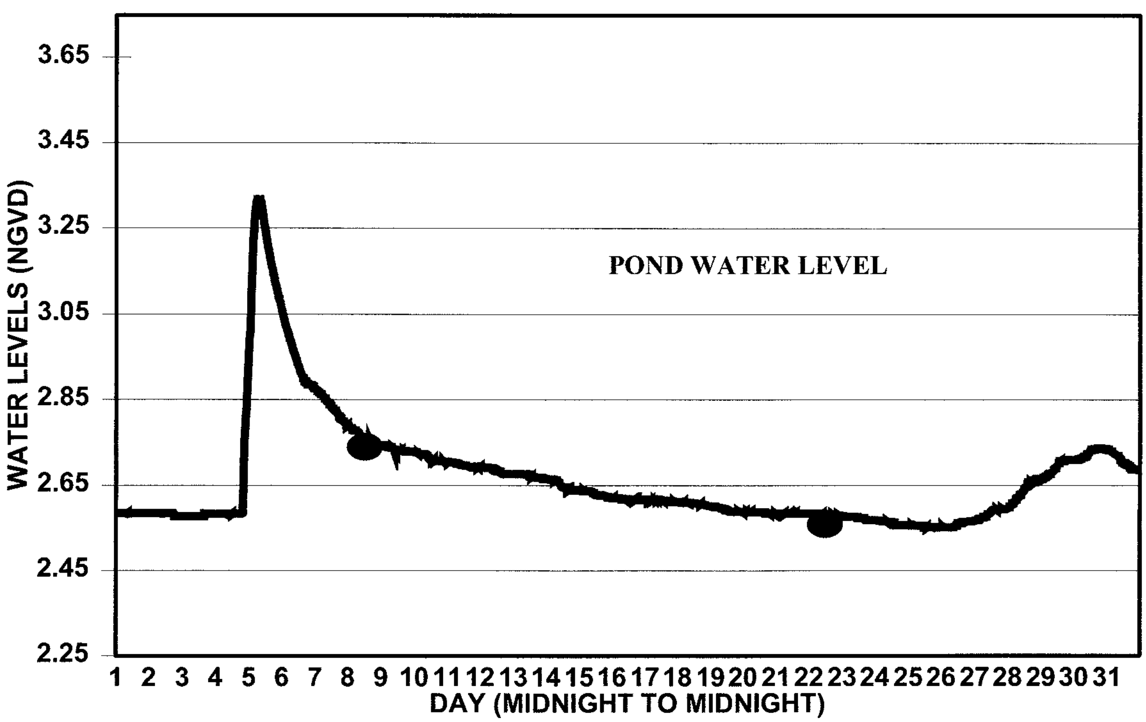
OCTOBER 1999

RAINFALL



WATER LEVELS



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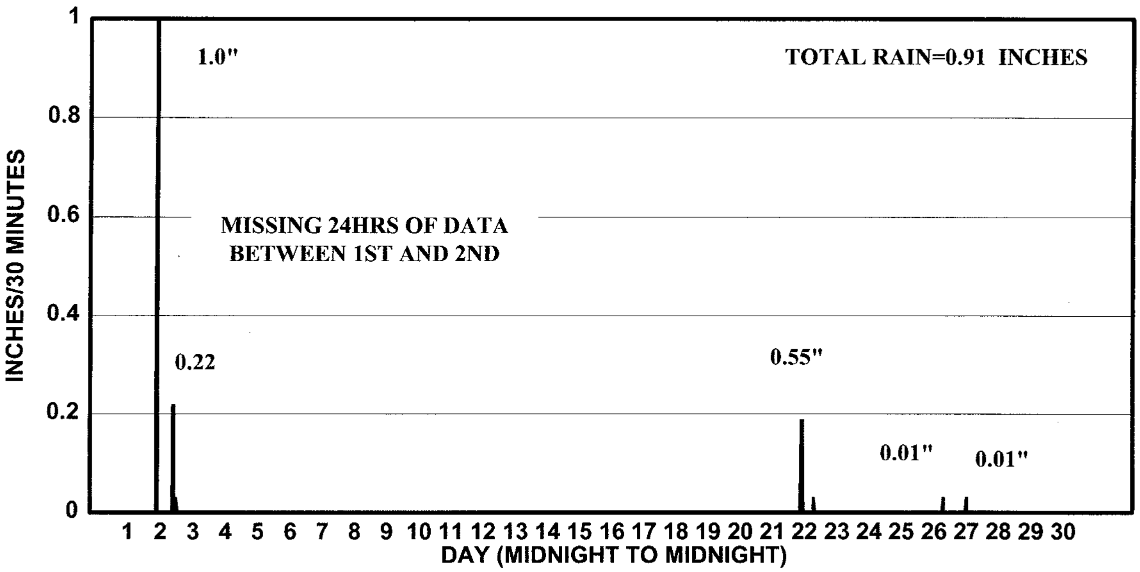
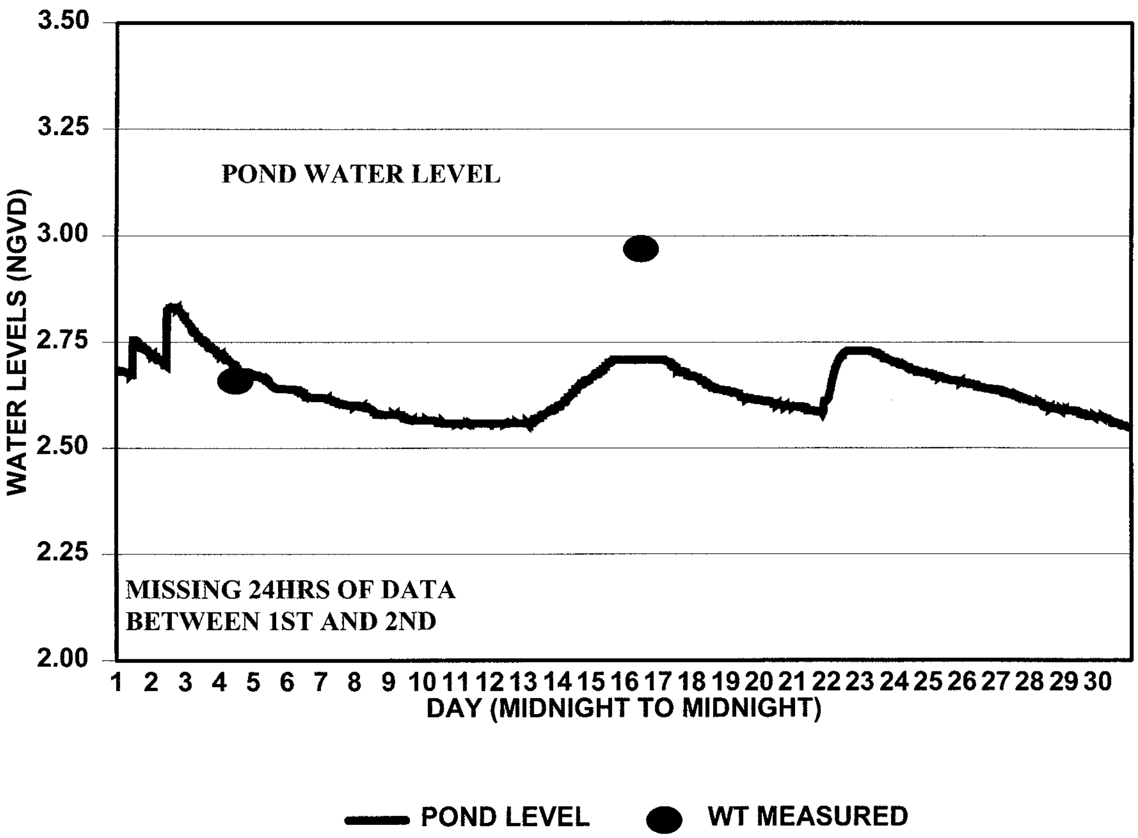
NOVEMBER 1999

RAINFALL

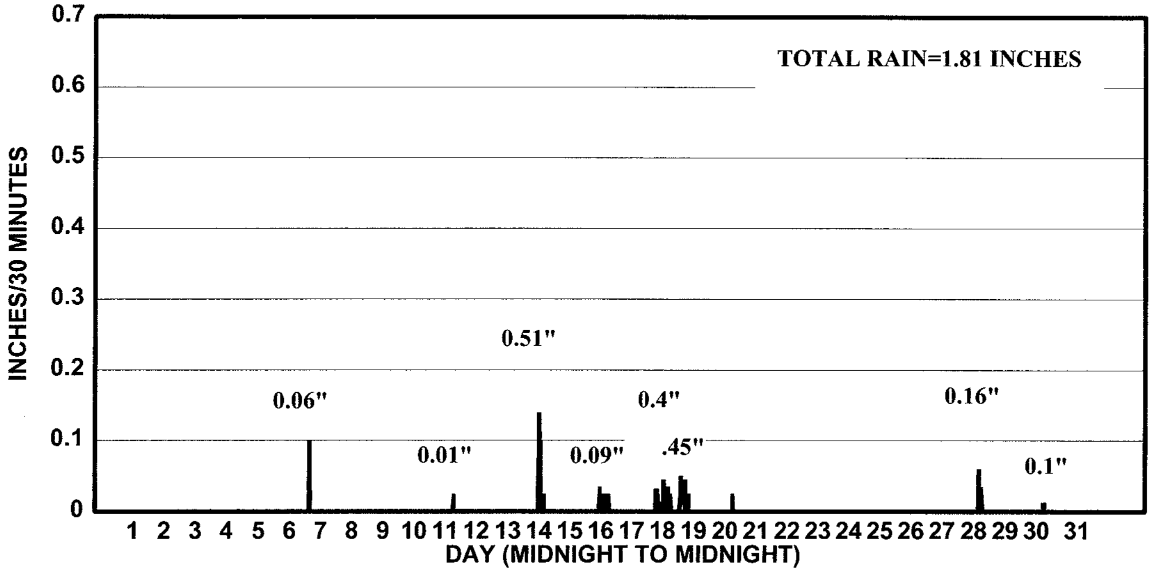


WATER LEVELS

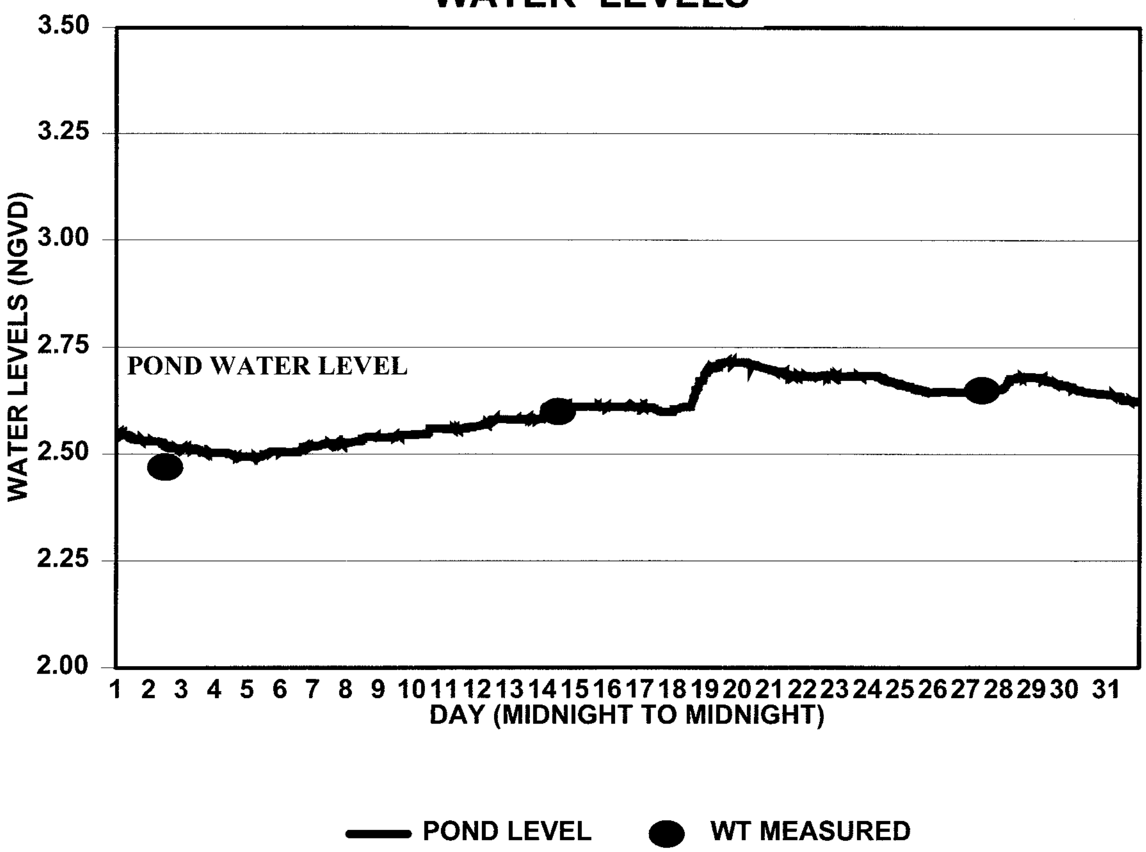


DECEMBER 1999

RAINFALL

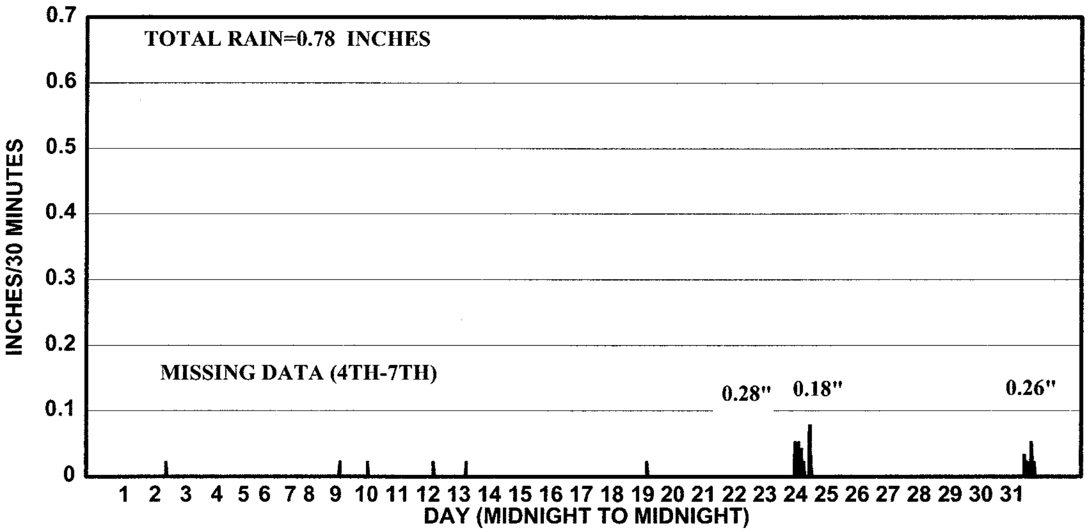


WATER LEVELS

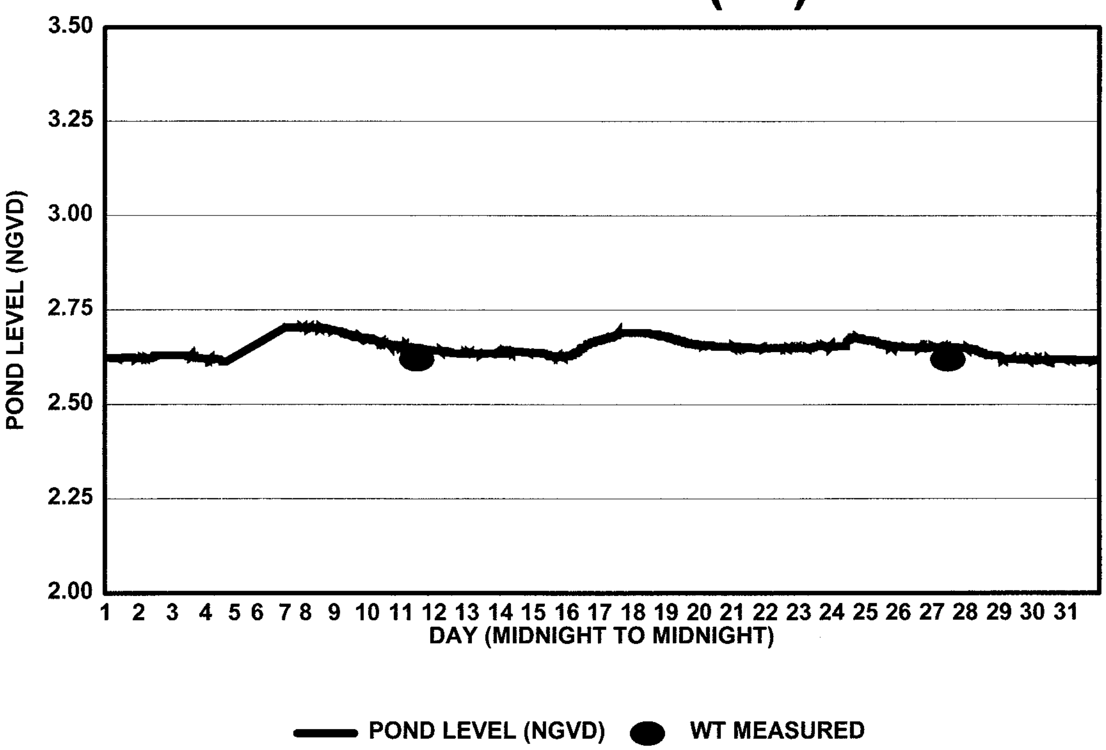


JANUARY 2000

RAINFALL



POND LEVEL (FT)



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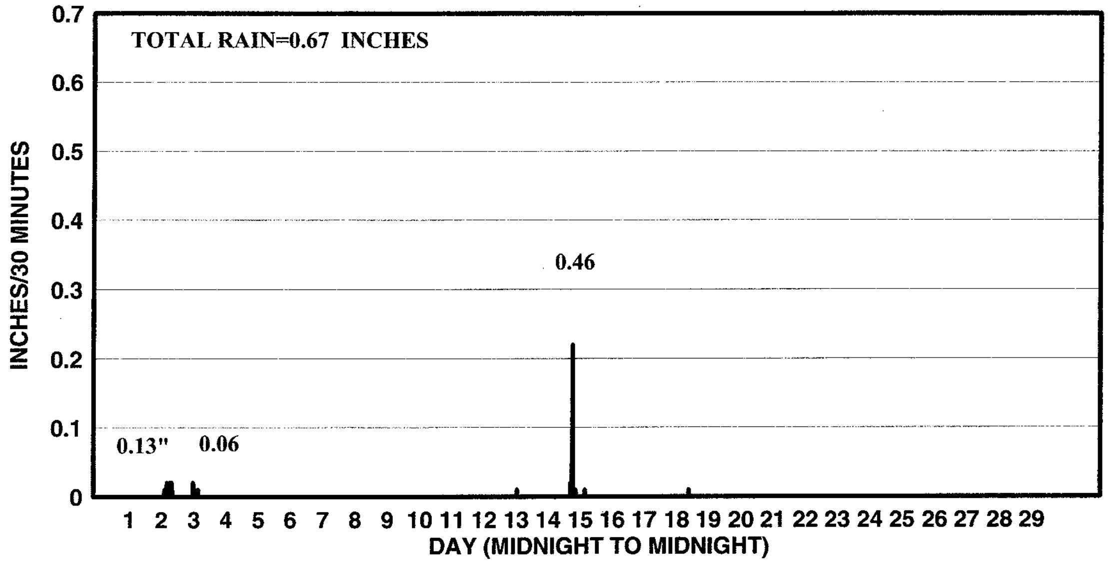
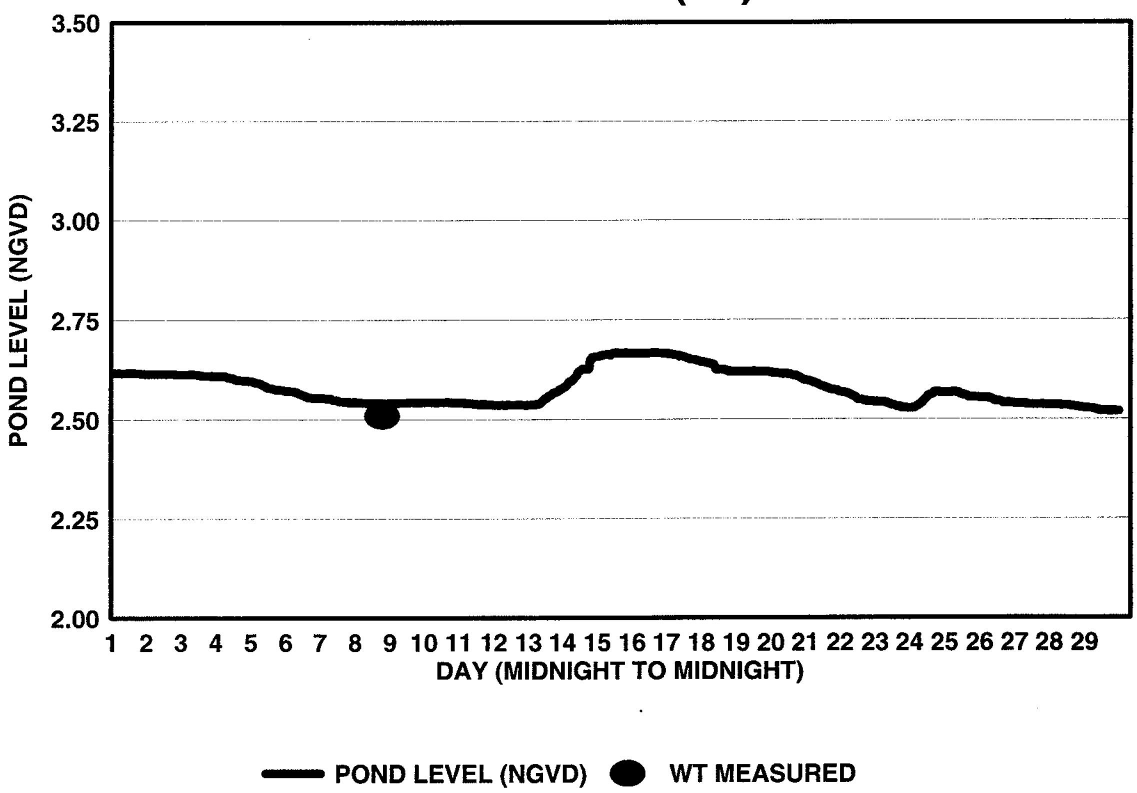
FEBRUARY 2000
RAINFALL



POND LEVEL (FT)



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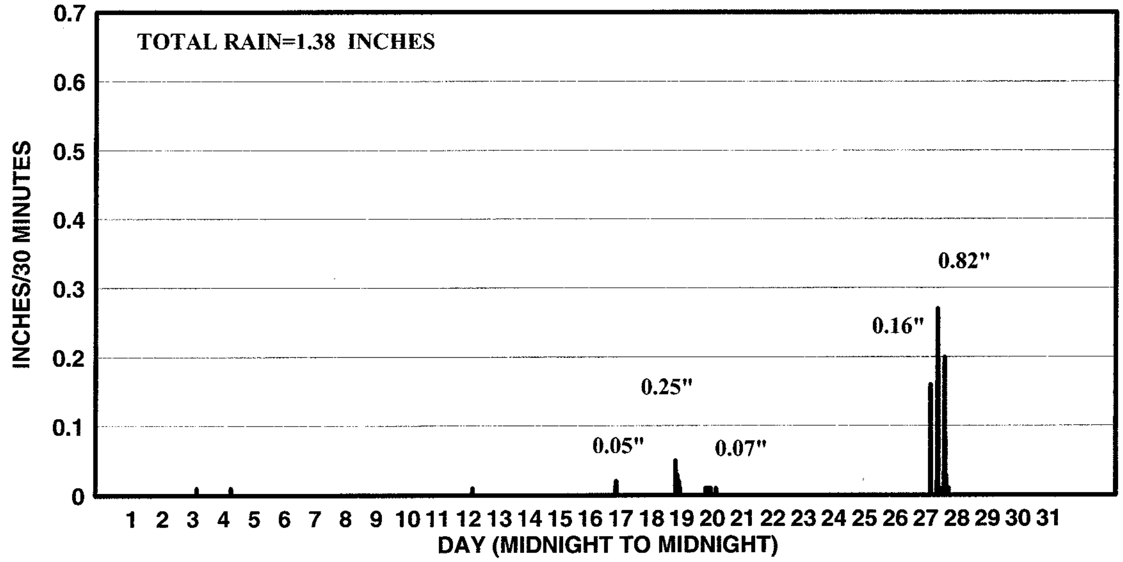
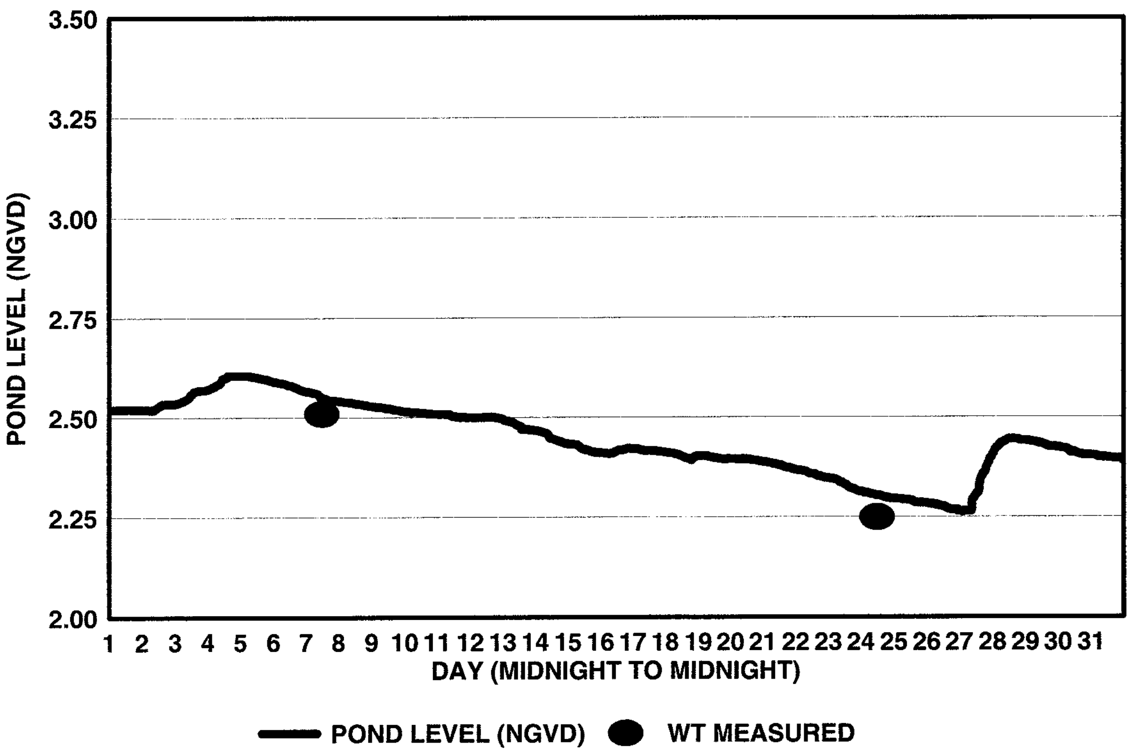
MARCH 2000

RAINFALL



POND LEVEL (FT)



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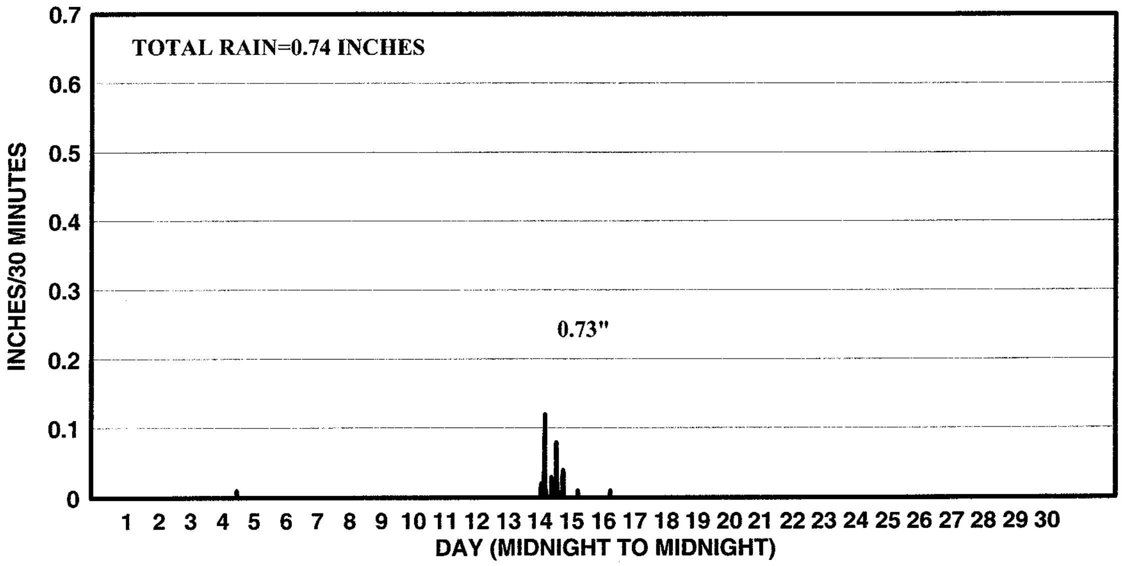
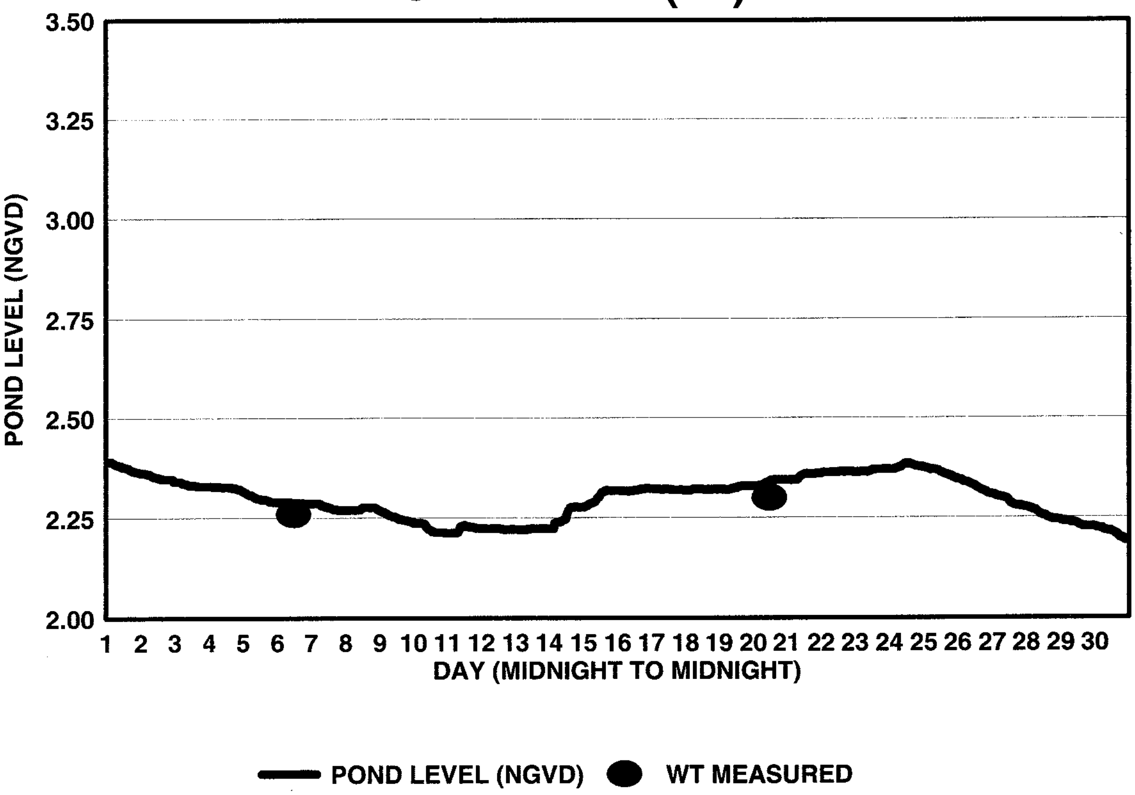
APRIL 2000

RAINFALL



POND LEVEL (FT)



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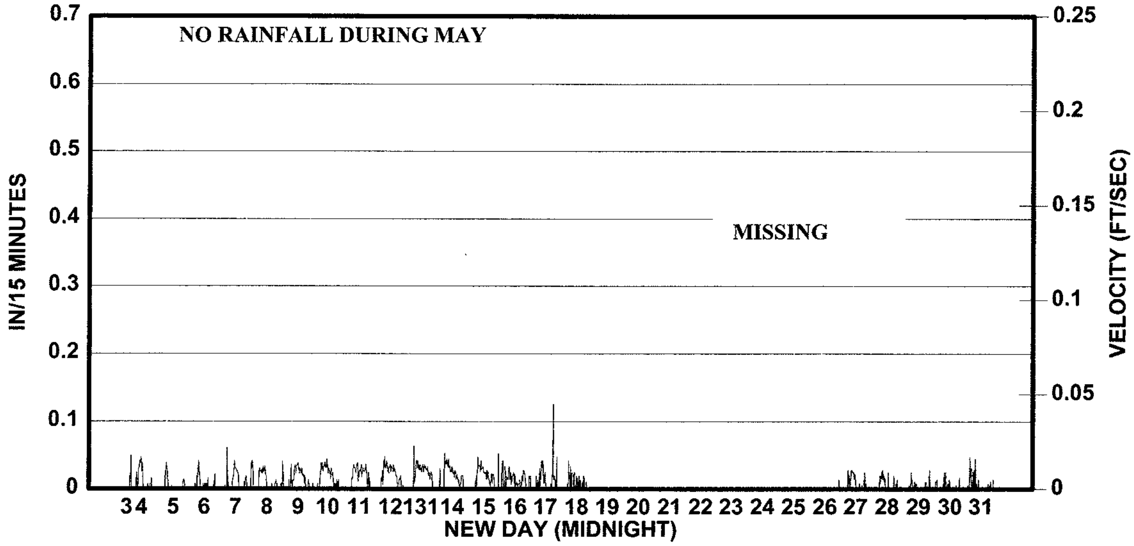
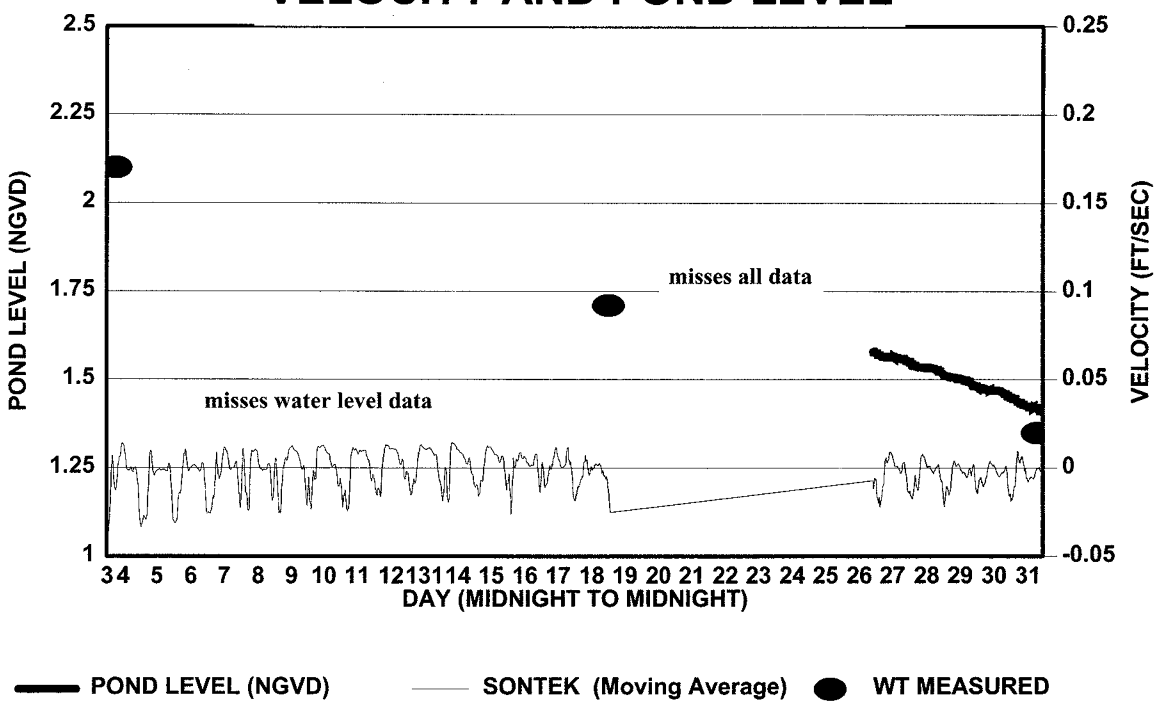
MAY 2000

RAINFALL and VELOCITY



VELOCITY AND POND LEVEL



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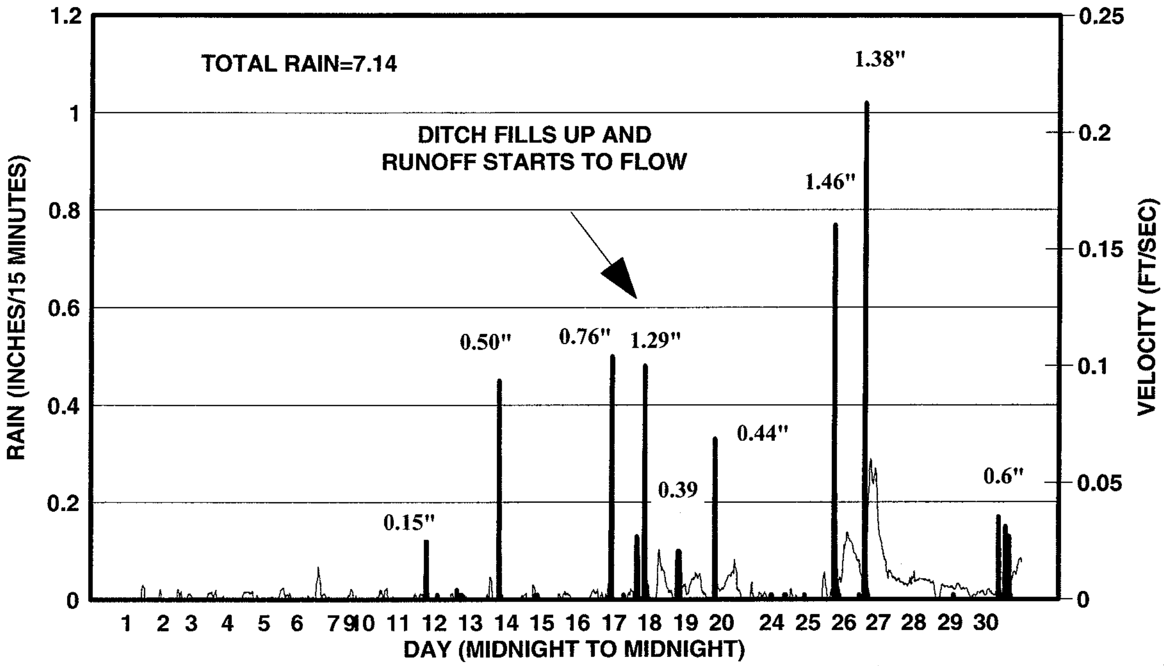
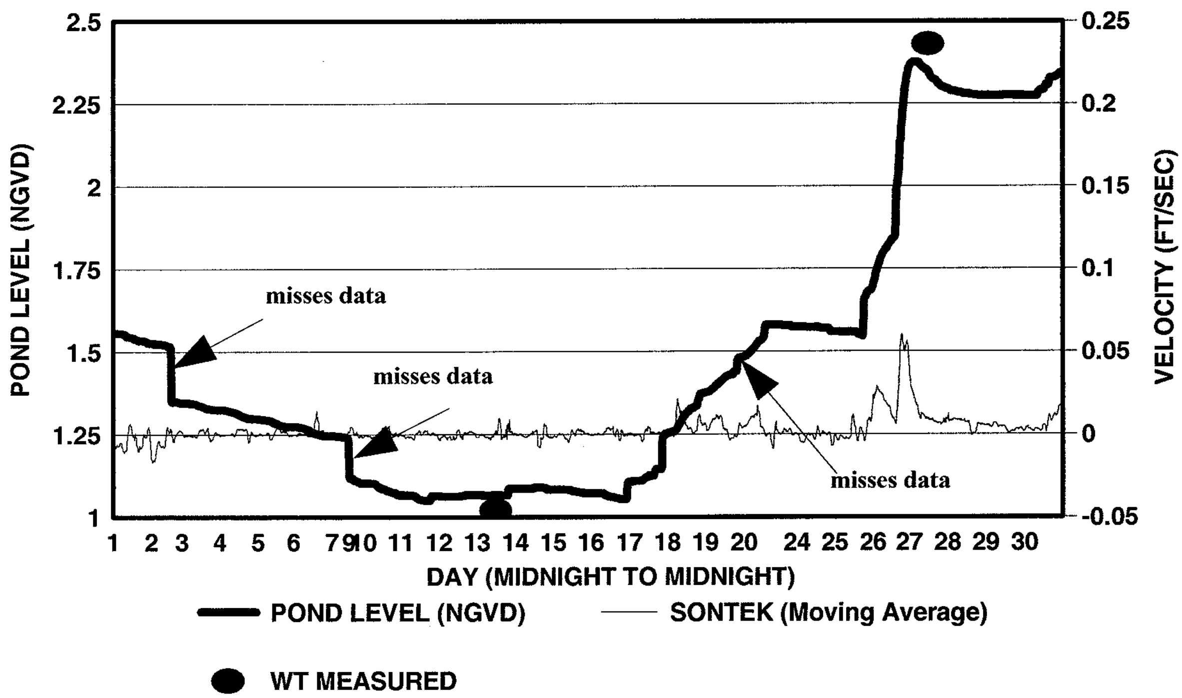
JUNE 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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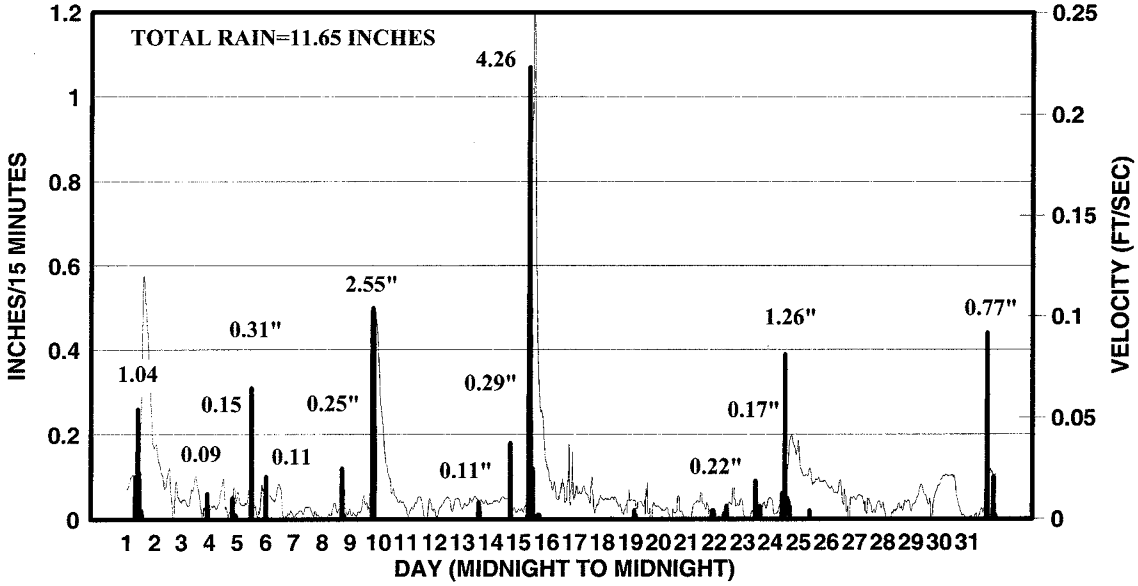
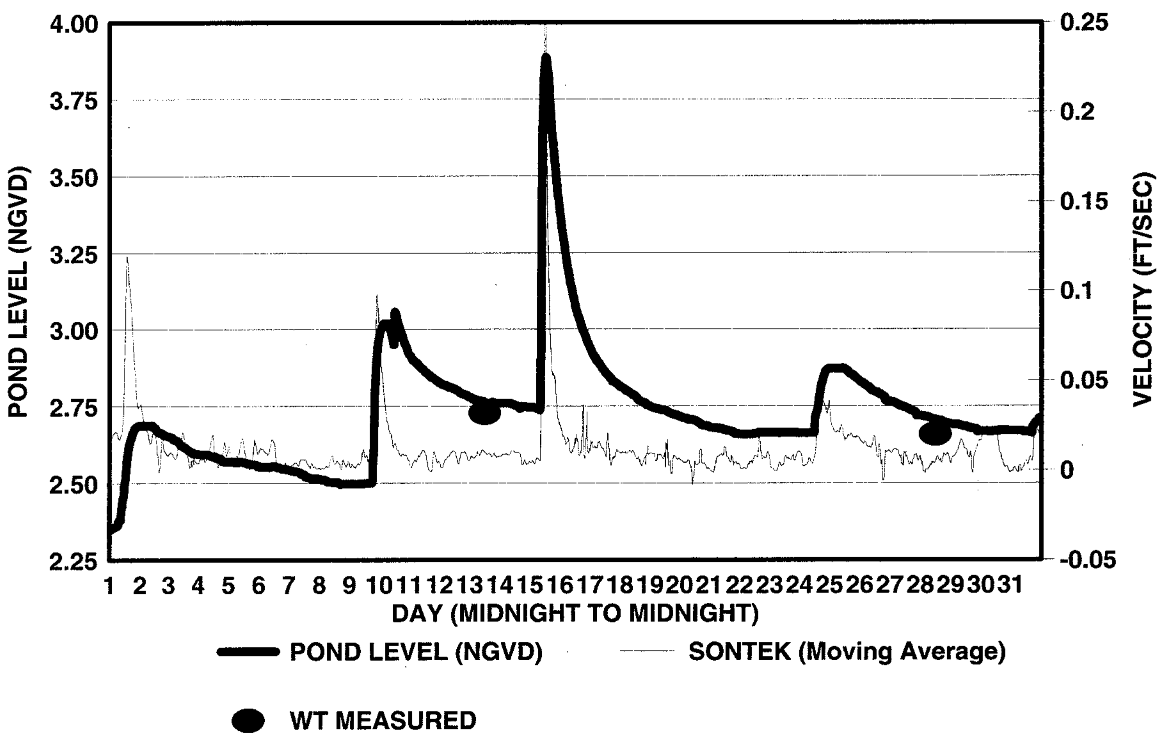
JULY 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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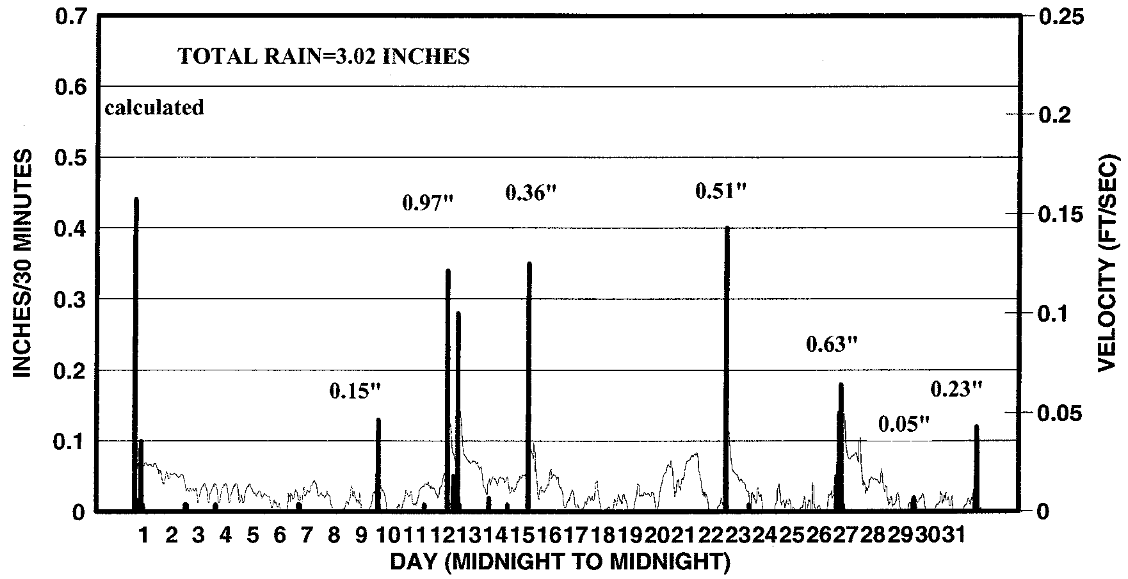
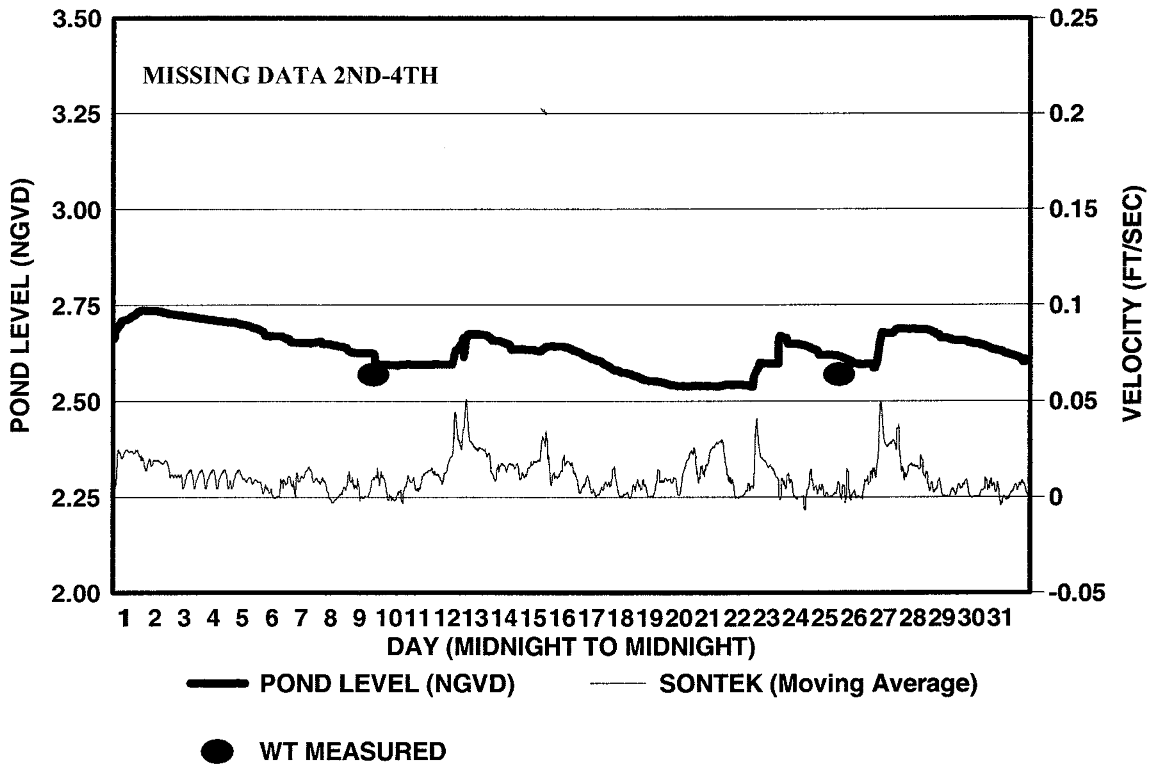
AUGUST 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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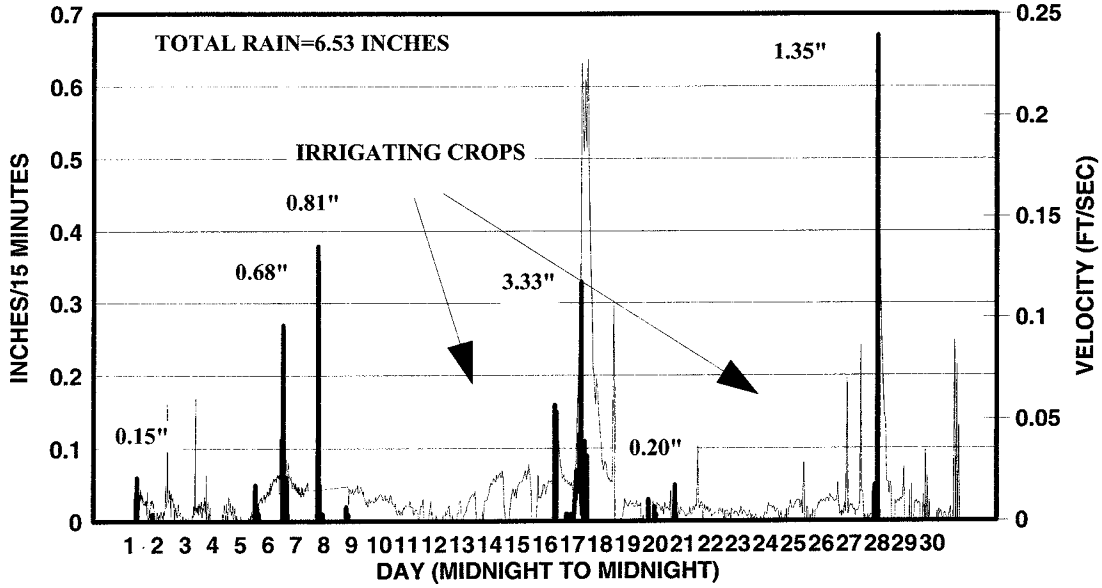
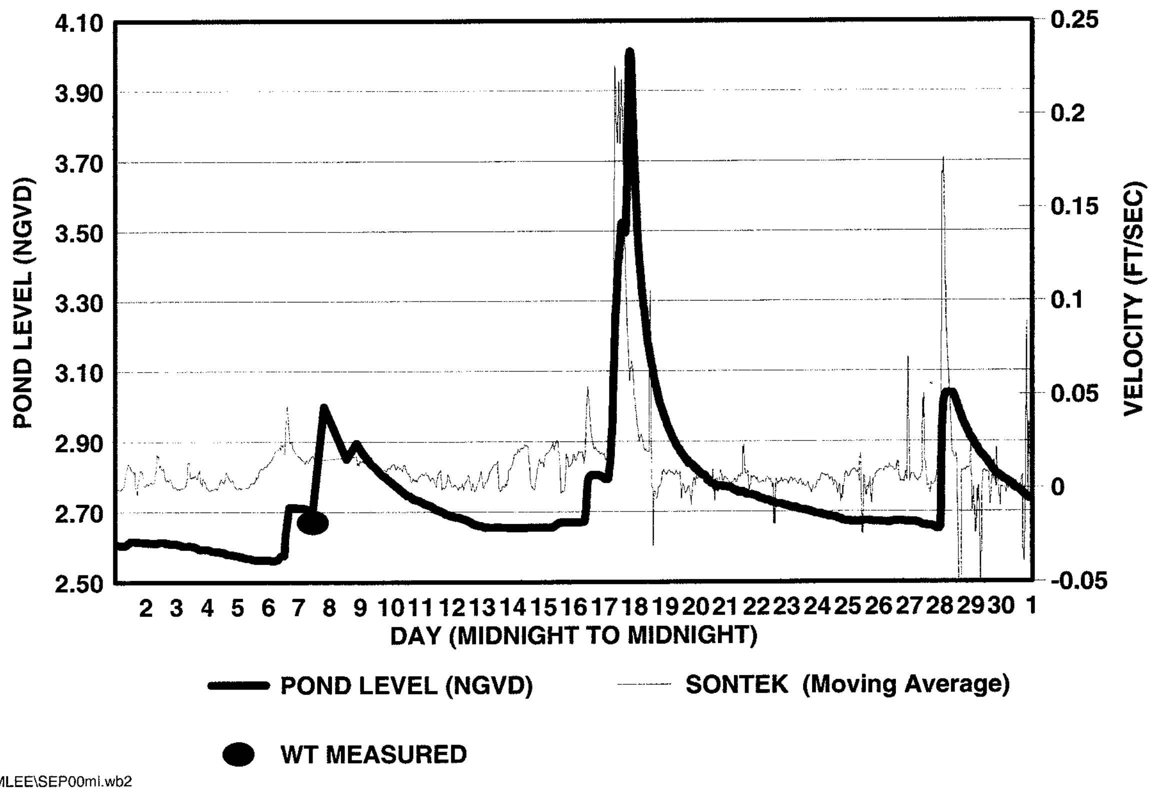
SEPTEMBER 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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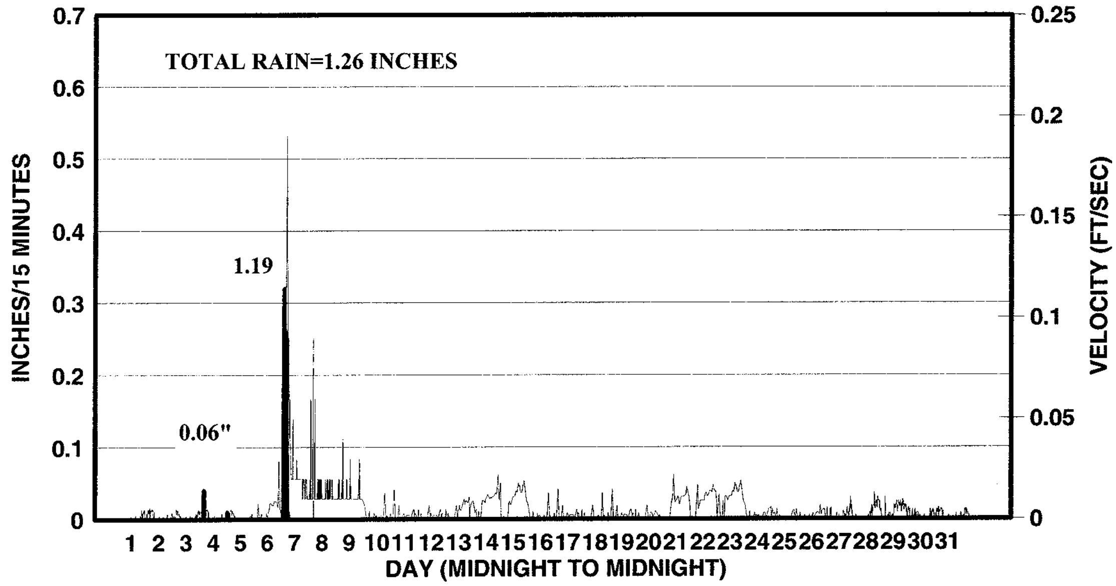
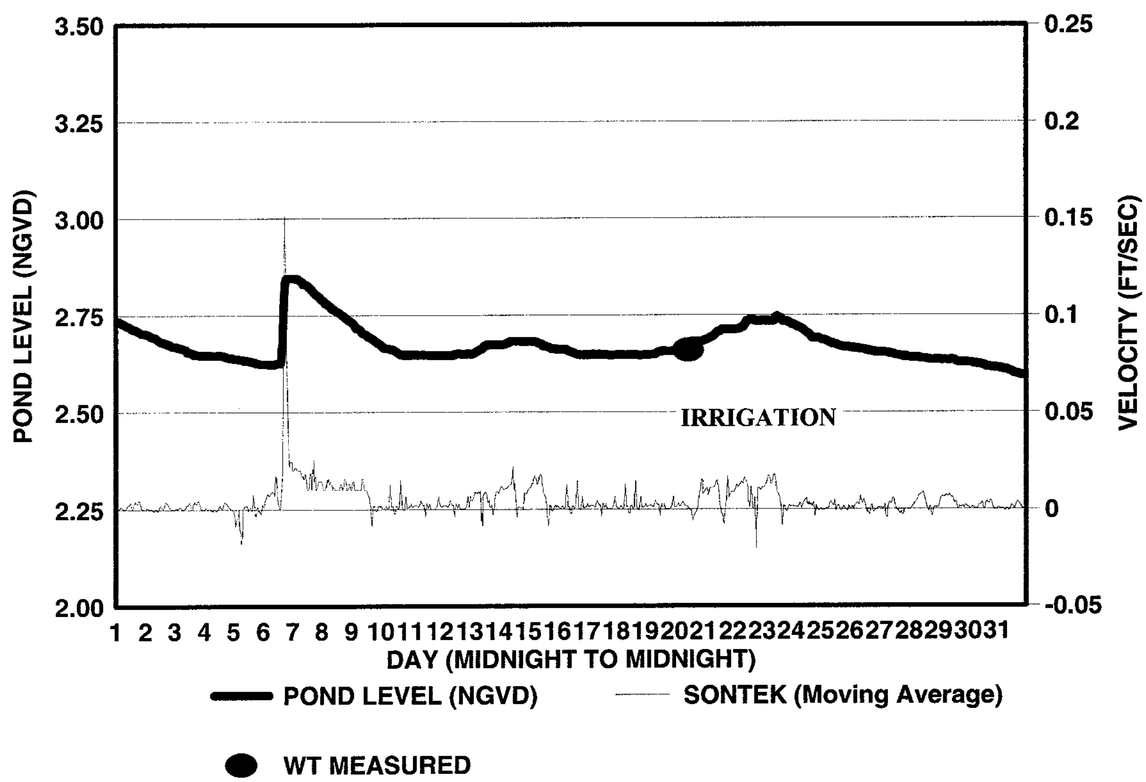
OCTOBER 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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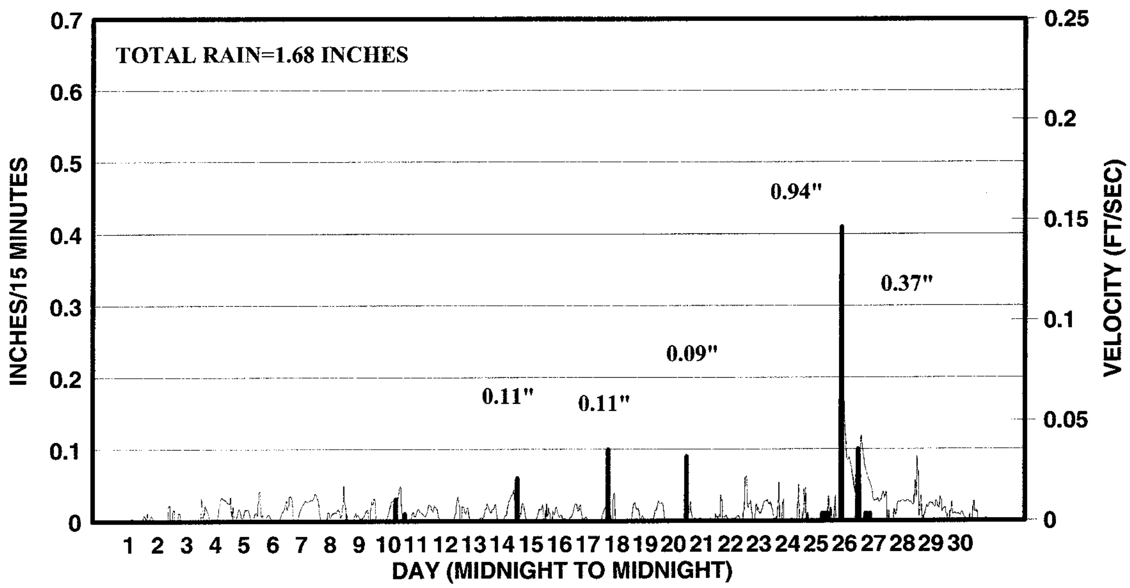
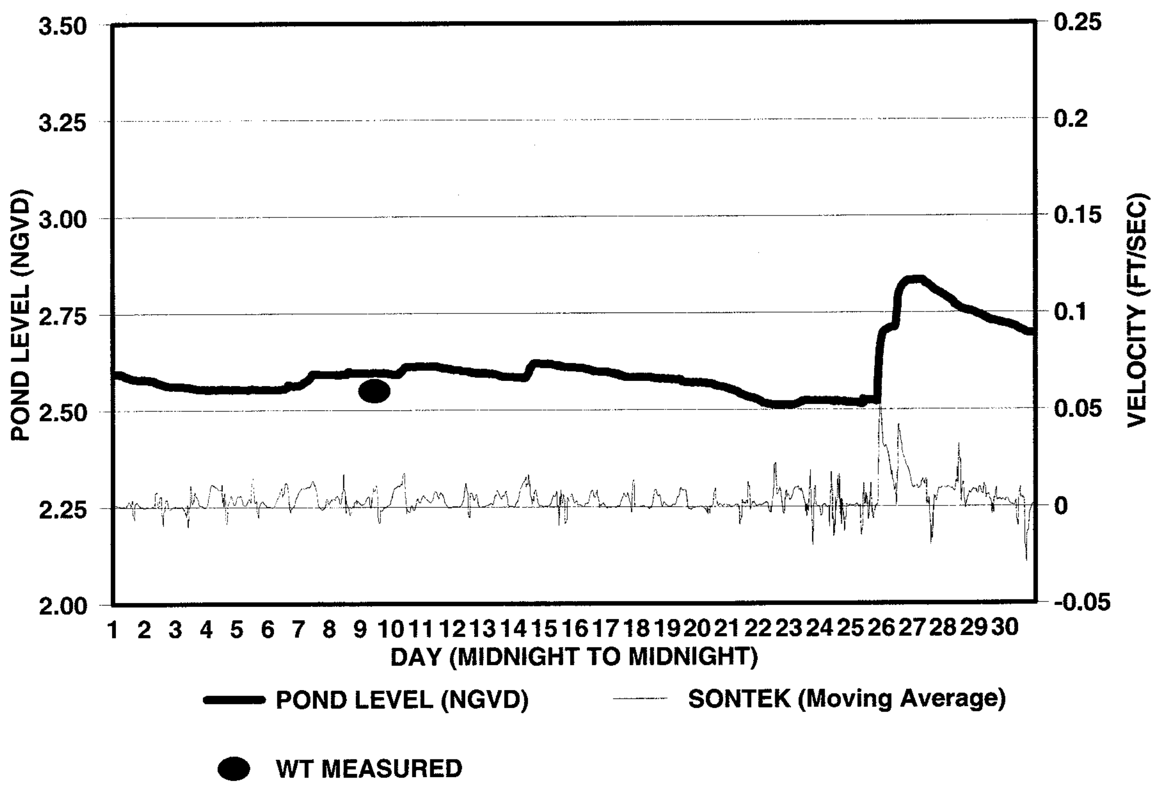
NOVEMBER 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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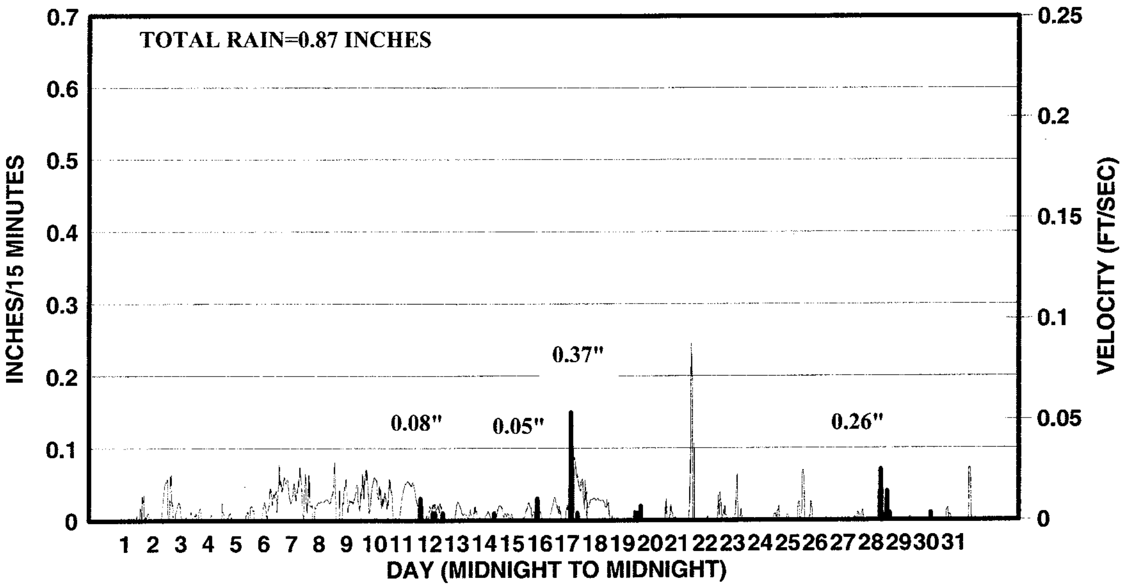
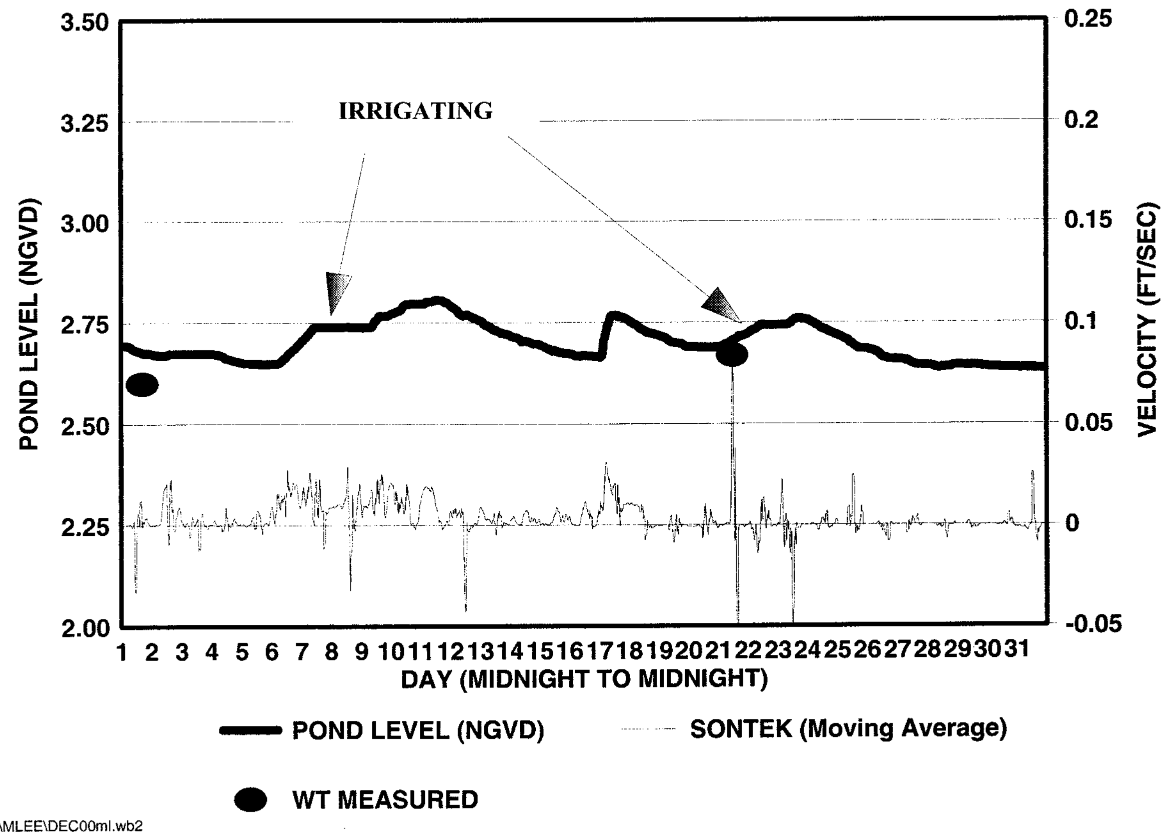
DECEMBER 2000

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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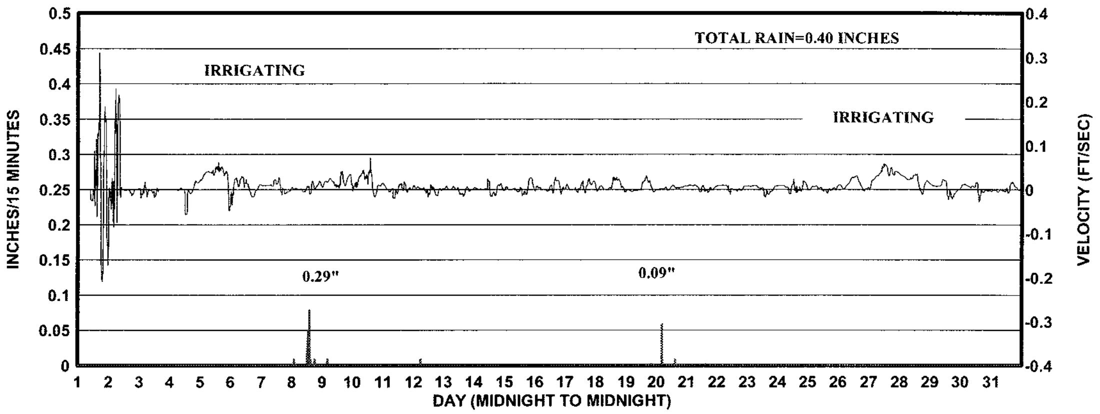
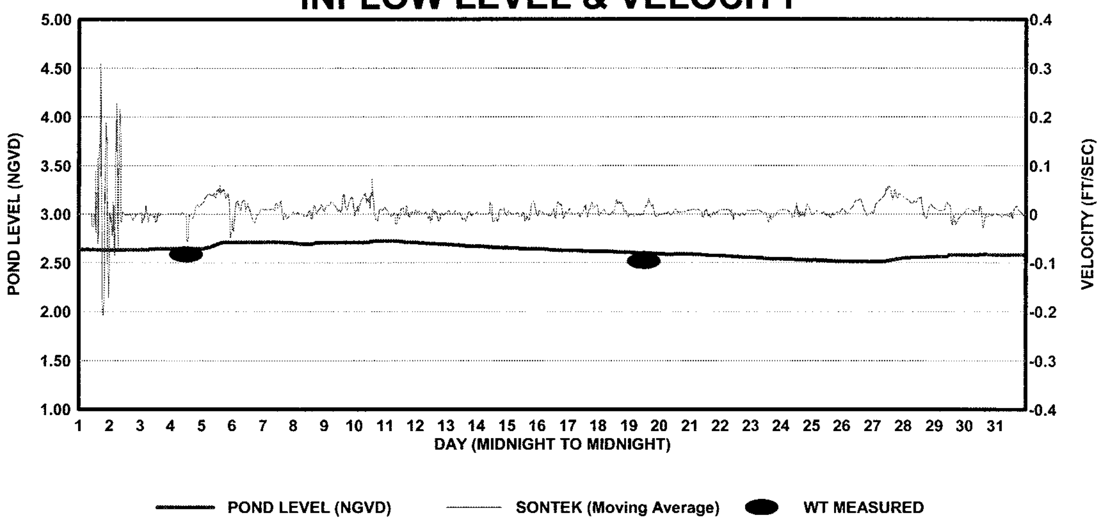
JANUARY 2001

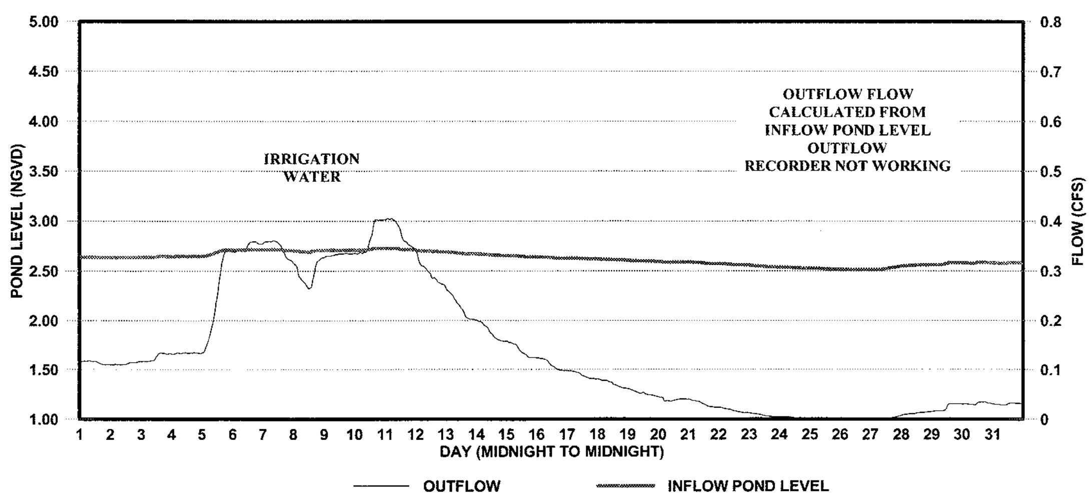
RAINFALL AND INFLOW VELOCITY



INFLOW LEVEL & VELOCITY



OUTFLOW LEVEL & FLOW



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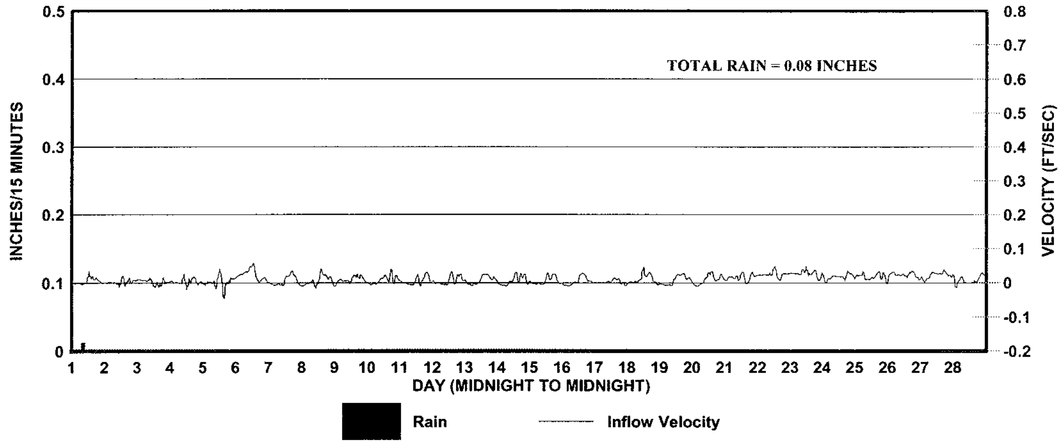
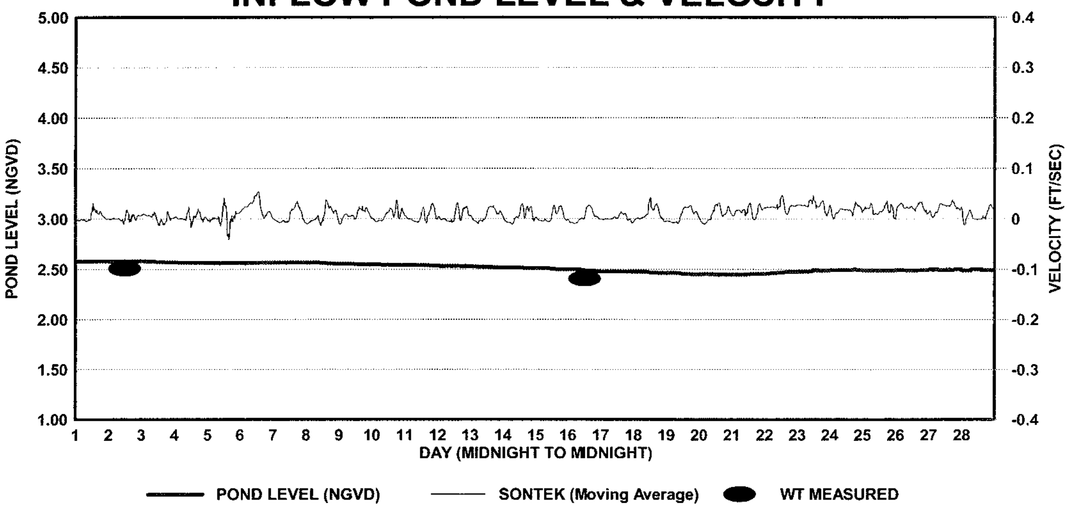
FEBRUARY 2001

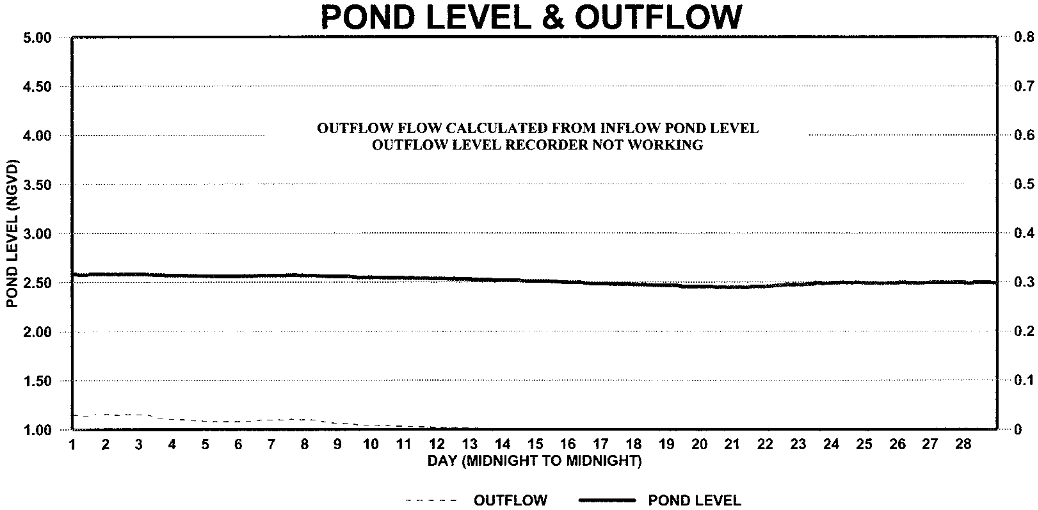
RAINFALL AND INFLOW VELOCITY



INFLOW POND LEVEL & VELOCITY

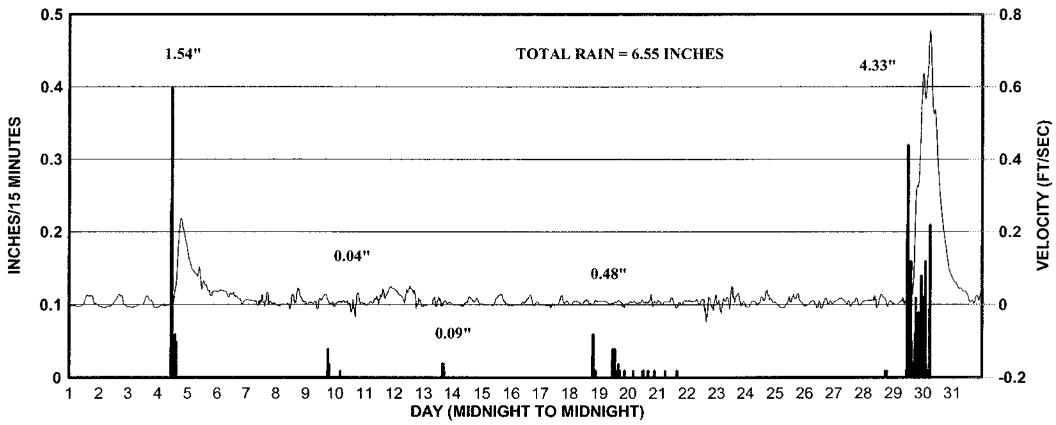


POND LEVEL & OUTFLOW

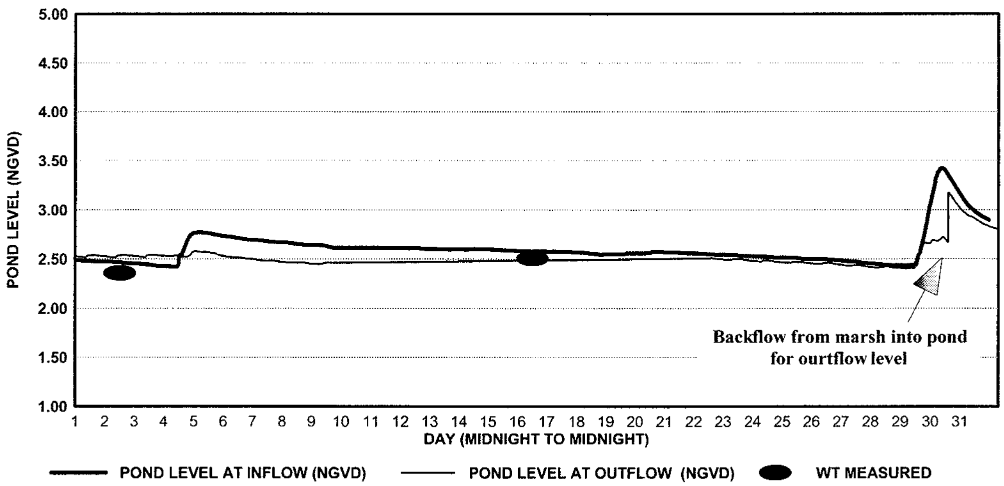


MARCH 2001

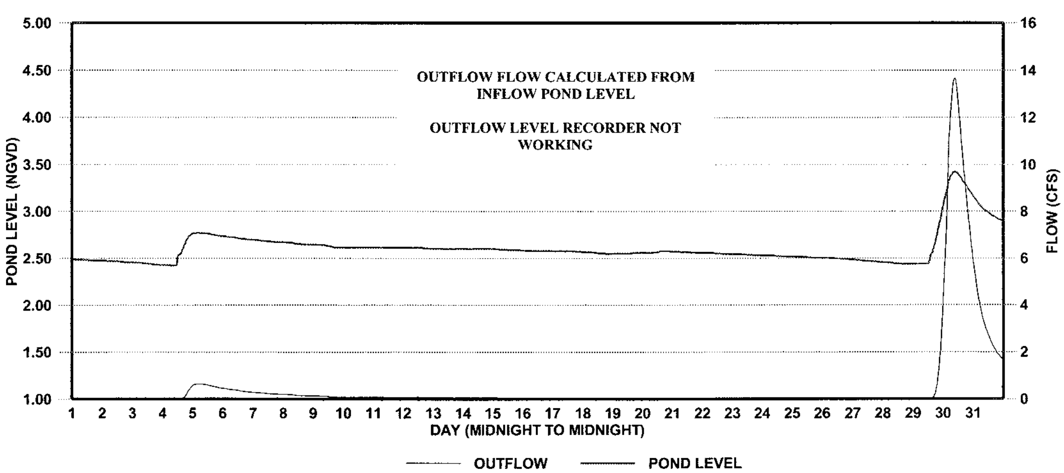
RAINFALL AND VELOCITY



POND LEVEL



POND LEVEL AND OUTFLOW



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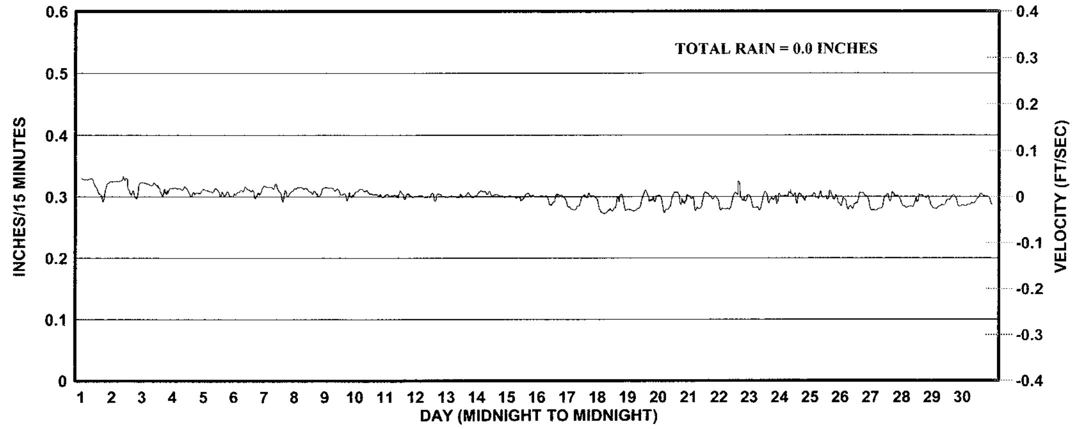
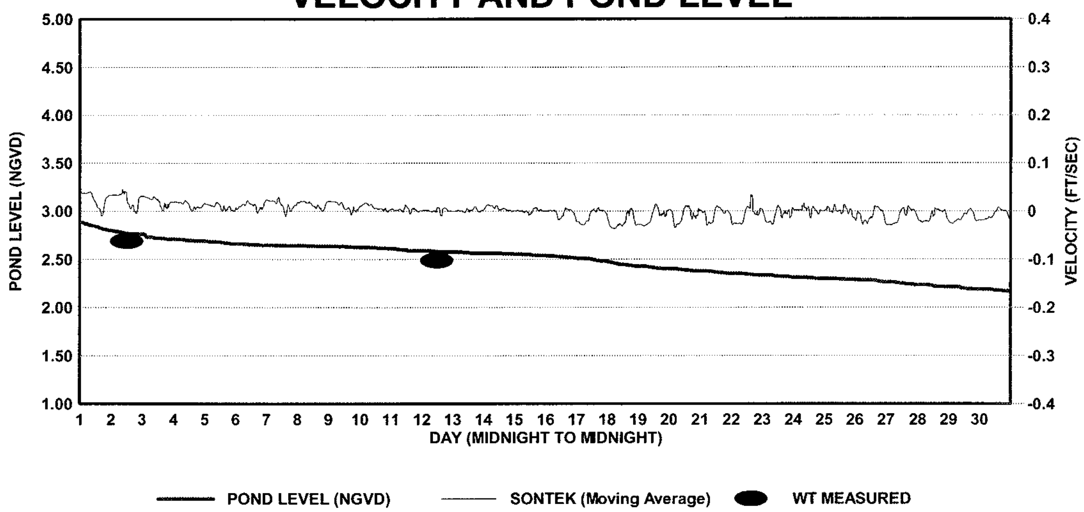
APRIL 2001

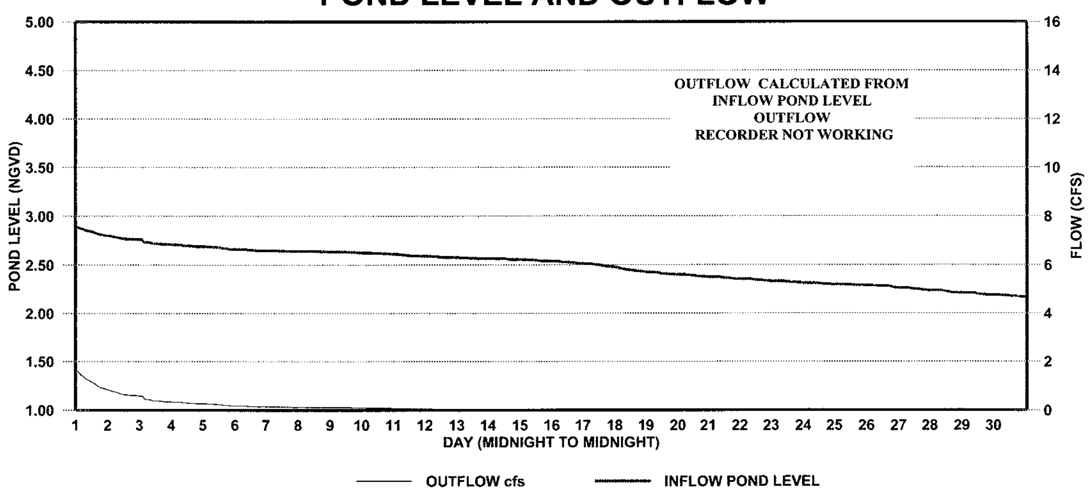
RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



POND LEVEL AND OUTFLOW



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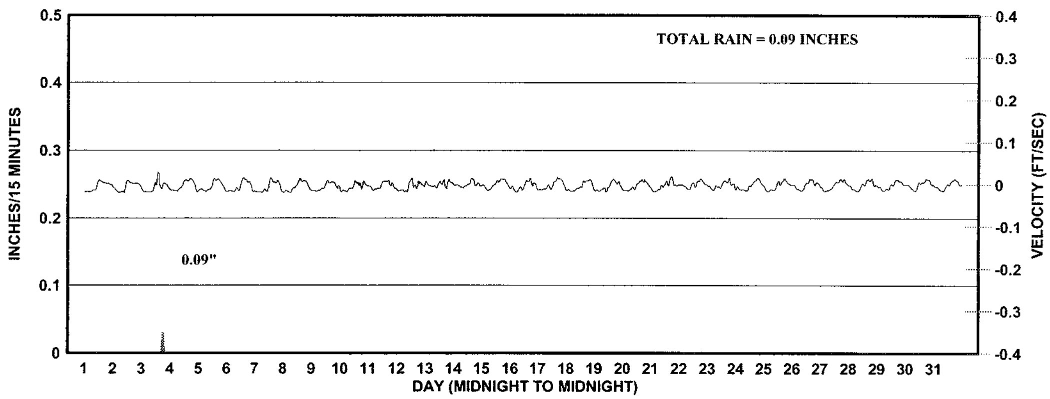
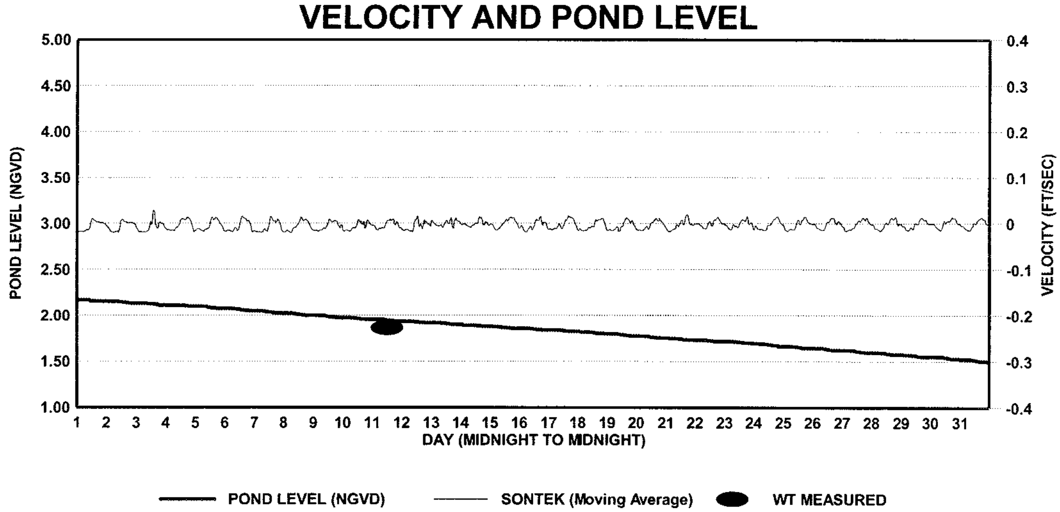
MAY 2001

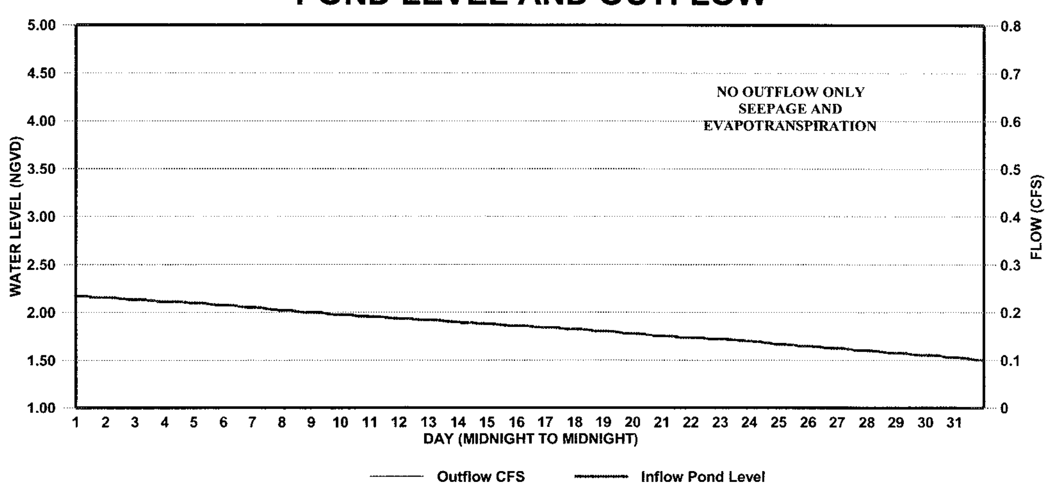
RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



POND LEVEL AND OUTFLOW



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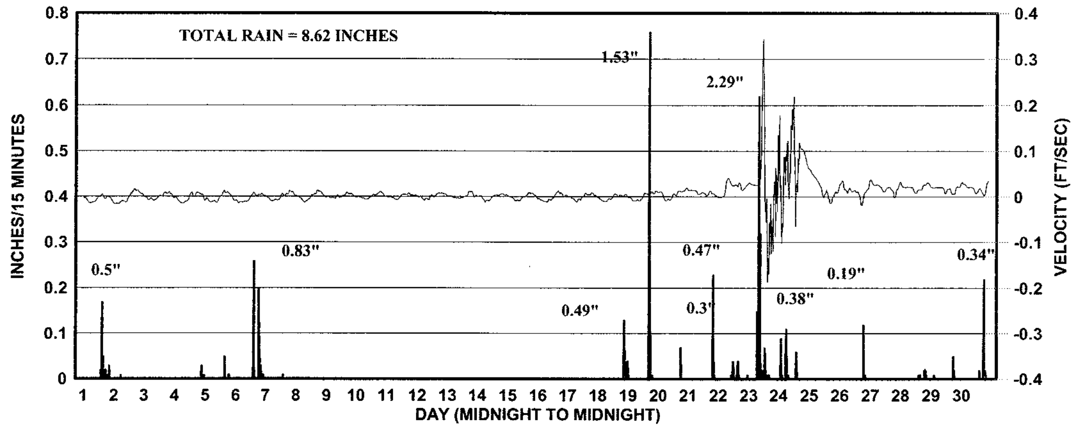
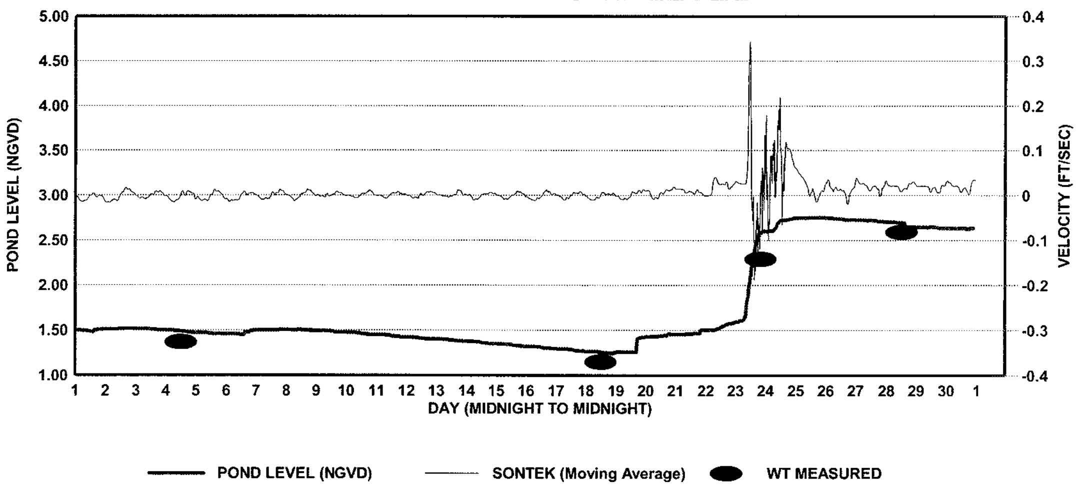
JUNE 2001

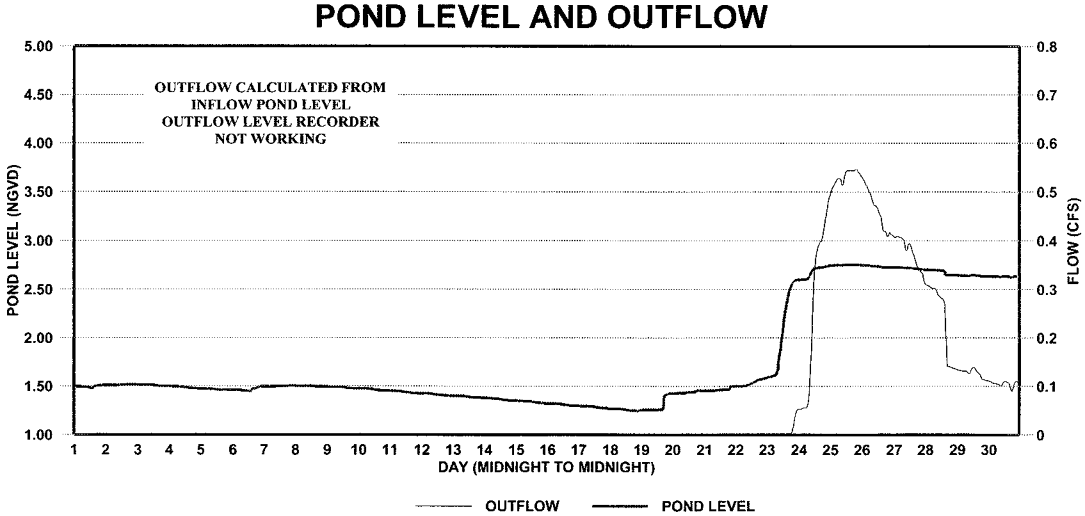
RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



POND LEVEL AND OUTFLOW



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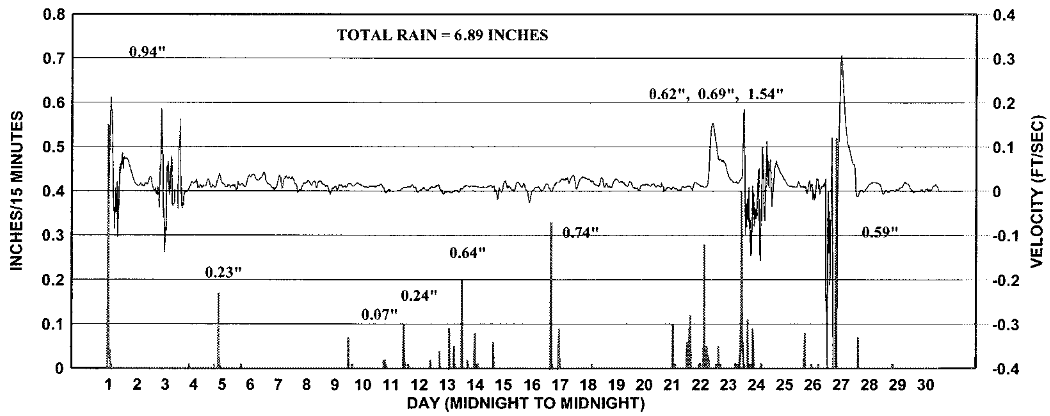
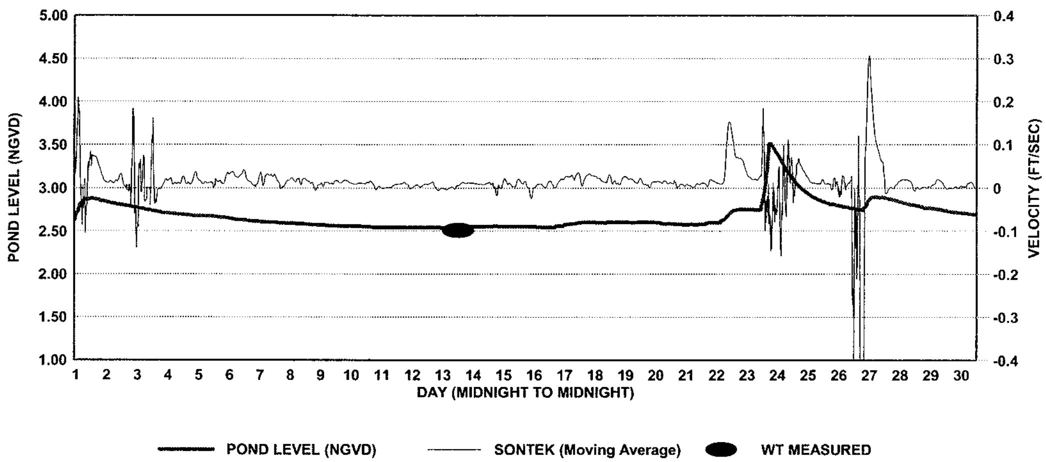
JULY 2001

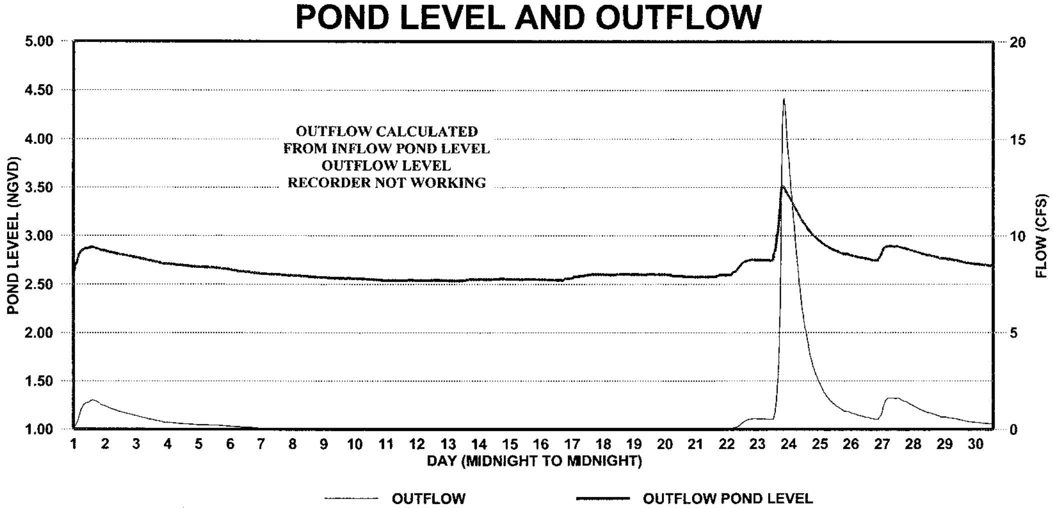
RAINFALL AND VELOCITY



INFLOW LEVEL & VELOCITY



POND LEVEL AND OUTFLOW



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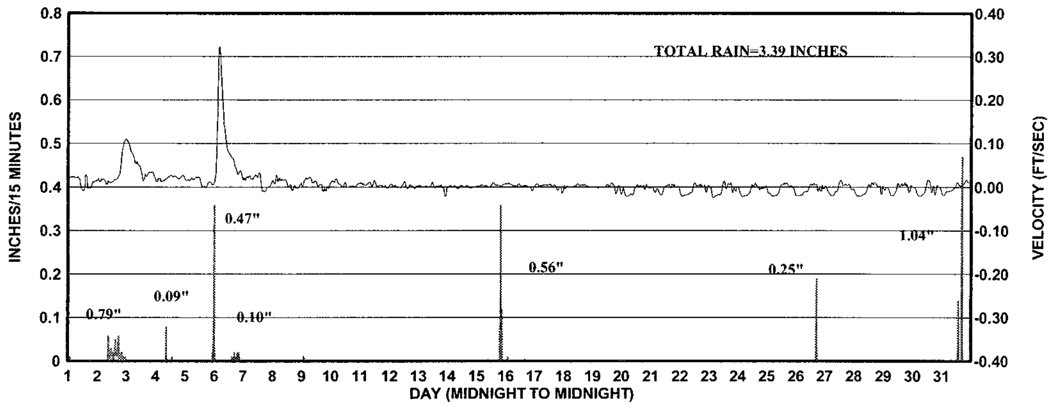
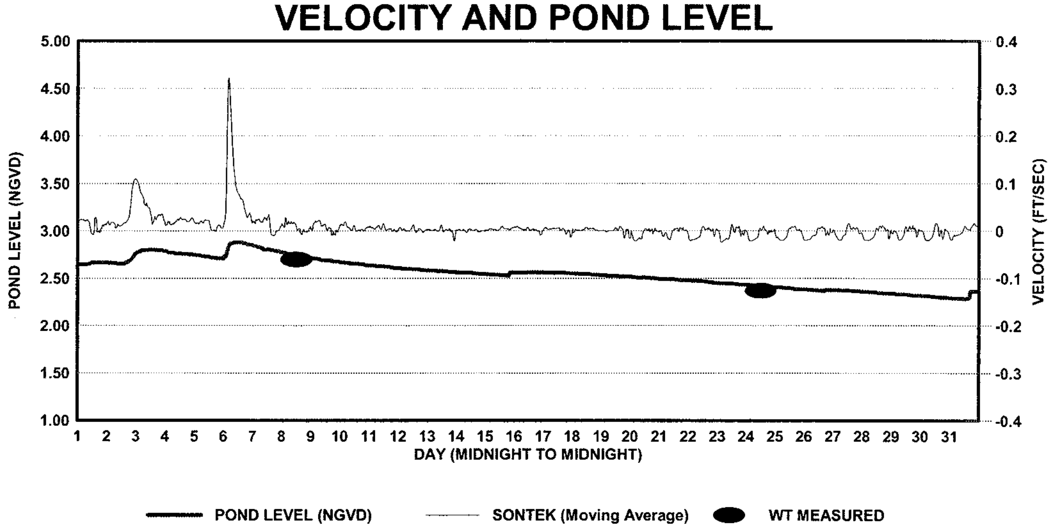
AUGUST 2001

RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



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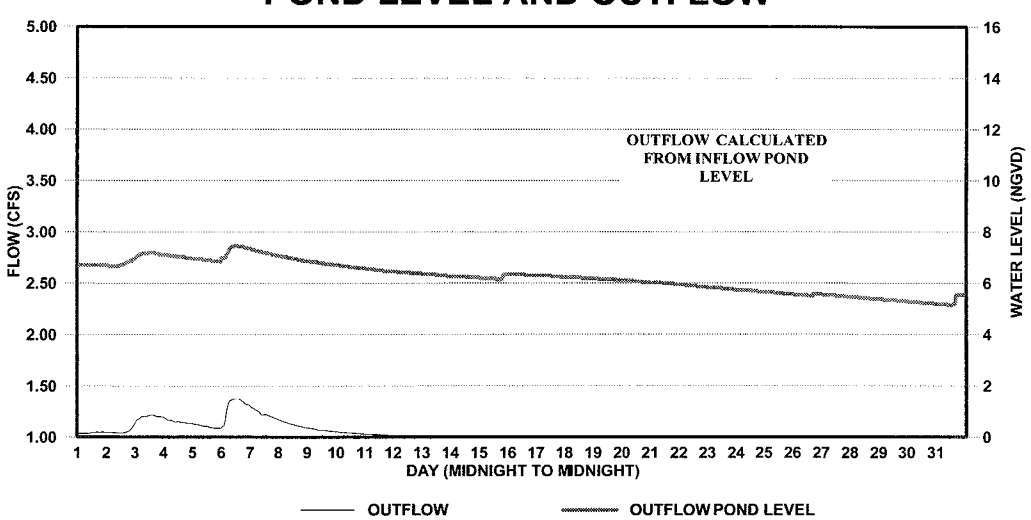

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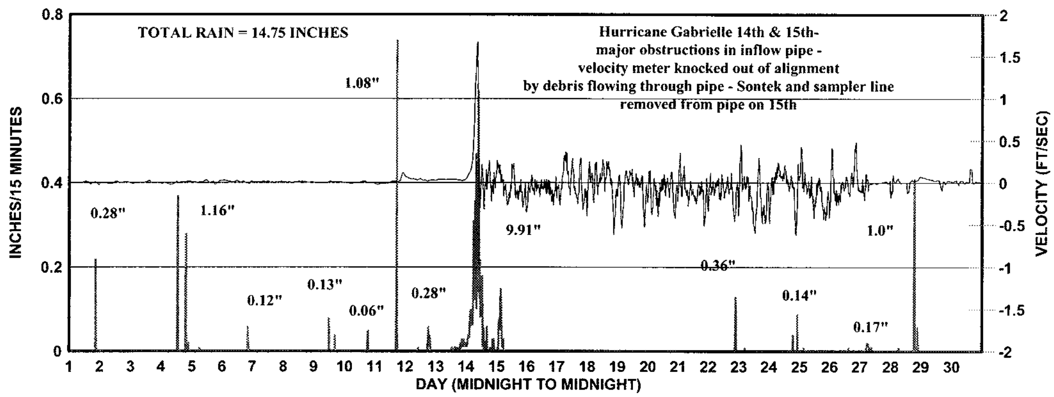
SEPTEMBER 2001

RAINFALL AND VELOCITY



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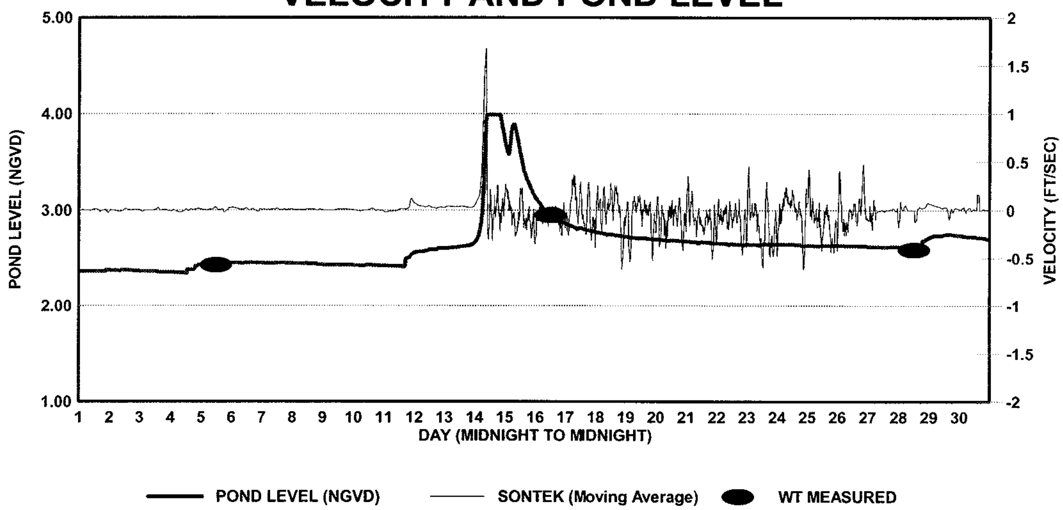

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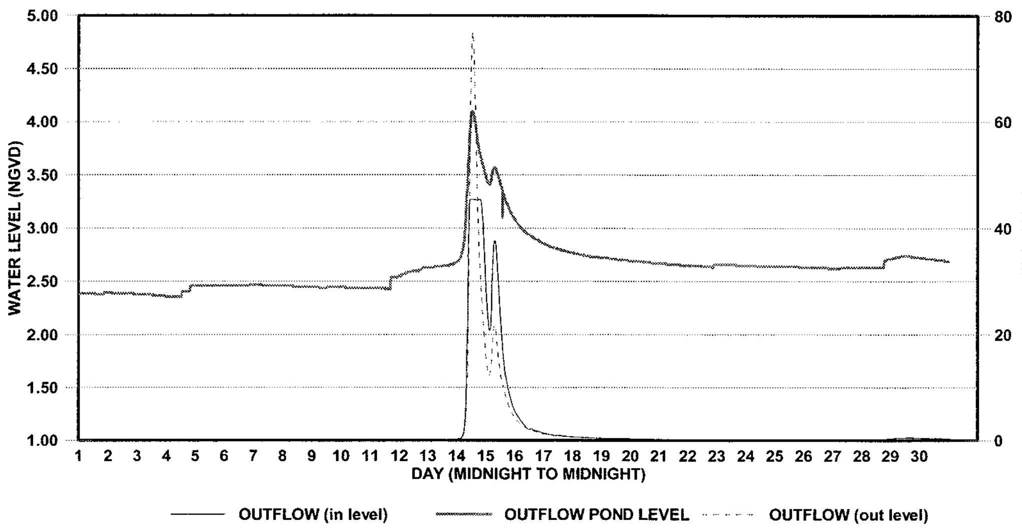

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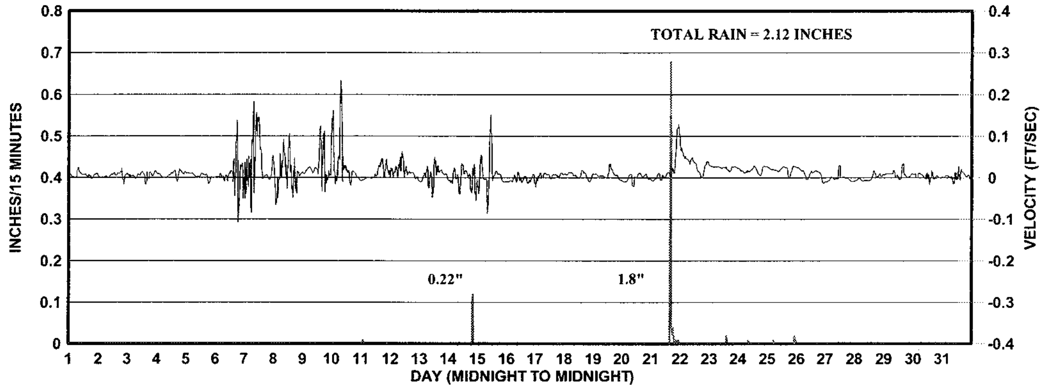
OCTOBER 2001

RAINFALL AND VELOCITY



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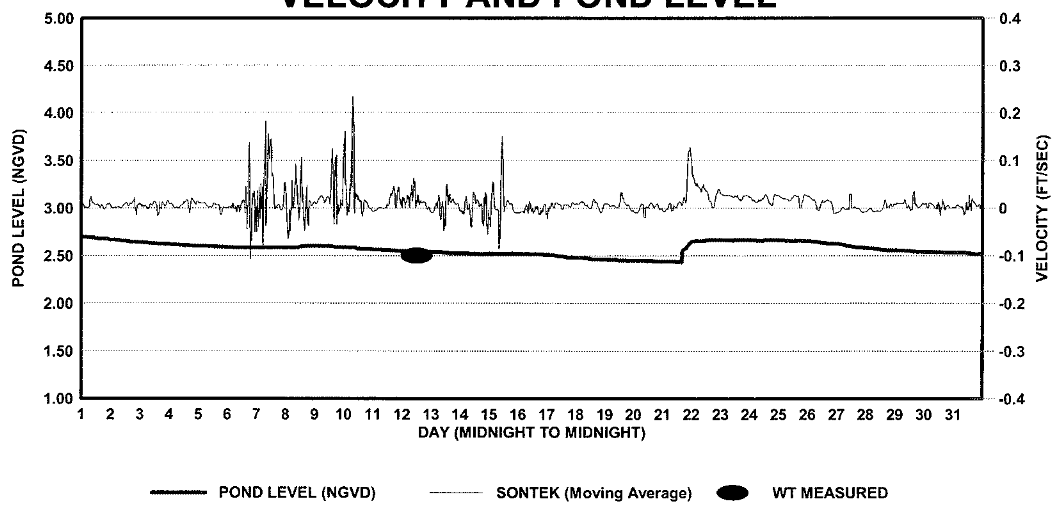

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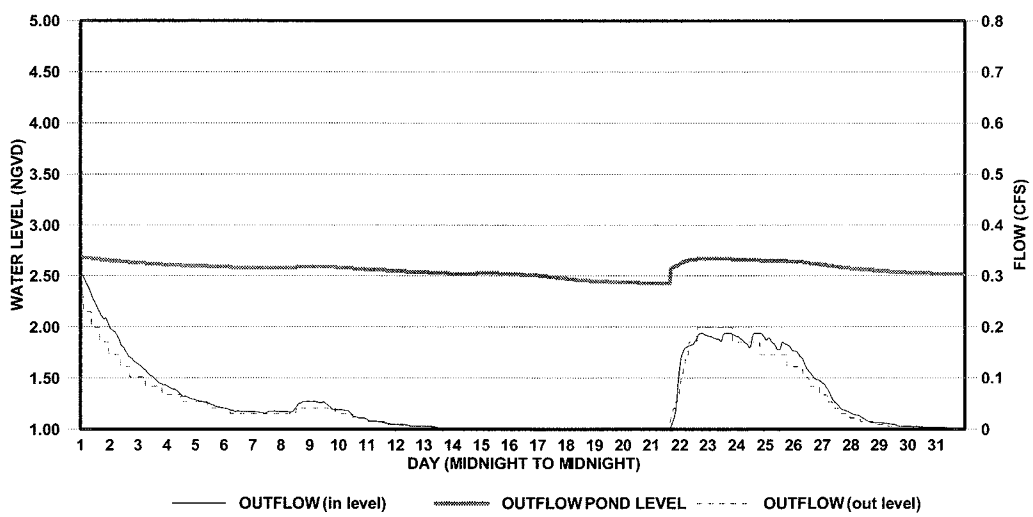

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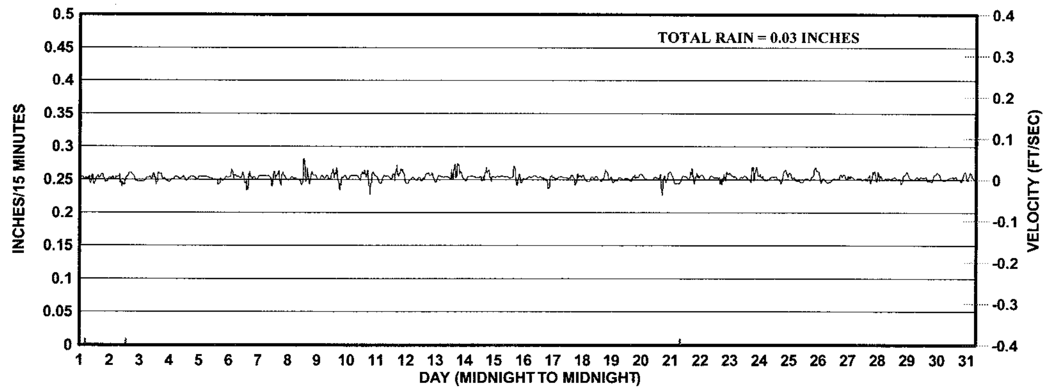
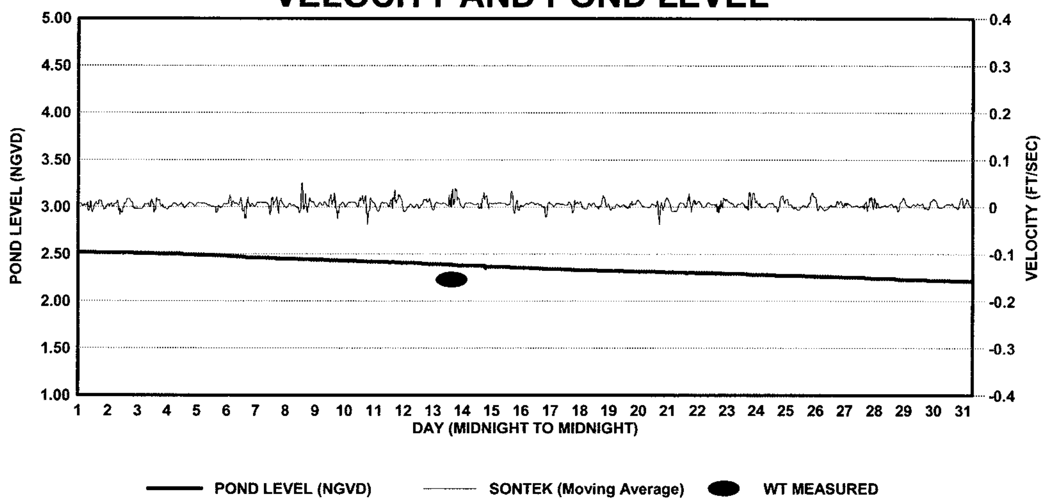
NOVEMBER 2001

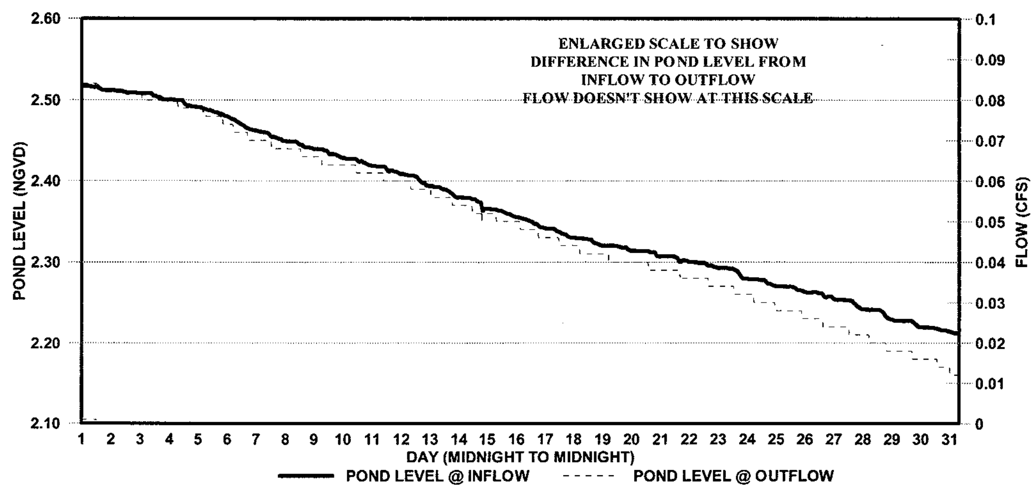
RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



POND LEVEL AND OUTFLOW



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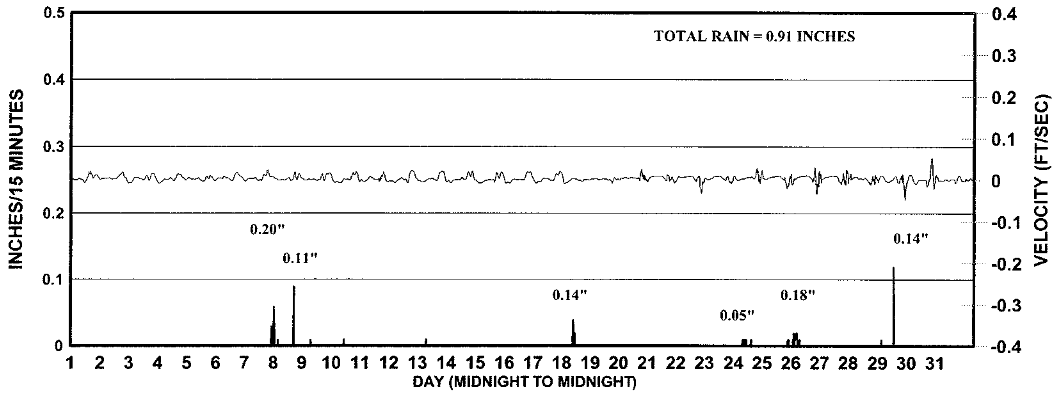
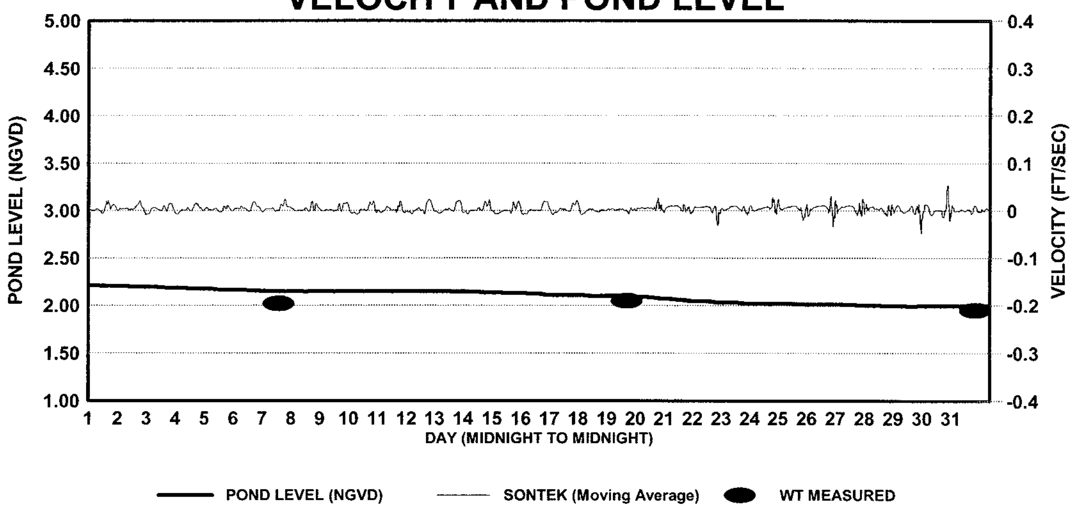
DECEMBER 2001

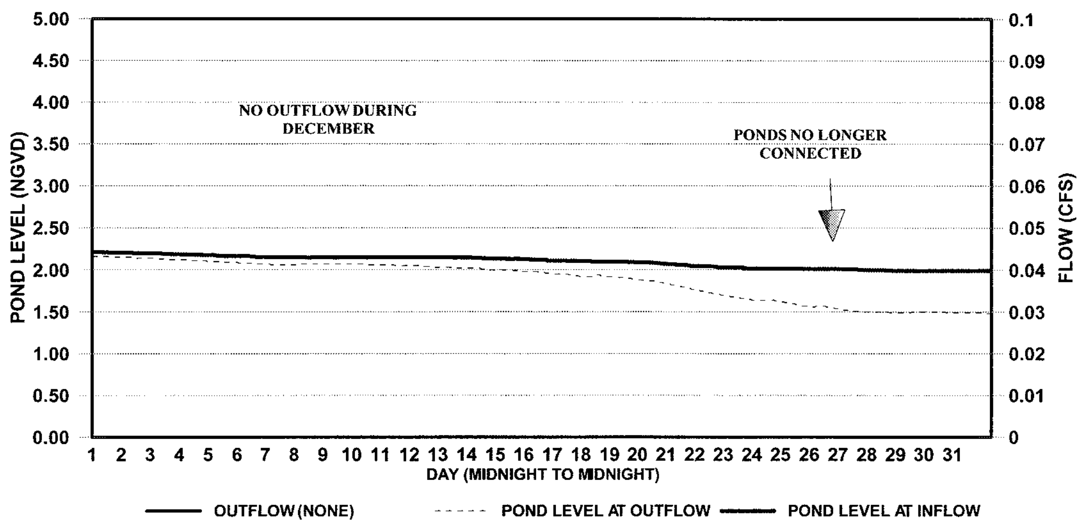
RAINFALL AND VELOCITY



VELOCITY AND POND LEVEL



POND LEVEL AND OUTFLOW



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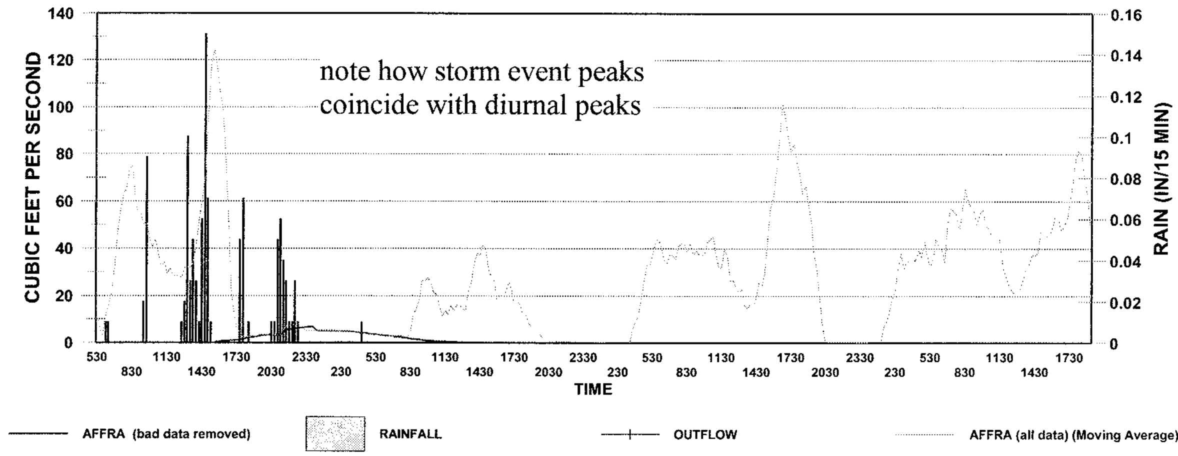

FLOW
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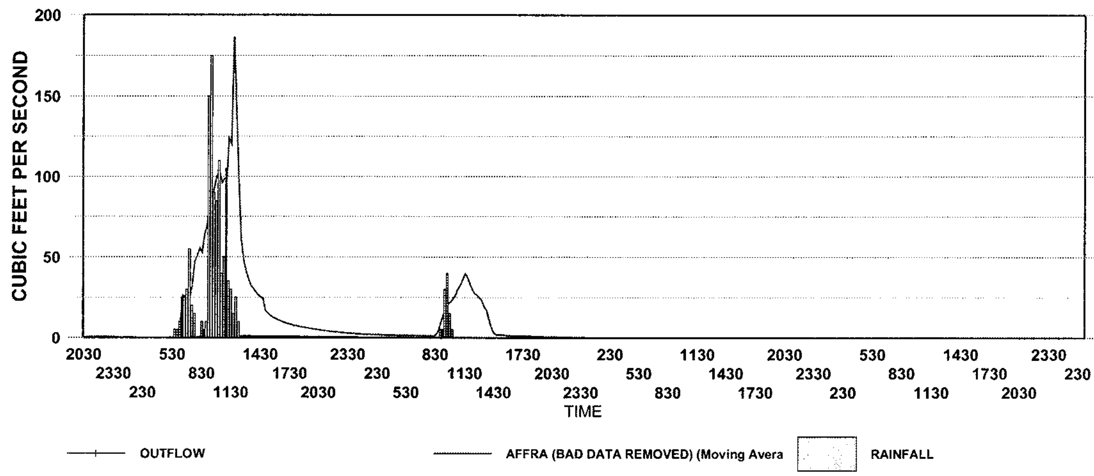
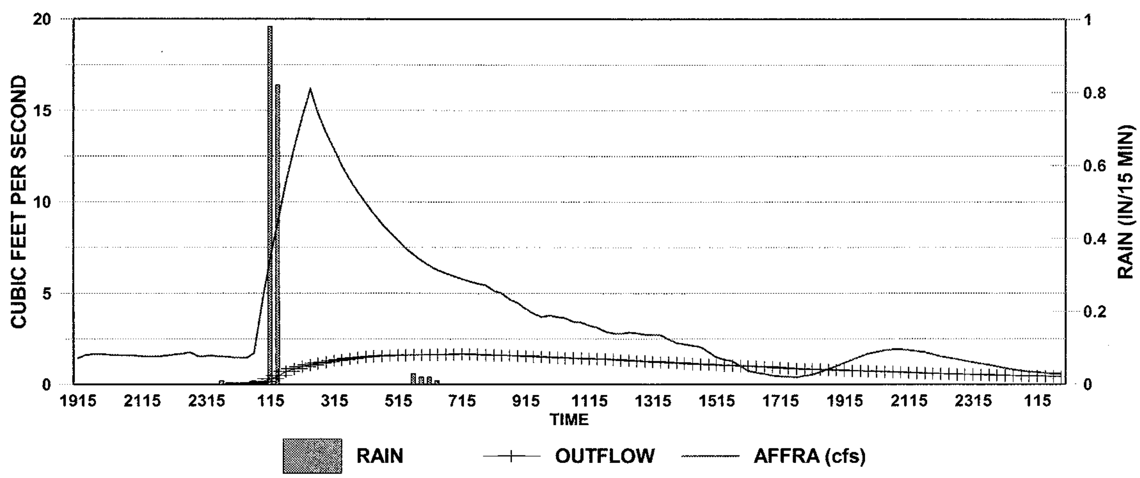


FLOW
MARCH 1, 1998



Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflo

APPENDIX B

Rainfall Characteristics

Appendix B. Rainfall Intensity, Inter-event dry period, and storm duration calculated for individual storm events > 0.4 cm (0.15 inches).

DATE	JDAY (JD)	Start (hhmm)	End hhmm)	Duration (hr)	Event Rain (cm)	Event Rain (in)	Intensity (cm/hr)	Intensity (in/hr)	Max Int./15 min (cm/hr)	Max Int./15 min (in/hr)	Inter-event Dry Period (hr)	stm #
Jun 1997												
06/23/97	174	1500	2100	6.00	5.56	2.19	0.93	0.37	1.24	0.49	na	
06/24/97	175	1545	1930	3.75	1.12	0.44	0.30	0.12	0.41	0.16	22.50	
06/25/97	176	1515	2200	6.75	4.04	1.59	0.60	0.24	1.88	0.74	19.75	
06/28/97	179	1330	1400	0.50	3.35	1.32	6.71	2.64	2.41	0.95	63.50	
Jul 1997												
07/04/97	185	1915	2215	3.00	0.48	0.19	0.16	0.06	0.08	0.03	125.25	
07/05/97	186	1545	2345	8.00	1.50	0.59	0.19	0.07	0.64	0.25	18.50	
07/10/97	191	1515	1945	4.50	6.73	2.65	1.50	0.59	1.83	0.72	111.50	
07/13/97	194	2245	2315	0.50	1.12	0.44	2.23	0.88	0.71	0.28	75.00	
07/19/97	200	1915	2030	1.25	0.86	0.34	0.69	0.27	0.38	0.15	140.00	
07/21/97	202	2130	2215	0.75	4.29	1.69	5.72	2.25	2.26	0.89	47.00	
07/24/97	205	1915	2000	0.75	2.13	0.84	2.84	1.12	1.04	0.41	70.00	
07/26/97	207	1430	1530	1.00	0.74	0.29	0.74	0.29	0.41	0.16	42.50	
07/27/97	208	1315	1345	0.75	1.45	0.57	1.93	0.76	0.91	0.36	21.75	
07/28/97	209	1245	1330	0.75	2.41	0.95	3.22	1.27	1.75	0.69	23.00	
07/30/97	211	1315	1345	0.75	2.13	0.84	2.85	1.12	1.14	0.45	48.00	
Aug 1997												
08/01/97	213	1200	1215	0.50	0.46	0.18	0.91	0.36	0.30	0.12	46.25	
08/05/97	217	330	345	0.50	0.81	0.32	1.63	0.64	0.58	0.23	87.50	
08/05/97	217	1015	1030	0.50	0.84	0.33	1.68	0.66	0.56	0.22	6.50	
08/08/97	220	2015	2045	0.75	1.02	0.40	1.35	0.53	0.81	0.32	57.75	
08/11/97	223	1900	2115	2.25	0.79	0.31	0.35	0.14	0.20	0.08	70.25	
08/13/97	225	2030	2045	0.50	1.32	0.52	2.64	1.04	1.14	0.45	47.75	
08/22/97	234	145	530	3.75	1.24	0.49	0.33	0.13	0.48	0.19	197.00	
Sep 1997												
09/01/97	244	1330	1645	3.25	1.91	0.75	0.59	0.23	1.24	0.49	248.00	
09/04/97	247	430	545	1.25	1.75	0.69	1.40	0.55	0.94	0.37	59.75	
09/23/97	266	1645	1845	3.00	2.44	0.96	0.81	0.32	1.17	0.46	467.75	
09/26/97	269	700	2215*	39.25	25.15	9.90	0.64	0.25	1.35	0.53	60.25	
Oct 1997												
10/08/97	281	845	900	0.50	0.43	0.17	0.86	0.34	0.41	0.16	250.50	
10/19/97	292	915	1815	9.00	1.19	0.47	0.13	0.05	0.23	0.09	264.25	
10/27/97	300	1030	2000	9.50	7.32	2.88	0.77	0.30	0.84	0.33	185.75	
10/31/97	304	1100	1445	3.75	2.87	1.13	0.77	0.30	0.48	0.19	87.00	
Nov 1997												
11/13/97	317	745	115 *	17.50	9.45	3.72	0.54	0.21	0.81	0.32	305.00	
11/30/97	334	800	1730	9.50	0.94	0.37	0.10	0.04	0.10	0.04	390.75	
Dec 1997												
12/04/97	338	315	845	5.50	2.01	0.79	0.36	0.14	0.33	0.13	81.75	
12/12/97	346	1145	1500	3.25	1.45	0.57	0.45	0.18	0.38	0.15	222.00	
12/12/97	346	2230	1515 *	16.75	9.88	3.89	0.59	0.23	0.58	0.23	168.50	
12/14/97	348	515	745	2.50	0.61	0.24	0.24	0.10	0.15	0.06	38.00	
12/25/97	359	1815	130 *	7.25	1.32	0.52	0.18	0.07	0.18	0.07	274.50	
12/26/97	360	2145	1245 *	15.00	7.09	2.79	0.47	0.19	0.69	0.27	20.25	
Jan 1998												
01/06/98	6	1615	2115	5.00	1.42	0.56	0.28	0.11	0.79	0.31	243.50	1
01/08/98	8	415	800	3.75	2.24	0.88	0.60	0.23	0.48	0.19	30.00	
01/15/98	15	915	2230	13.25	2.64	1.04	0.20	0.08	0.38	0.15	169.25	2
01/23/98	23	530	1200	6.50	5.77	2.27	0.89	0.35	0.89	0.35	175.00	3
01/24/98	24	845	1000	1.25	0.51	0.20	0.41	0.16	0.20	0.08	20.75	
01/27/98	27	515	1100	5.75	0.71	0.28	0.12	0.05	0.28	0.11	67.25	
Feb 1998												
02/02/98	33	1415	2115	7.00	3.07	1.21	0.44	0.17	0.38	0.15	147.25	
02/06/98	37	1500	2045	5.75	0.66	0.26	0.11	0.05	0.10	0.04	89.75	
02/13/98	44	1315	1930	6.25	0.58	0.23	0.09	0.04	0.23	0.09	160.50	
02/15/98	46	1645	1445 *	22.00	9.75	3.84	0.44	0.17	0.66	0.26	45.25	5
02/17/98	48	345	500	1.25	0.79	0.31	0.63	0.25	0.64	0.25	13.00	6
02/19/98	50	2215	230 *	4.25	9.09	3.58	2.14	0.84	2.57	1.01	79.50	7

Appendix B. Rainfall Intensity, Inter-event dry period, and storm duration calculated for individual storm events > 0.4 cm (0.15 inches).

DATE	JDAY (JD)	Start (hhmm)	End hhmm)	Duration (hr)	Event Rain (cm)	Event Rain (in)	Intensity (cm/hr)	Intensity (in/hr)	Max Int./15 min (cm/hr)	Max Int./15 min (in/hr)	Inter-event Dry Period (hr)	stm #
02/22/98	53	2245	30 *	1.75	0.69	0.27	0.39	0.15	0.58	0.23	68.25	
02/28/98	59	1215	1230	0.50	0.81	0.32	1.63	0.64	0.74	0.29	131.75	9
02/28/98	59	2330	100 *	2.80	7.19	2.83	2.57	1.01	2.49	0.98	11.00	
Mar 1998												
03/08/98	67	2330	30 *	1.00	1.73	0.68	1.73	0.68	0.23	0.09	190.50	10
03/18/98	77	2045	1745 *	45.00	13.01	5.12	0.29	0.11	0.99	0.39	236.25	11
Apr 1998												
04/20/98	110	1345	1545	2.00	0.84	0.33	0.42	0.17	0.51	0.20	740.00	12
May 1998												
05/28/98	148	1100	1645	5.75	2.24	0.88	0.39	0.15	1.70	0.67	907.25	13
05/30/98	150	1315	1330	0.75	0.74	0.29	0.98	0.39	0.61	0.24	44.50	14
Jun 1998												
06/08/98	159	1930	2130	2.00	1.02	0.40	0.51	0.20	0.66	0.26	222.00	
06/22/98	173	2245	2315	0.75	2.59	1.02	3.45	1.36	1.93	0.76	337.25	15
06/23/98	174	2200	200 *	4.00	0.81	0.32	0.20	0.08	0.41	0.16	22.75	
Jul 1998												
07/06/98	187	1415	1530	1.25	0.99	0.39	0.79	0.31	0.30	0.12	300.25	16
07/10/98	191	1100	1415	3.25	0.99	0.39	0.30	0.12	0.18	0.07	91.50	17
07/12/98	193	2145	2300	1.25	0.76	0.30	0.61	0.24	0.36	0.14	55.50	
07/13/98	194	1415	1515	1.00	0.41	0.16	0.41	0.16	0.30	0.12	15.25	
07/13/98	194	2130	2215	0.75	3.46	1.36	4.61	1.81	1.70	0.67	6.25	18
07/14/98	195	1530	2345	8.25	0.56	0.22	0.07	0.03	0.08	0.03	18.25	18
07/15/98	196	700	1300	6.00	1.35	0.53	0.22	0.09	0.74	0.29	7.25	18
07/21/98	202	1630	1845	2.25	1.04	0.41	0.46	0.18	0.43	0.17	147.50	19
07/26/98	207	1600	1630	0.75	0.48	0.19	0.64	0.25	0.33	0.13	117.25	
Aug 1998												
08/07/98	219	1830	2045	2.25	1.50	0.59	0.67	0.26	0.76	0.30	290.00	
08/09/98	221	1745	1900	1.25	1.45	0.57	1.16	0.46	0.64	0.25	45.00	
08/16/98	228	1915	2345	4.50	2.08	0.82	0.46	0.18	0.56	0.22	168.25	20
08/18/98	230	1930	2215	2.75	1.88	0.74	0.68	0.27	0.71	0.28	20.75	21
08/19/98	231	1530	2015	4.75	0.41	0.16	0.09	0.03	0.08	0.03	17.25	
Sep 1998												
09/03/98	246	500	1345	8.75	1.47	0.58	0.17	0.07	0.38	0.15	347.25	22
09/04/98	247	545	715	1.75	0.58	0.23	0.33	0.13	0.13	0.05	16.00	22
09/06/98	249	1845	2045	2.00	5.26	2.07	2.63	1.04	1.88	0.74	59.50	23
09/07/98	250	1715	1815	1.00	2.21	0.87	2.21	0.87	0.81	0.32	21.25	23
09/17/98	260	915	1015	1.00	0.46	0.18	0.46	0.18	0.13	0.05	231.00	
09/18/98	261	1830	2345	5.25	4.32	1.70	0.82	0.32	1.35	0.53	32.25	24
09/19/98	262	1145	930 *	12.00	4.37	1.72	0.36	0.14	0.41	0.16	12.00	25
09/22/98	265	1000	1045	0.75	0.79	0.31	1.05	0.41	0.33	0.13	48.50	26
09/25/98	268	1615	2145	5.50	3.48	1.37	0.63	0.25	0.91	0.36	77.50	
Oct 1998	No storm events											
Nov 1998												
11/04/98	308	130	830 *	24.00	4.70	1.85	0.20	0.08	0.15	0.06	939.75	
Dec 1998												
12/13/98	347	1400	1600	2.00	1.47	0.58	0.74	0.29	1.07	0.42	917.50	27
12/20/98	354	1945	2045	1.00	0.64	0.25	0.64	0.25	0.48	0.19	171.75	
Jan 1999												
01/02/99	2	2345	215*	2.50	2.95	1.16	1.18	0.46	2.36	0.93	315.00	1
01/09/99	9	1845	2115	2.50	0.64	0.25	0.25	0.10	0.28	0.11	160.50	
01/23/99	23	2130	200 *	4.50	7.21	2.84	1.60	0.63	2.16	0.85	336.25	2
Feb 1999	No storm events											
Mar 1999												
03/14/99	73	1230	1600	3.50	2.57	1.01	0.73	0.29	1.17	0.46	1186.50	3
Apr 1999												
04/17/99	107	1015	1515	2.75	0.89	0.35	0.32	0.13	0.23	0.09	810.25	
04/30/99	120	800	930	1.00	2.79	1.10	2.79	1.10	2.46	0.97	304.75	4
May 1999												
05/18/99	138	2130	2230	0.75	0.41	0.16	0.54	0.21	0.23	0.09	444.00	

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Appendix B. Rainfall Intensity, Inter-event dry period, and storm duration calculated for individual storm events > 0.4 cm (0.15 inches).

DATE	JDAY	Start	End	Duration	Event Rain		Intensity		Max Int./15 min		Inter-event	stm
	(JD)	(hhmm)	hhmm)	(hr)	(cm)	(in)	(cm/hr)	(in/hr)	(cm/hr)	(in/hr)	Dry Period (hr)	#
05/30/99	150	1430	1900	2.50	2.59	1.02	1.04	0.41	1.88	0.74	280.00	5
Jun 1999												
06/02/99	153	1600	1700	0.75	2.34	0.92	3.12	1.23	1.42	0.56	69.00	6
06/05/99	156	1630	1700	0.25	1.60	0.63	6.40	2.52	0.86	0.34	71.50	7
06/07/99	158	1300	1730	2.50	0.41	0.16	0.16	0.06	0.23	0.09	44.00	
06/16/99	167	1545	1945	2.25	1.19	0.47	0.53	0.21	0.81	0.32	214.25	8
06/17/99	168	1215	1845*	15.75	2.59	1.02	0.17	0.06	1.63	0.64	16.50	8
06/20/99	171	2000	1030*	7.50	0.66	0.26	0.09	0.03	0.18	0.07	49.25	8
06/30/99	181	1245	2015	4.00	1.32	0.52	0.33	0.13	0.71	0.28	218.25	
Jul 1999												
07/01/99	182	1615	2315	3.75	2.80	1.09	0.74	0.29	1.47	0.58	20.00	9
07/02/99	183	1730	1800	0.50	0.99	0.39	1.98	0.78	0.89	0.35	18.25	10
07/03/99	184	1600	2100	2.75	0.41	0.16	0.15	0.06	0.13	0.05	22.00	
07/04/99	185	1330	1730	2.25	0.56	0.22	0.25	0.10	0.33	0.13	16.50	
07/09/99	190	1430	1515	1.00	1.47	0.58	1.47	0.58	0.74	0.29	117.00	11
07/12/99	193	2330	115*	2.00	0.97	0.38	0.48	0.19	0.53	0.21	80.25	
07/13/99	194	1730	1815	1.00	2.69	1.06	2.69	1.06	0.91	0.36	40.25	
07/14/99	195	1645	2330	6.00	1.70	0.67	0.28	0.11	0.86	0.34	22.50	
07/26/99	207	915	930	0.25	1.90	0.75	6.32	2.49	1.42	0.56	273.75	12
07/30/99	211	415	1000	6.00	1.37	0.54	0.23	0.09	0.64	0.25	90.75	
Aug 1999												
08/06/99	218	1230	1515	3.00	1.39	0.55	0.47	0.18	0.66	0.26	170.50	13
08/12/99	224	930	1345	4.25	0.84	0.33	0.19	0.08	0.36	0.14	138.25	14
08/14/99	226	2400	15*	0.25	1.37	0.54	4.57	1.80	1.02	0.40	58.25	15
08/16/99	228	2100	2215	1.25	2.99	1.18	2.30	0.91	1.63	0.64	44.75	16
08/17/99	229	1600	1915	3.25	0.41	0.16	0.12	0.05	0.05	0.02	30.25	17
08/18/99	230	1745	2115	3.75	3.07	1.21	0.82	0.32	1.24	0.49	22.50	17
08/22/99	234	1215	145*	13.75	4.24	1.67	0.31	0.12	0.66	0.26	87.00	18
08/28/99	240	2345	130*	2.00	1.09	0.43	0.55	0.22	0.76	0.30	142.00	19
Sep 1999												
09/06/99	249	715	1815	11.25	3.83	1.51	0.34	0.13	0.86	0.34	197.75	20
09/07/99	250	1630	1900	2.75	0.53	0.21	0.19	0.08	0.13	0.05	22.25	20
09/11/99	254	2030	2145	1.50	0.86	0.34	0.58	0.23	0.61	0.24	97.50	21
09/19/99	262	2045	2345	3.25	1.83	0.72	0.56	0.22	0.33	0.13	192.00	22
09/20/99	263	900	300*	18.25	2.24	0.88	0.12	0.05	0.23	0.09	9.25	22
Oct 1999												
10/03/99	276	1545	1700	1.50	0.46	0.18	0.30	0.12	0.18	0.07	300.75	23
10/04/99	277	1915	1830	23.50	8.99	3.54	0.38	0.15	1.60	0.63	26.25	23
10/06/99	279	1630	2015	4.00	0.56	0.22	0.14	0.06	0.15	0.06	22.00	23
Nov 1999												
11/01/99	305	na	na	na	na	1.22	na	na	na	na	624.00	24
11/21/99	325	2145	2245	1.25	1.40	0.55	1.12	0.44	0.48	0.19	480.50	25
Dec 1999												
12/13/99	347	2400	200	2.25	1.27	0.50	0.56	0.22	0.36	0.14	529.25	
12/17/99	351	1845	630	12.00	1.02	0.40	0.08	0.03	0.08	0.03	88.75	
12/18/99	352	1330	2000	6.75	1.14	0.45	0.17	0.07	0.08	0.03	7.00	
12/28/99	362	430	700	2.75	0.41	0.16	0.15	0.06	0.15	0.06	224.50	
Jan 2000												
01/23/00	23	2300	1200	13.00	1.17	0.46	0.09	0.04	0.10	0.04	640.00	
01/31/00	31	945	1730	7.75	0.66	0.26	0.09	0.03	0.10	0.04	189.75	
Feb 2000												
02/14/00	45	1730	2100	3.75	1.14	0.45	0.31	0.12	0.56	0.22	297.50	1
Mar 2000												
03/18/00	78	1915	2300	3.75	0.64	0.25	0.17	0.07	0.13	0.05	46.25	
03/27/00	87	345	400	0.25	0.41	0.16	1.63	0.64	0.41	0.16	172.50	
03/27/00	87	830	1800	9.50	2.08	0.82	0.22	0.09	0.69	0.27	4.50	2
Apr 2000												
04/14/00	105	30	1745	17.25	1.80	0.71	0.10	0.04	0.30	0.12	414.50	3
May 2000	No storm events											

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Appendix B. Rainfall Intensity, Inter-event dry period, and storm duration calculated for individual storm events > 0.4 cm (0.15 inches).

DATE	JDAY (JD)	Start (hhmm)	End hhmm)	Duration (hr)	Event Rain (cm)	(in)	Intensity (cm/hr)	(in/hr)	Max Int./15 min (cm/hr)	(in/hr)	Inter-event Dry Period (hr)	stm #
Jun 2000												
06/11/00	163	1845	1945	1.00	0.38	0.15	0.38	0.15	0.36	0.14	1369.00	
06/13/00	165	1930	2000	0.50	1.24	0.49	2.49	0.98	1.14	0.45	47.75	
06/16/00	168	2145	2315	1.50	1.93	0.76	1.29	0.51	1.27	0.50	73.75	
06/17/00	169	1530	2300	7.50	3.28	1.29	0.44	0.17	1.22	0.48	16.25	
06/18/00	170	1845	2045	2.00	0.99	0.39	0.50	0.20	0.25	0.10	21.75	
06/19/00	171	1945	2015	0.50	1.12	0.44	2.24	0.88	0.84	0.33	23.00	
06/25/00	177	1730	2115	3.75	3.71	1.46	0.99	0.39	1.96	0.77	141.25	4
06/26/00	178	1345	1645	3.00	3.51	1.38	1.17	0.46	2.59	1.02	16.50	5
06/30/00	182	800	1630	8.50	1.52	0.60	0.18	0.07	0.43	0.17	87.25	
Jul 2000												
07/01/00	183	700	1300	6.00	2.64	1.04	0.44	0.17	0.66	0.26	14.50	6
07/04/00	186	1915	2245	3.50	0.38	0.15	0.11	0.04	0.13	0.05	20.25	6
07/05/00	187	1130	1145	0.25	0.79	0.31	3.15	1.24	0.79	0.31	12.75	7
07/08/00	190	1645	1915	2.50	0.64	0.25	0.25	0.10	0.30	0.12	88.25	8
07/09/00	191	1830	2100	2.50	6.48	2.55	2.59	1.02	1.24	0.49	23.25	9
07/14/00	196	1630	1715	0.75	0.74	0.29	0.98	0.39	0.46	0.18	114.25	
07/15/00	197	730	1745	10.25	10.82	4.26	1.06	0.42	2.72	1.07	14.25	10
07/23/00	205	1045	1515	4.50	0.43	0.17	0.10	0.04	0.23	0.09	179.75	
07/24/00	206	915	1645	7.50	3.20	1.26	0.43	0.17	0.99	0.39	18.00	
07/31/00	213	1630	2230	6.00	1.93	0.76	0.32	0.13	1.12	0.44	173.75	11
Aug 2000												
08/09/00	222	1500	1545	0.75	0.38	0.15	0.51	0.20	0.33	0.13	209.25	
08/12/00	225	430	500	0.50	1.02	0.40	2.03	0.80	0.86	0.34	60.75	12
08/12/00	225	1000	1645	6.75	1.45	0.57	0.21	0.08	0.71	0.28	5.00	12
08/15/00	228	530	600	0.50	0.91	0.36	1.83	0.72	0.89	0.35	60.75	12
08/22/00	235	1315	1400	0.75	1.30	0.51	1.73	0.68	1.02	0.40	175.25	13
08/26/00	239	1545	2130	5.75	1.60	0.63	0.28	0.11	0.36	0.14	97.75	14
08/31/00	244	1800	2000	2.00	0.58	0.23	0.29	0.12	0.30	0.12	53.00	
Sep 2000												
09/01/00	245	530	630	1.00	0.38	0.15	0.38	0.15	0.15	0.06	9.50	
09/06/00	250	1245	1700	4.25	1.52	0.60	0.36	0.14	0.69	0.27	126.25	15
09/07/00	251	1900	2130	2.50	1.93	0.76	0.77	0.30	0.97	0.38	26.00	16
09/16/00	260	815	1000	1.75	1.57	0.62	0.90	0.35	0.41	0.16	202.75	17
09/17/00	261	115	1300	11.75	6.78	2.67	0.58	0.23	0.84	0.33	15.25	17
09/20/00	264	1615	1800	1.75	0.33	0.13	0.19	0.07	0.13	0.05	75.25	
09/27/00	271	2130	115*	3.75	3.43	1.35	0.91	0.36	1.70	0.67	171.50	18
Oct 2000												
10/06/00	280	1400	1800	4.00	3.02	1.19	0.76	0.30	0.81	0.32	70.00	19
Nov 2000												
11/25/00	330	2100	2200	1.00	2.21	0.87	2.21	0.87	1.04	0.41	356.75	20
11/26/00	331	1045	1215	1.50	0.86	0.34	0.58	0.23	0.25	0.10	12.75	20
Dec 2000												
12/17/00	352	245	400	1.25	0.94	0.37	0.75	0.30	0.38	0.15	492.50	21
12/28/00	363	800	1615	8.25	0.66	0.26	0.08	0.03	0.18	0.07	268.00	
Jan 2001												
01/08/01	8	1230	1500	2.50	0.69	0.27	0.27	0.11	0.20	0.08	236.25	
Feb 2001	No storm events, total for month .08 inches											
Mar 2001												
03/04/01	63	1130	1600	4.50	4.11	1.62	0.91	0.36	0.84	0.33	1316.50	1
03/17/01	77	1915	2045	1.50	0.41	0.16	0.27	0.11	0.13	0.05	291.25	
03/18/01	78	1200	1645	4.75	0.56	0.22	0.12	0.05	0.15	0.06	21.50	
03/29/01	88	1230	1015	18.75	10.80	4.25	0.58	0.23	2.21	0.87	259.75	2
Apr 2001	No storm events, total for month 0.00 inches											
May 2001	No storm events, total for month 0.09 inches											
Jun 2001												
06/01/01	152	1400	2100	7.00	1.27	0.50	0.18	0.07	0.43	0.17	1539.75	
06/06/01	157	1400	1515	1.25	1.04	0.41	0.83	0.33	0.66	0.26	114.00	
06/06/01	157	1830	2215	3.75	1.07	0.42	0.28	0.11	0.20	0.08	3.25	

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Appendix B. Rainfall Intensity, Inter-event dry period, and storm duration calculated for individual storm events > 0.4 cm (0.15 inches).

DATE	JDAY (JD)	Start (hhmm)	End hhmm)	Duration (hr)	Event Rain (cm)	Event Rain (in)	Intensity (cm/hr)	Intensity (in/hr)	Max Int./15 min (cm/hr)	Max Int./15 min (in/hr)	Inter-event Dry Period (hr)	stm #
06/18/01	169	2045	045	5.00	1.24	0.49	0.25	0.10	0.33	0.13	286.50	
06/19/01	170	1630	1930	3.00	3.89	1.53	1.30	0.51	1.93	0.76	15.75	
06/21/01	172	1930	2100	1.50	1.19	0.47	0.80	0.31	0.58	0.23	48.00	3
06/22/01	173	1015	1630	6.25	0.76	0.30	0.12	0.05	0.10	0.04	13.25	3
06/23/01	174	645	1630	9.75	5.82	2.29	0.60	0.23	1.57	0.62	14.25	3
Jul 2001												
06/30/01	181	2330	215	2.75	2.39	0.94	0.87	0.34	1.40	0.55	175.00	4
07/04/01	185	2045	2230	1.75	0.58	0.23	0.33	0.13	0.43	0.17	90.50	5
07/11/01	192	1030	1215	1.75	0.61	0.24	0.35	0.14	0.25	0.10	154.00	
07/16/01	197	1600	1730	1.50	1.40	0.55	0.93	0.37	0.84	0.33	123.75	6
07/16/01	197	2230	2400	1.50	0.48	0.19	0.32	0.13	0.23	0.09	5.00	6
07/21/01	202	1245	1600	3.25	1.24	0.49	0.38	0.15	0.30	0.12	108.75	7
07/22/01	203	245	730	4.75	1.75	0.69	0.37	0.15	0.71	0.28	10.75	7
07/23/01	204	945	1345	4.00	2.87	1.13	0.72	0.28	0.64	0.25	26.25	8
07/23/01	204	1615	2145	5.30	1.04	0.41	0.20	0.08	0.23	0.09	2.50	8
07/26/01	207	1915	2000	0.75	1.50	0.59	2.00	0.79	1.32	0.52	69.50	9
Aug 2001												
08/02/01	214	915	2330	14.25	2.01	0.79	0.14	0.06	0.15	0.06	157.25	
08/05/01	217	2300	30	1.50	1.19	0.47	0.80	0.31	0.91	0.36	71.50	10
08/06/01	218	1915	2115	2.00	0.25	0.10	0.13	0.05	0.05	0.02	18.75	
08/15/01	227	1930	2115	1.75	1.42	0.56	0.81	0.32	0.91	0.36	214.75	
08/26/01	238	1645	1730	0.75	0.64	0.25	0.85	0.33	0.48	0.19	259.25	
08/31/01	243	1330	1400	0.50	0.46	0.18	0.91	0.36	0.36	0.14	116.00	
08/31/01	243	1630	1715	0.75	2.64	1.04	3.52	1.39	1.19	0.47	2.50	
Sep 2001												
09/01/01	244	2045	2145	1.00	0.71	0.28	0.71	0.28	0.56	0.22	27.50	
09/04/01	247	1300	1330	0.50	1.47	0.58	2.95	1.16	0.94	0.37	63.25	
09/04/01	247	1915	2145	2.50	1.47	0.58	0.59	0.23	0.71	0.28	5.75	
09/06/01	249	2000	2130	1.50	0.30	0.12	0.20	0.08	0.15	0.06	46.25	
09/11/01	254	1645	1800	1.25	2.74	1.08	2.19	0.86	1.88	0.74	115.25	11
09/12/01	255	1730	2000	2.50	0.71	0.28	0.28	0.11	0.15	0.06	23.50	
9/13-9/15	256-25	1245	615	41.50	25.17	9.91	0.61	0.24	1.57	0.62	16.75	12
09/22/01	265	2115	2215	1.00	0.91	0.36	0.91	0.36	0.33	0.13	183.00	
09/27/01	270	500	915	4.25	0.43	0.17	0.10	0.04	0.05	0.02	102.75	
09/28/01	271	1845	2200	3.25	2.54	1.00	0.78	0.31	1.04	0.41	30.75	13
Oct 2001												
10/14/02	287	2000	2045	0.75	0.56	0.22	0.75	0.29	0.30	0.12	142.00	
10/21/01	294	1600	2300	7.00	4.57	1.80	0.65	0.26	1.73	0.68	163.25	14
Nov 2001	No rain											
Dec 2001	No rain											
No. Obs.				**220**	**220**	**221**	**220**	**220**	**220**	**220**	**220**	
Mean				**4.64**	**2.28**	**0.90**	**0.93**	**0.37**	**0.74**	**0.29**	**158.74**	
Median				**2.75**	**1.33**	**0.53**	**0.57**	**0.22**	**0.60**	**0.24**	**79.88**	
max				**45.00**	**25.17**	**9.91**	**6.71**	**2.64**	**2.72**	**1.07**	**1539.75**	
min				**0.25**	**0.25**	**0.10**	**0.07**	**0.03**	**0.05**	**0.02**	**2.50**	
Std.Dev.				**6.21**	**3.09**	**1.21**	**1.12**	**0.44**	**0.60**	**0.24**	**230.99**	
c.v				**1.34**	**1.35**	**1.35**	**1.20**	**1.20**	**0.81**	**0.81**	**1.46**	

***next day**

APPENDIX C

Water Budget Calculations with Comments

and

Some Hydrograph Comparisons

Appendix C-1998. Water budget for the wet-detention pond. When available the inflow estimates are compared to two flow meters installed at the site. Calculations for the runoff coefficient are combined for overlapping storms. At the outflow runoff occurs for several days and the percentages used to composite water quality samples are also included.

WATER BUDGET **PRECIPITATION + INFLOW - OUTFLOW - EVAPOTRANSPIRATION +/- SEEPAGE = CHANGE IN STORAGE**

SEEPAGE INCLUDES THE ERROR TERM WHICH IS AFFECTED BY IRRIGATION WATER INTO THE POND, OUTFALL WEIR LEAKS, A SEEPAGE AREA OUT OF THE POND AND TO A MINOR EXTENT TIDAL FLUCTUATIONS. THE WEIR LEAK WAS FIXED BY OCT. 1998.

STR #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	INFLOW AFFRA (CU FT)	INFLOW MMacB (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	NUMBER DAYS IN CALCS (DAYS)	NUMBER AMPLES OUT	EMARK % OUTFL	Runoff Coef.
JANUARY 1998			**ESTIMATED POND AREA 622,969**													
1	01/06/98	01/08/98	01/08/98	1.36	70,603	Vandals pulled the plug on the pond No outflow data									Two storms	
2	01/15/98	01/15/98	01/15/98	1.07	55,548	176,351	203,427	na	(95,000)	15,574	(21,804)	(99,521)	7	9		0.22
3	01/23/98	01/23/98	01/23/98	2.27	117,845	444,865	405,065	na	(362,500)	44,231	(15,346)	(140,633)	4	35	35%	0.26
			02/03/98		WQ samples at outflow from 1/23 rain event (includes 0.38 inches of additional rain)										65%	
FEBRUARY 1998			**D POND AREA 622,969**													
4	02/02/98	02/02/98	02/03/98	1.16	60,220	182,550	na	na	(99,300)	24,919	(2,907)	(115,644)	2	0	No WQ	0.21
5	02/15/98	02/16/98	02/16/98	3.84	199,350	795,651	na	na	(631,930)	348,863	(1,381)	(12,828)	1	35	miss tail	0.28
6	02/17/98	02/17/98	02/17/98	0.31	16,093	101,235	na	na	(172,360)	(255,417)	(16,041)	(184,344)	3	12		
7	02/19/98	02/20/98	02/20/98	3.58	185,852	1,001,698	na	na	(1,004,570)	24,919	(29,072)	(128,990)	4	59	59%	0.35
8	02/22/98	02/23/98	02/24/98	0.27	14,017	27,486	na	na	(8,250)	(62,297)	(10,102)	(85,448)	2	11	41%	
# 4 no water quality samples at inflow. All the samples were from the 1/23/98 storm at the outflow.																
# 8 represents the end of 2/20/98 storm , therefore no inflow WQ samples and outflow and rain composited with # 7.																
MARCH 1998			**ESTIMATED POND AREA 622,969**													
9	02/28/98	03/01/98	03/03/98	1.48	76,833	343,896	358,464	na	(206,030)	(12,459)	(57,469)	(169,690)	8	20		0.30
10	03/08/98	03/09/98	03/10/98	0.68	35,302	56,349	na	na	(8,870)	(49,838)	(66,450)	(66,168)	10	3		0.11
11	03/18/98	03/19/98	03/19/98	5.12	265,800	1,023,261	na	na	(1,099,770)	31,148	(77,871)	(80,271)	11	40	1st half storm	0.26
	Seepage out of pond, no apparent irrigation															
APRIL 1998			**ESTIMATED POND AREA 517,357**													
12	04/20/98	04/20/98	04/22/98	0.30	12,934	2,587	na	na	0	15,521	(15,210)	15,210	1	0		0.01
MAY 1998			**ESTIMATED POND AREA 517,357**													
13	05/28/98	05/29/98	05/29/98	0.88	37,940	8,623	na	na	0	46562	(1,992)	1,992	1	0		0.07
14	05/30/98	05/30/98	06/01/98	0.29	12,503	49,580	na	na	0	56909	(1,328)	(3,846)	1	0		0.22
JUNE 1998			**ESTIMATED POND AREA 517,357**													
	No WQ data		06/08/98	0.40	17,246	862	na	na	0	18,107	0	0	0	0		0.00
15	06/23/98	06/23/98	06/23/98	1.02	43,976	12,933	na	na	0	56,909	0	0	0	0		0.02
	Since these are essentially reading over about one hour during a rain event no ET															
JULY 1998			**ESTIMATED POND AREA 361,413**													
16	07/06/98	07/08/98	07/08/98	0.39	11,746	2,711	na	na	0	7,228	(9,198)	1,970	3	0		0.01
17	07/10/98	07/12/98	07/13/98	0.65	19,577	12,951	na	na	0	28,913	(9,613)	5,999	3	0	2 storms	0.03
18	07/14/98	07/17/98	07/17/98	2.11	63,548	37,647	na	na	0	97,582	(16,618)	13,004	4	0		0.02
19	07/21/98	07/21/98	07/22/98	0.41	12,348	2,108	na	na	0	10,842	(12,312)	8,698	3	0		0.01
AUGUST 1998			**ESTIMATED POND AREA 361,413**													
	no WQ samples		08/08/98	0.71	21,384	3,915	na	na	0	14,457	(7,295)	(3,548)	?	0		0.01
	no WQ samples		08/10/98	0.58	17,468	2,409	na	na	0	19,878	(9,698)	9,698	?	0		0.01
20	08/16/98	08/16/98	08/17/98	0.82	24,697	4,216	na	na	0	28,913	(11,637)	11,637	2	0		0.01
21	08/17/98	08/20/98	08/20/98	0.74	22,287	10,240	na	na	0	3,614	(9,535)	(19,378)	2	0		0.02

Appendix C. 1998 (continued)

STR #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	INFLOW AFFRA (CU FT)	INFLOW MMacB (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	NUMBER DAYS IN CALCS (DAYS)	NUMBER SAMPLES OUT	EMARK % OUTFL	Runoff Coef.
SEPTEMBER 1998			**ESTIMATED POND AREA 622,969**													
22	09/02/98	09/03/98	09/03/98	1.41	73,199	9,486	9,486	na	0	393,940	(9,127)	320,382	1	0	Backflow	
23	09/06/98	09/08/98	09/08/98	2.92	151,589	123,469	147,996	122,112	(9,540)	112,134	(29,457)	(123,926)	4	0		0.06
24	09/18/98	09/19/99	09/19/98	1.70	88,254	86,865	108,180	89,244	(5,180)	37,378	(5,788)	(126,773)	1	4		0.07
25	09/19/98	09/20/98	09/20/98	1.72	89,292	344,953	446,112	397,872	(128,160)	142,037	(7,420)	(156,629)	2	9		0.38
26	09/20/98	09/23/98	09/23/98	0.35	18,170	252,864	346,112	252,864	(97,580)	na	(18,476)	na	3	14		
# 22 Backflow from marsh has filled pond during Hurricane Earl and inflow estimated from AFFRA flow meter																
# 26 Inflow estimated from Marsh McBirney flow meter. Equipment had been disconnected for end of storm in anticipation of Hurricane Mitch.																
OCTOBER 1998			NO RAIN													
NOVEMBER 1998			**ESTIMATED POND AREA 244,681. PONDS NOT CONNECTED USED EA ST POND FOR CALCULATIONS.**													
no WQ samples			11/05/99	1.85	37,722	60,357	61,799	na	0	4,894	(9,563)	(83,622)	4	0	No WQ	0.04
DECEMBER 1998			**ESTIMATED POND AREA 417,357**													
27	12/13/98	12/14/98	12/14/98	0.58	20,172	5,287	na	na	0	21,703	(2,626)	(1,130)	2	0	irrigating	0.01

Appendix C (1999). Water budget for the wet-detention pond. When available the inflow estimates are compared to two flow meters installed at the site. Calculations for the runoff coefficient are combined for overlapping storms. At the outflow runoff occurs for several days and the percentages used to composite water quality samples are also included.

WATER BUDGET **PRECIPITATION + INFLOW - OUTFLOW - EVAPOTRANSPIRATION +/- SEEPAGE = CHANGE IN STORAGE**

SEEPAGE INCLUDES THE ERROR TERM WHICH IS AFFECTED BY IRRIGATION WATER INTO THE POND, OUTFALL WEIR LEAKS, A SEEPAGE AREA OUT OF THE POND AND TO A MINOR EXTENT TIDAL FLUCTUATIONS. THE WEIR LEAK WAS FIXED BY OCT. 1998.

TOR MBE	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	INFLOW AFFRA (CU FT)	INFLOW MMacB (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	NUMBER DAYS IN CALCS (DAYS)	NUMBER SAMPLES OUT	EMARK % OUTFL	Runoff Coef.
JANUARY 1999			**ESTIMATED POND AREA 417357 STORM #1 AND 622969 STORM #2**													
1	01/02/99	01/03/99	01/05/99	1.38	47,996	81,385	na	na	0	66,064	(13,293)	(50,023)	5	0		0.08
2	01/23/99	01/24/99	01/25/99	2.69	139,649	399,878	448,200	330,190	(78,530)	411,160	(5,259)	(44,579)	3	12	43%	0.20
**	01/25/99	01/30/99	02/01/99	0	0	0	0	0	(103,830)	(49,838)	(6,622)	60,615	4	53	57%	
	** End of 24th storm (data used to composite sample). #2 is a grab sample.The residual on 2/1/99 is irrigation water into pond														irrigating	
FEBRUARY 1999			**ESTIMATED POND AREA 417357 STORM #1 AND 622969 STORM #2**													
	no WQ data		02/13/99	0	0	205,195	na	na	(105,520)	74,756	(49,277)	24,358	5	0	irrigating	
	no WQ data		02/16/99	0.40	20,766	99,851	na	na	(97,200)	(99,675)	(29,145)	(93,947)		0	no WQ	0.33
	Rainfall data from weather station in Ruskin, no CR10 data															
MARCH 1999			**ESTIMATED POND AREA 622969**													
	no WQ samples		Irrigation	0	0	324,815	na	na	(128,580)	149,513	(68,900)	22,178	10	0	irrigating	
3	03/14/99	03/16/99	03/16/99	1.01	52,433	117,029	na	na	(33,250)	(6,230)	(35,976)	(106,466)	6	9		0.15
	Outflow sample included everthing at outflowsince March 8th including the storm and irrigation inflow															
APRIL 1999			**ESTIMATED POND AREA 361416**													
4	04/30/99	04/30/99	04/30/99	1.10	33,130	14,577	na	na	0	(723)	(9,867)	(38,563)	2	0		0.02
MAY 1999			**ESTIMATED POND AREA 244681 (ponds not connectd figued on west pond only)**													
5	05/30/99	05/30/99	06/02/99	1.02	20,798	15,904	na	na	0	(7,830)	(14,216)	(30,316)	3	0		0.02
JUNE 1999	ED POND AREA 361416															
6	06/02/99	06/02/99	06/03/99	0.92	27,709	5,542	na	na	0	29,636	(9,529)	5,915	2	0		0.01
7	06/05/99	06/05/99	06/06/99	0.63	18,974	2,711	na	na	0	16,264	(10,752)	5,331	2		can't	0.01
8	06/16/99	06/18/99	06/18/99	1.83	55,116	70,476	na	na	0	97,582	(39,467)	11,457	9		separate	0.05
	#8 included all the flowthrough the 23rd when storms peaked . Can't separate storms, sample collected for first 2 days when 1.16" rain fell														storms	
JULY 1999			**ESTIMATED POND AREA 361416 after26th 622969**													
9	07/01/99	07/02/99	07/02/99	1.09	32,829	28,251	na	na	0	57,827	(5,903)	2,650	1	0	still flowin	0.03
10	07/02/99	07/03/99	07/03/99	0.39	11,746	9,939	na	na	0	23,000	(3,584)	4,899	1	0	also 2nd	0.03
11	07/09/99	07/09/99	07/11/99	0.55	16,565	12,047	na	na	0	25,299	(8,770)	5,457	2	0		0.03
12	07/26/99	07/26/99	07/28/99	0.75	38,936	15,263	na	na	0	38,001	(7,801)	(8,397)	2	0		0.03
	# 1 and # 2 Storage is impossible to calculate from the graphs. Not enough time elapses and small rain shows continue after the storm. These are rough estimates.															
AUGUST 1999			**ESTIMATED POND AREA 622969**													
13	08/06/99	08/06/99	08/07/99	0.66	34,263	5,607	na	na	0	29,903	(5,000)	(4,968)	1	0		0.01
14	08/12/99	08/12/99	08/13/99	0.32	16,613	2,077	na	na	0	11,213	(3,373)	(4,103)	1	0		0.01
15	08/14/99	08/14/99	08/15/99	0.18	9,345	4,984	na	na	0	(8,722)	(4,217)	(18,833)	1	0		0.04
16	08/16/99	08/16/99	08/17/99	1.18	61,259	45,869	na	na	(600)	99,675	(3,373)	(3,480)	1	1		0.05
17	08/18/99	08/18/99	08/19/99	1.37	71,122	203,250	na	na	(171,760)	67,281	(16,868)	(18,464)	4	32		0.19
18	08/22/99	08/23/99	08/24/99	1.71	88,773	350,176	na	390,788	(383,430)	(13,705)	(21,355)	(47,869)	5	25	still flowin	0.27
19	08/28/99	08/30/99	08/31/99	0.51	26,476	7,397	na	na	(11,810)	(11,213)	(12,651)	(20,626)	3	42	in here	0.02

19 Still getting outflowfrom previous storms

No more pan evaporation data. Using estimates from previous data for same months for the rest of the estimates

Appendix C. (1999)(continued)

STR #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	INFLOW AFFRA (CU FT)	INFLOW MMacB (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	NUMBER DAYS IN CALCS (DAYS)	NUMBER AMPLES OUT	EMARK % OUTFL	Runoff Coef.
SEPTEMBER 1999			**ESTIMATED POND AREA**		**622969**											
20	09/06/99	09/07/99	09/07/99	1.94	100,713	218,066	na	na	(240,580)	92,822	(36,359)	50,982	6	30	still flowin	0.15
21	09/11/99	09/11/99	09/12/99	0.34	17,651	20,023	na	na	(38,910)	(41,739)	(20,294)	(20,209)	3	56	above sto	0.08
22	09/19/99	09/23/99	09/20/99	1.62	84,101	265,687	na	na	(238,270)	89,085	(13,476)	(8,957)	3	4	4%	0.22
	# 20 & # 21 are Overlapping storm s which accounts for positive residual for storm 20 when water was still flowing into pond.													36	34%	
	# 22 represents two storms close together (Sept 20 and 21).													30	28%	
	STARTED IRRIGATING FIELDS													37	35%	
OCTOBER 1999			**ESTIMATED POND AREA**		**622969**											
23	10/04/99	10/05/99	10/05/99	3.95	205,061	1,098,728	na	na	(880,170)	179,415	(27,602)	(216,602)	4	37	25%	0.37
			10/08/99											40	75%	
	Water continued to flow out of pond from the last rain event and also from a few light rain sprinkles. Most of the residual is unmeasured irrigation water into pond.															
			10/11/99	0.08	4,153	41,789	na	na	(112,600)	(66,658)	(17,289)	17,289	3	30	50%	
			10/12/99	0.05	2,596	20,404	na	na	(23,000)	0	(6,233)	6,233	1	6	10%	
			10/15/99	0.06	3,115	5,687	na	na	(52,410)	(43,608)	(17,140)	17,140	3	14	23%	
			10/18/99	0.09	4,672	0	na	na	(16,500)	(12,459)	(19,663)	19,031	4	5	7%	
			10/22/99	0.11	5,711	0	na	na	(11,510)	(12,459)	(22,928)	16,268	4	4	5%	
			10/27/99	0	0	0	na	na	(7,890)	(18,689)	(33,613)	22,814	5	3	4%	
NOVEMBER 1999			ESTIMATED POND AREA		622969											
			11/02/99	1.22	63,335	62,819	na	na	(37,070)					9	25%	0.07
			11/04/99	0	0									28	75%	
24	10/01/99	10/04/99	**TOTAL**	1.22	63,335	114,069	na	na	(147,200)	(2,492)	(9,738)	(22,958)	4			0.12
			11/15/99	0	0	120,818	na	na	(34,200)					9	34%	
			11/16/99	0	0	9,764	na	na	(30,810)					7	31%	
			11/18/99	0	0	22,545	na	na	(34,460)					9	35%	
**	o inflow WQ		**TOTAL**	0	0	153,127	na	na	(99,470)	93,445	(16,214)	56,002	5			
			** Irrigation water no rainfall													
			11/22/99	0.55	28,553	90,883	na	100,206	(15,400)					4	14%	0.22
			11/24/99	0	0	7,424	na	na	(54,770)					14	49%	
			11/29/99	0	0	0	na	na	(41,930)					10	37%	
25	11/22/99	11/29/99	**TOTAL**	0.55	28,553	98,307	na	100,206	(112,100)	0	(17,286)	2,526	7			0.23
DECEMBER 1999			**:D POND AREA**		**622969**											
	12/17/99	12/20/99	12/22/99	0.85	44,127	86,278	na	99,163	(91,710)	46,100	(4,025)	11,429	4	23	irrigating	0.13
	Still a lot of irrigation water coming into pond accounting for positive residual.															

APPENDIX C (2000). Water Budget for the wet-detention pond for the year 2000. When available, the inflow estimates are compared to a SonTek flow meter installed in May 2000. For composite samples, the number of individual aliquots taken are given or when the value represented a grab sample that information is substituted.

WATER BUDGET **PRECIPITATION + INFLOW - OUTFLOW - EVAPOTRANSPIRATION +/- SEEPAGE = CHANGE IN STORAGE**

SEEPAGE INCLUDES THE ERROR TERM WHICH IS AFFECTED BY IRRIGATION WATER INTO THE POND, OUTFALL WEIR LEAKS, A SEEPAGE AREA OUT OF THE POND AND TO A MINOR EXTENT TIDAL FLUCTUATIONS. THE WEIR LEAK WAS FIXED BY OCT. 1998.

STM #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW BUDGET (CU FT)	INFLOW SonTek (CU FT)	INFLOW (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	DAYS in CALCs (days)	# SAMPS. OUT	# SAMPS. IN	Runoff coeffic.
JANUARY 2000			Not enough rain for a sample													
FEBRUARY 2000			**ESTIMATED POND AREA 622969**													
0	02/14/00	02/15/00	02/22/00	0.46	23,880	80,986	na	na	(48,520)	0	(68,988)	12,642	7	20	40	0.23
	Irrigating fields causes high water table, high runoff coefficient and positive residuals															
MARCH 2000			**ESTIMATED POND AREA 517356**													
1	03/27/00	03/28/00	03/28/00	0.79	34,059	103,471	na	na	0	96,746	(6,832)	(33,953)	1	grab	24	0.17
	Irrigation stops and water table begins to decline for storm event															
APRIL 2000			**ESTIMATED POND AREA 622969**													
2	04/13/00	04/14/00	04/14/00	0.73	37,897	24,400	na	na	0	62,297	(7,257)	7,257	1	grab	15	0.04
MAY 2000	Not enough rain for water quality samples															
JUNE 2000			**ESTIMATED POND AREA 244681**													
3	06/25/00	06/25/00	06/26/00	1.46	29,770	41,188	22,824	na	0	70,957	(3,400)	3,400	1	NF	5	0.04
4	06/26/00	06/26/00	06/27/00	1.38	28,138	101,543	43,344	na	0	106,436	(17,069)	(6,176)	3	NF	6	0.10
			06/30/00												8	
JULY 2000			**ESTIMATED POND AREA 622969**													
5	07/01/00	07/02/00	noWQ	1.04	53,991	149,097	109,440	na	0	158,110	(7,801)	(37,178)	2	0		0.19
	07/06/00			0.57	29,591	43,504	43,504		0	12,459	(17,312)	(43,324)	3			
	07/08/00			0.25	12,979	8,622			**(1,197)**	(623)	(3,200)	(17,827)				
7	07/09/00	07/13/99	7/1/&7/13	2.55	132,381	427,547	60,714+	na	(354,890)	193,120	(18,540)	6,623	4	80		0.22
9	07/15/00	07/16/00	07/16/00	4.26	221,154	1,515,606	no good	na	(1,525,656)	174,431	(5,903)	(30,769)	2	na		0.47
	07/23/00	07/23/00	noWQ	1.46	75,795	116,597	112,248	na	(102,613)	28,034	(16,321)	(45,424)	4	na	no WQ	0.10
	07/31/00	08/11/00	08/07/00	0.76	39,455	43,177	no good	na	(60,886)	(8,722)	(24,122)	(6,345)	7	na		0.07

7/15 storm still flowing out and the tail end collected with the next storm accounting for more outflow than inflow on 7/15

7/31/00 Had missing data and includes a lot of interpolation. Not good data, but the best available

Appendix C. (2000)(continued)

STR #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	INFLOW SonTek (CU FT)	INFLOW MMacB (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	NUMBER DAYS IN CALCS (DAYS)	# SAMPS. OUT	# SAMPS. IN	Runoff coeffic.
AUGUST 2000			**ESTIMATED POND AREA**		**622969**											
11	08/12/00	08/15/00	08/14/00	0.97	50,357	64,140	71,649	na	(53,818)	24,919	(8,801)	(26,959)	3	40	40	0.09
12	08/15/00	08/17/00	08/15/00	0.36	18,689	22,670	34,830	na	(28,900)	(24,919)	(7,940)	(29,438)	2	16	15	0.08
			08/17/00											23	0	
TOTAL BOTH				1.33	69,046	86,811	106,479		(82,718)	0	(16,741)	(56,397)				0.09
13	08/22/00	08/23/00	08/23/00	0.51	26,476	33,216	35,280		(30,961)	(623)	(8,521)	(20,833)	3	5	40	0.09
			08/25/00											5		
14	08/26/00	08/27/00	08/27/00	0.63	32,706	69,640	89,748		(44,945)	13,705	(19,056)	(24,640)	5	6	40	0.15
			08/31/00											18		
SEPTEMBER 2000			**ESTIMATED POND AREA**		**622969**											
16	09/06/00	09/07/00	09/07/00	0.68	35,302	48,176	33,966+	na	(16,900)	76,002	(3,970)	13,394	1	12	32	
17	09/07/00	09/08/00	09/08/00	0.85	44,127	172,341		na	(76,400)	107,151	(3,400)	(29,517)	1	40	40	
			09/11/00	0	0	0	0	na	(78,605)	(69,773)	(10,500)	19,332	3	40	0	
TOTAL 6th and 7th				1.53	79,429	220,517	na	na	(171,905)	113,380	(17,870)	3,210				0.19
18	09/16/00	09/17/00	09/17/00	3.58	183,257	1,805,398	na	na	(1,627,400)	24,919	(19,147)	(317,189)	1	40	40	0.66
			09/25/00										5.5	22	33	
19	09/27/00	09/28/00		1.35	70,084	349,009			(231,261)	149,516	(6,000)	(32,316)	2			0.34
OCTOBER 2000			**ESTIMATED POND AREA**		**622969**											
20	10/06/00	10/06/00	10/09/00	1.19	61,778	114,785	93,996	na	(65,850)	52,329	(14,432)	(43,952)	3	4	40	0.13
NOVEMBER 2000			**ESTIMATED POND AREA**		**622969**											
21	11/25/00	11/26/00	11/26/00	1.31	68,007	291,400	322,740	na	(264,685)	109,020	(11,685)	**(5,358)**	5	14	29	0.29
			12/01/00											13		
DECEMBER 2000			**ESTIMATED POND AREA**		**622969**											
22	12/17/00	12/17/00	12/18/00	0.37	19,208	87,158	65,376		(68,302)	21,804	(1,341)	(14,919)		22	33	0.31

August 2000 notes:
According to velocity meter, a small amount of outside flow is entering the pond on a diurnal cy cle ???
Outflow meter not working, calculating outflow from pond level with appropriate formulas and an adjustment to out flow staff gauge
SonTek velocity meter reading higher because of diurnal rise and fall of flow readings???

September 2000 notes:
This month having more than the usual problem s with sensors, the inflow was measured with the best data available and are at best educated guesses
9/17 Overflowed sampler bottle so number of pulses decreased at both inflow and outflow for the rest of hurricane Gordon and then reset on the 20th.
9/16 During Hurrican Gordon also som e back flow from marsh into pond affecting the runoff coefficient and other m easurements. It was almost impossible to separate backflow from pond discharge. The fields were saturated from irrigation occurring on 13, 14 and 15

October 2000 note:
Recalculated outflow using water level adjusted to staff gauge at outflow. The flowmeter at the outflow is not providing accurate readings but it is possible to calculate flow from pond level.

November 2000 note:
Stilll having trouble with outflow meter. Recalculated these from level

December 2000 note:
Stilll having trouble with outflow meter. Recalculated these from level. Inflow velocity meter obvously reading low

APPENDIX C (2001). Water Budget for the wet-detention pond for the year 2000. When reliable data are available, the inflow estimates are compared to a SonTek point velocity meter installed in May 2000. For composite samples, the number of individual aliquots taken at the inflow and outflow stations are given or when the value represented a grab sample that information is substituted. Often storms occurred close together or it took many days for the the discharge at the outflow to stop and the storm event samples were picked up on several days. The values for the last pick up date are cumulative for the entire storm.

WATER BUDGET **PRECIPITATION + INFLOW - OUTFLOW - EVAPOTRANSPIRATION +/- SEEPAGE = CHANGE IN STORAGE**

SEEPAGE INCLUDES THE ERROR TERM WHICH IS AFFECTED BY IRRIGATION WATER INTO THE POND, OUTFALL WEIR LEAKS, A SEEPAGE AREA OUT OF THE POND AND TO A MINOR EXTENT TIDAL FLUCTUATIONS. THE WEIR LEAK WAS FIXED BY OCT. 1998.

STM #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW BUDGET (CU FT)	INFLOW SonTek (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	DAYS in CALCs (days)	# SAMPS. OUT	# SAMPS. IN	Runoff coeffic.
	JANUARY 2001				Not enough rain for a sample										
	FEBRUARY 2001				Not enough rain for a sample										
	MARCH 2001			ESTIMATED POND AREA		622969									
1	03/04/01	03/04/01	03/05/01	1.62	84,101	205,544	260,892	(94,800)	189,383	(5,386)	(77)	2	grab	40	0.17
2	03/29/01	03/30/01	03/30/01	4.25	220,635	756,779	911,340	(345,100)	591,198	(3,693)	(37,423)	1.5	40	40	
			04/02/01	4.33	224,788	831,546	933,779	(789,800)	224,892	(28,735)	(12,907)	4	50		0.25
	#1 Sontek measures irrigation water not included in calculations for budget														
	#2 Backflow from marsh into pond makes estimations for budget method difficult														
	APRIL 2001				Not enough rain for a sample										
	MAY 2001				Not enough rain for a sample										
	JUNE 2001			ESTIMATED POND AREA		622969									
3	06/23/01	06/24/01	06/25/01	2.74	142,245	610,462	na	(79,900)	718,906	(13,409)	59,509	3	grab	grab	
			06/28/01	2.91	151,070	682,936	na	(115,100)	680,282	(30,350)	(8,274)	5	24	0	0.31
4	06/30/01	07/01/01	07/01/01	1.16	60,220	245,606	230,472	(226,400)	44,231	(24,215)	(10,980)	4	30	40	0.28
	#3 No sontek. Grass was caught on sensor, but at least 150,000 cubic feet measured for the part of storm where sensor was reading. Misses about 30 hours near beginning of storm power problems caused by lightening inactivated the WQ samplers and only grab samples taken for first pickup.														
	#4 Grass on Sontek for almost a day and this part of curve interpolated. (See graph in appendix C3).														
	JULY 2001			ESTIMATED POND AREA		622969									
5	07/04/01	07/05/01	07/05/01	0.23	11,940	20,826	20,826	(19,800)	(5,607)	(6,107)	(12,466)	1	50	19	0.12
6	07/16/01	07/17/01	07/17/01	0.74	38,416	15,862	13,540	(16,900)	34,263	(12,100)	8,985	2	5	30	0.03
7	07/21/01	02/22/01	07/22/01	0.82	42,570	100,137	129,096	(44,900)	95,314	(8,219)	5,727	1.25	20	40	0.16
8	07/23/01	07/23/01	07/24/01	1.70	88,254	1,038,631	na	(1,002,400)	170,071	(15,210)	60,795	2.5	50	40	
			07/25/01	1.85	96,041	1,114,331	na	(1,173,000)	50,460	(21,317)	34,405	3.5	40		0.79
9	07/26/01	07/27/01	07/27/01	0.59	30,629	132,778	158,094	(73,700)	86,593	(6,800)	3,685	1	16	40	
			07/30/01	0.69	35,821	189,847	173,502	(226,600)	(34,886)	(27,200)	(6,754)	4	19	40	0.36

#5 A lot of the water lost from storage was from past rain events. Pond level has stayed above the control elevation since June.Not enough flow to do water budget method. Used data from Sontek. Ditch level indicates very low if any flow. Level 0.13 feet above pipe invert on 1st and only 0.03 ft above pipe invert on July 5th.

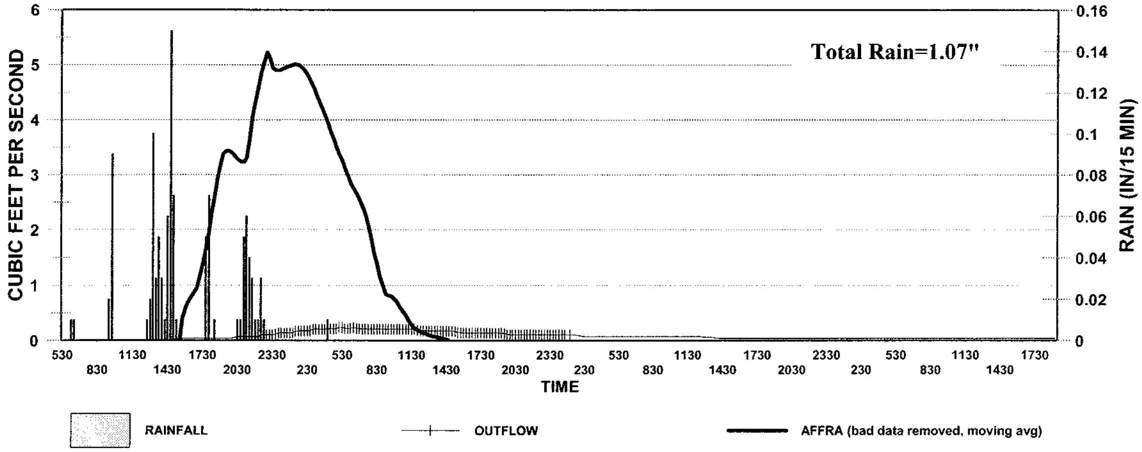
#6 So little flow that it is difficult to determine the correct amount, especially for the Sontek that is very erratic at low flows. The numbers make sense given the field conditions. Only about 0.2 feet of water in ditch and slowly seeping into pond over several days. Only slow increase and decrease of pond levels.

#8 Sontek had trash on unit for too long to use for an estimate.

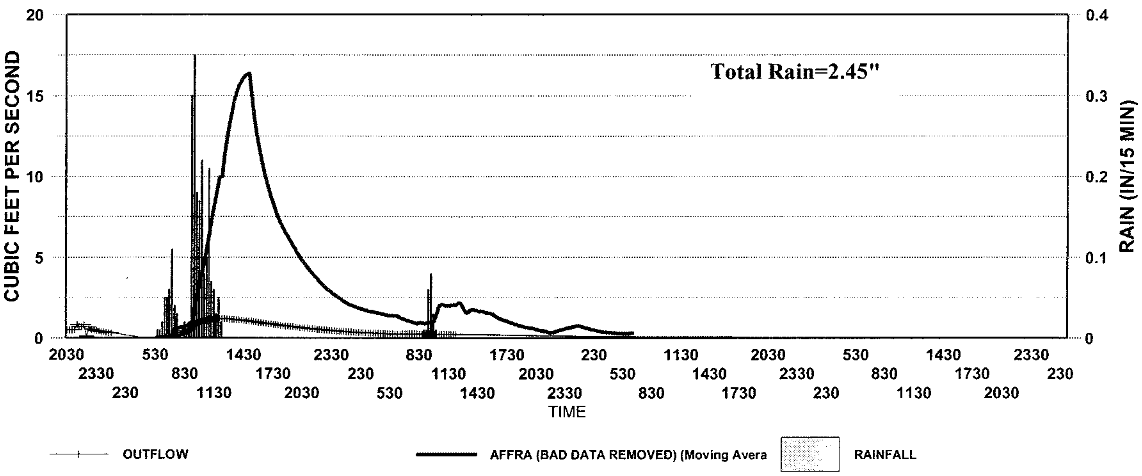
Appendix C. (2001)(continued)

STR #	STORM DATE START	STORM DATE STOP	PICKUP DATE	RAIN AM'T (IN)	RAIN AM'T (CU FT)	INFLOW (CU FT)	INFLOW SonTek (CU FT)	OUTFLOW (CU FT)	STORAGE (CU FT)	PAN*0.7 ET+ (CU FT)	RESIDS NET SEEPAGE (CU FT)	UMBER DAYS IN CALCS (DAYS)	# SAMPS. OUT	# SAMPS. IN	Runoff coeffic.
	AUGUST 2001			ESTIMATED POND AREA 622969											
10	08/05/01	08/06/01	08/06/01	0.47	24,400	140,974	160,002	(57,600)	100,298	10,300	(17,776)	1.75	50	40	0.39
	#10 Everything seemed to work. Water quality sampling cut short because of another sm all storm 0.14".														
	SEPTEMBER 2001			ESTIMATED POND AREA 622969											
11	09/11/01	01/12/01	09/12/01	1.08	56,067	58,435	68,076	(1,122)	109,020	(6,430)	2,069	1	grab	40	0.07
	# 11 Electricity failure at outflow so no rain sam ple or WQ sample														
12	09/13/01	09/14/01	09/14/01	7.29	378,454	706,472	731,202	(228,966)	855,959	(500)	500	1	29	40	
			09/15/01	9.91	514,469	3,238,861	na	(3,292,466)	459,128	(6,840)	5,105	2	5	40	
			09/21/01	9.91	514,469	3,425,799	na	(3,891,466)	30,525	(27,611)	9,335	7	21	0	0.45
	# 12 Hurrican Gabrielle. Som e power problems. Great masses of grass caught up in Sontek so m iss some inflow. 9/14 last part of Sontek interpolated. Values are cum ulative.														
13	09/28/01	09/29/01	09/30/01	1.00	51,914	58,994	75,514	(56,300)	59,182	(7,900)	12,474	2	29	none	0.08
	# 13 Inflow sampler was turned off, so no inflow samples. Some of Sontek flow was interpolated.														
	OCTOBER 2001			ESTIMATED POND AREA 622969											
14	10/21/01	10/22/01	01/22/01	1.80	93,445	76,629	73,944+	(6,900)	140,791	(11,933)	(10,451)	3		40	0.06
			10/24/01					(40,500)					20		
			10/26/01					(66,700)					12		
	# 14 Estimated inflow over three day period. No outflow sample taken on first day. Just a slow seep into and out of pond for the entire five day s?? hard to estimcate Only used Sontek flow data for one day because it became erratic after that, so it probably was marginally higher.														
	NOVEMBER 2001				Not enough rain for a sam ple										
	DECEMBER 2001				Not enough rain for a sam ple										

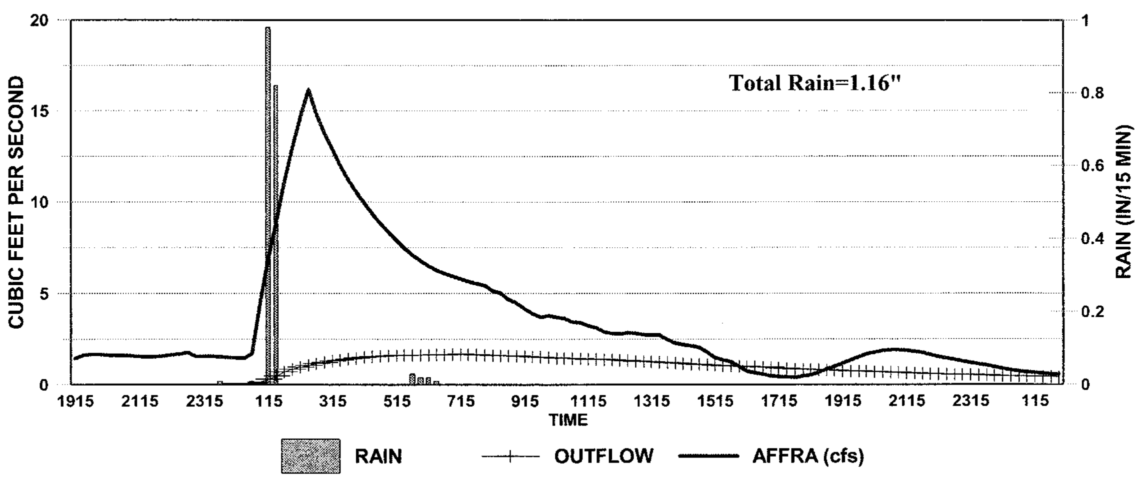
JANUARY 15 - 16, 1998
FLOW AND RAINFALL



JANUARY 23 - 24, 1998
FLOW AND RAINFALL

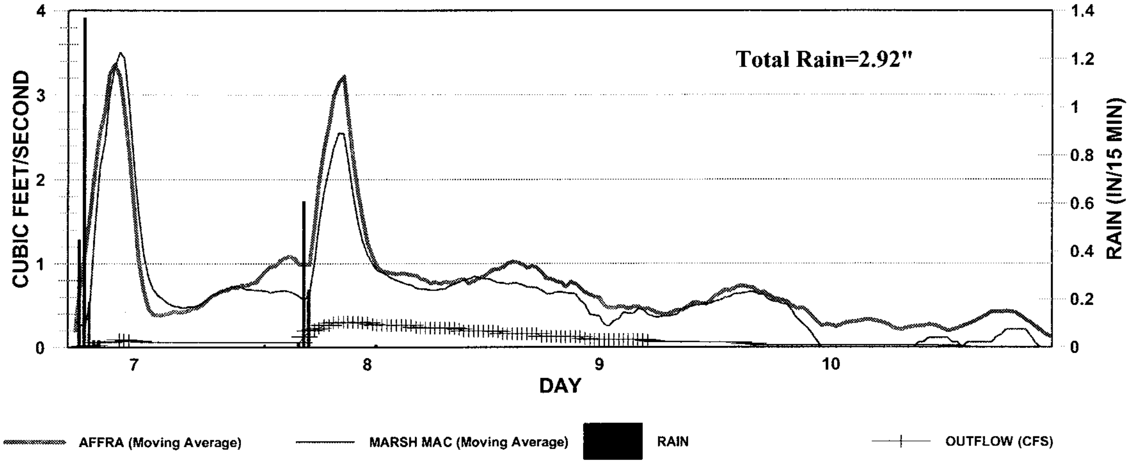


MARCH 1, 1998
FLOW AND RAINFALL

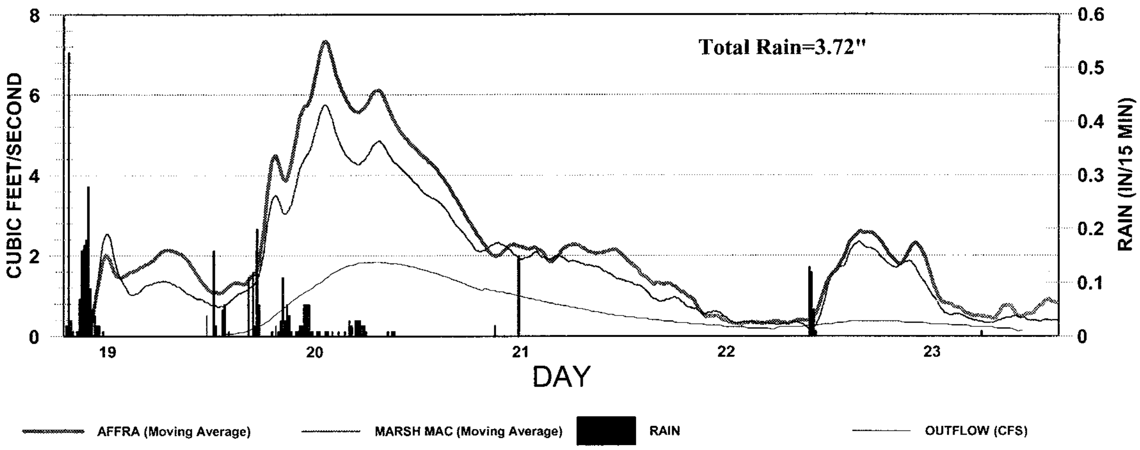


Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

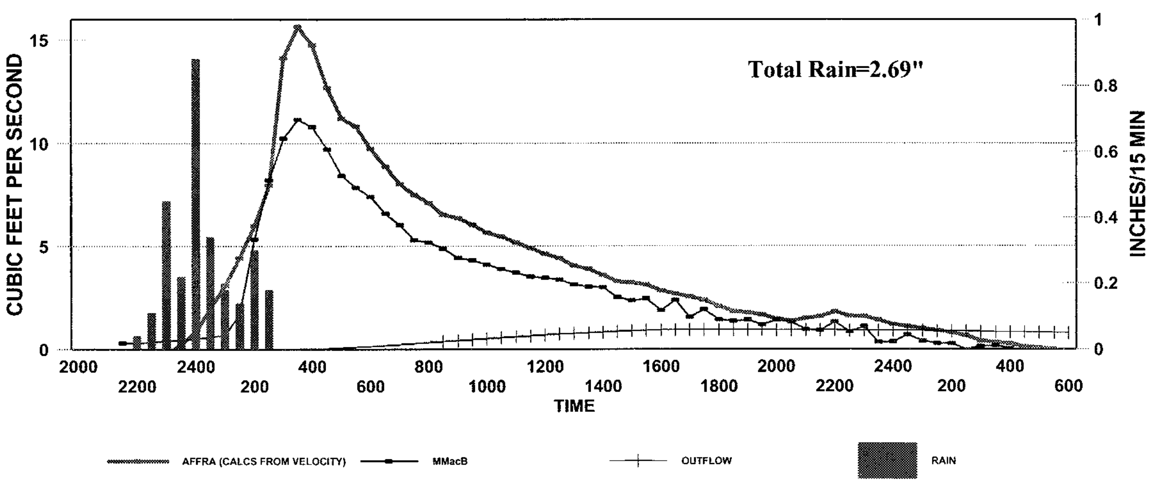
SEPTEMBER 6 - 10, 1998
FLOW AND RAINFALL



SEPTEMBER 19 - 23, 1998
FLOW AND RAINFALL



JANUARY 23, 1999
FLOW AND RAINFALL



Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

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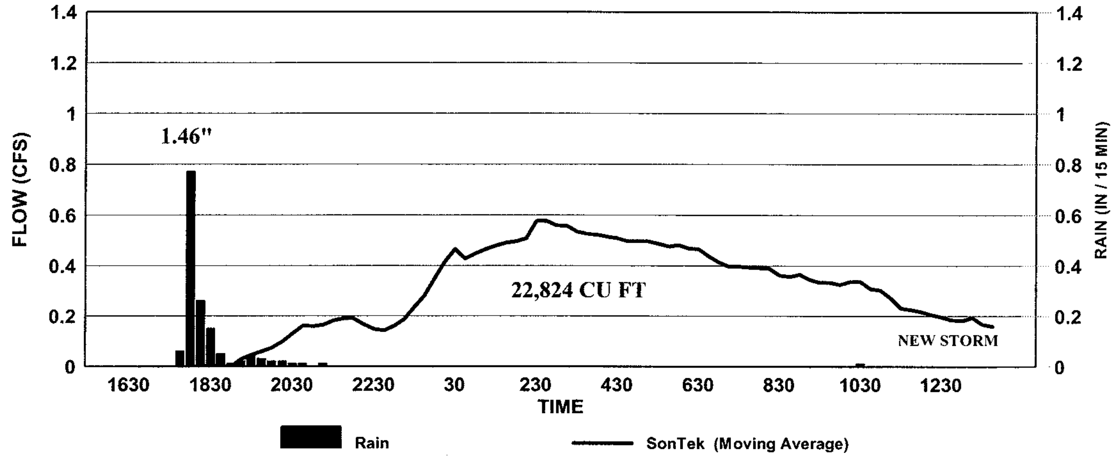
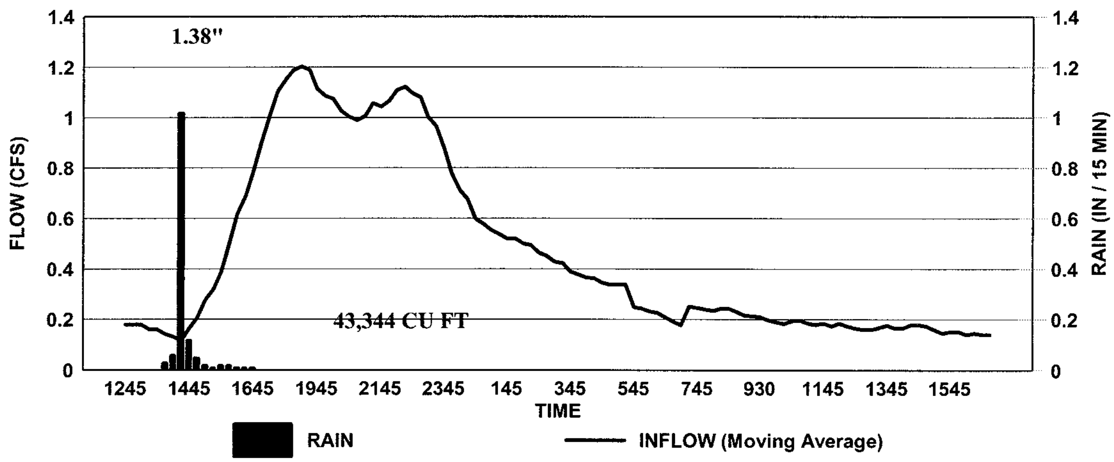
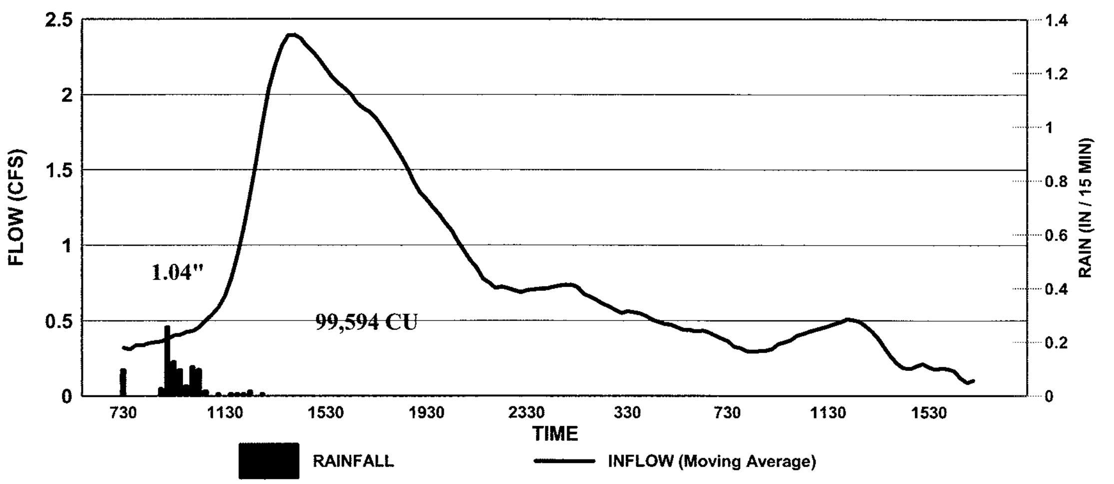
JUNE 25-26, 2000
FLOW AND RAINFALL



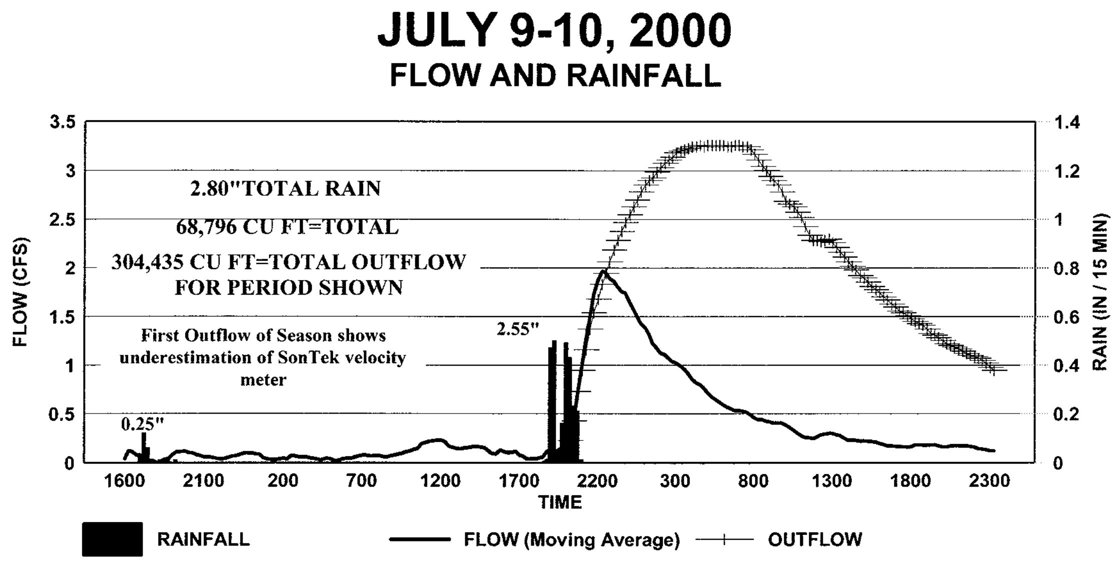
JUNE 26-27, 2000
FLOW AND RAINFALL

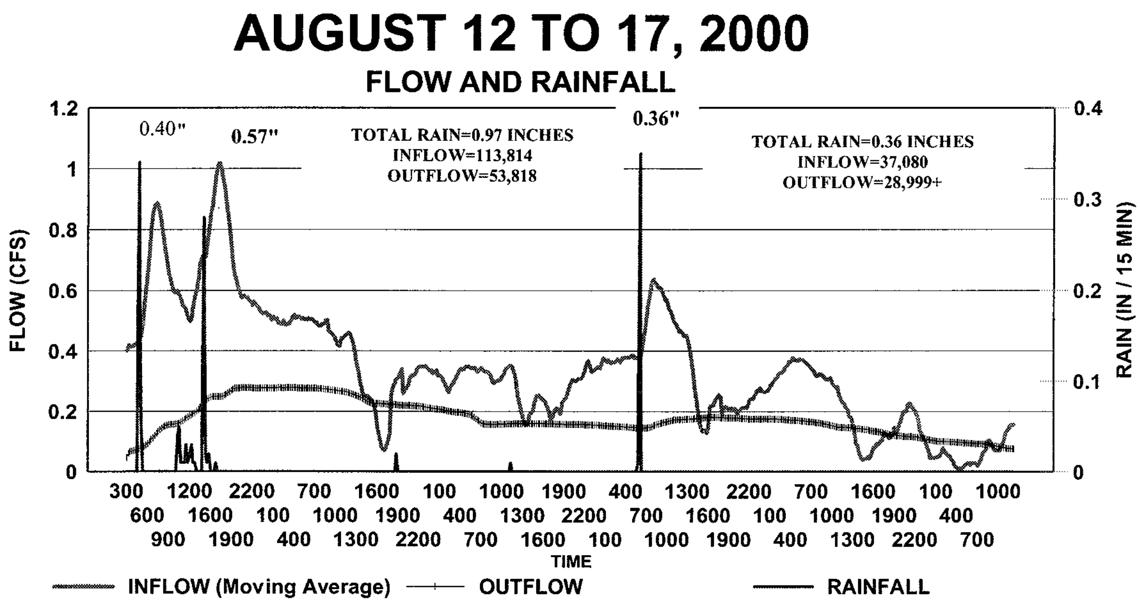


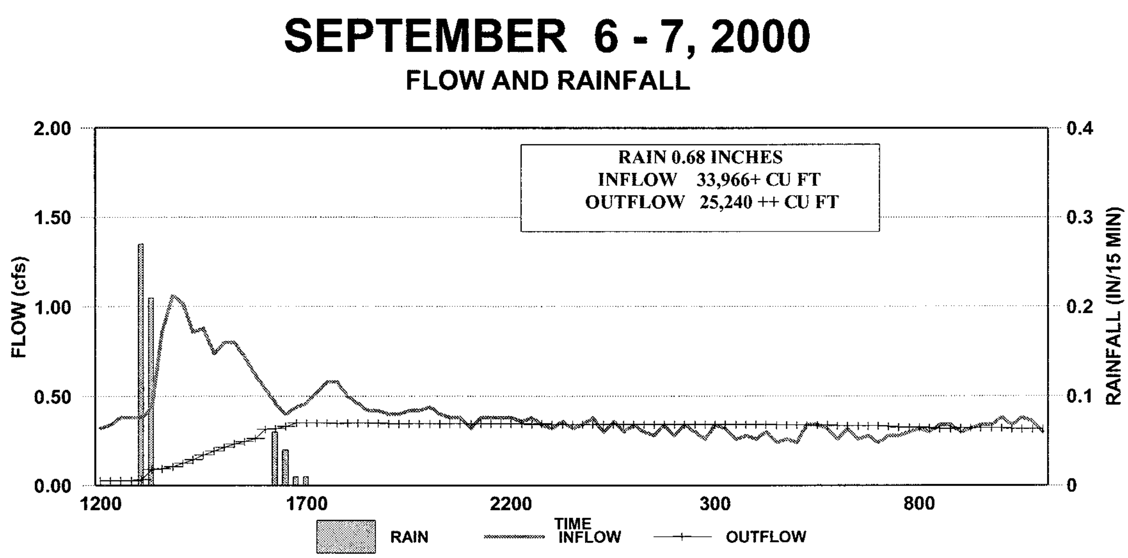
JULY 1-2, 2000
RAINFALL AND FLOW



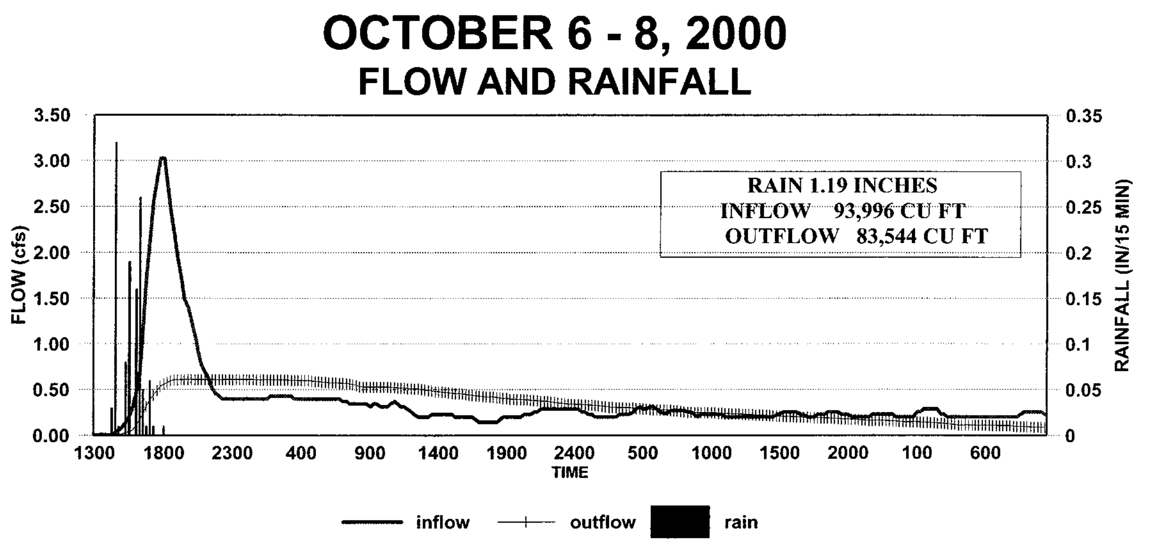
Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

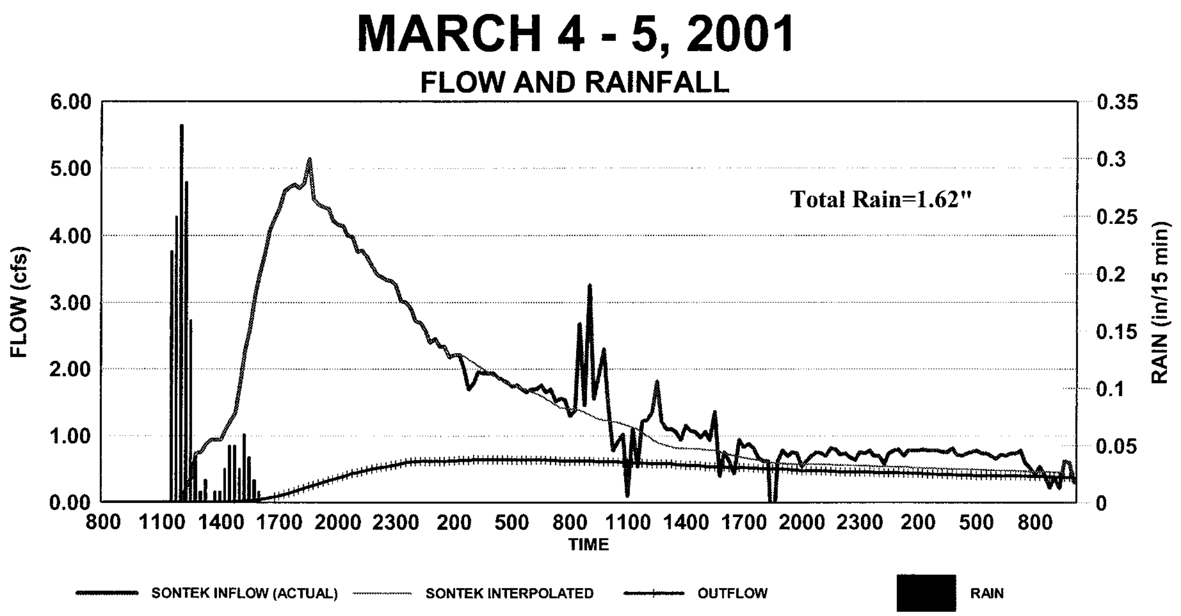


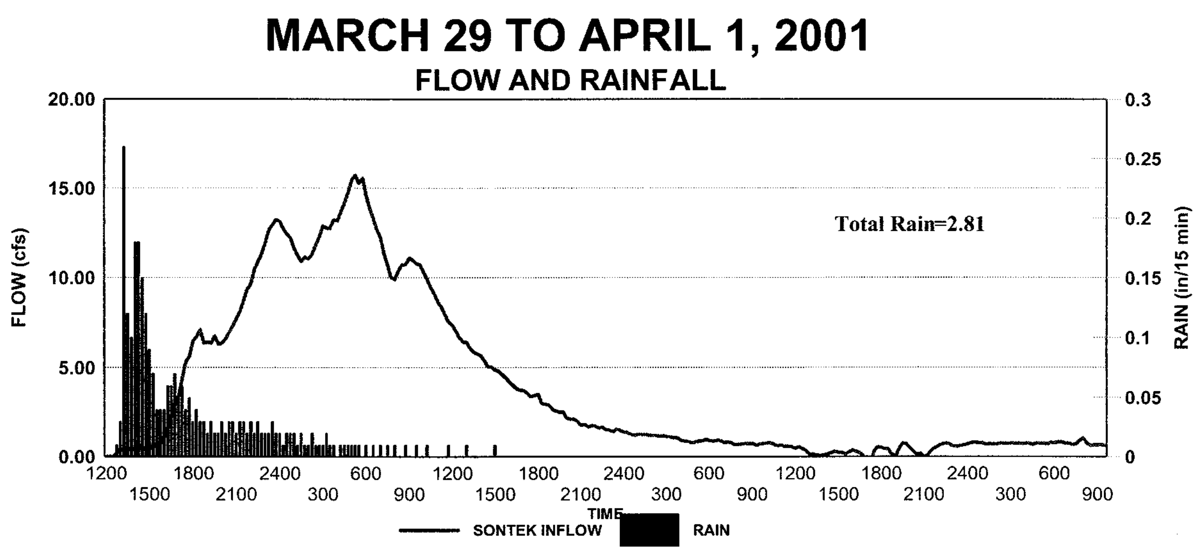




Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow







Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

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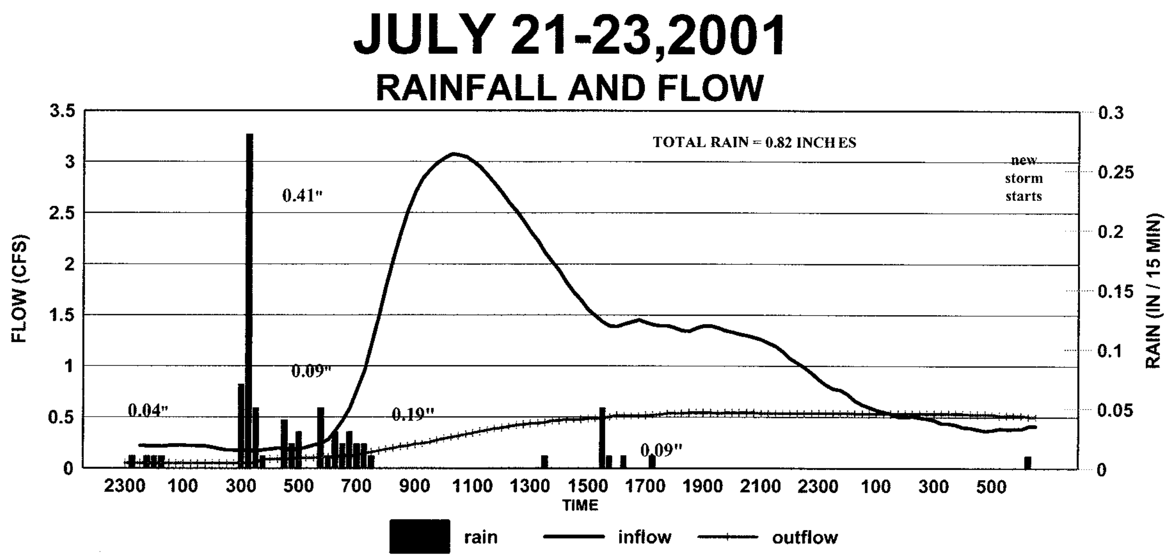
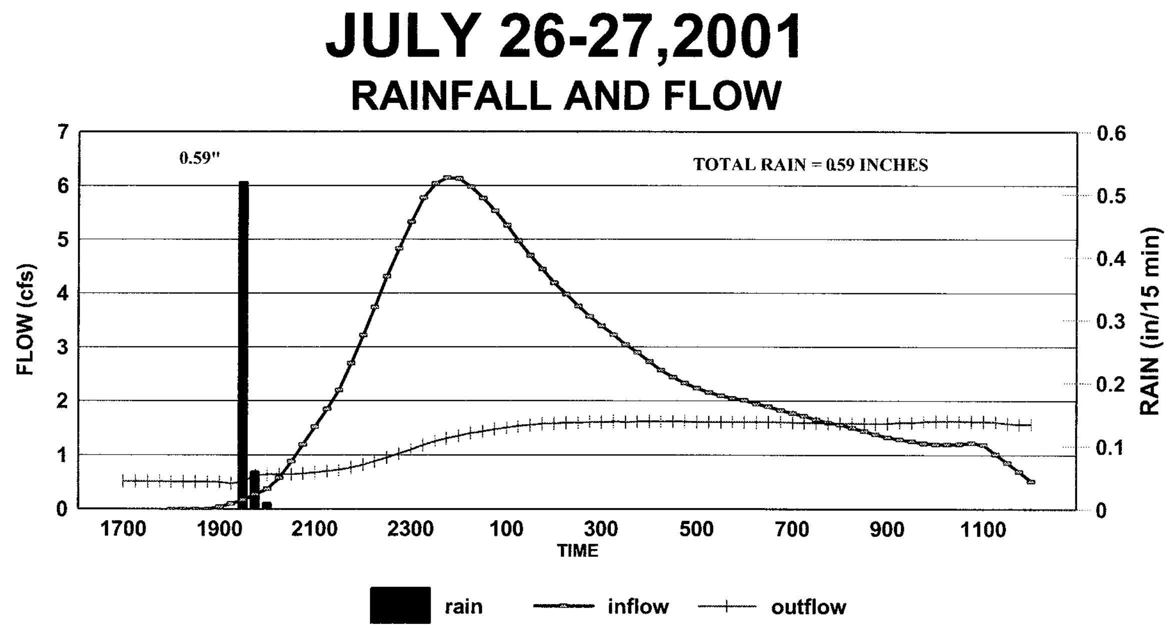
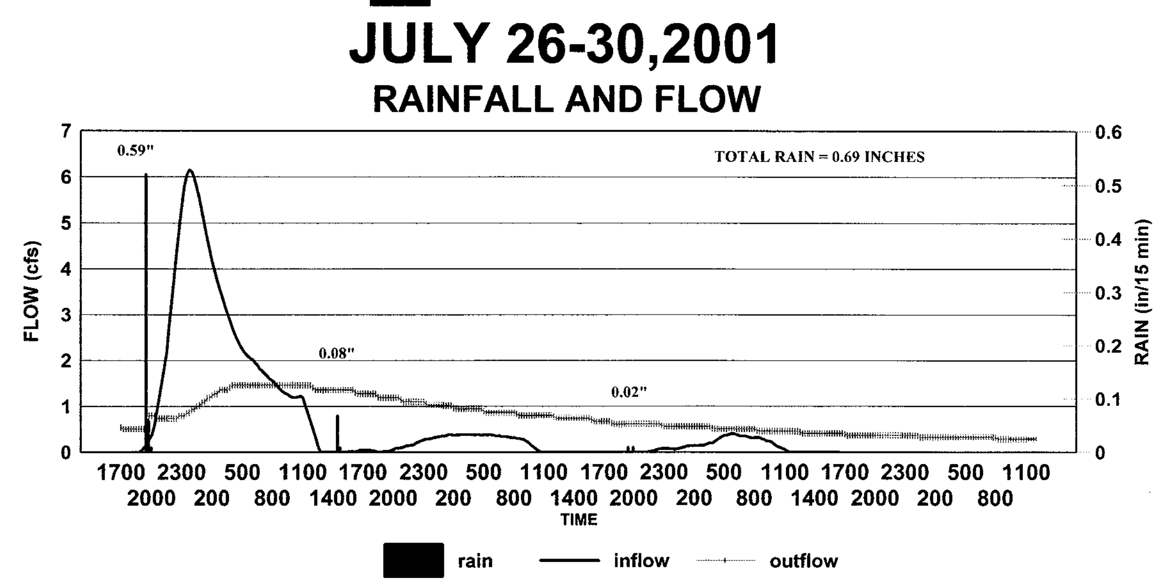
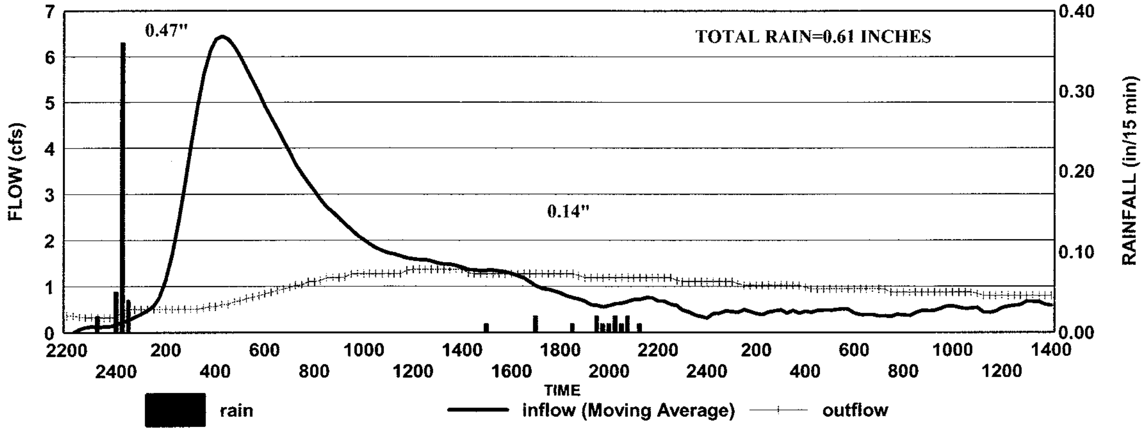




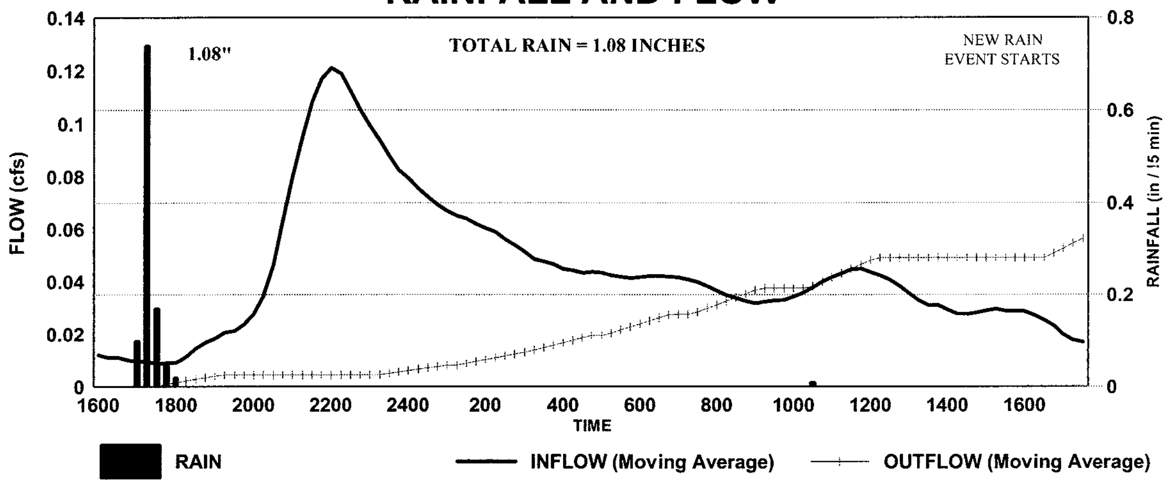


Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

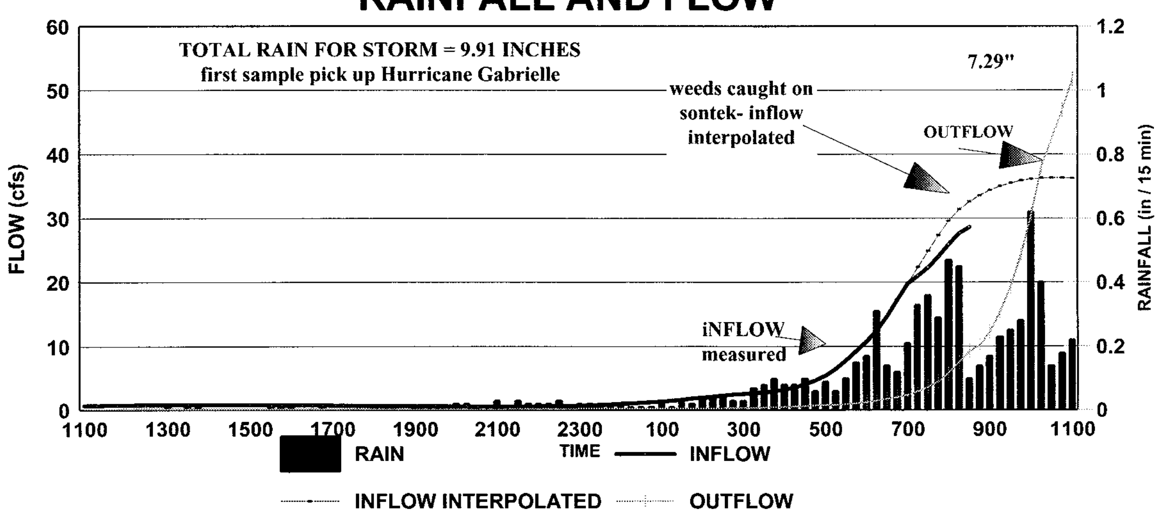
AUGUST 5 - 7, 2001
RAINFALL AND FLOW



SEPTEMBER 11 - 12, 2001
RAINFALL AND FLOW

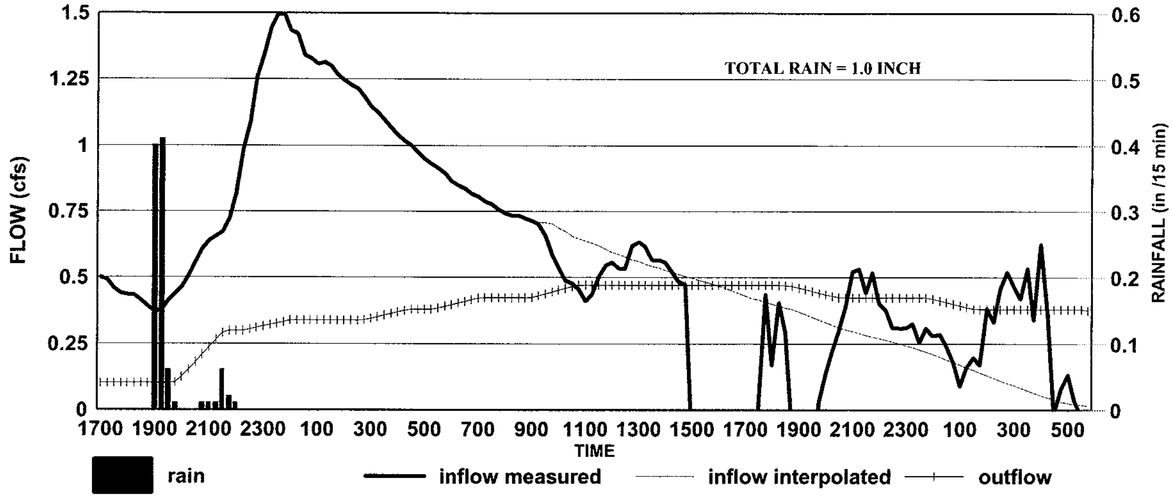


SEPTEMBER 13 - 14, 2001
RAINFALL AND FLOW



Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

SEPTEMBER 28-30, 2001
RAINFALL AND FLOW



Appendix C-3. Hydrographs of some of the flow meter data compared to rainfall and outflow

APPENDIX D

Concentrations of Constituents and
Calculations for percent reduction (increase) from inflow to outflow

Appendix D-1. Concentrations of nutrients in rainfall, at the inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Detection limit for inorganic nitrogen and phosphorus is 0.01 mg/L and for organic nitrogen 0.1 mg/L Abbreviations: NA=Data not available, NF=No Flow.

YEAR ONE - WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Ammonia Lab detection limit 0.01 mg/L as N			Nitrate+Nitrite Lab detection limit 0.01 mg/L as N			Organic Nitrogen Lab detection limit 0.06 mg/L as N			Total Nitrogen Lab detection limit 0.06 mg/L as N			Ortho-Phosphorus Lab detection limit 0.01 mg/L as P			Total Phosphorus Lab detection limit 0.01 mg/L as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/06/98	1	0.222	0.149	NA	0.306	0.680	NA	0.778	1.451	NA	1.000	1.600	NA	0.022	1.010	NA	0.022	1.200	NA
01/15/98	2	0.165	0.101	0.110	0.139	0.355	0.492	0.645	1.299	0.370	0.810	1.400	0.480	0.033	3.104	0.776	0.035	5.050	1.010
01/23/98	3	0.107	0.065	0.075	0.162	0.167	0.244	0.215	0.695	0.897	0.322	0.760	0.937	0.005	3.380	0.706	0.005	5.560	0.757
02/15/98	5	0.203	0.050	0.057	0.238	0.382	0.139	0.897	1.150	0.943	1.100	1.200	1.000	0.020	0.638	0.645	0.001	2.650	0.874
02/17/98	6	0.220	0.286	0.027	0.187	2.600	0.224	0.330	2.514	0.803	0.550	2.800	0.830	0.015	0.728	0.687	0.026	8.650	0.757
02/19/98	7	0.195	0.220	0.137	0.110	0.295	0.477	0.210	0.780	0.983	0.405	1.000	1.118	0.023	0.540	0.778	0.020	2.350	1.039
02/28/98	9	0.242	0.130	0.115	0.143	0.296	0.114	0.348	1.070	0.755	0.590	1.200	0.870	0.005	1.490	0.567	0.005	2.060	0.760
03/08/98	10	0.401	0.133	NF	0.220	0.377	NF	0.449	1.167	NF	0.850	1.300	NF	0.005	1.440	NF	0.005	1.890	NF
03/18/98	11	0.055	0.134	0.048	0.111	0.656	0.031	0.235	1.166	0.626	0.290	1.300	0.700	0.510	0.005	0.772	0.681	0.005	1.040
04/20/98	12	0.817	0.022	NF	0.286	0.066	NF	1.183	0.678	NF	2.000	0.700	NF	0.019	0.963	NF	0.521	2.113	NF
05/28/98	13	0.872	0.110	NF	0.450	3.235	NF	0.428	3.590	NF	1.300	3.700	NF	0.073	0.717	NF	0.097	1.433	NF
05/30/98	14	1.410	0.027	NF	2.450	0.307	NF	1.169	1.173	NF	3.900	1.200	NF	0.047	0.769	NF	0.046	1.030	NF
06/23/98	15	1.030	0.058	NF	0.912	0.131	NF	2.888	0.662	NF	3.800	0.720	NF	0.098	0.514	NF	0.102	0.674	NF
07/06/98	16	0.943	0.013	NF	1.010	0.016	NF	1.990	0.677	NF	3.000	0.690	NF	0.021	0.332	NF	0.028	0.487	NF
07/10/98	17	0.349	0.031	NF	0.752	0.019	NF	0.448	0.629	NF	1.200	0.660	NF	0.019	0.308	NF	0.015	0.440	NF
07/17/98	18	0.143	0.100	NF	0.345	0.041	NF	0.235	0.730	NF	0.580	0.830	NF	0.026	0.680	NF	0.117	0.886	NF
07/21/98	19	0.518	0.005	NF	0.175	0.005	NF	1.725	0.650	NF	1.900	0.650	NF	0.368	0.403	NF	0.404	0.507	NF
08/16/98	20	0.190	0.147	NF	0.425	0.076	NF	0.225	1.153	NF	0.650	1.300	NF	0.032	0.103	NF	0.028	0.222	NF
08/17/98	21	0.188	0.122	NF	0.777	0.133	NF	0.523	0.718	NF	1.300	0.840	NF	0.055	0.525	NF	0.057	0.892	NF
09/02/98	22	0.229	0.124	NF	0.258	0.024	NF	0.312	1.276	NF	0.570	1.400	NF	0.032	0.023	NF	0.065	0.113	NF
09/06/98	23	0.209	0.062	NF	0.229	0.416	NF	0.651	1.638	NF	0.880	1.700	NF	0.027	0.838	NF	0.024	1.760	NF
09/18/98	24	0.167	0.105	NF	0.059	0.119	NF	0.211	0.525	NF	0.270	0.630	NF	0.017	0.822	NF	0.028	1.067	NF
09/19/98	25	0.031	0.148	0.016	0.036	0.150	0.010	0.054	0.672	0.684	0.090	0.820	0.700	0.012	1.850	0.272	0.005	2.120	0.390
09/20/98	26	0.109	0.134	0.005	0.087	0.118	0.015	0.143	1.066	1.390	0.230	1.200	1.400	0.005	1.810	0.407	0.005	2.030	0.636
12/13/98	27	0.124	0.013	NF	0.283	0.010	NF	0.133	0.627	NF	0.540	0.640	NF	0.022	0.630	NF	0.019	0.869	NF
No. Obs.		**25**	**25**	**9**	**25**	**25**	**9**	**25**	**25**	**9**	**25**	**25**	**9**	**25**	**25**	**9**	**25**	**25**	**9**
Mean		**0.366**	**0.100**	**0.066**	**0.406**	**0.427**	**0.194**	**0.657**	**1.110**	**0.828**	**1.125**	**1.210**	**0.893**	**0.060**	**0.945**	**0.623**	**0.094**	**1.842**	**0.807**
Median		**0.209**	**0.105**	**0.057**	**0.238**	**0.150**	**0.139**	**0.428**	**1.066**	**0.803**	**0.810**	**1.200**	**0.870**	**0.022**	**0.717**	**0.687**	**0.028**	**1.200**	**0.760**
max		**1.410**	**0.286**	**0.137**	**2.450**	**3.235**	**0.492**	**2.888**	**3.590**	**1.390**	**3.900**	**3.700**	**1.400**	**0.510**	**3.380**	**0.778**	**0.681**	**8.650**	**1.040**
min		**0.031**	**0.005**	**0.005**	**0.036**	**0.005**	**0.010**	**0.054**	**0.525**	**0.370**	**0.090**	**0.630**	**0.480**	**0.005**	**0.005**	**0.272**	**0.001**	**0.005**	**0.390**
Std.Dev.		**0.352**	**0.066**	**0.044**	**0.492**	**0.763**	**0.175**	**0.664**	**0.662**	**0.266**	**1.026**	**0.691**	**0.252**	**0.115**	**0.829**	**0.168**	**0.170**	**1.920**	**0.201**
C.V.		**0.963**	**0.662**	**0.675**	**1.212**	**1.786**	**0.900**	**1.011**	**0.596**	**0.321**	**0.912**	**0.571**	**0.282**	**1.909**	**0.877**	**0.270**	**1.803**	**1.042**	**0.249**
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																			
				34.2			**54.6**			**25.4**			**26.2**			**34.0**			**56.2**

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TABLE D-1 (CONTINUED)

YEAR TWO - WATER QUALITY CONCENTRATIONS

Date of storm	Storm	Ammonia Lab detection limit 0.01 mg/L as N			Nitrate+Nitrite Lab detection limit 0.01 mg/L as N			Organic Nitrogen Lab detection limit 0.06 mg/L as N			Total Nitrogen Lab detection limit 0.06 mg/L as N			Ortho-Phosphorus Lab detection limit 0.01 mg/L as P			Total Phosphorus Lab detection limit 0.01 mg/L as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/02/99	1	0.035	0.058	NF	0.212	0.027	NF	0.038	1.042	NF	0.250	1.100	NF	0.005	0.628	NF	0.014	0.754	NF
01/25/99	2	0.141	0.473	0.025	0.143	2.355	0.018	0.197	2.527	1.462	0.340	3.000	1.500	0.005	0.871	0.354	0.010	1.040	0.425
03/14/99	3	0.005	0.035	0.028	0.032	0.010	0.010	0.068	0.375	1.172	0.100	0.410	1.200	0.005	0.478	0.193	0.005	0.554	0.494
04/30/99	4	0.234	0.067	NF	0.338	0.128	NF	0.342	1.433	NF	0.680	1.500	NF	0.012	0.820	NF	0.017	1.009	NF
05/30/99	5	0.619	0.021	NF	0.428	0.005	NF	0.053	0.894	NF	1.100	0.920	NF	0.024	0.143	NF	0.057	0.317	NF
06/02/99	6	0.285	0.020	NF	0.248	0.005	NF	0.007	0.795	NF	0.540	0.820	NF	0.027	0.191	NF	0.034	0.261	NF
06/06/99	7	0.639	0.017	NF	0.958	0.005	NF	0.203	0.778	NF	1.800	0.800	NF	0.088	0.227	NF	0.092	0.357	NF
06/16/99	8	0.143	0.038	NF	0.113	0.005	NF	0.084	1.057	NF	0.340	1.100	NF	0.022	0.176	NF	0.030	0.367	NF
07/01/99	9	0.110	0.022	NF	0.005	0.005	NF	0.515	1.373	NF	0.630	1.400	NF	0.023	0.248	NF	0.022	0.344	NF
07/02/99	10	0.238	0.033	NF	0.065	0.005	NF	0.057	0.812	NF	0.360	0.850	NF	0.005	1.070	NF	0.013	1.510	NF
07/09/99	11	0.254	0.012	NF	0.187	0.005	NF	0.259	1.183	NF	0.700	1.200	NF	0.005	0.364	NF	0.020	0.530	NF
07/26/99	12	0.147	0.005	NF	0.037	0.007	NF	0.096	0.368	NF	0.280	0.380	NF	0.029	0.854	NF	0.097	1.070	NF
08/06/99	13	0.005	0.017	NF	0.100	0.098	NF	-0.005	0.985	NF	0.100	1.100	NF	0.005	0.873	NF	0.005	0.987	NF
08/12/99	14	0.055	0.123	0.036	0.180	0.037	0.006	0.205	1.14	1.758	0.440	1.300	1.800	0.005	0.659	0.017	0.016	0.856	0.059
08/14/99	15	0.166	0.055	0.018	0.382	0.072	0.005	0.112	1.073	1.777	0.660	1.200	1.800	0.005	0.866	0.005	0.011	1.006	0.043
08/16/99	16	0.408	0.048	0.054	0.295	0.03	0.005	0.037	1.322	1.640	0.740	1.400	1.700	0.005	0.834	0.010	0.024	0.867	0.047
08/18/99	17	0.057	0.005	0.044	0.384	0.106	0.007	0.049	-0.083	0.489	0.490	0.080	0.540	0.012	1.300	0.146	0.005	1.440	0.197
08/22/99	18	0.024	0.035	0.022	0.051	0.013	0.005	0.155	0.473	0.914	0.230	0.510	0.941	0.005	1.020	0.271	0.005	1.041	0.333
08/28/99	19	0.041	0.052	0.089	0.030	0.005	0.005	0.299	0.063	0.016	0.370	0.120	0.110	0.005	0.998	0.292	0.015	1.297	0.406
09/06/99	20	0.014	0.005	0.027	0.025	0.005	0.005	0.221	0.750	0.518	0.260	0.760	0.550	0.005	1.520	0.333	0.010	1.678	0.406
09/11/99	21	0.162	0.046	0.033	0.081	0.008	0.005	0.457	0.946	0.892	0.700	1.000	0.930	0.014	0.928	0.234	0.015	1.104	0.352
09/19/99	22	0.012	0.005	0.038	0.101	0.024	0.005	0.047	1.371	1.167	0.160	1.400	1.225	0.005	1.220	0.339	0.014	1.420	0.580
10/04/99	23	0.089	0.035	0.045	0.101	0.148	*0.005*	0.067	0.497	0.615	0.257	0.68	0.665	*0.005*	1.099	0.210	0.009	NA	0.368
10/11/99	IRW	NA	NA	0.088	NA	NA	*0.005*	NA	NA	0.87	NA	NA	0.963	NA	NA	0.459	NA	NA	0.645
11/01/99	24	*0.005*	0.067	0.016	0.023	0.056	0.009	NA	NA	NA	NA	NA	NA	0.013	1.718	0.200	0.015	1.95	0.267
11/15/99	IRW	NA	NA	0.026	NA	NA	0.005	NA	NA	1.09	NA	NA	1.1	NA	NA	0.240	NA	NA	0.589
11/22/99	25	0.157	0.03	*0.005*	0.201	0.114	*0.005*	0.073	0.47	2.39	0.431	0.614	2.4	NA	NA	NA	0.017	1.21	0.662
12/17/99	26	0.098	NA	0.056	NA	NA	*0.005*	NA	NA	1.335	NA	NA	1.494	0.012	NA	0.264	0.016	NA	0.365
No. Obs.		**26**	**25**	**17**	**25**	**25**	**17**	**24**	**24**	**16**	**24**	**24**	**16**	**25**	**24**	**16**	**26**	**24**	**17**
Mean		**0.159**	**0.053**	**0.038**	**0.189**	**0.131**	**0.006**	**0.152**	**0.902**	**1.132**	**0.498**	**0.985**	**1.182**	**0.014**	**0.796**	**0.223**	**0.023**	**0.957**	**0.367**
Median		**0.126**	**0.035**	**0.033**	**0.113**	**0.013**	**0.005**	**0.090**	**0.920**	**1.129**	**0.401**	**0.960**	**1.150**	**0.005**	**0.860**	**0.237**	**0.015**	**1.008**	**0.368**
max		**0.639**	**0.473**	**0.089**	**0.958**	**2.355**	**0.018**	**0.515**	**2.527**	**2.390**	**1.800**	**3.000**	**2.400**	**0.088**	**1.718**	**0.459**	**0.097**	**1.950**	**0.662**
min		**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**-0.005**	**-0.083**	**0.016**	**0.100**	**0.080**	**0.110**	**0.005**	**0.143**	**0.005**	**0.005**	**0.261**	**0.043**
Std.Dev.		**0.168**	**0.090**	**0.022**	**0.200**	**0.456**	**0.003**	**0.137**	**0.524**	**0.574**	**0.359**	**0.575**	**0.566**	**0.017**	**0.420**	**0.125**	**0.023**	**0.451**	**0.192**
C.V.		**1.055**	**1.691**	**0.587**	**1.059**	**3.479**	**0.500**	**0.902**	**0.581**	**0.508**	**0.721**	**0.583**	**0.478**	**1.231**	**0.528**	**0.561**	**1.032**	**0.471**	**0.522**
AVERAGE REDUCTION (INCREASE) IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																			
				27.8			**95.1**			**-25.5**			**-20.0**			**72.0**			**61.7**

IRW = Irrigation water from the fields. No rainfall or inflow samples taken.

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TABLE D-1 (CONTINUED)

YEAR THREE - WATER QUALITY CONCENTRATIONS

Date of Storm	Storm	Ammonia Lab detection limit 0.01 mg/L as N			Nitrate+Nitrite Lab detection limit 0.01 mg/L as N			Organic Nitrogen Lab detection limit 0.06 mg/L as N			Total Nitrogen Lab detection limit 0.06 mg/L as N			Ortho-Phosphorus Lab detection limit 0.01 mg/L as P			Total Phosphorus Lab detection limit 0.01 mg/L as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
02/14/00	0	*0.005*	0.943	0.056	0.019	0.050	*0.050*	0.275	1.857	1.844	0.299	2.850	1.950	*0.005*	0.418	0.273	0.01	0.891	0.555
03/28/00	1	0.091	0.044	NF	0.199	0.038	NF	0.139	4.366	NF	0.429	4.448	NF	0.014	0.294	NF	0.016	0.868	NF
04/14/00	2	0.018	0.156	NF	*0.005*	0.496	NF	0.247	1.848	NF	0.270	2.500	NF	*0.005*	0.755	NF	0.018	1.370	NF
06/26/00	3	0.307	0.159	NF	0.307	*0.005*	NF	-0.224	1.736	NF	0.390	1.900	NF	0.012	1.300	NF	0.018	1.660	NF
06/27/00	4	0.069	0.073	NF	0.147	0.035	NF	0.144	1.121	NF	0.360	1.220	NF	0.005	0.974	NF	0.055	1.288	NF
07/05/00	5	0.023	0.101	NF	0.062	0.017	NF	-0.025	0.982	NF	*0.060*	1.100	NF	*0.005*	1.200	NF	0.019	1.510	NF
07/06/00	6	0.204	0.089	NF	0.514	0.022	NF	0.482	0.409	NF	1.200	0.520	NF	0.018	1.200	NF	0.068	1.580	NF
07/09/00	7	0.062	0.031	0.020	0.440	0.027	0.033	na	0.682	1.447	na	0.740	1.500	0.010	0.679	0.601	0.014	0.910	0.845
07/10/00	8	0.410	0.178	0.084	0.374	0.295	0.020	0.316	2.227	1.343	1.100	2.700	1.450	0.005	0.999	0.394	0.024	2.640	0.686
07/16/00	9	0.048	0.119	0.014	0.125	0.097	*0.005*	0.037	1.384	1.581	0.210	1.600	1.600	0.010	0.464	0.389	0.013	2.250	0.507
07/31/00	10	0.134	0.625	0.065	0.261	0.567	*0.029*	0.065	1.108	0.816	0.460	2.300	0.910	0.011	0.944	0.538	0.015	1.210	0.606
08/04/00	11	0.153	0.093	0.059	0.557	0.031	*0.005*	na	1.676	1.236	na	1.800	1.300	*0.005*	0.964	0.612	0.010	1.170	0.702
08/12/00	11	na	0.144	0.072	na	1.42	*0.005*	na	1.136	1.623	na	2.700	1.700	na	0.721	0.300	na	1.010	0.431
08/15/00	12	na	0.156	0.056	na	0.531	0.009	na	1.513	1.725	na	2.200	1.790	na	0.823	0.449	na	1.310	0.762
08/23/00	13	0.020	0.006	0.234	0.005	0.528	0.464	0.495	1.367	2.558	0.520	1.900	3.030	0.005	0.749	0.335	0.014	0.988	0.067
08/27/00	14	0.075	0.135	0.121	0.381	0.964	0.005	0.544	1.601	4.727	1.000	2.700	4.850	0.005	0.819	0.314	0.022	1.180	0.925
09/07/00	16	0.044	0.086	0.156	0.090	1.050	0.005	0.196	1.764	3.139	0.330	2.900	3.300	0.005	0.580	0.333	0.010	1.300	0.694
09/08/00	17	0.032	0.118	0.049	0.240	0.371	0.005	0.178	2.311	1.687	0.450	2.800	1.750	0.005	0.649	0.183	0.005	1.320	0.429
09/17/00	18	0.021	0.331	0.060	0.027	2.113	0.03	0.032	0.056	1.590	0.080	2.500	1.680	0.005	1.199	0.440	0.020	1.507	0.570
09/28/00	19	0.092	0.133	0.060	0.247	0.792	0.041	0.131	1.775	1.899	0.470	2.700	2.000	0.01	0.618	0.332	*0.005*	1.650	0.611
10/06/00	20	0.057	0.154	0.261	0.172	0.864	*0.005*	1.271	1.582	2.734	1.500	2.600	3.000	0.005	0.741	0.509	0.005	1.610	1.400
11/26/00	21	0.025	0.017	0.123	0.046	0.211	0.026	0.169	3.572	3.629	0.240	3.800	3.778	0.005	0.625	0.235	0.005	2.010	1.068
12/17/00	22	0.044	0.016	0.041	0.058	0.193	0.020	0.348	1.291	2.139	0.450	1.500	2.200	0.005	0.558	0.285	0.005	0.982	0.628
No. Obs.		**21**	**23**	**17**	**28**	**23**	**17**	**26**	**23**	**17**	**26**	**23**	**17**	**28**	**23**	**17**	**28**	**23**	**17**
Mean		**0.092**	**0.170**	**0.090**	**0.204**	**0.466**	**0.045**	**0.254**	**1.624**	**2.101**	**0.517**	**2.260**	**2.223**	**0.007**	**0.794**	**0.384**	**0.018**	**1.401**	**0.676**
Median		**0.057**	**0.119**	**0.067**	**0.172**	**0.295**	**0.026**	**0.178**	**1.582**	**1.687**	**0.429**	**2.500**	**1.790**	**0.005**	**0.749**	**0.335**	**0.014**	**1.310**	**0.628**
max		**0.410**	**0.943**	**0.261**	**0.557**	**2.113**	**0.464**	**1.271**	**4.366**	**4.727**	**1.500**	**4.448**	**4.850**	**0.018**	**1.300**	**0.612**	**0.068**	**2.640**	**1.400**
min		**0.005**	**0.006**	**0.014**	**0.005**	**0.005**	**0.005**	**-0.224**	**0.056**	**0.816**	**0.060**	**0.520**	**0.910**	**0.005**	**0.294**	**0.183**	**0.005**	**0.868**	**0.067**
Std.Dev.		**0.100**	**0.207**	**0.067**	**0.167**	**0.525**	**0.106**	**0.302**	**0.898**	**0.955**	**0.383**	**0.896**	**0.998**	**0.004**	**0.262**	**0.121**	**0.015**	**0.433**	**0.280**
C.V.		**1.088**	**1.217**	**0.748**	**0.822**	**1.127**	**2.375**	**1.192**	**0.553**	**0.454**	**0.741**	**0.397**	**0.449**	**0.504**	**0.330**	**0.316**	**0.876**	**0.309**	**0.415**
AVERAGE REDUCTION (INCREASE) IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (																			
				47.0			**90.4**			**-29.3**			**1.6**			**51.7**			**51.8**

Appendix D-1. Concentrations of nutrients in rainfall, at the inflowand at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Detection limit for inorganic nitrogen and phosphorus is 0.01 mg/L and for organic nitrogen 0.1 mg/L Abbreviations: NA=Data not available, NF=No Flow

YEAR FOUR (2001) - WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Ammonia Lab detection limit 0.01 mg/L as N			Nitrate+Nitrite Lab detection limit 0.01 mg/L as N			Organic Nitrogen Lab detection limit 0.06 mg/L as N			Total Nitrogen Lab detection limit 0.06 mg/L as N			Ortho-Phosphorus Lab detection limit 0.01 mg/L as P			Total Phosphorus Lab detection limit 0.01 mg/L as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
03/04/01	1	0.326	0.534	0.011	0.152	2.090	*0.005*	0.922	2.676	1.184	1.400	5.300	1.200	0.023	0.481	0.407	0.032	0.769	0.476
03/29/01	2	0.239	0.197	0.036	0.144	4.190	0.672	0.067	2.213	1.727	0.450	6.600	2.435	*0.005*	0.919	0.326	0.011	1.650	0.538
06/23/01	3	0.060	0.032	0.453	0.304	*0.005*	0.083	0.116	4.363	2.305	0.480	4.400	2.841	*0.005*	2.170	1.420	*0.005*	5.170	1.733
06/30/01	4	0.087	0.126	0.022	0.266	0.044	*0.005*	0.117	3.230	1.373	0.470	3.400	1.400	*0.005*	1.020	0.870	0.010	na	1.200
07/04/01	5	na	0.630	0.014	na	0.017	*0.005*	na	1.753	1.281	na	2.400	1.300	na	2.040	0.745	na	2.700	0.943
07/16/01	6	0.143	0.054	0.186	0.354	*0.005*	*0.005*	0.073	2.001	1.689	0.570	2.060	1.880	*0.005*	0.849	2.140	0.006	0.984	2.370
07/21/01	7	0.121	0.099	0.032	0.203	*0.005*	*0.005*	0.836	1.696	1.603	1.160	1.800	1.640	*0.005*	2.290	1.030	0.019	2.580	1.170
07/23/01	8	0.019	0.058	0.086	0.026	*0.005*	0.005	0.005	1.287	1.082	0.050	1.350	1.173	*0.005*	0.697	0.592	0.010	1.210	0.787
07/26/01	9	0.085	0.180	0.044	0.173	*0.005*	0.012	0.000	1.165	1.065	0.190	1.350	1.122	*0.005*	1.520	0.851	0.021	1.850	0.934
08/05/01	10	0.135	0.046	0.067	0.101	*0.005*	*0.005*	0.234	1.739	2.848	0.470	1.790	2.920	*0.005*	1.470	0.797	*0.005*	1.740	0.915
09/11/01	11	na	0.565	*0.005*	na	0.047	*0.005*	na	1.648	1.890	na	2.260	1.900	na	1.810	0.345	na	2.460	0.366
09/14/01	12	0.021	0.328	0.015	0.031	1.779	0.247	0.142	0.825	0.757	0.193	2.844	1.018	*0.005*	1.526	0.956	0.007	1.939	1.109
09/29/01	13	0.056	na	0.051	0.340	na	0.005	0.194	na	0.766	0.590	na	0.821	*0.005*	na	1.032	0.005	na	1.070
10/21/01	14	0.102	0.151	0.038	0.104	1.430	0.005	0.054	1.292	0.979	0.260	2.873	1.022	0.013	1.500	0.926	0.010	1.760	0.998
No. Obs.		**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**12**	**14**
Mean		**0.116**	**0.231**	**0.076**	**0.183**	**0.741**	**0.076**	**0.230**	**1.991**	**1.468**	**0.524**	**2.956**	**1.619**	**0.007**	**1.407**	**0.888**	**0.012**	**2.068**	**1.044**
Median		**0.095**	**0.151**	**0.037**	**0.163**	**0.017**	**0.005**	**0.117**	**1.739**	**1.327**	**0.470**	**2.400**	**1.350**	**0.005**	**1.500**	**0.861**	**0.010**	**1.805**	**0.971**
max		**0.326**	**0.630**	**0.453**	**0.354**	**4.190**	**0.672**	**0.922**	**4.363**	**2.848**	**1.400**	**6.600**	**2.920**	**0.023**	**2.290**	**2.140**	**0.032**	**5.170**	**2.370**
min		**0.019**	**0.032**	**0.005**	**0.026**	**0.005**	**0.005**	**0.000**	**0.825**	**0.757**	**0.050**	**1.350**	**0.821**	**0.005**	**0.481**	**0.326**	**0.005**	**0.769**	**0.366**
Std.Dev.		**0.085**	**0.205**	**0.114**	**0.108**	**1.241**	**0.177**	**0.298**	**0.921**	**0.573**	**0.377**	**1.532**	**0.661**	**0.005**	**0.556**	**0.452**	**0.008**	**1.098**	**0.495**
C.V.		**0.736**	**0.888**	**1.502**	**0.588**	**1.675**	**2.330**	**1.296**	**0.463**	**0.390**	**0.720**	**0.518**	**0.408**	**0.734**	**0.395**	**0.509**	**0.672**	**0.531**	**0.474**
		AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																	
				67.2%			**89.7%**			**26.3%**			**45.2%**			**36.9%**			**49.5%**
		INCLUDE RAINFALL AS AN INPUT IN CALCULATION																	
				78.2%			**91.8%**			**33.9%**			**53.5%**			**37.2%**			**49.8%**

Appendix D-2. Concentrations of metals in rainfall, at the inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Values in bold exceed State Water Quality Standards for Class II waters. Abbreviations: NA=no sample analyzed, NF=no flow therefore no sample collected.

Date of storm	Storm #	Aluminum ug/L Lab Detection Limit 5			Cadmium ug/L Lab Detection Limit 0.30			Chromium ug/L Lab Detection Limit 4.7		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/06/98	1	10.5	169	NF	0.15	0.36	NF	2.35	2.35	NF
01/15/98	2	71.9	8610	345	0.15	3.03	0.15	2.35	68.60	2.35
01/23/98	3	11.8	8340	537	0.15	3.01	0.15	2.35	135.00	6.23
02/15/98	5	120.0	7240	4540	0.15	1.5	0.15	2.35	69.80	6.2
02/17/98	6	46.3	21800	753	0.15	8.00	0.15	2.35	420.00	2.35
02/19/98	7	27.2	30000	1169	0.15	13.30	0.25	2.35	545.00	9.6
02/28/98	9	26.9	1963	1363	0.15	0.70	0.15	2.35	19.70	5.3
03/08/98	10	102.0	1370	NF	0.15	0.70	NF	2.35	16.80	NF
03/18/98	11	56.6	1220	793	0.15	0.15	0.15	2.35	11.60	2.35
04/20/98	12	125.0	160	NF	0.70	0.15	NF	2.35	2.35	NF
05/28/98	13	71.8	698	NF	0.40	0.30	NF	2.35	14.00	NF
05/30/98	14	NA	176	NF	NA	0.15	NF	NA	2.35	NF
06/23/98	15	528.0	455	NF	1.6	0.15	NF	2.35	2.35	NF
07/06/98	16	283.0	392	NF	1.1	0.15	NF	2.35	2.35	NF
07/10/98	17	381.0	322	NF	0.5	0.15	NF	2.35	2.35	NF
07/17/98	18	162.0	300	NF	0.4	0.15	NF	2.35	2.35	NF
07/21/98	19	207.0	272	NF	0.3	0.15	NF	2.35	2.35	NF
08/16/98	20	199.0	194	NF	0.15	0.15	NF	2.35	2.35	NF
08/17/98	21	335.0	313	NF	0.3	0.15	NF	2.35	2.35	NF
09/02/98	22	380.0	153	NF	0.15	0.15	NF	2.35	2.35	NF
09/06/98	23	240.0	1430	NF	0.15	0.40	NF	2.35	36.00	NF
09/18/98	24	181.0	432	NF	0.15	0.15	NF	2.35	7.30	NF
09/19/98	25	147.0	245	828	0.4	0.15	0.15	2.35	2.35	2.35
09/20/98	26	79.6	186	1360	0.15	0.15	0.15	2.35	2.35	5.6
12/13/98	27	231.0	414	NF	0.6	0.15	NF	2.35	2.35	NF
No. Obs.		**24**	**25**	**9**	**24**	**25**	**9**	**24**	**25**	**9**
Mean		**168**	**3474**	**1299**	**0.35**	**1.34**	**0.16**	**2.35**	**55.07**	**4.70**
Median		**231**	**307**	**1094**	**0.30**	**0.15**	**0.15**	**2.35**	**2.35**	**3.98**
max		**528**	**30000**	**4540**	**1.60**	**13.30**	**0.25**	**2.35**	**545.00**	**9.60**
min		**11**	**153**	**345**	**0.15**	**0.15**	**0.15**	**2.35**	**2.35**	**2.35**
Std.Dev.		**133**	**7157**	**1192**	**0.35**	**2.95**	**0.03**		**130.82**	**2.40**
C.V.		**0.793**	**2.060**	**0.918**	**0.994**	**2.201**	**0.201**		**2.376**	**0.510**
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)				**62.6**			**88.0**			**91.5**

Date of storm	Storm #	Copper ug/L Lab Detection Limit 1.0			Iron ug/L Lab Detection Limit 30.0			Lead ug/L Lab Detection Limit 2.0		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/06/98	1	0.5	16.6	NF	15	333	NF	1.0	1.0	NF
01/15/98	2	0.5	168.0	7.2	15	3710	134	1.0	9.2	1.0
01/23/98	3	0.5	291.0	28.5	15	5850	154	1.0	36.0	1.0
02/15/98	5	0.5	120	22.4	15	3030	810	1.0	17.3	3.1
02/17/98	6	1.1	712.0	19.2	15	14200	700	1.0	128.0	1.0
02/19/98	7	0.5	1100.0	32.7	15	21500	639	1.0	178.0	3.5
02/28/98	9	0.5	54.1	13.1	15	1220	470	1.0	7.7	2.0
03/08/98	10	8.5	44.1	NF	40	800	NF	1.0	4.9	NF
03/18/98	11	7.1	54.4	14.4	60	540	300	1.0	3.3	1.0
04/20/98	12	3.9	9.0	NF	15	70	NF	1.0	1.0	NF
05/28/98	13	0.5	129.0	NF	15	580	NF	1.0	4.2	NF
05/30/98	14	NA	24.4	NF	NA	130	NF	NA	1.0	NF
06/23/98	15	16	11.2	NF	280	210	NF	1.0	1.0	NF
07/06/98	16	11.9	19.0	NF	30	210	NF	1.0	1.0	NF
07/10/98	17	10.5	5.9	NF	50	190	NF	1.0	1.0	NF
07/17/98	18	8.8	15.4	NF	60	280	NF	1.0	1.0	NF
07/21/98	19	5.4	7.8	NF	40	150	NF	1.0	1.0	NF
08/16/98	20	0.5	3.0	NF	15	110	NF	1.0	1.0	NF
08/17/98	21	3.2	19.1	NF	15	290	NF	1.0	2.8	NF
09/02/98	22	4.8	6.8	NF	15	70	NF	1.0	1.0	NF
09/06/98	23	3.1	55.4	NF	15	1090	NF	1.0	8.5	NF
09/18/98	24	1.3	15.3	NF	15	350	NF	1.0	1.0	NF
09/19/98	25	1.1	20.4	4.4	15	210	370	1.0	1.0	1.0
09/20/98	26	2.1	29.0	9.2	15	280	670	1.0	1.0	1.0
12/13/98	27	2.2	5.2	NF	15	210	NF	1.0	1.0	NF
No. Obs.		**24**	**25**	**9**	**24**	**25**	**9**	**24**	**25**	**9**
Mean		**4**	**117**	**17**	**34**	**2225**	**472**	**1.0**	**16.6**	**1.6**
Median		**3**	**15**	**7**	**15**	**210**	**520**	**1.0**	**1.0**	**1.0**
max		**16**	**1100**	**33**	**280**	**21500**	**810**	**1.0**	**178.0**	**3.5**
min		**1**	**3**	**4**	**15**	**70**	**134**	**1.0**	**1.0**	**1.0**
Std.Dev.		**4**	**247**	**9**	**53**	**4907**	**233**	**0.0**	**41.5**	**0.9**
C.V.		**1.075**	**2.107**	**0.543**	**1.571**	**2.206**	**0.494**	**0.000**	**2.508**	**0.584**
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)				**85.7**			**78.8**			**90.2**

TABLE D-2 (CONTINUED)
YEAR TWO

Date of storm	Storm #	Aluminum ug/L Lab Detection Limit 5			Cadmium ug/L Lab Detection Limit 0.30			Chromium ug/L Lab Detection Limit 4.7			Copper ug/L Lab Detection Limit 1.0			Iron ug/L Lab Detection Limit 30.0			Lead ug/L Lab Detection Limit 2.0		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/02/99	1	69.5	354	NF	0.15	0.15	NF	2.35	2.35	NF	0.5	6.5	NF	15	150	NF	1.0	1.0	NF
01/25/99	2	86.5	178	384	0.15	0.15	0.15	2.35	2.35	8.6	2.1	15.4	1.2	15	130	200	1.0	1.0	1.0
03/14/99	3	109.0	275	2980	0.15	0.15	0.15	2.35	2.35	35.2	0.5	4.2	6.0	15	80	1350	1.0	1.0	3.8
04/30/99	4	185.0	725	NF	0.15	0.15	NF	2.35	2.35	NF	0.5	8.1	NF	30	350	NF	1.0	1.0	NF
05/30/99	5	NA	503	NF	NA	*0.15*	NF	NA	*2.35*	NF	NA	2.4	NF	NA	190	NF	NA	*1.0*	NF
06/02/99	6	213.0	463	NF	*0.15*	*0.15*	NF	*2.35*	*2.35*	NF	*0.5*	1.2	NF	50	260	NF	*1.0*	*1.0*	NF
06/06/99	7	224.0	435	NF	0.30	*0.15*	NF	*2.35*	*2.35*	NF	*0.1*	*0.5*	NF	35	260	NF	*1.0*	*1.0*	NF
06/16/99	8	95.0	381	NF	*0.15*	*0.15*	NF	0.8	1.9	NF	2.7	5.0	NF	30	170	NF	*1.0*	*1.0*	NF
07/01/99	9	128.0	219	NF	*0.15*	*0.15*	NF	0.6	1.2	NF	3.3	2.7	NF	40	110	NF	*1.0*	*1.0*	NF
07/02/99	10	111.0	149	NF	*0.15*	*0.15*	NF	0.5	1.9	NF	*1.0*	7.2	NF	60	140	NF	*0.8*	*0.8*	NF
07/09/99	11	82.8	275	NF	*0.15*	*0.15*	NF	*1.0*	*1.0*	NF	2.8	2.2	NF	30	150	NF	*0.8*	*0.8*	NF
07/26/99	12	479.0	118	NF	*0.15*	*0.15*	NF	*1.0*	*1.0*	NF	3.8	4.9	NF	230	130	NF	*0.8*	*0.8*	NF
08/06/99	13	62.3	118	NF	0.50	0.70	NF	*1.0*	*1.0*	NF	*1.0*	*1.0*	NF	40	330	NF	*0.8*	*0.8*	NF
08/12/99	14	141.0	88.2	133	*0.15*	*0.15*	*0.15*	*1.0*	*1.0*	*1.0*	*1.0*	2.8	*1.0*	*12.5*	90	110	*0.8*	*0.8*	*0.75*
08/14/99	15	43.8	115	143	*0.15*	*0.15*	*0.15*	*1.0*	*1.0*	*1.0*	2.3	3.1	2.9	*12.5*	150	120	*0.8*	*0.8*	*0.75*
08/16/99	16	115.0	161	223	*0.15*	*0.15*	*0.15*	*1.0*	*1.0*	*1.0*	*1.0*	4.6	*1.0*	*12.5*	210	150	*0.8*	*0.8*	*0.75*
08/18/99	17	67.5	182	1190	*0.15*	*0.15*	*0.15*	*0.2*	2.8	7.6	*1.0*	7.6	1.9	*12.5*	290	560	*0.8*	*0.8*	1.8
08/22/99	18	55.1	86.1	559	*0.15*	*0.15*	*0.15*	1.0	1.0	2.1	1.0	3.9	3.5	30	190	304	*0.8*	*0.8*	*0.769*
08/28/99	19	41.3	103	783	*0.15*	*0.15*	*0.15*	*1.0*	*1.0*	3.9	*1.0*	2.6	2.3	*12.5*	180	350	*0.8*	*0.8*	1.7
09/06/99	20	37.2	144	929	*0.15*	0.30	*0.15*	*1.0*	*1.0*	3.5	1.0	2.5	*1.0*	*12.5*	180	510	*0.8*	*0.8*	*0.75*
09/11/99	21	79.3	95	641	*0.15*	*0.15*	*0.15*	*1.0*	*1.0*	2.1	2.1	4.8	2.9	30	150	340	*0.8*	*0.8*	*0.75*
09/19/99	22	105.0	172	1920	0.30	*0.15*	*0.15*	0.6	2.2	5.0	*1.0*	2.5	3.3	30	290	815	*0.8*	*0.8*	2
10/04/99	23	133.1	1520	958	0.3	0.3	0.15	1.0	16.5	6.1	1.0	52.7	4.1	36.5	950	307.5	0.75	5.2	0.9
10/11/99	IRW	NA	NA	3254	NA	NA	0.15	NA	NA	8.0	NA	NA	6.4	NA	NA	1211	NA	NA	3.4
11/01/99	24	38.8	583	948	0.15	0.15	0.15	1.0	8.5	3.2	1.0	24.8	3.1	40	660	355	0.75	1.9	1.0
11/15/99	IRW	NA	NA	2917	NA	NA	0.15	NA	NA	8.0	NA	NA	4.2	NA	NA	1056	NA	NA	2.7
11/22/99	25	461	605	3390	0.15	0.15	0.15	1.0	5.1	9.3	4.5	32.9	9.1	40	350	1270	0.75	0.75	3.7
12/17/99	26	374	NA	1731	0.3	NA	0.15	1.0	NA	4.8	1.0	NA	7.4	50	NA	643	0.75	NA	1.8
No. Obs.		**25**	**25**	**17**	**25**	**25**	**17**	**25**	**24**	**17**	**25**	**25**	**17**	**25**	**25**	**17**	**25**	**25**	**17**
Mean		**141**	**322**	**1358**	**0.19**	**0.18**	**0.15**	**1.23**	**2.42**	**6.49**	**1.51**	**8.24**	**3.61**	**37**	**246**	**568**	**0.83**	**1.07**	**1.67**
Median		**105**	**182**	**948**	**0.15**	**0.15**	**0.15**	**1.00**	**1.90**	**4.80**	**1.00**	**4.20**	**3.10**	**30**	**180**	**355**	**0.75**	**0.80**	**1.00**
max		**479**	**1520**	**3390**	**0.50**	**0.70**	**0.15**	**2.35**	**16.50**	**35.20**	**4.50**	**52.70**	**9.10**	**230**	**950**	**1350**	**1.00**	**5.20**	**3.80**
min		**37**	**86**	**133**	**0.15**	**0.15**	**0.15**	**0.20**	**1.00**	**1.00**	**0.05**	**0.50**	**1.00**	**13**	**80**	**110**	**0.75**	**0.75**	**0.75**
Std.Dev.		**121**	**304**	**1098**	**0.08**	**0.11**	**0.00**	**0.66**	**3.08**	**7.68**	**1.12**	**11.69**	**2.31**	**42**	**186**	**408**	**0.12**	**0.88**	**1.07**
C.V.		**0.86**	**0.95**	**0.81**	**0.45**	**0.61**	**0.00**	**0.53**	**1.27**	**1.18**	**0.74**	**1.42**	**0.64**	**1.13**	**0.76**	**0.72**	**0.14**	**0.82**	**0.64**
		AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																	
				-321.8			**18.5**			**-168.5**			**56.3**			**-131.2**			**-56.0**

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TABLE D-2 (CONTINUED)

YEAR THREE WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Aluminum ug/L Lab Detection Limit 5			Cadmium ug/L Lab Detection Limit 0.30			Chromium ug/L Lab Detection Limit 2			Copper ug/L Lab Detection Limit 1.0			Iron ug/L ab Detection Limit 30.			Lead ug/L Lab Detection Limit 1.5		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	NFLO	OUTFL	RAIN	INFLOW	OUTFL
02/14/00	0	47.5	387	3330	0.015	0.02	0.02	1.00	3.40	8.00	1.00	15.50	5.30	50	300	1250	0.75	0.75	3.00
03/28/00	1	101.0	1310	NF	0.15	0.15	NF	1.00	10.50	NF	1.00	14.70	NF	70	860	NF	0.75	2.30	NF
04/14/00	2	72.2	997	NF	0.15	0.40	NF	1.00	17.60	NF	1.00	43.60	NF	110	850	NF	0.75	5.30	NF
06/26/00	3	32.1	179	NF	0.15	0.15	NF	1.00	2.10	NF	1.00	7.30	NF	13	540	NF	0.75	0.75	NF
06/27/00	4	140.0	214	NF	0.15	0.15	NF	1.00	1.00	NF	1.00	14.30	NF	100	588	NF	0.75	0.75	NF
07/05/00	5	68.8	127	NF	0.15	0.15	NF	1.00	1.00	NF	1.00	1.00	NF	40	630	NF	0.75	0.75	NF
07/06/00	6	193.0	19200	NF	0.15	0.15	NF	1.00	2.00	NF	3.20	3.50	NF	60	640	NF	0.75	0.75	NF
07/09/00	7	92.2	298	228	0.15	0.15	0.15	1.00	1.00	1.00	1.00	34.30	4.70	13	300	80	0.75	0.75	2.30
07/10/00	8	79.3	3070	906	0.15	1.00	0.15	1.00	46.30	1.00	2.10	99.50	3.80	60	1880	360	0.75	15.30	1.63
07/16/00	9	50.1	3170	486	0.15	1.40	0.15	1.00	69.50	2.90	1.00	133.00	6.60	50	2480	270	0.75	21.30	0.75
07/31/00	10	161.0	253	89	0.15	0.15	0.15	1.00	4.80	1.00	5.20	18.20	1.00	100	270	60	0.75	1.50	0.75
08/04/00	11	91.4	71	88	0.15	0.15	0.15	1.00	10.40	1.00	4.10	4.40	1.00	110	190	60	0.75	0.75	0.75
08/15/00	12	158.0	1100	379	0.15	0.50	0.15	1.00	17.10	3.98	1.00	46.70	2.30	140	840	207	0.75	5.60	0.76
08/23/00	13	na	na	1010	0.15	0.15	0.15	na	na	8.80	2.70	23.20	9.40	70	310	690	0.75	0.75	2.80
08/27/00	14	169.0	649	2610	0.15	0.30	0.15	1.00	9.60	8.75	4.20	29.00	11.88	90	490	1165	0.75	3.10	5.10
09/07/00	16	29.6	1460	1730	0.15	0.60	0.15	1.00	25.70	4.40	3.50	69.90	6.40	40	900	570	0.75	6.30	1.90
09/08/00	17	31.9	1450	534	0.15	0.70	0.15	1.00	28.20	1.55	1.00	124.00	1.00	13	960	225	0.75	8.40	0.75
09/17/00	18	26.9	433	621	0.15	0.50	0.15	1.00	7.30	5.60	1.00	60.10	1.75	40	388	266	0.75	2.00	0.97
09/28/00	19	26.3	1810	1140	0.15	0.80	0.15	1.00	34.90	3.80	1.00	170.00	3.60	30	1340	530	0.75	12.40	0.75
10/06/00	20	22.7	1770	6920	0.15	0.60	0.15	1.00	28.20	16.00	1.00	189.00	19.90	50	1300	3480	0.75	8.40	5.90
11/26/00	21	20.7	3230	0	0.15	1.00	0.00	1.00	32.40	8.80	1.00	250.00	14.56	13	2660	1742	0.75	12.10	3.73
12/17/00	22	11.5	2530	3120	0.15	0.40	0.15	1.00	12.20	8.50	1.00	83.00	7.80	13	830	1150	0.75	4.00	3.40
No. Obs.		**21**	**21**	**16**	**22**	**22**	**16**	**21**	**21**	**16**	**22**	**22**	**16**	**22**	**22**	**16**	**22**	**22**	**16**
Mean		**77**	**2081**	**1449**	**0.14**	**0.43**	**0.13**	**1.00**	**17.39**	**5.32**	**1.8**	**65.2**	**6.3**	**58**	**888**	**757**	**0.75**	**5.18**	**2.20**
Median		**69**	**1100**	**764**	**0.15**	**0.35**	**0.15**	**1.00**	**10.50**	**4.19**	**1.0**	**39.0**	**5.0**	**50**	**735**	**445**	**0.75**	**2.70**	**1.76**
max		**193**	**3961**	**3120**	**0.15**	**22.00**	**69.60**	**1.00**	**21.00**	**72.18**	**5.2**	**83.0**	**90.4**	**140**	**888**	**1150**	**0.75**	**22.00**	**60.61**
min		**12**	**71**	**0**	**0.02**	**0.02**	**0.00**	**1.00**	**1.00**	**1.00**	**1.0**	**1.0**	**1.0**	**13**	**190**	**60**	**0.75**	**0.75**	**0.75**
Std.Dev.		**55**	**3961**	**1753**	**0.03**	**0.35**	**0.05**	**0.00**	**17.32**	**4.09**	**1.3**	**67.3**	**5.2**	**36**	**664**	**855**	**0.00**	**5.56**	**1.61**
C.V.		**0.71**	**1.90**	**1.21**	**0.20**	**0.82**	**0.36**	**0.00**	**1.00**	**0.77**	**0.72**	**1.03**	**0.83**	**0.63**	**0.75**	**1.13**	**0.00**	**1.07**	**0.73**
AVERAGE REDUCTION (INCREASE) IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																			
				30.4			**69.6**			**69.4**			**90.3**			**14.8**			**57.5**

Appendix D-2. Concentrations of metals in rainfall, at the inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Values in bold exceed State Water Quality Standards for Class II waters. Abbreviations: NA=no sample analyzed, NF=no flow therefore no sample collected.

YEAR FOUR (2001) - WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Aluminum ug/L Lab Detection Limit 5			Cadmium ug/L Lab Detection Limit 0.3			Chromium ug/L Lab Detection Limit 4.7			Copper ug/L Lab Detection Limit 15			Iron ug/L Lab Detection Limit 30.0			Lead ug/L Lab Detection Limit 1.5		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
03/04/01	1	64	1080	348	*0.15*	*0.15*	*0.15*	*1.00*	3.20	*1.00*	3.8	13.7	4.8	50	340	90	*0.75*	*0.75*	*0.75*
03/29/01	2	311	2490	1521	*0.15*	0.50	0.16	3.80	16.50	4.17	3.5	80.9	5.72	340	1570	501	1.70	7.40	1.49
06/23/01	3	85	12400	262	*0.15*	1.30	*0.15*	*1.00*	53.70	*1.00*	2.2	138.0	7.5	*13*	6580	150	*0.75*	14.30	*0.75*
06/30/01	4	81	5890	1130	*0.15*	0.90	*0.15*	*1.00*	30.10	*1.00*	*1.0*	102.0	*1.0*	40	3790	110	*0.75*	9.00	*0.75*
07/04/01	5	na	1290	14	na	*0.15*	*0.15*	na	8.30	*1.00*	na	17.3	1.2	na	1020	100	na	1.70	*0.75*
07/16/01	6	42	266	839	*0.15*	*0.15*	*0.15*	*1.00*	*1.00*	3.40	*1.0*	1.0	6.5	60	110	540	*0.75*	*0.75*	*0.75*
07/21/01	7	30	1040	1400	*0.15*	*0.15*	*0.15*	*1.00*	3.20	*1.00*	*1.0*	8.3	*1.0*	50	320	90	*0.75*	*0.75*	*0.75*
07/23/01	8	21	2410	390	0.15	0.40	*0.15*	*1.00*	12.40	*1.00*	*1.0*	37.4	*1.0*	30	1540	328	*0.75*	3.60	*0.75*
07/26/01	9	73	508	1142	*0.15*	*0.15*	*0.15*	*1.00*	3.90	*1.00*	1.0	12.3	0.7	70	480	116	*0.75*	*0.75*	*0.75*
08/05/01	10	53	191	140	*0.15*	*0.15*	*0.15*	*1.00*	3.40	*1.00*	*1.0*	10.8	*1.0*	30	330	70	*0.75*	*0.75*	*0.75*
09/11/01	11	na	917	115	na	*0.15*	*0.15*	na	5.50	*1.00*	na	23.9	2.3	na	810	120	na	1.90	*0.75*
09/14/01	12	37	432	170	*0.15*	*0.15*	*0.15*	*1.00*	6.41	*1.00*	*1.0*	54.4	20.6	*13*	156	94	*0.75*	2.80	*0.75*
09/29/01	13	48	na	57	*0.13*	na	*0.15*	*1.00*	na	*1.00*	*1.0*	na	1.8	*40*	na	89	*0.75*	na	*0.75*
10/21/01	14	35	297	107	*0.15*	*0.15*	*0.15*	*1.00*	4.40	*1.00*	*1.0*	36.2	5.41	*13*	310	87	*0.75*	1.60	*0.75*
No. Obs.		**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**
Mean		**73**	**2247**	**545**	**0.15**	**0.34**	**0.15**	**1.23**	**11.69**	**1.40**	**1.5**	**41.2**	**4.3**	**62**	**1335**	**178**	**0.83**	**3.54**	**0.80**
Median		**51**	**1040**	**305**	**0.15**	**0.15**	**0.15**	**1.00**	**5.50**	**1.00**	**1.0**	**23.9**	**2.1**	**40**	**480**	**105**	**0.75**	**1.70**	**0.75**
max		**311**	**12400**	**1521**	**0.15**	**1.30**	**0.16**	**3.80**	**53.70**	**4.17**	**3.8**	**138.0**	**20.6**	**340**	**6580**	**540**	**1.70**	**14.30**	**1.49**
min		**21**	**191**	**14**	**0.13**	**0.15**	**0.15**	**1.00**	**1.00**	**1.00**	**1.0**	**1.0**	**0.7**	**13**	**110**	**70**	**0.75**	**0.75**	**0.75**
Std.Dev.		**74**	**3284**	**522**	**0.01**	**0.35**	**0.00**	**0.77**	**14.27**	**0.99**	**1.0**	**40.1**	**5.1**	**86**	**1791**	**153**	**0.26**	**4.02**	**0.19**
C.V.		**1.01**	**1.46**	**0.96**	**0.04**	**1.02**	**0.02**	**0.63**	**1.22**	**0.70**	**0.65**	**0.97**	**1.17**	**1.375**	**1.342**	**0.861**	**0.32**	**1.13**	**0.24**
		AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																	
				75.7%			**55.9%**			**88.0%**			**89.5%**			**86.7%**			**77.3%**
		INCLUDE RAINFALL AS AN INPUT IN CALCULATION																	
				76.5%			**69.3%**			**89.2%**			**89.9%**			**87.3%**			**81.6%**

Appendix D-3. Concentrations of metals in rainfall, at yhe inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Values in bold exceed State Water Quality Standards for Class II waters. Abbreviations: NA=no sample analyzed, NF=no flow therefore no sample collected.

YEAR ONE

Date of storm	Storm #	Magnesium mg/L Lab Detection Limit			Manganese ug/L Lab Detection Limit			Nickel ug/L Lab Detection Limit 4.3			Silver ug/L Lab Detection Limit 0.1			Zinc ug/L Lab Detection Limit 30			TSS mg/L	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
01/06/98	1	0.12	30.0	NF	2.5	83.6	NF	2.15	2.15	NF	0.05	0.186	NF	15	15	NF	8.1	NF
01/15/98	2	0.04	22.9	20.8	1.6	351.0	28.5	2.15	8.47	2.15	0.05	0.859	0.05	57	164	15	148.0	13.5
01/23/98	3	0.07	8.2	31.7	2.1	449.0	21.7	2.15	13.5	3.47	0.05	1.15	0.05	15	232	15	208.3	9.5
02/15/98	5	0.10	18.3	21.0	0.6	239.0	38.2	2.15	6.9	2.15	0.05	0.6	0.05	50	160	15	143.0	30.0
02/17/98	6	0.21	6.0	21.8	0.3	1150.0	22.0	2.15	24.6	2.15	0.1	3	0.1	40	570	15	428.3	7.8
02/19/98	7	0.08	6.6	15.3	0.4	1570.0	52.8	2.15	33.1	2.15	0.097	4.5	0.141	29	820	34	2546	20.7
02/28/98	9	0.09	19.7	11.2	2.4	231.0	67.0	2.15	2.15	2.15	0.05	0.3	0.1	40	60	15	55.4	10.7
03/08/98	10	0.14	19.3	NF	7.4	245.0	NF	2.15	2.15	NF	0.2	0.2	NF	40	40	NF	41.2	NF
03/18/98	11	0.03	7.2	12.0	2.5	67.2	54.4	2.15	2.15	2.15	0.05	0.05	0.05	15	30	15	35.0	6.6
04/20/98	12	0.06	6.0	12.7	2.8	67.3	36.6	2.15	2.15	2.15	0.05	0.5	0.05	15	30	15	39.0	9.9
05/28/98	13	NA	29.6	NF	5.7	65.6	NF	2.15	2.15	NF	0.05	0.05	NF	15	15	NF	6.0	NF
05/30/98	14	0.20	30.7	NF	3.9	175.0	NF	2.15	2.15	NF	0.05	0.2	NF	60	40	NF	31.5	NF
06/23/98	15	NA	28.9	NF	13.3	47.7	NF	4.9	2.15	NF	0.05	0.05	NF	250	15	NF	12.7	NF
07/06/98	16	NA	27.7	NF	8.6	34.4	NF	2.15	2.15	NF	0.05	0.05	NF	320	15	NF	13.7	NF
07/10/98	17	0.07	28.1	NF	3.5	35.0	NF	2.15	2.15	NF	0.05	0.05	NF	100	15	NF	8.6	NF
07/17/98	18	0.04	30.0	NF	2.3	247.0	NF	2.15	2.15	NF	0.05	0.05	NF	100	15	NF	8.0	NF
07/21/98	19	NA	27.7	NF	4.5	33.8	NF	2.15	2.15	NF	0.05	0.05	NF	90	40	NF	9.9	NF
08/16/98	20	0.11	28.6	NF	1.8	45.1	NF	2.15	2.15	NF	0.05	0.05	NF	100	15	NF	12.2	NF
08/17/98	21	0.14	20.8	NF	2.2	90.5	NF	7.8	2.15	NF	0.05	0.05	NF	150	30	NF	16.0	NF
09/02/98	22	0.46	30.3	NF	4.0	14.3	NF	2.15	2.15	NF	0.05	0.05	NF	120	15	NF	7.7	NF
09/06/98	23	0.07	14.2	NF	1.7	349.0	NF	2.15	2.15	NF	0.05	0.4	NF	15	70	NF	68.0	NF
09/18/98	24	0.07	29.1	NF	0.8	287.0	NF	2.15	2.15	NF	0.05	0.05	NF	15	15	NF	12.5	NF
09/19/98	25	0.02	19.9	175.0	0.8	289.0	95.6	2.15	2.15	2.15	0.05	0.05	0.05	15	15	15	3.4	19.5
09/20/98	26	0.05	26.9	130.0	1.4	142.0	120.0	2.15	2.15	2.15	0.05	0.1	0.05	30	15	15	5.8	75.0
12/13/98	27	0.13	39.4	NF	2.3	62.6	NF	2.15	2.15	NF	0.05	0.05	NF	40	15	NF	14.0	NF
No. Obs.		21	25	10	25	25	10	25	25	10	25	25	10	25	25	10	25	10
Mean		0.1	22.2	45.1	3.2	254.8	53.7	2.5	5.2	2.3	0.1	0.5	0.1	69.4	98.6	16.9	155	20
Median		0.1	28.6	152.5	2.3	65.6	107.8	2.2	2.2	2.2	0.1	0.1	0.1	90.0	15.0	15.0	12	47
max		0.5	39.4	175.0	13.3	1570.0	120.0	7.8	33.1	3.5	0.2	4.5	0.1	320.0	820.0	34.1	2546	75
min		0.0	6.0	11.2	0.3	14.3	21.7	2.2	2.2	2.2	0.1	0.1	0.1	15.0	15.0	15.0	3	7
Std.Dev.		0.1	9.3	54.9	2.9	352.1	30.9	1.2	7.5	0.4	0.0	1.0	0.0	74.5	187.5	5.7	497	19
C.V.		0.85	0.42	1.22	0.91	1.38	0.58	0.49	1.46	0.17	0.53	2.01	0.45	1.07	1.90	0.34	3.20	0.96
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)			-103.0			78.9			56.0			86.3				82.9		86.9

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TABLE D-3 (CONTINUED)
YEAR TWO

Date of storm	Storm #	Magnesium mg/L Lab Detection Limit RAIN	INFLOW	OUTFL	Manganese ug/L Lab Detection Limit RAIN	INFLOW	OUTFL	Nickel ug/L Lab Detection Limit 4.3 RAIN	INFLOW	OUTFL	Silver ug/L Lab Detection Limit 0.1 RAIN	INFLOW	OUTFL	Zinc ug/L Lab Detection Limit 30 RAIN	INFLOW	OUTFL	TSS mg/L INFLOW	OUTFL
01/02/99	1	0.10	39.8	*NF*	*0.8*	35.0	*NF*	*2.15*	*2.15*	*NF*	*0.05*	*0.05*	*NF*	*15*	*15*	*NF*	*6*	*NF*
01/25/99	2	1.71	32.4	*169.0*	*3.0*	51.7	*41.1*	*2.15*	*2.15*	*5.6*	*0.05*	*0.05*	*0.05*	*70*	*15*	*15*	*3*	*7*
03/14/99	3	0.30	46.3	*146.0*	*1.7*	24.6	*73.9*	*2.15*	*2.15*	*18.3*	*0.05*	*0.05*	*0.05*	*40*	*15*	*15*	*3*	*31*
04/30/99	4	0.09	52.6	*NF*	*1.5*	102.0	*NF*	*2.15*	*2.15*	*NF*	*0.05*	0.13	*NF*	*40*	*15*	*NF*	*15*	*NF*
05/30/99	5	NA	50.9	NF	NA	49.3	NF	NA	*2.15*	NF	NA	*0.05*	NF	NA	*15*	NF	20	NF
06/02/99	6	0.21	52.4	NF	6.0	38.9	NF	*2.15*	*2.15*	NF	*0.05*	*0.05*	NF	60	*15*	NF	19	NF
06/06/99	7	0.15	54.3	NF	2.6	53.8	NF	*2.15*	*2.15*	NF	*0.05*	*0.05*	NF	260	*15*	NF	16	NF
06/16/99	8	NA	54.1	NF	1.8	50.7	NF	*2.15*	*2.15*	NF	*0.05*	*0.05*	NF	*15*	*15*	NF	13	NF
07/01/99	9	0.06	50.8	NF	3.1	52.3	NF	*2.15*	*2.15*	NF	*0.05*	*0.05*	NF	70	*15*	NF	9	NF
07/02/99	10	0.08	45.1	NF	3.5	182.0	NF	*2.15*	*2.15*	NF	*0.05*	*0.05*	NF	40	20	NF	6	NF
07/09/99	11	0.48	50.5	NF	3.5	123.0	NF	*2.15*	2.70	NF	*0.05*	*0.05*	NF	40	20	NF	13	NF
07/26/99	12	0.33	46.1	NF	2.0	561.0	NF	*1.25*	3.30	NF	0.10	*0.05*	NF	20	*8*	NF	8	NF
08/06/99	13	0.31	49.3	NF	*0.5*	480.0	NF	*1.25*	3.10	NF	*0.05*	*0.05*	NF	20	*8*	NF	6	NF
08/12/99	14	0.30	33.7	89.7	2.3	363.0	89.5	*1.25*	3.20	*1.25*	*0.05*	*0.05*	*0.05*	100	*8*	*8*	6	8
08/14/99	15	0.11	31.6	84.6	1.4	408.0	72.5	*1.25*	*1.25*	*1.25*	*0.05*	*0.05*	*0.05*	30	*8*	*8*	8	7
08/16/99	16	0.37	35.6	112.0	1.4	254.0	72.7	*1.25*	2.70	*1.25*	*0.05*	*0.05*	*0.05*	20	*8*	*8*	NA	7
08/18/99	17	0.19	30.0	94.5	*0.5*	158.0	256.0	*1.25*	*1.25*	4.80	*0.05*	*0.05*	*0.05*	20	*8*	20	NA	22
08/22/99	18	0.22	42.0	93.8	*0.5*	160.0	90.2	*1.25*	*1.25*	*1.25*	*0.05*	*0.05*	*0.05*	20	*8*	20	5	15
08/28/99	19	0.35	40.0	72.1	1.0	207.0	120.0	*1.25*	*1.25*	*1.25*	*0.05*	0.3	*0.05*	40	*8*	*8*	4	16
09/06/99	20	0.57	44.6	399.0	*0.5*	173.0	203.0	*1.25*	*1.25*	*1.25*	*0.05*	*0.05*	*0.05*	50	*8*	20	6	34
09/11/99	21	NA	41.6	194.0	1.2	135.0	108.0	*1.25*	*1.25*	*1.25*	*0.05*	*0.05*	*0.05*	*8*	*8*	*8*	6	17
09/19/99	22	0.22	37.8	223.8	1.3	209.0	119.7	*1.25*	2.70	2.30	0.08	*0.05*	*0.05*	40	*8*	20	9	100
10/04/99	23	0.28	18.9	48.7	2.0	183.0	25.6	1.25	1.25	1.25	0.05	0.1	0.05	12	30	8	31	16
10/11/99	IRW	NA	NA	45.6	NA	NA	98.3	NA	NA	1.25	NA	NA	0.05	NA	NA	16	NA	72
11/01/99	24	0.31	9.18	47	1.6	128.0	22.5	1.25	1.25	1.25	0.05	0.1	0.05	40	30	30	21	22
11/15/99	IRW	NA	NA	50.6	NA	NA	50.1	NA	NA	3.30	NA	NA	0.1	NA	NA	30	NA	117
11/22/99	25	NA	42.0	46.4	4.2	192.0	40.2	1.25	3.80	3.30	0.05	0.05	0.05	50	20	40	15	66
12/17/99	26	0.16	NA	48	1.3	NA	16.4	1.25	NA	1.25	0.05	NA	0.1	20	NA	16	NA	36
No. Obs.		**22**	**25**	**17**	**25**	**25**	**17**	**25**	**25**	**17**	**25**	**25**	**17**	**24**	**24**	**16**	**23**	**17**
Mean		**0.31**	**41**	**116**	**2.0**	**175.0**	**88.2**	**1.61**	**2.12**	**3.02**	**0.05**	**0.07**	**0.06**	**46**	**13**	**16**	**10.8**	**34.9**
Median		**0.25**	**42**	**90**	**1.6**	**158.0**	**73.9**	**1.25**	**2.15**	**1.25**	**0.05**	**0.05**	**0.05**	**40**	**15**	**15**	**8.1**	**22.0**
max		**1.71**	**54**	**399**	**6.0**	**561.0**	**256.0**	**2.15**	**3.80**	**18.30**	**0.10**	**0.30**	**0.10**	**260**	**30**	**40**	**31.5**	**116.6**
min		**0.06**	**9**	**46**	**0.5**	**24.6**	**16.4**	**1.25**	**1.25**	**1.25**	**0.05**	**0.05**	**0.05**	**8**	**8**	**8**	**2.8**	**6.6**
Std.Dev.		**0.33**	**11**	**89**	**1.3**	**140.0**	**61.3**	**0.44**	**0.73**	**4.05**	**0.01**	**0.05**	**0.02**	**50**	**6**	**9**	**6.9**	**32.6**
C.V.		**1.05**	**0.26**	**0.77**	**0.66**	**0.80**	**0.69**	**0.27**	**0.35**	**1.34**	**0.21**	**0.77**	**0.29**	**1.08**	**0.45**	**0.55**	**0.6**	**0.9**
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)				**-180.1**			**49.6**			**-42.5**			**16.8**			**-25.2**		**-222.1**

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TABLE C-3(CONTINUED)

YEAR THREE

Date of storm	Storm #	Magnesium mg/L Lab Detection Limit			Manganese ug/L Lab Detection Limit			Nickel ug/L Lab Detection Limit 2.5			Silver ug/L Lab Detection Limit 0.1			Zinc ug/L Lab Detection Limit 30			TSS ug/L	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
02/14/00	0	na	48.4	48.5	2.5	142.0	28.2	1.25	1.25	1.25	0.05	0.05	0.05	50.0	20.0	20.0	42.3	118.0
03/28/00	1	na	56.2	NF	2.4	212.0	NF	1.25	2.50	NF	0.05	0.10	NF	40.0	20.0	NF	74.2	NF
04/14/00	2	na	35.5	NF	0.50	211.0	NF	1.25	2.80	NF	0.10	0.20	NF	20.0	30.0	NF	na	NF
06/26/00	3	0.00	49.1	NF	1.2	632.0	NF	1.25	1.25	NF	0.05	0.05	NF	7.5	7.5	NF	14.0	NF
06/27/00	4	0.03	40.7	NF	2.6	319.8	NF	1.25	1.25	NF	0.05	0.05	NF	7.5	7.5	NF	7.1	NF
07/05/00	5	0.01	46.6	NF	1.2	284.0	NF	1.25	1.25	NF	0.05	0.05	NF	20.0	7.5	NF	13.6	NF
07/06/00	6	0.00	46.7	NF	1.6	242.0	NF	3.3	1.25	NF	0.05	0.05	NF	30.0	8.0	NF	12.2	NF
07/09/00	7	na	48.6	58.0	2.8	139.0	100.0	1.25	1.25	1.25	0.05	0.05	0.05	80.0	8.0	7.5	9.0	6.7
07/10/00	8	0.00	11.6	41.7	1.1	295.0	111.5	1.25	4.70	1.25	0.05	0.50	0.05	7.5	70.0	7.5	97.1	17.1
07/16/00	9	0.11	15.3	54.6	1.3	286.0	130.0	1.25	6.00	3.50	0.05	0.70	0.05	40.0	120.0	7.5	220.5	11.4
07/31/00		0.00	38.3	34.5	2.6	211.0	61.9	10	1.25	5.20	0.05	0.05	0.05	50.0	20.0	20.0	15.7	1.4
08/04/00	10	na	36.7	32.9	2.9	158.0	69.7	1.25	2.50	1.25	0.10	0.10	0.10	7.5	7.5	7.5	11.4	1.3
08/12/00	11	na	37.8	na	na	118.0	na	na	1.25	na	na	0.20	na	na	30.0	na	25.8	na
08/15/00	12	na	35.5	35.9	5.2	216.0	41.4	1.25	2.60	1.25	0.05	0.30	0.05	20.0	40.0	11.1	34.9	22.1
08/23/00	13	0.12	37.0	35.4	2.8	164.0	86.3	na	na	1.25	na	na	0.10	30.0	30.0	35.0	15.8	85.4
08/27/00	14	0.00	35.4	36.8	3.1	169.0	70.0	1.25	2.50	3.10	0.10	0.20	0.10	40.0	30.0	47.5	24.9	102.0
09/07/00	16	na	34.4	35.0	1.8	206.0	132.0	1.25	5.50	1.25	0.05	0.30	0.05	20.0	50.0	30.0	48.2	54.7
09/08/00	17	0.00	18.3	34.5	0.50	172.0	58.3	1.25	3.90	1.25	0.05	0.30	0.05	20.0	60.0	7.5	51.2	20.1
09/17/00	18	0.00	28.2	33.7	1.1	98.5	13.1	1.25	3.00	1.44	0.05	0.20	0.06	7.5	22.9	10.1	13.0	33.0
09/28/00	19	0.05	14.8	62.4	0.50	201.0	107.0	1.25	2.80	1.25	0.05	0.40	0.05	20.0	70.0	20.0	76.6	38.6
10/06/00	20	0.03	29.3	81.0	1.2	265.0	243.0	1.25	3.50	4.70	0.05	0.10	0.05	30.0	50.0	50.0	62.9	176.0
11/26/00	21	0.03	33.3	79.3	0.5	462.0	32.9	1.25	4.10	3.90	0.05	0.50	0.10	30.0	90.0	50.0	26.3	100.1
12/17/00	22	0.14	47.5	72.2	1.0	129.0	32.1	1.25	3.60	5.30	0.05	0.10	0.05	20.0	40.0	30.0	39.3	90.2
No. Obs.		**15**	**23**	**16**	**22**	**23**	**16**	**21**	**22**	**16**	**21**	**22**	**16**	**22**	**23**	**16**	**22**	**16**
Mean		**0.03**	**35.9**	**48.5**	**1.84**	**231.8**	**82.3**	**1.76**	**2.7**	**2.4**	**0.06**	**0.2**	**0.1**	**27**	**36**	**23**	**43**	**55**
Median		**0.01**	**36.7**	**39.3**	**1.45**	**211.0**	**69.9**	**1.25**	**2.6**	**1.3**	**0.05**	**0.2**	**0.1**	**20**	**30**	**20**	**26**	**36**
max		**0.14**	**56.2**	**81.0**	**5.20**	**632.0**	**243.0**	**10.00**	**6.0**	**5.3**	**0.10**	**0.7**	**0.1**	**80**	**120**	**50**	**220**	**176**
min		**0.00**	**11.6**	**32.9**	**0.50**	**98.5**	**13.1**	**1.25**	**1.3**	**1.3**	**0.05**	**0.1**	**0.1**	**8**	**8**	**8**	**7**	**1**
Std.Dev.		**0.05**	**11.8**	**16.7**	**1.13**	**116.2**	**54.8**	**1.89**	**1.4**	**1.5**	**0.02**	**0.2**	**0.0**	**17**	**29**	**15**	**46**	**50**
C.V.		**1.36**	**0.33**	**0.34**	**0.62**	**0.50**	**0.67**	**1.07**	**0.52**	**0.64**	**0.31**	**0.86**	**0.34**	**0.64**	**0.79**	**0.69**	**1.08**	**0.91**
AVERAGE REDUCTION (INCREASE) IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																		
				-35.2			**64.5**			**12.0**			**69.5**			**38.1**		**-29.0**

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Appendix D-3. Concentrations of metals in rainfall, at yhe inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Values in bold exceed State Water Q uality Standards for Class II waters. Abbreviations: NA=no sample analyz ed, NF=no flow therefore no sample collected.

YEAR FOUR (2001) - WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Magnesium mg/L Lab Detection Limit 0.006			Manganese ug/L Lab Detection Limit 0.6			Nickel ug/L Lab Detection Limit 4.3			Silver ug/L Lab Detection Limit 0.1			Zinc ug/L Lab Detection Limit 30			TSS ug/L Lab D. L. 0.05	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
03/04/01	1	0.35	50.00	63.90	2.8	163.0	67.5	*1.25*	*1.25*	*1.25*	*0.05*	0.10	*0.05*	140.0	20.0	*7.5*	30.3	1.1
03/29/01	2	*0.10*	45.60	52.92	4.1	257.0	23.2	4.00	5.70	2.22	*0.05*	0.20	0.05	40.0	50.0	23.38	72.0	27.47
06/23/01	3	*0.10*	36.90	50.68	1.2	1170.0	122.5	*1.25*	10.40	2.00	0.10	0.50	0.08	20.0	120.0	23.12	391.3	16.25
06/30/01	4	*0.10*	26.60	57.00	1.6	449.0	99.3	*1.25*	8.10	*1.25*	*0.05*	0.40	*0.05*	30.0	90.0	*7.5*	116.9	2.3
07/04/01	5	na	44.60	54.60	na	437.0	85.5	na	3.20	3.10	na	0.10	*0.05*	na	20.0	*7.5*	27.3	2.6
07/16/01	6	*0.10*	53.60	41.40	2.2	126.0	396.0	5.50	*1.25*	2.80	*0.05*	*0.05*	*0.05*	50.0	20.0	20.0	na	12.5
07/21/01	7	*0.10*	42.20	53.30	*0.5*	403.0	118.0	*1.25*	3.00	3.40	*0.05*	*0.05*	*0.05*	20.0	*7.5*	*7.5*	11.6	4.7
07/23/01	8	*0.10*	19.20	46.04	1.1	195.0	67.0	*1.25*	4.30	*1.25*	*0.05*	0.10	*0.05*	*7.5*	40.0	*7.5*	66.3	11.93
07/26/01	9	*0.10*	35.90	67.32	1.7	293.0	97.8	1.25	2.60	*1.25*	0.10	0.10	*0.03*	*7.5*	20.0	*7.5*	13.9	2.86
08/05/01	10	*0.10*	34.70	98.50	2.2	272.0	58.2	*1.25*	*1.25*	*1.25*	*0.05*	*0.05*	*0.05*	20.0	20.0	*7.5*	14.9	1.7
09/11/01	11	na	37.00	95.00	na	316.0	141.0	na	*1.25*	*1.25*	na	*0.05*	*0.05*	na	30.0	30.0	28.3	4.8
09/14/01	12	0.41	28.83	26.91	*0.5*	136.25	41.6	*1.25*	2.47	*1.25*	*0.05*	0.17	0.09	35.20	24.15	16.79	22.50	4.20
09/29/01	13	*0.10*	na	28.98	*0.5*	na	64.8	*1.25*	na	*1.25*	*0.05*	na	*0.05*	40.0	na	53.24	na	4.38
10/21/01	14	*0.10*	39.90	31.34	1.2	171.0	84.5	*1.25*	2.70	*1.25*	*0.05*	0.10	*0.05*	40.0	50.0	34.27	12.0	3.07
No. Obs.		**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**13**	**14**	**12**	**14**
Mean		**0.15**	**38.08**	**54.85**	**1.6**	**337.6**	**104.8**	**1.83**	**3.65**	**1.77**	**0.06**	**0.15**	**0.05**	**37.5**	**39.4**	**18.1**	**67.3**	**7.1**
Median		**0.10**	**37.00**	**53.11**	**1.4**	**272.0**	**85.0**	**1.25**	**2.70**	**1.25**	**0.05**	**0.10**	**0.05**	**32.6**	**24.2**	**12.1**	**27.8**	**4.3**
max		**0.41**	**53.60**	**98.50**	**4.1**	**1170.0**	**396.0**	**5.50**	**10.40**	**3.40**	**0.10**	**0.50**	**0.09**	**140.0**	**120.0**	**53.2**	**391.3**	**27.5**
min		**0.10**	**19.20**	**26.91**	**0.5**	**126.0**	**23.2**	**1.25**	**1.25**	**1.25**	**0.05**	**0.05**	**0.03**	**7.5**	**7.5**	**7.5**	**11.6**	**1.1**
Std.Dev.		**0.10**	**9.18**	**20.78**	**1.0**	**262.6**	**86.5**	**1.34**	**2.73**	**0.76**	**0.02**	**0.14**	**0.01**	**33.5**	**31.0**	**13.3**	**102.4**	**7.2**
C.V.		**0.72**	**0.24**	**0.38**	**0.63**	**0.78**	**0.83**	**0.73**	**0.75**	**0.43**	**0.32**	**0.90**	**0.26**	**0.89**	**0.79**	**0.74**	**1.52**	**1.01**
		AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																
				-44.0%			**69.0%**			**51.6%**			**64.4%**			**54.0%**		**89.4%**
		INCLUDE RAINFALL AS AN INPUT IN CALCULATION																
				-43.5%			**69.1%**			**67.7%**			**74.3%**			**76.5%**		

Appendix D-4. Concentrations of major ions in rainfall, at the inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Values in bold exceed State Water Quality Standards for Class II waters. Abbreviations: NA=no sample analyzed, NF=no flow therefore no sample collected.

YEAR ONE

Date of storm	Calcium mg/L Lab Detection Limit 0.05			Chloride mg/L Lab Detection Limit			Potassium mg/L Lab Detection Limit 0.05			Sodium mg/L Lab Detection Limit 0.05			Sulfate mg/L Lab Detection Limit 0.05			Hardness mg/L as CaCO3 Lab Detection Limit 0.02		
	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/08/98	0.30	125	NF	2.0	36.8	NF	0.5	16.3	NF	1.3	17.6	NF	1.4	220	NF	1.24	435	NF
01/16/98	0.11	97	77	0.9	31.8	24.1	0.1	12.7	13.1	0.5	12.9	12.1	1.2	163	144	0.44	336	278
01/23/98	0.08	33	79	0.3	8.3	24.7	0.1	4.0	12.2	0.2	4.5	12.4	0.6	5	148	0.28	117	285
02/03/98	0.62	NA	83	1.2	NA	273.0	*0.0*	NA	17.6	0.8	NA	176.0	1.0	NA	179	2.00	NA	352
02/16/98	0.26	68	73	1.5	21.5	25.9	0.1	9.9	12.3	0.8	10.8	12.9	2.0	134	153	1.00	244	268
02/17/98	0.25	24	79	2.6	6.7	24.9	0.1	5.7	12.6	1.6	3.4	12.8	1.5	32	151	1.49	85	288
02/20/98	0.16	NA	62	0.9	NA	19.8	*0.0*	NA	10.2	0.7	NA	9.7	1.5	NA	108	0.73	NA	225
02/24/98	NA	27	45	NA	6.8	14.6	NA	3.6	7.5	NA	3.6	7.1	NA	40	82	NA	95	164
03/03/98	0.19	73	39	1.1	22.7	13.4	0.1	10.9	6.2	0.6	11.3	6.5	1.1	129	67	0.85	264	143
03/10/98	0.25	77	NF	2.4	20.7	NF	0.1	11.6	NF	1.2	10.2	NF	1.8	124	NF	1.20	272	NF
03/19/98	0.13	27	44	0.6	8.0	15.2	0.1	5.4	6.0	0.3	3.6	7.3	0.8	54	75	0.45	96	160
03/20/98	0.12	22	48	1.0	7.2	15.7	*0.0*	3.7	6.8	0.5	3.2	7.7	2.0	40	83	0.55	79	172
04/22/98	NA	88	NF	NA	39.0	NF	NA	9.1	NF	NA	16.4	NF	NA	184	NF	NA	340	NF
05/29/98	0.81	111	NF	2.6	42.2	NF	0.7	16.6	NF	1.7	16.2	NF	3.0	284	NF	2.80	404	NF
06/01/98	NA	111	NF	NA	53.6	NF	NA	9.3	NF	NA	22.2	NF	NA	268	NF	NA	440	NF
06/23/98	NA	108	NF	NA	38.4	NF	NA	13.3	NF	NA	20.3	NF	NA	201	NF	NA	389	NF
07/08/98	NA	102	NF	NA	37.7	NF	NA	13.0	NF	NA	18.0	NF	NA	186	NF	NA	369	NF
07/13/98	0.19	105	NF	1.9	37.5	NF	0.1	13.0	NF	0.6	18.2	NF	4.6	183	NF	0.76	378	NF
07/17/98	0.41	127	NF	0.6	36.8	NF	*0.0*	12.4	NF	0.1	20.8	NF	3.9	380	NF	1.20	440	NF
07/22/98	NA	108	NF	NA	34.8	NF	NA	12.9	NF	NA	18.3	NF	NA	175	NF	NA	384	NF
08/17/98	0.29	63	NF	1.1	37.9	NF	0.1	13.6	NF	0.6	19.4	NF	3.7	182	NF	1.20	274	NF
08/20/98	0.41	54	NF	1.0	24.7	NF	0.1	11.4	NF	0.4	16.1	NF	5.9	144	NF	1.60	220	NF
09/03/98	0.34	70	NF	6.7	39.4	NF	0.7	15.4	NF	4.1	21.3	NF	4.1	189	NF	2.70	299	NF
09/08/98	0.00	49	NF	1.4	47.6	NF	*0.0*	9.1	NF	0.4	23.3	NF	1.9	118	NF	0.29	182	NF
09/19/98	0.02	93	NF	0.8	131.0	NF	*0.0*	13.8	NF	0.3	68.3	NF	0.7	203	NF	0.33	351	NF
09/20/98	0.04	94	121	0.7	26.1	2480.0	*0.0*	13.2	58.9	0.2	9.7	1360.0	0.6	130	426	0.18	317	1023
09/23/98	0.39	108	111	1.0	41.3	1500.0	*0.0*	22.2	51.5	0.6	19.9	897.0	1.3	190	323	1.18	380	812
10/06/98	0.01	81	114	1.4	50.0	1490.0	0.1	14.6	50.1	0.6	26.2	877.0	1.6	155	333	0.35	300	799
12/14/98	0.34	117	NF	1.1	108.0	NF	*0.0*	18.4	NF	0.7	56.1	NF	1.2	230	NF	1.26	454	NF
No. Obs.	23	27	13	23	27	13	23	27	13	23	27	13	23	27	13	23	27	13
Mean	0	80	75	2	37	455	0	12	20	1	18	261	2	161	175	1	294	382
Median	0	88	77	1	37	25	0	13	12	1	18	12	2	175	148	1	317	278
max	1	127	121	7	131	2480	1	22	59	4	68	1360	6	380	426	3	454	1023
min	0	22	39	0	7	13	0	4	6	0	3	6	1	5	67	0	79	143
Std.Dev.	0	32	26	1	27	785	0	4	18	1	14	444	1	81	110	1	117	282
C.V.	0.775	0.404	0.353	0.841	0.735	1.722	1.443	0.379	0.907	0.984	0.778	1.700	0.692	0.504	0.627	0.675	0.396	0.738
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)			6.3			-1134.2			-74.8			-1335.2			-8.6			-29.9

TABLE D-4(continued)
YEAR TWO

Date of storm	Calcium mg/L Lab Detection Limit 0.05			Chloride mg/L Lab Detection Limit			Potassium mg/L Lab Detection Limit 0.05			Sodium mg/L Lab Detection Limit 0.05			Sulfate mg/L Lab Detection Limit 0.05			Hardness mg/L as CaCO3 Lab Detection Limit 0.02		
	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/05/99	0.34	122	NF	2.4	105.0	NF	0.2	19.0	NF	1.5	54.9	NF	1.8	232	NF	1.71	469	NF
01/25/99	0.20	108	134	0.9	64.7	2120.0	0.1	20.1	67.2	0.7	29.0	1190.0	0.5	236	468	0.79	403	1030
02/01/99	NA	NA	140	NA	NA	1720.0	NA	NA	44.8	NA	NA	908.0	NA	NA	416	NA	NA	926
03/16/99	0.59	113	139	2.9	39.8	1920.0	0.0	3.4	50.7	0.0	19.4	958.0	1.1	293	475	2.70	473	948
04/30/99	0.81	148	NF	0.9	120.0	NF	0.5	17.5	NF	0.4	56.6	NF	3.4	310	NF	2.40	586	NF
05/24/99	NA	113	NF	NA	133.0	NF	NA	18.7	NF	NA	66.4	NF	NA	317	NF	NA	491	NF
06/02/99	1.04	120	NF	2.0	117.0	NF	0.2	20.0	NF	1.0	68.6	NF	4.2	298	NF	3.46	515	NF
06/03/99	0.68	117	NF	1.3	124.0	NF	0.3	17.7	NF	0.6	63.3	NF	2.4	302	NF	2.35	513	NF
06/06/99	0.92	118	NF	1.6	125.0	NF	0.5	17.8	NF	0.61	63.8	NF	7.99	307	NF	2.91	518	NF
06/17/99	NA	122	NF	NA	125	NF	NA	18.6	NF	NA	65.9	NF	NA	310	NF	NA	527	NF
06/30/99	NA	109	NF	NA	115	NF	NA	18.5	NF	NA	63.6	NF	NA	296	NF	NA	479	NF
07/02/99	0.54	110	NF	0.7	115	NF	0.02	17.8	NF	0.37	64	NF	2.32	299	NF	1.59	483	NF
07/03/99	0.55	130	NF	0.49	90.9	NF	0.02	19	NF	0.32	42.4	NF	2.95	256	NF	1.7	510	NF
07/07/99	NA	115	228	NA	122	4330	NA	17.5	87.7	NA	61.2	2430	NA	283	772	NA	502.5	1866
07/11/99	1.88	125	NF	1.9	113	NF	0.1	19	NF	1.26	59.5	NF	1.42	302	NF	6.67	520	NF
07/28/99	1.73	144	NF	0.43	85.6	NF	0.02	20.2	NF	0.31	42.4	NF	1.57	264	NF	5.67	549	NF
08/07/99	1.72	147	NF	0.85	82.1	NF	0.02	20.4	NF	0.55	46.3	NF	1.83	266	NF	5.57	570	NF
08/13/99	0.89	151	136	1.06	129	1680	0.02	17.3	56.2	0.62	47.8	835	1.86	304	416	3.45	515.8	708.9
08/15/99	0.61	147	132	0.46	89.6	1570	0.02	17.6	50.3	0.29	45.2	813	3.92	292	415	1.976	497.1	677.9
08/17/99	1.42	140	127	0.54	78.8	1440	0.02	17.9	42.3	0.36	38.9	755	2.37	263	335	5.069	496.1	778.3
08/19/99	1.26	128	111	0.2	52.9	1070	0.02	14.5	31.5	0.33	24.6	576	3.38	211	343	3.928	443.1	666.3
08/24/99	0.97	141	139	0.2	64.1	1020	0.02	18.4	38.8	0.25	29.6	560	0.56	260	333	3.328	525	833
08/25/99	NA	NA	142	NA	NA	729	NA	NA	33.1	NA	NA	390	NA	NA	350	NA	NA	682.3
08/31/99	1.37	179	145	0.67	61.9	694	0.04	22.1	33.3	0.41	30.5	367	3.31	260	336	4.86	611.6	658.9
09/07/99	0.68	167	219	1.42	63	5960	0.02	16.8	141	1.15	30.4	3220	1.16	253	961	4.04	600.6	2189
09/12/99	NA	144	142	NA	57.2	2440	NA	23.7	65.8	NA	30.8	1415	NA	276	554	NA	530.8	1153.4
09/20/99	0.99	136	138	1	51.4	1900	0.02	24	54.4	0.55	28.9	1060	1.63	250	470	3.213	495.2	978.7
09/21/99	0.61	NA	215	0.64	NA	6460	0.02	NA	142	0.45	NA	3480	1.09	NA	988	2.75	NA	2422
09/23/99	NA	NA	136	NA	NA	1590	NA	NA	50.1	NA	NA	863	NA	NA	438	NA	NA	907.8
09/28/99	NA	NA	118	NA	NA	427	NA	NA	27.6	NA	NA	231	NA	NA	298	NA	NA	568
10/05/99	1.61	62.8	83.8	0.41	23.2	294	0.06	11	20.7	0.2	11	159	1.33	109	224	5.25	234.6	407.3
10/08/99	1.33	NA	111	0.76	NA	216	0.24	NA	21.6	0.17	NA	107	2.51	NA	265	4.26	NA	478.5
10/11/99	NA	NA	108	NA	NA	197	NA	NA	22.7	NA	NA	100	NA	NA	249	NA	NA	463
10/12/99	NA	NA	108	NA	NA	185	NA	NA	20.6	NA	NA	92.1	NA	NA	248	NA	NA	459.9
10/15/99	NA	NA	106	NA	NA	182	NA	NA	20.7	NA	NA	90.5	NA	NA	249	NA	NA	449.5
10/18/99	NA	NA	108	NA	NA	175	NA	NA	20.4	NA	NA	89.4	NA	NA	248	NA	NA	455.8
10/22/99	NA	NA	103	NA	NA	177	NA	NA	20.2	NA	NA	88.6	NA	NA	251	NA	NA	439.6
10/27/99	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/02/99	1.49	25.7	112	0.56	10	310	0.02	2.9	74.1	0.38	4.77	126	0.79	48.9	215	4.99	101.9	479.7
11/04/99	NA	NA	107	NA	NA	178	NA	NA	20.9	NA	NA	94.1	NA	NA	230	NA	NA	458.2
11/15/99	NA	NA	120	NA	NA	152	NA	NA	19.6	NA	NA	80.5	NA	NA	256	NA	NA	499.3
11/16/99	NA	NA	123	NA	NA	181	NA	NA	22	NA	NA	95.6	NA	NA	268	NA	NA	523.7
11/18/99	NA	NA	120	NA	NA	159	NA	NA	21.4	NA	NA	83.8	NA	NA	264	NA	NA	509.6
11/22/99	NA	125	115	NA	52.3	130	NA	13.9	20.9	NA	23.5	71.7	NA	280	245	NA	485	478.2
11/24/99	NA	NA	117	NA	NA	161	NA	NA	21.6	NA	NA	85	NA	NA	249	NA	NA	495.1
11/29/99	NA	NA	119	NA	NA	117	NA	NA	20.5	NA	NA	66.4	NA	NA	249	NA	NA	490.6
12/22/99	0.93	NA	121	0.54	NA	148	0.02	NA	19.1	0.2	NA	77.7	1.79	NA	263	2.98	NA	498.5
12/27/99	NA	NA	125	NA	NA	123	NA	NA	19.4	NA	NA	61.2	NA	NA	278	NA	NA	508.9
No. Obs.	25	28	34	25	28	34	25	28	34	25	28	34	25	28	34	25	28	34
Mean	1	125	131	1	86	1181	0	17	42	1	43	636	2	263	371	4	487	767
Median	1	125	122	1	88	369	0	18	30	0	44	195	2	278	288	3	506	546
max	2	179	228	3	133	6460	1	24	142	2	69	3480	8	317	988	7	612	2422
min	0	26	84	0	10	117	0	3	19	0	5	61	0	49	215	1	102	407
Std.Dev.	0	29	31	1	34	1564	0	5	31	0	18	853	2	58	190	1	100	480
C.V.	0.451	0.230	0.239	0.683	0.399	1.324	1.425	0.271	0.738	0.685	0.419	1.341	0.673	0.220	0.512	0.419	0.206	0.626
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)			-4.4			-1271.9			-141.5			-1367.5			-40.9			-57.5

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TABLE C-4 (CONTINUED) Concentrations of major ions measured in rainfall, at the inflow and at the outflow. This is the raw data. Samples have not been combined to represent event mean concentrations for individual storm events. NA=no sample or no flow. Higher concentrations of most ions at the outflow represents backflow from the brackish marsh.

YEAR THREE MAJOR IONS

Date	Calcium mg/L Lab Detection Limit 0.05			Chloride mg/L Lab Detection Limit			Potassium 0.036 mg/L Lab Detection Limit 0.05			Sodium mg/L Lab Detection Limit 0.05			Sulfate mg/L Lab Detection Limit 0.05			Hardness mg/L as CaCO3 Lab Detection Limit 0.02		
	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/04/00	NA	NA	127.0	NA	NA	117.0	NA	NA	19.4	NA	NA	57.6	NA	NA	289.0	NA	NA	516
01/07/00	NA	143.0	120.0	NA	58.2	118.0	NA	17.8	18.9	NA	26.0	59.6	NA	313.0	268.0	NA	549	486
01/11/00	NA	NA	132.0	NA	NA	117.0	NA	NA	18.6	NA	NA	59.7	NA	NA	288.0	NA	NA	533
01/20/00	NA	NA	139.0	NA	NA	99.6	NA	NA	19.1	NA	NA	51.8	NA	NA	310.0	NA	NA	558
01/27/00	NA	NA	132.0	NA	NA	99.2	NA	NA	19.7	NA	NA	48.0	NA	NA	289.0	NA	NA	530
02/03/00	NA	NA	145.0	NA	NA	94.4	NA	NA	19.4	NA	NA	47.0	NA	NA	304.0	NA	NA	572
02/15/00	NA	147.0	134.0	NA	61.5	102.0	NA	14.4	18.6	NA	26.6	49.9	NA	322.0	290.0	NA	566	534
02/24/00	NA	NA	134.0	NA	NA	100.0	NA	NA	18.9	NA	NA	48.5	NA	NA	294.0	NA	NA	534
03/16/00	1.1	NA	NA	0.2	NA	NA	0.0	NA	NA	0.0	NA	NA	0.1	NA	NA	3.9	NA	NA
03/28/00	NA	145.0	157.0	NA	65.7	150.0	NA	16.0	16.0	NA	28.2	78.7	NA	349.0	346.0	NA	594	655
04/14/00	NA	116.0	NA	NA	35.9	NA	NA	17.3	NA	NA	18.1	NA	NA	241.0	NA	NA	436	NA
06/26/00	0.5	140.0	NA	1.7	59.8	NA	0.3	28.8	NA	0.0	25.3	NA	2.6	358.0	NA	1.2	552	NA
06/27/00	0.9	106.0	NA	1.9	37.2	NA	0.2	20.6	NA	0.2	14.9	NA	1.2	253.0	NA	2.2	383	NA
06/30/00	NA	127.0	NA	NA	62.0	NA	NA	22.5	NA	NA	26.7	NA	NA	334.0	NA	NA	518	NA
07/05/00	0.5	130.0	NA	2.3	57.3	NA	0.0	21.9	NA	0.7	25.5	NA	1.5	311.0	NA	1.3	517	NA
07/06/00	0.3	127.0	NA	2.0	58.9	NA	0.3	21.6	NA	0.5	25.8	NA	5.1	317.0	NA	0.8	509	NA
07/09/00	NA	126.0	128.0	NA	55.7	105.0	NA	17.4	25.0	NA	26.0	49.6	NA	329.0	344.0	NA	515	558
07/10/00	0.0	54.2	76.4	1.8	15.8	75.9	0.7	9.9	16.0	0.3	6.9	37.6	4.2	104.0	183.0	0.0	183	320
07/13/00	NA	NA	116.0	NA	NA	99.9	NA	NA	22.7	NA	NA	48.2	NA	NA	333.0	NA	NA	505
07/16/00	0.4	48.7	118.0	2.0	15.0	92.7	0.2	6.0	23.8	0.7	7.9	45.0	1.8	93.8	308.0	1.5	185	519
07/19/00	NA	NA	84.0	NA	NA	47.6	NA	NA	15.2	NA	NA	22.7	NA	NA	208.0	NA	NA	357
07/31/00	0.0	128.0	83.6	2.2	38.6	46.4	0.2	19.5	14.9	0.4	19.0	22.6	1.8	257.0	189.0	0.0	477	351
08/04/00	NA	119.0	84.0	NA	42.4	47.5	NA	15.7	13.8	NA	19.0	21.5	NA	239.0	188.0	NA	448	345
08/07/00	NA	119.0	84.4	NA	42.4	56.7	NA	15.7	13.6	NA	18.9	25.8	NA	241.0	176.0	NA	448	350
08/09/00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
08/10/00	NA	118.0	NA	NA	41.6	NA	NA	12.6	NA	NA	19.8	NA	NA	255.0	NA	NA	457	NA
08/12/00	NA	110.0	NA	NA	35.5	NA	NA	16.4	NA	NA	17.2	NA	NA	277.0	NA	NA	430	NA
08/15/00	NA	117.0	86.3	NA	35.5	63.6	NA	17.1	15.6	NA	17.8	30.7	NA	243.0	177.0	NA	438	364
08/17/00	NA	NA	87.5	NA	NA	61.3	NA	NA	15.2	NA	NA	29.3	NA	NA	183.0	NA	NA	365
08/21/00	NA	NA	91.3	NA	NA	53.4	NA	NA	14.5	NA	NA	25.8	NA	NA	195.0	NA	NA	376
08/23/00	0.8	116.0	88.0	1.9	35.4	56.8	0.4	16.5	15.1	0.5	18.2	27.3	1.6	265.0	171.0	2.4	442	361
08/25/00	NA	NA	93.1	NA	NA	61.3	NA	NA	15.5	NA	NA	29.0	NA	NA	175.0	NA	NA	382
08/27/00	0.4	120.0	89.6	2.2	34.5	62.3	0.3	18.2	17.0	0.4	17.0	30.3	3.4	253.0	170.0	1.0	445	368
08/31/00	NA	NA	94.7	NA	NA	67.5	NA	NA	15.8	NA	NA	32.2	NA	NA	190.0	NA	NA	390
09/07/00	NA	116.0	95.6	NA	33.1	72.6	NA	19.5	16.4	NA	16.8	35.1	NA	248.0	149.0	NA	431	383
09/08/00	0.2	70.4	78.8	1.8	19.0	70.7	0.2	13.4	15.5	0.2	8.9	35.3	3.0	151.0	154.0	0.5	251	333
09/11/00	NA	NA	95.3	NA	NA	55.2	NA	NA	15.1	NA	NA	27.0	NA	NA	191.0	NA	NA	386
09/15/00	NA	NA	106.0	NA	NA	54.4	NA	NA	15.0	NA	NA	26.5	NA	NA	196.0	NA	NA	421
09/17/00	0.4	128.0	93.1	1.8	37.7	67.2	0.0	27.0	15.2	0.2	18.4	33.6	1.2	296.0	159.0	1.0	479	376
09/18/00	NA	92.9	94.5	NA	32.3	43.5	NA	32.0	14.5	NA	11.2	21.2	NA	185.0	189.0	NA	330	372
09/20/00	NA	NA	NA	NA	NA	293.0	NA	NA	21.3	NA	NA	159.0	NA	NA	229.0	NA	NA	NA
09/22/00	NA	NA	NA	NA	NA	358.0	NA	NA	23.4	NA	NA	197.0	NA	NA	223.0	NA	NA	NA
09/28/00	0.1	54.0	96.3	1.9	16.7	535.0	0.1	9.7	31.0	0.5	6.7	295.0	2.4	120.0	215.0	NA	NA	NA
10/06/00	0.2	92.4	110.0	1.7	29.2	829.0	0.0	14.8	39.0	0.2	14.8	456.0	1.8	206.0	253.0	0.5	351	608
No. Obs.	**14**	**26**	**32**	**14**	**26**	**34**	**14**	**26**	**34**	**14**	**26**	**34**	**14**	**26**	**34**	**13**	**25**	**31**
Mean	**0.4**	**111.9**	**106.1**	**1.8**	**40.7**	**128.6**	**0.2**	**17.8**	**18.5**	**0.3**	**18.5**	**66.6**	**2.2**	**252.3**	**230.2**	**1.3**	**437.4**	**442.3**
Median	**0.3**	**118.5**	**95.5**	**1.9**	**37.5**	**74.3**	**0.2**	**17.2**	**16.2**	**0.4**	**18.3**	**36.5**	**1.8**	**254.0**	**202.0**	**1.0**	**448.3**	**386.2**
max	**1.1**	**147.0**	**157.0**	**2.3**	**65.7**	**829.0**	**0.7**	**32.0**	**39.0**	**0.7**	**28.2**	**456.0**	**5.1**	**358.0**	**346.0**	**3.9**	**593.5**	**654.8**
min	**0.0**	**48.7**	**76.4**	**0.2**	**15.0**	**43.5**	**0.0**	**6.0**	**13.6**	**0.0**	**6.7**	**21.2**	**0.1**	**93.8**	**149.0**	**0.0**	**183.1**	**319.6**
Std.Dev.	**0.3**	**27.1**	**22.0**	**0.5**	**14.9**	**156.4**	**0.2**	**5.6**	**5.2**	**0.2**	**6.4**	**87.2**	**1.3**	**71.8**	**60.4**	**1.0**	**105.8**	**94.8**
C.V.	**0.77**	**0.24**	**0.21**	**0.27**	**0.37**	**1.22**	**0.84**	**0.32**	**0.28**	**0.66**	**0.34**	**1.31**	**0.56**	**0.28**	**0.26**	**0.83**	**0.24**	**0.21**
AVERAGE REDUCTION (INCREASE) IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																		
			5.2			**-216.5**			**-4.0**			**-259.5**			**8.8**			**-1.1**

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Appendix C-4. Concentrations of major ions in rainfall, at the inflow and at the outflow. When concentrations were below the laboratory limit of detection 1/2 the detection limit was used and the value is in italics. Values in bold exceed State Water Quality Standards for Class II waters. Abbreviations: NA=no sample analyzed, NF=no flow therefore no sample collected.

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YEAR FOUR (2001) - WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Calcium mg/L Lab Detection Limit 0.05			Chloride mg/L Lab Detection Limit 0.05			Potassium mg/L Lab Detection Limit 0.07			Sodium mg/L Lab Detection Limit 0.05			Sulfate mg/L Lab Detection Limit 0.05			Hardness mg/L as CaCO3 Lab Detection Limit 0.02		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
03/04/01	1	1.05	125.00	118.00	3.5	53.9	345.0	*0.1*	20.0	26.5	2.14	26.90	194.00	1.95	330.00	326.00	1.40	193.00	557.79
03/29/01	2	*0.13*	127.00	94.30	1.6	59.3	253.0	0.1	20.9	23.0	0.67	23.60	138.00	1.65	324.00	243.00	*0.50*	132.00	130.00
04/02/01	2	na	na	124.00	na	na	197.0	na	na	24.2	na	na	105.00	na	na	323.00	na	na	173.00
04/06/01	2	na	na	150.00	na	na	192.0	*na*	na	27.2	na	na	104.00	na	na	334.00	na	na	198.00
04/24/01	bkgnd	na	134.00	146.00	na	77.3	211.0	na	39.5	15.6	na	28.90	105.00	na	370.00	379.00	na	170.00	199.00
06/23/01	3	*0.13*	154.00	93.30	0.9	53.8	282.0	0.1	35.8	45.6	0.36	19.20	156.00	1.57	310.00	338.00	*0.50*	181.00	69.30
06/28/01	3	na	na	121.00	na	na	183.0	na	na	36.2	na	na	90.10	na	na	402.00	na	na	144.00
06/30/01	4	*0.13*	110.00	104.00	1.1	32.7	149.0	*0.1*	19.1	35.4	0.33	14.20	73.70	1.62	200.00	356.00	0.78	384.20	494.00
07/04/01	5	na	157.00	107.00	na	61.5	144.0	na	30.1	33.6	na	26.50	71.60	na	327.00	373.00	na	576.00	492.00
07/16/01	6	*0.13*	116.00	149.00	3.3	129.0	60.2	0.0	37.1	29.5	0.87	66.40	25.90	1.79	303.00	247.00	0.72	511.00	543.00
07/17/01	bkgnd	na	114.00	133.00	na	128.0	70.1	na	37.2	35.4	na	65.20	26.80	na	298.00	340.00	na	503.30	520.00
07/21/01	7	*0.13*	141.00	106.00	1.5	46.9	135.0	0.1	23.4	36.0	0.73	22.70	70.40	1.57	204.00	288.00	0.72	525.86	484.17
07/23/01	8	*0.13*	80.00	210.00	2.4	49.6	**4310.0**	0.0	12.8	148.0	1.25	9.96	**3240.00**	0.78	162.00	**5070.00**	0.72	278.83	701.86
07/25/01	8	na	na	123.00	na	na	378.0	na	na	38.4	na	na	206.00	na	na	348.00	na	na	568.00
07/26/01	9	*0.13*	12.00	124.00	1.3	46.6	445.0	*0.2*	26.8	38.4	0.61	20.30	234.00	1.53	255.00	355.00	0.74	177.80	581.00
07/30/01	9	na	na	127.00	na	na	491.0	na	na	38.8	na	na	256.00	na	na	356.00	na	na	597.14
08/05/01	10	0.39	121.00	146.00	1.3	49.9	975.0	0.1	29.1	46.1	0.61	18.50	512.00	1.14	238.00	386.00	1.39	445.03	771.00
09/11/01	11	na	132.00	118.00	na	54.7	**1030.0**	na	26.3	43.4	na	22.60	559.00	na	258.00	331.00	na	481.97	686.00
09/14/01	12	0.78	103.00	101.00	2.6	59.0	**1120.0**	*0.0*	44.2	44.6	1.31	18.00	611.00	0.90	303.00	331.00	3.14	391.44	646.00
09/15/01	12	*0.13*	51.90	56.20	8.0	71.5	122.0	*0.0*	15.1	16.6	4.91	34.70	63.60	1.59	119.00	135.00	3.36	204.13	235.00
09/21/01	12	na	na	59.10	na	na	105.0	na	na	16.3	na	na	56.20	na	na	121.00	na	na	241.46
09/26/01	12	na	na	58.40	na	na	32.5	na	na	16.3	na	na	68.00	na	na	28.60	na	na	249.19
09/28/01	12	na	na	68.10	na	na	170.0	na	na	17.8	na	na	89.00	na	na	137.00	na	na	284.94
09/29/01	13	*0.13*	na	63.50	*0.2*	na	179.0	*0.0*	na	18.9	0.18	na	94.80	1.93	na	140.00	0.74	na	274.28
10/05/01	13	na	na	74.60	na	na	182.0	na	na	18.9	na	na	101.00	na	na	148.00	na	na	310.23
10/21/01	14	0.26	118.00	na	1.2	33.9	na	0.1	23.2	na	0.56	22.00	na	1.13	201.00	na	1.06	458.95	na
10/24/01	14	na	na	68.20	na	na	213.0	na	na	20.0	na	na	115.00	na	na	144.00	na	na	298.78
10/26/01	14	na	na	68.50	na	na	191.0	na	na	19.9	na	na	103.00	na	na	150.00	na	na	301.59
No. Obs.		**11**	**14**	**23**	**11**	**14**	**23**	**11**	**14**	**23**	**11**	**14**	**23**	**11**	**14**	**23**	**11**	**14**	**23**
Mean		**0.222**	**110.279**	**105.430**	**2.16**	**63.89**	**485.99**	**0.05**	**28.55**	**35.20**	**1.065**	**27.797**	**301.222**	**1.414**	**253.429**	**474.070**	**1.261**	**377.822**	**421.388**
Median		**0.125**	**117.000**	**106.000**	**1.29**	**54.25**	**183.00**	**0.05**	**27.95**	**35.40**	**0.610**	**22.300**	**101.000**	**1.570**	**256.500**	**331.000**	**0.736**	**418.235**	**484.171**
max		**0.780**	**157.000**	**210.000**	**8.04**	**129.00**	**4310.00**	**0.15**	**44.20**	**148.00**	**4.910**	**66.400**	**3240.000**	**1.930**	**370.000**	**5070.000**	**3.360**	**576.000**	**771.000**
min		**0.125**	**12.000**	**56.200**	**0.20**	**32.70**	**32.50**	**0.02**	**12.80**	**15.60**	**0.180**	**9.960**	**25.900**	**0.780**	**119.000**	**28.600**	**0.500**	**170.000**	**69.300**
Std.Dev.		**0.194**	**38.107**	**37.422**	**2.04**	**28.86**	**870.33**	**0.04**	**9.06**	**26.31**	**1.262**	**16.566**	**647.555**	**0.352**	**67.529**	**985.987**	**0.964**	**141.105**	**194.162**
C.V.		**0.875**	**0.346**	**0.355**	**0.94**	**0.45**	**1.79**	**0.76**	**0.32**	**0.75**	**1.184**	**0.596**	**2.150**	**0.249**	**0.266**	**2.080**	**0.765**	**0.373**	**0.461**
AVERAGE REDUCTION IN CONSTITUENT CONCENTRATION BETWEEN THE INFLOW AND OUTFLOW (%)																			
				4.4			**-660.7**			**-23.3**			**-983.6**			**-87.1**			**-11.5**

APPENDIX E

Mass Loading and Efficiency Calculations

Appendix E-1 Mass loading of pollutants for 1998 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 25 storm events for 36 inches of rain. A total of 44 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significant runoff. It is estimated that samples were collected for 82 per cent of all storms with runoff during 1998.

YEAR ONE - MASS LOADING

Date of storm	Storm #	Ammonia kg as N RAIN	Ammonia INFLOW	Ammonia OUTFL	Nitrate+Nitrite kg as N RAIN	Nitrate+Nitrite INFLOW	Nitrate+Nitrite OUTFL	Organic Nitrogen kg as N RAIN	Organic Nitrogen INFLOW	Organic Nitrogen OUTFL	Total Nitrogen kg as N RAIN	Total Nitrogen INFLOW	Total Nitrogen OUTFL	Ortho-Phosphorus kg as P RAIN	Ortho-Phosphorus INFLOW	Ortho-Phosphorus OUTFL	Total Phosphorus kg as P RAIN	Total Phosphorus INFLOW	Total Phosphorus OUTFL
01/06/98	1	0.444	0.844	0.000	0.605	3.808	0.000	1.556	8.218	0.000	1.999	9.062	0.000	0.044	5.721	0.000	0.044	6.797	0.000
01/15/98	2	0.260	0.504	0.296	0.216	1.753	1.309	1.015	6.488	0.995	1.274	6.992	1.291	0.052	15.502	2.088	0.055	25.221	2.717
01/23/98	3	0.357	0.819	0.770	0.535	2.080	2.477	0.718	8.756	9.209	1.075	9.575	9.619	0.017	42.583	7.248	0.017	70.048	7.771
02/15/98	5	1.146	1.127	1.020	1.328	8.510	2.459	5.064	25.913	16.876	6.210	27.039	17.896	0.113	14.376	11.543	0.006	59.712	15.641
02/17/98	6	0.100	0.820	0.132	0.084	7.370	1.081	0.150	7.208	3.920	0.251	8.028	4.051	0.007	2.087	3.353	0.012	24.799	3.695
02/19/98	7	1.026	6.241	3.898	0.572	8.274	13.417	1.105	22.127	27.966	2.132	28.368	31.806	0.121	15.319	22.134	0.105	66.665	29.559
02/28/98	9	0.527	1.266	0.671	0.308	2.850	0.658	0.757	10.421	4.405	1.284	11.687	5.076	0.011	14.511	3.308	0.011	20.063	4.434
03/08/98	10	0.401	0.212	0.000	0.217	0.595	0.000	0.449	1.862	0.000	0.850	2.075	0.000	0.005	2.298	0.000	0.005	3.016	0.000
03/18/98	11	0.414	3.883	1.495	0.826	18.795	0.955	1.769	33.789	19.497	2.183	37.672	21.802	3.839	0.145	24.044	5.126	0.145	32.391
04/20/98	12	0.299	0.002	0.000	0.104	0.005	0.000	0.433	0.050	0.000	0.733	0.051	0.000	0.007	0.071	0.000	0.191	0.155	0.000
05/28/98	13	0.937	0.027	0.000	0.478	0.781	0.000	0.460	0.877	0.000	1.397	0.904	0.000	0.078	0.175	0.000	0.104	0.350	0.000
05/30/98	14	0.499	0.038	0.000	0.858	0.426	0.000	0.414	1.647	0.000	1.381	1.685	0.000	0.017	1.080	0.000	0.016	1.446	0.000
06/23/98	15	1.283	0.021	0.000	1.123	0.047	0.000	3.597	0.242	0.000	4.733	0.264	0.000	0.122	0.188	0.000	0.127	0.247	0.000
07/06/98	16	0.314	0.001	0.000	0.332	0.001	0.000	0.662	0.052	0.000	0.998	0.053	0.000	0.007	0.025	0.000	0.009	0.037	0.000
07/10/98	17	0.193	0.011	0.000	0.412	0.007	0.000	0.248	0.231	0.000	0.665	0.242	0.000	0.011	0.113	0.000	0.008	0.161	0.000
07/17/98	18	0.257	0.107	0.000	0.614	0.043	0.000	0.423	0.778	0.000	1.044	0.885	0.000	0.047	0.725	0.000	0.211	0.945	0.000
07/21/98	19	0.181	0.000	0.000	0.061	0.000	0.000	0.603	0.039	0.000	0.664	0.039	0.000	0.129	0.024	0.000	0.141	0.030	0.000
08/16/98	20	0.133	0.018	0.000	0.294	0.009	0.000	0.157	0.138	0.000	0.455	0.155	0.000	0.022	0.012	0.000	0.020	0.027	0.000
08/17/98	21	0.119	0.035	0.000	0.485	0.038	0.000	0.330	0.208	0.000	0.821	0.244	0.000	0.035	0.152	0.000	0.036	0.259	0.000
09/02/98	22	0.475	0.033	0.000	0.529	0.006	0.000	0.647	0.343	0.000	1.182	0.376	0.000	0.066	0.006	0.000	0.135	0.030	0.000
09/06/98	23	0.897	0.217	0.000	0.972	1.438	0.000	2.795	5.727	0.000	3.778	5.944	0.000	0.116	2.930	0.000	0.103	6.154	0.000
09/18/98	24	0.417	0.258	0.000	0.146	0.289	0.000	0.527	1.292	0.000	0.675	1.550	0.000	0.042	2.022	0.000	0.070	2.625	0.000
09/19/98	25	0.078	1.446	0.058	0.090	1.449	0.036	0.137	6.565	2.483	0.228	8.011	2.541	0.030	18.073	0.987	0.013	20.710	1.416
09/20/98	26	0.056	0.960	0.014	0.044	0.835	0.041	0.074	7.634	3.841	0.118	8.593	3.869	0.003	12.962	1.125	0.003	14.537	1.758
12/13/98	27	0.071	0.002	0.000	0.160	0.001	0.000	0.076	0.094	0.000	0.308	0.096	0.000	0.013	0.094	0.000	0.011	0.130	0.000
TOTAL LOADS (kg)		10.44	18.05	8.35	10.79	55.61	22.43	22.61	142.48	89.19	34.44	160.53	97.95	4.91	145.47	75.83	6.53	317.51	99.38
% Reduction from inflow to outflow (%efficiency)																			
Inflow to outflow				54%			60%			37%			39%			48%			69%
includes rain as input				71%			66%			46%			50%			50%			69%
TOTAL LOADS (kg/ac)			0.09	0.04		0.26	0.11		0.68	0.42		0.76	0.47		0.69	0.36		1.51	0.47
TOTAL LOADS (kg/ac-yr) if all storms measured (18% more rain and runoff)			0.10	0.05		0.31	0.13		0.80	0.50		0.90	0.55		0.82	0.43		1.78	0.56

Appendix E-1 (continued) . Mass loading of pollutants for 1999 at the C ockroach Bay Agricultural site. Flow and water quality data in the table include 25 storm ev ent for 28.91 inches of rain. A total of 33.43 inches of rain w as measured at the site for all storms greater than 0.16 inches. Many of these w ere storms which were too sm to produce significnt runoff. It is estimated that samples w ere collected for 82 per cent of all storms w ith runoff during 1998.

YEAR TWO - MASS LOADING

Date of storm	Storm #	Ammonia kg as N			Nitrate+Nitrite kg as N			Organic Nitrogen kg as N			Total Nitrogen kg as N			Ortho-Phosphorus kg as P			Total Phosphorus kg as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/02/99	1	0.048	0.134	0.000	0.288	0.062	0.000	0.052	2.402	0.000	0.340	2.535	0.000	0.007	1.447	0.000	0.019	1.738	0.000
01/25/99	2	0.558	5.357	0.006	0.566	26.669	0.004	0.779	28.617	0.353	1.345	33.974	0.362	0.020	9.864	0.086	0.040	11.778	0.103
03/14/99	3	0.007	0.116	0.026	0.048	0.033	0.009	0.101	1.243	1.104	0.148	1.359	1.130	0.007	1.584	0.182	0.007	1.836	0.465
04/30/99	4	0.220	0.028	0.000	0.317	0.053	0.000	0.321	0.592	0.000	0.638	0.619	0.000	0.011	0.339	0.000	0.016	0.417	0.000
05/30/99	5	0.365	0.009	0.000	0.252	0.002	0.000	0.031	0.403	0.000	0.648	0.414	0.000	0.014	0.064	0.000	0.034	0.143	0.000
06/02/99	6	0.224	0.003	0.000	0.195	0.001	0.000	0.005	0.125	0.000	0.424	0.129	0.000	0.021	0.030	0.000	0.027	0.041	0.000
06/06/99	7	0.343	0.001	0.000	0.515	0.000	0.000	0.109	0.060	0.000	0.967	0.061	0.000	0.047	0.017	0.000	0.049	0.027	0.000
06/16/99	8	0.223	0.076	0.000	0.176	0.010	0.000	0.131	2.110	0.000	0.531	2.195	0.000	0.034	0.351	0.000	0.047	0.732	0.000
07/01/99	9	0.102	0.018	0.000	0.005	0.004	0.000	0.479	1.098	0.000	0.586	1.120	0.000	0.021	0.198	0.000	0.020	0.275	0.000
07/02/99	10	0.079	0.009	0.000	0.022	0.001	0.000	0.019	0.229	0.000	0.120	0.239	0.000	0.002	0.301	0.000	0.004	0.425	0.000
07/09/99	11	0.119	0.004	0.000	0.088	0.002	0.000	0.122	0.404	0.000	0.328	0.409	0.000	0.002	0.124	0.000	0.009	0.181	0.000
07/26/99	12	0.162	0.002	0.000	0.041	0.003	0.000	0.106	0.159	0.000	0.309	0.164	0.000	0.032	0.369	0.000	0.107	0.462	0.000
08/06/99	13	0.005	0.003	0.000	0.097	0.016	0.000	0.000	0.156	0.000	0.097	0.175	0.000	0.005	0.139	0.000	0.005	0.157	0.000
08/12/99	14	0.026	0.007	0.000	0.085	0.002	0.000	0.096	0.067	0.000	0.207	0.076	0.000	0.002	0.039	0.000	0.008	0.050	0.000
08/14/99	15	0.044	0.008	0.000	0.101	0.010	0.000	0.030	0.151	0.000	0.175	0.169	0.000	0.001	0.122	0.000	0.003	0.142	0.000
08/16/99	16	0.708	0.062	0.001	0.512	0.039	0.000	0.064	1.717	0.028	1.284	1.819	0.029	0.009	1.083	0.000	0.042	1.126	0.001
08/18/99	17	0.115	0.029	0.214	0.773	0.610	0.034	0.099	0.000	2.379	0.987	0.460	2.627	0.024	7.483	0.710	0.010	8.289	0.958
08/22/99	18	0.060	0.347	0.239	0.128	0.129	0.054	0.390	4.691	9.925	0.578	5.058	10.218	0.013	10.115	2.943	0.013	10.324	3.616
08/28/99	19	0.031	0.011	0.030	0.022	0.001	0.002	0.224	0.013	0.005	0.277	0.025	0.037	0.004	0.209	0.098	0.011	0.272	0.136
09/06/99	20	0.040	0.031	0.184	0.071	0.031	0.034	0.630	4.632	3.529	0.742	4.693	3.747	0.014	9.387	2.269	0.029	10.363	2.766
09/11/99	21	0.081	0.026	0.036	0.040	0.005	0.006	0.228	0.536	0.983	0.350	0.567	1.025	0.007	0.526	0.258	0.007	0.626	0.388
09/19/99	22	0.029	0.038	0.256	0.241	0.181	0.034	0.112	10.316	7.875	0.381	10.534	8.266	0.012	9.180	2.288	0.033	10.684	3.914
10/04/99	23	0.517	1.089	1.122	0.587	4.605	0.125	0.389	15.465	15.330	1.492	21.159	16.576	0.029	34.196	5.235	0.052	62.543	9.173
11/01/99	24	0.009	0.216	0.067	0.041	0.181	0.038	0.161	2.972	8.875	0.719	3.101	4.794	0.023	5.550	0.834	0.027	6.299	1.113
11/22/99	25	0.127	0.084	0.016	0.163	0.317	0.016	0.059	1.309	7.587	0.349	1.709	7.619	0.004	2.394	0.752	0.014	3.369	2.102
TOTAL LOADS (kg)		4.19	7.57	2.20	5.08	32.91	0.36	4.69	77.06	57.97	13.68	90.23	56.43	0.36	93.67	15.65	0.61	130.56	24.73
% Reduction from inflow to outflow (%efficiency)																			
Inflow to outflow				71%			99%			25%			37%			83%			81%
includes rain as input				81%			99%			29%			46%			83%			81%
TOTAL LOADS (kg/ac)																			
			0.036	0.010		0.157	0.002		0.367	0.276		0.430	0.269		0.446	0.075		0.622	0.118
TOTAL LOADS (kg/ac-yr) if all storms measured (14% more rain and runoff)																			
			0.041	0.012		0.179	0.002		0.418	0.326		0.490	0.317		0.508	0.088		0.709	0.139

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Appendix E-1 (continued). . Mass loading of pollutants for 2000 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 21 storm events for 28.36 inches of rain. A total of 33.27 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significant runoff. It is estimated that samples were collected for 85 per cent of all storms with runoff

YEAR THREE - MASS LOADING

Date of storm	Storm #	Ammonia kg as N			Nitrate+Nitrite kg as N			Organic Nitrogen kg as N			Total Nitrogen kg as N			Ortho-Phosphorus kg as P			Total Phosphorus kg as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
1	02/14/00	0.003	2.163	0.077	0.013	0.115	0.069	0.186	4.259	2.534	0.202	6.537	2.679	0.003	0.959	0.375	0.007	2.044	0.763
2	03/27/00	0.088	0.129	0.000	0.190	0.111	0.000	0.134	12.794	0.000	0.414	13.034	0.000	0.014	0.862	0.000	0.015	2.544	0.000
3	04/13/00	0.019	0.108	0.000	0.005	0.343	0.000	0.265	1.277	0.000	0.290	1.727	0.000	0.005	0.522	0.000	0.019	0.947	0.000
4	06/25/00	0.259	0.185	0.000	0.256	0.006	0.000	-0.189	2.025	0.000	0.329	2.216	0.000	0.010	1.516	0.000	0.015	1.936	0.000
5	06/26/00	0.055	0.210	0.000	0.116	0.101	0.000	0.115	3.224	0.000	0.287	3.508	0.000	0.004	2.801	0.000	0.044	3.704	0.000
6	07/01/00	0.038	0.426	0.000	0.102	0.072	0.000	-0.042	4.146	0.000	0.100	4.645	0.000	0.008	5.067	0.000	0.032	6.376	0.000
7	07/06/00	0.171	0.110	0.000	0.426	0.027	0.000	0.404	0.504	0.000	1.006	0.641	0.000	0.015	1.478	0.000	0.057	1.947	0.000
8	07/08/00	0.023	0.008	0.001	0.160	0.007	0.001	0.065	0.167	0.049	0.158	0.181	0.051	0.004	0.166	0.020	0.005	0.222	0.029
9	07/09/00	1.537	2.155	0.844	1.386	3.572	0.201	1.185	26.965	13.498	4.124	32.692	14.573	0.019	12.096	3.960	0.090	31.965	6.895
10	07/15/00	0.301	5.108	0.605	0.774	4.163	0.216	0.232	59.404	68.310	1.315	68.675	69.131	0.063	19.916	16.807	0.081	96.574	21.906
11	07/31/00	0.150	0.764	0.112	0.288	0.693	0.050	0.073	1.355	1.407	0.514	2.812	1.569	0.012	1.154	0.928	0.017	1.480	1.045
12	08/12/00	0.111	0.354	0.169	0.333	3.491	0.012	0.348	2.793	3.802	0.839	6.638	3.982	0.010	1.773	0.703	0.027	2.483	1.010
13	08/22/00	0.015	0.005	0.205	0.004	0.497	0.407	0.371	1.285	2.243	0.390	1.787	2.657	0.004	0.705	0.294	0.010	0.929	0.059
14	08/26/00	0.069	0.266	0.154	0.349	1.901	0.006	0.504	3.158	6.017	0.926	5.325	6.173	0.005	1.615	0.400	0.020	2.327	1.177
15	09/06/00	0.044	0.117	0.213	0.089	1.433	0.007	0.196	2.407	4.283	0.330	3.957	4.502	0.005	0.791	0.454	0.010	1.774	0.947
16	09/07/00	0.040	0.576	0.106	0.297	1.811	0.011	0.222	11.279	3.650	0.562	13.666	3.786	0.006	3.168	0.396	0.006	6.443	0.928
17	09/16/00	0.109	16.924	2.765	0.139	108.035	1.383	0.166	2.863	73.280	0.415	127.822	77.428	0.026	61.304	20.279	0.104	77.051	26.270
18	09/27/00	0.183	1.315	0.393	0.485	7.828	0.269	0.260	17.544	12.437	0.933	26.687	13.099	0.020	6.108	2.174	0.010	16.308	4.002
19	10/06/00	0.100	0.501	0.487	0.298	2.809	0.009	2.224	5.143	5.099	2.624	8.452	5.595	0.009	2.409	0.949	0.009	5.234	2.611
20	11/25/00	0.048	0.140	0.923	0.088	1.741	0.197	0.325	29.478	27.199	0.462	31.359	28.319	0.010	5.158	1.765	0.010	16.587	8.002
21	12/17/00	0.024	0.039	0.079	0.031	0.476	0.039	0.189	3.187	4.137	0.245	3.702	4.255	0.003	1.377	0.551	0.003	2.424	1.215
TOTAL LOADS (kg)		**3.387**	**31.603**	**7.133**	**5.826**	**139.231**	**2.875**	**7.234**	**195.255**	**227.944**	**16.464**	**366.063**	**237.800**	**0.253**	**130.943**	**50.055**	**0.592**	**281.298**	**76.857**
% Reduction from inflow to outflow (%efficiency)																			
Inflow to Outflow																			
Includes rainfall as input																			
Inflow to outflow				77%			98%			-17%			35%			62%			73%
includes rain as input				88%			97%			-13%			24%			22%			62%
TOTAL LOADS (kg/ac)																			
			0.150	0.034		0.663	0.014		0.930	1.085		1.743	1.132		0.624	0.238		1.340	0.366
TOTAL LOADS (kg/ac-yr) if all storms measured (15% more rain and runoff)																			
			0.173	0.039		0.762	0.016		1.069	1.248		2.005	1.302		0.717	0.274		1.540	0.421

Appendix E-1 (continued). . Mass loading of pollutants for 2001 at the C ockroach Bay Agricultural site. Flow and water quality data in the table include 14 storm events for 28.36 inches of rain. A total of 36.72 inches of rain w as measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significant runoff. It is estimated that samples w ere collected for 86 per cent of all storms w ith runoff. One hurricane produced 9.91 inches of rain and accounts for the largest percentageof all loads measured.

YEAR FOUR - MASS LOADING

Date of storm	Storm #	Ammonia kg as N			Nitrate+Nitrite kg as N			Organic Nitrogen kg as N			Total Nitrogen kg as N			Ortho-Phosphorus kg as P			Total Phosphorus kg as P		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
1	03/04/01	0.776	3.108	0.030	0.159	12.166	0.013	2.196	15.577	3.179	3.334	30.851	3.222	0.055	2.800	1.093	0.076	4.476	1.278
2	03/29/01	1.493	4.222	0.351	0.151	89.800	6.566	0.419	47.429	16.876	2.812	141.451	23.793	0.031	19.696	3.189	0.069	35.363	5.257
3	06/23/01	0.257	0.619	1.478	0.319	0.097	0.270	0.496	84.384	7.514	2.054	85.099	9.261	0.021	41.969	4.627	0.021	99.992	5.650
4	06/30/01	0.148	0.876	0.141	0.279	0.306	0.032	0.200	22.466	8.803	0.802	23.649	8.976	0.009	7.095	5.578	0.017	12.555	7.694
5	07/04/01	0.032	0.372	0.008	0.171	0.010	0.003	0.040	1.034	0.718	0.159	1.416	0.729	0.002	1.203	0.418	0.003	1.592	0.529
6	07/16/01	0.156	0.024	0.089	0.372	0.002	0.002	0.079	0.899	0.808	0.620	0.925	0.900	0.005	0.381	1.024	0.007	0.442	1.134
7	07/21/01	0.146	0.281	0.041	0.213	0.014	0.006	1.008	4.810	2.038	1.398	5.105	2.085	0.006	6.494	1.310	0.023	7.317	1.488
8	07/23/01	0.052	1.830	2.861	0.027	0.158	0.166	0.014	40.615	35.931	0.136	42.603	38.957	0.014	21.996	19.652	0.027	38.185	26.141
9	07/26/01	0.086	0.968	0.285	0.182	0.027	0.080	0.000	6.264	6.837	0.193	7.258	7.201	0.005	8.172	5.463	0.021	9.946	5.994
10	08/05/01	0.093	0.184	0.109	0.106	0.020	0.008	0.162	6.943	4.646	0.325	7.146	4.763	0.003	5.869	1.300	0.003	6.947	1.493
11	09/11/01	0.151	0.935	0.000	0.171	0.078	0.000	0.186	2.727	0.060	0.746	3.740	0.060	0.008	2.995	0.011	0.016	4.071	0.012
12	09/14/01	0.299	31.822	1.648	0.033	172.604	27.181	2.067	80.040	83.387	2.818	275.960	112.216	0.073	148.041	105.331	0.103	188.100	122.261
13	09/29/01	0.082	0.252	0.081	0.358	0.028	0.008	0.285	2.905	1.221	0.867	4.010	1.310	0.007	2.506	1.646	0.007	3.016	1.706
14	10/21/01	0.283	0.445	0.072	0.110	4.210	0.009	0.151	3.804	1.849	0.723	8.459	1.931	0.036	4.416	1.750	0.028	5.182	1.886
TOTAL LOADS (kg)		**4.056**	**45.938**	**7.193**	**2.651**	**279.520**	**34.345**	**7.301**	**319.897**	**173.868**	**16.987**	**637.672**	**215.405**	**0.275**	**273.634**	**152.392**	**0.422**	**417.183**	**182.522**
% Reduction from inflow to outflow (%efficiency)																			
Inflow to Outflow																			
Includes rainfall as input																			
Inflow to outflow				84%			88%			46%			66%			44%			56%
includes rain as input				86%.			88%			47%			67%			44%			56%
TOTAL LOADS (kg/ac)																			
			0.219	0.034		1.331	0.164		1.523	0.828		3.037	1.026		1.303	0.726		1.987	0.869
TOTAL LOADS (kg/ac-yr) if all storms measured (14% more rain and runoff)																			
			0.249	0.039		1.531	0.188		1.752	0.952		3.492	1.180		1.498	0.835		2.285	1.000

Appendix E-2. Mass loading of pollutants for 1998 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 25 storm events for 36 inches of rain. A total of 44 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significnt runoff. It is estimated that samples were collected for 82 per cent of all storms with runoff during 1998.

YEAR ONE - MASS LOADING

Date of storm	Storm #	Aluminum grams			Cadmium grams			Chromium grams			Copper grams			Iron grams			Lead grams		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/06/98	1	20.8	946.4	na	0.297	2.005	na	4.6	13.2	na	1.0	93.0	na	29.7	1864.8	na	2.0	5.6	na
01/15/98	2	111.8	42514.6	917.7	0.233	14.962	0.399	3.7	338.7	6.3	0.8	829.6	19.2	23.3	18319.3	356.4	1.6	45.6	2.7
01/23/98	3	38.9	103884.8	5450.6	0.495	37.493	1.523	7.8	1681.6	63.2	1.6	3624.8	289.3	49.5	72868.8	1563.1	3.3	448.4	10.2
02/15/98	5	669.8	161294.4	80330.9	0.837	33.417	2.654	13.1	1555.0	109.7	2.8	2673.4	396.3	83.7	67503.0	14332.2	5.6	385.4	54.9
02/17/98	6	20.9	61793.9	3634.0	0.068	22.677	0.724	1.1	1190.5	11.3	0.5	2018.2	92.7	6.8	40251.1	3378.3	0.5	362.8	4.8
02/19/98	7	141.5	841426.3	32881.6	0.781	373.03	7.116	12.2	15285.9	270.0	2.6	30852.3	919.8	78.1	603022.2	17973.8	5.2	4992.5	97.3
02/28/98	9	57.9	18901.9	7862.9	0.323	6.740	0.865	5.1	189.7	30.6	1.1	520.9	75.6	32.3	11747.5	2711.4	2.2	74.1	11.5
03/08/98	10	100.8	2161.6	0.0	0.148	1.104	0.000	2.3	26.5	0.0	8.4	69.6	0.0	39.5	1262.2	0.0	1.0	7.7	0.0
03/18/98	11	421.2	34954.6	24419.3	1.116	4.298	4.619	17.5	332.4	72.4	52.8	1558.6	443.4	446.5	15471.7	9238.1	7.4	94.5	30.8
04/20/98	12	45.3	11.6	0.0	0.254	0.011	0.000	0.9	0.2	0.0	1.4	0.7	0.0	5.4	5.1	0.0	0.4	0.1	0.0
05/28/98	13	76.3	168.5	0.0	0.425	0.072	0.000	2.5	3.4	0.0	0.5	31.1	0.0	15.9	140.0	0.0	1.1	1.0	0.0
05/30/98	14	na	244.3	0.0	na	0.208	0.000	na	3.3	0.0	na	33.9	0.0	na	180.5	0.0	na	1.4	0.0
06/23/98	15	650.1	164.8	0.0	1.970	0.054	0.000	2.9	0.9	0.0	19.7	4.1	0.0	344.8	76.0	0.0	1.2	0.4	0.0
07/06/98	16	93.1	29.8	0.0	0.362	0.011	0.000	0.8	0.2	0.0	3.9	1.4	0.0	9.9	15.9	0.0	0.3	0.1	0.0
07/10/98	17	208.8	116.8	0.0	0.274	0.054	0.000	1.3	0.9	0.0	5.8	2.1	0.0	27.4	68.9	0.0	0.5	0.4	0.0
07/17/98	18	288.3	316.2	0.0	0.712	0.158	0.000	4.2	2.5	0.0	15.7	16.2	0.0	106.8	295.2	0.0	1.8	1.1	0.0
07/21/98	19	71.6	16.1	0.0	0.104	0.009	0.000	0.8	0.1	0.0	1.9	0.5	0.0	13.8	8.9	0.0	0.3	0.1	0.0
08/16/98	20	137.6	22.9	0.0	0.104	0.018	0.000	1.6	0.3	0.0	0.3	0.4	0.0	10.4	13.0	0.0	0.7	0.1	0.0
08/17/98	21	209.1	89.7	0.0	0.187	0.043	0.000	1.5	0.7	0.0	2.0	5.5	0.0	9.4	83.1	0.0	0.6	0.8	0.0
09/02/98	22	778.8	40.6	0.0	0.307	0.040	0.000	4.8	0.6	0.0	9.8	1.8	0.0	30.7	18.6	0.0	2.0	0.3	0.0
09/06/98	23	1018.7	4943.7	0.0	0.637	1.383	0.000	10.0	124.5	0.0	13.2	191.5	0.0	63.7	3768.3	0.0	4.2	29.4	0.0
09/18/98	24	447.3	1050.7	0.0	0.371	0.365	0.000	5.8	17.8	0.0	3.2	37.2	0.0	37.1	851.3	0.0	2.5	2.4	0.0
09/19/98	25	367.5	2366.4	2971.3	1.000	1.449	0.538	5.9	22.7	8.4	2.8	197.0	15.8	37.5	2028.3	1327.7	2.5	9.7	3.6
09/20/98	26	40.5	1316.9	3715.8	0.076	1.062	0.410	1.2	16.6	15.3	1.1	205.3	25.1	7.6	1982.5	1830.6	0.5	7.1	2.7
12/13/98	27	130.5	61.3	0.0	0.339	0.022	0.000	1.3	0.3	0.0	1.2	0.8	0.0	8.5	31.1	0.0	0.6	0.1	0.0
TOTAL LOADS (g)		6126	1277892	162184	11.12	498.68	18.85	108.1	20795.1	587.2	153.1	42876.9	2277.2	1488.5	840012.5	52711.5	46.0	6465.4	218.5
% Reduction from inflow to outflow (%efficiency)																			
Inflow to outflow				87%			96%			97%			95%			94%			97%
includes rain as input				87%			96%			97%			95%			94%			97%
TOTAL LOADS																			
(g/ac)			6085.202	772.305		2.37	0.09		99.02	2.80		204.18	10.84		4000.06	251.01		30.79	1.04
(kg/ac)			6.09	0.77		0.0024	0.0001		0.0990	0.0028		0.2042	0.0108		4.0001	0.2510		0.0308	0.0010
TOTAL LOADS if all storms measured (14% more rain and runoff)																			
(g/ac-yr)			6937.130	911.320		2.80	0.11		116.85	3.30		240.93	12.80		4720.07	296.19		36.33	1.23
(kg/ac-yr)			6.94	0.91		0.0028	0.0001		0.1168	0.0033		0.2409	0.0128		4.7201	0.2962		0.0363	0.0012

* Does not include storm # 1 since it has no outflow data

copper

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Appendix E-2. Mass loading of pollutants for 1999 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 25 storm events for 28.91 inches of rain. A total of 33.43 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significnt runoff. It is estimated that samples were collected for 82 per cent of all storms with runoff during 1999.

YEAR TWO - MASS LOADING

Date of storm	Storm #	Aluminum grams			Cadmium grams			Chromium grams			Copper grams			Iron grams			Lead grams		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
01/02/99	1	93.4	806.7	0.0	0.202	0.342	0.000	3.2	5.4	0.0	0.7	14.8	0.0	20.2	341.8	0.0	1.3	2.3	0.0
01/25/99	2	338.2	1993.0	91.7	0.587	1.679	0.036	9.2	26.3	2.1	8.2	172.4	0.3	58.7	1455.6	47.8	3.9	11.2	0.2
03/14/99	3	160.0	901.1	2774.4	0.220	0.492	0.140	3.5	7.7	32.8	0.7	13.8	5.6	22.0	262.1	1256.9	1.5	3.3	3.5
04/30/99	4	171.6	295.9	0.0	0.139	0.061	0.000	2.2	1.0	0.0	0.5	3.3	0.0	27.8	142.9	0.0	0.9	0.4	0.0
05/30/99	5	61.1	224.0	0.0	0.087	0.067	0.000	0.6	1.0	0.0	0.6	1.1	0.0	17.5	84.6	0.0	0.4	0.4	0.0
06/02/99	6	165.3	71.8	0.0	0.116	0.023	0.000	1.8	0.4	0.0	0.4	0.2	0.0	38.8	40.3	0.0	0.8	0.2	0.0
06/06/99	7	119.0	33.0	0.0	0.159	0.011	0.000	1.2	0.2	0.0	0.0	0.0	0.0	18.6	19.7	0.0	0.5	0.1	0.0
06/16/99	8	146.6	751.8	0.0	0.231	0.296	0.000	1.2	3.7	0.0	4.2	9.9	0.0	46.3	335.5	0.0	1.5	2.0	0.0
07/01/99	9	117.7	173.2	0.0	0.138	0.119	0.000	0.6	0.9	0.0	3.0	2.1	0.0	36.8	87.0	0.0	0.9	0.8	0.0
07/02/99	10	36.5	41.5	0.0	0.049	0.042	0.000	0.2	0.5	0.0	0.3	2.0	0.0	19.7	39.0	0.0	0.2	0.2	0.0
07/09/99	11	38.4	92.8	0.0	0.070	0.051	0.000	0.5	0.3	0.0	1.3	0.7	0.0	13.9	50.6	0.0	0.3	0.3	0.0
07/26/99	12	522.2	50.4	0.0	0.164	0.064	0.000	1.1	0.4	0.0	4.1	2.1	0.0	250.7	55.6	0.0	0.8	0.3	0.0
08/06/99	13	59.8	18.5	0.0	0.480	0.110	0.000	1.0	0.2	0.0	1.0	0.2	0.0	38.4	51.8	0.0	0.7	0.1	0.0
08/12/99	14	65.6	5.1	0.0	0.070	0.009	0.000	0.5	0.1	0.0	0.5	0.2	0.0	5.8	5.2	0.0	0.3	0.0	0.0
08/14/99	15	11.5	16.0	0.0	0.039	0.021	0.000	0.3	0.1	0.0	0.6	0.4	0.0	3.3	20.9	0.0	0.2	0.1	0.0
08/16/99	16	197.3	206.8	3.7	0.257	0.193	0.003	1.7	1.3	0.0	1.7	5.9	0.0	21.4	269.7	2.5	1.3	1.0	0.0
08/18/99	17	134.4	1035.8	5723.0	0.299	0.854	0.721	0.4	15.9	36.6	2.0	43.3	9.3	24.9	1650.4	2693.2	1.5	4.3	8.7
08/22/99	18	137.0	844.2	6001.4	0.373	1.471	1.610	2.5	9.8	22.5	2.5	38.2	37.6	74.6	1862.9	3263.8	1.9	7.4	8.3
08/28/99	19	30.6	21.3	258.9	0.111	0.031	0.050	0.7	0.2	1.3	0.7	0.5	0.7	9.3	37.3	115.7	0.6	0.2	0.6
09/06/99	20	104.9	879.2	6258.0	0.423	1.832	1.010	2.8	6.1	23.6	2.8	15.3	6.7	35.2	1099.1	3435.5	2.1	4.6	5.1
09/11/99	21	39.2	53.3	698.4	0.074	0.084	0.163	0.5	0.6	2.3	1.0	2.7	3.2	14.8	84.1	370.4	0.4	0.4	0.8
09/19/99	22	247.3	1279.5	12809.4	0.706	1.116	1.001	1.5	16.4	33.4	2.4	18.6	22.0	70.6	2157.4	5437.3	1.8	5.6	13.3
10/04/99	23	764.2	46761.9	23609.7	1.723	9.229	3.697	5.7	507.6	150.3	5.7	1621.3	101.0	209.6	29226.2	7578.3	4.3	160.0	22.2
11/01/99	24	68.8	1862.1	3907.3	0.266	0.479	0.618	1.8	27.1	13.2	1.8	79.2	12.8	70.9	2108.0	1463.2	1.3	6.1	4.1
11/22/99	25	368.6	1665.3	10640.5	0.120	0.413	0.471	0.8	14.0	29.2	3.6	90.6	28.6	32.0	963.4	3986.3	0.6	2.1	11.6
Number Storms		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
TOTAL LOADS (g)		4199	60084	72776	7.10	19.09	9.52	45.30	647.33	347.16	50.33	2138.74	227.79	1181.81	42451.06	29650.76	30.22	213.10	78.39
% Reduction from inflow to outflow (%efficiency)																			
Inflow to outflow				-21%			50%			46%			89%			30%			63%
includes rain as input				-13%			64%			50%			90%			32%			68%
TOTAL LOADS																			
(g/ac)			286.1	346.6		0.091	0.045		3.083	1.653		10.184	1.085		202.148	141.194		1.015	0.373
(kg/ac)			0.29	0.35		0.0001	0.0000		0.0031	0.0017		0.0102	0.0011		0.2021	0.1412		0.0010	0.0004
TOTAL LOADS if all storms measured (18% more rain and runoff)																			
(g/ac-yr)			337.6	408.9		0.1073	0.0535		3.6374	1.9507		12.0177	1.2800		238.5345	166.6091		1.1974	0.4405
(kg/ac-yr)			0.34	0.41		0.0001	0.0001		0.0036	0.0020		0.0120	0.0013		0.2385	0.1666		0.0012	0.0004

Appendix E-2 (continued). Mass loading of pollutants for 2000 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 21 storm events for 28.36 inches of rain. A total of 33.27 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significant runoff. It is estimated that samples were collected for 85 per cent of all storms with runoff

YEAR THREE - MASS LOADING

Date of storm	Storm #	Aluminum grams			Cadmium grams			Chromium grams			Copper grams			Iron grams			Lead grams		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
1	02/14/00	31.8	877.6	4524.0	0.010	0.034	0.020	0.7	7.7	10.9	0.7	35.1	7.2	33.4	680.3	1698.2	0.5	1.7	4.1
2	03/27/00	96.3	3795.3	0.0	0.143	0.435	0.000	1.0	30.4	0.0	1.0	42.6	0.0	66.8	2491.6	0.0	0.7	6.7	0.0
3	04/13/00	76.6	681.1	0.0	0.159	0.273	0.000	1.1	12.0	0.0	1.1	29.8	0.0	116.7	580.7	0.0	0.8	3.6	0.0
4	06/25/00	26.8	206.4	0.0	0.125	0.173	0.000	0.8	2.4	0.0	0.8	8.4	0.0	10.4	622.8	0.0	0.6	0.9	0.0
5	06/26/00	110.3	608.4	0.0	0.118	0.426	0.000	0.8	2.8	0.0	0.8	40.7	0.0	78.8	1671.8	0.0	0.6	2.1	0.0
6	07/01/00	104.0	530.2	0.0	0.227	0.626	0.000	1.5	4.2	0.0	1.5	4.2	0.0	60.5	2630.1	0.0	1.1	3.1	0.0
7	07/06/00	159.9	23387.8	0.0	0.124	0.183	0.000	0.8	2.4	0.0	2.7	4.3	0.0	49.7	779.6	0.0	0.6	0.9	0.0
8	07/08/00	33.5	71.9	7.6	0.055	0.036	0.005	0.4	0.2	0.0	0.4	8.3	0.2	4.5	72.4	2.7	0.3	0.2	0.1
9	07/09/00	293.9	36751.9	9002.8	0.556	11.971	1.491	3.7	554.3	9.9	7.8	1191.1	37.8	222.4	22506.1	3577.3	2.8	183.2	16.1
10	07/15/00	310.2	134525.2	20761.1	0.929	59.412	6.408	6.2	2949.4	123.9	6.2	5644.1	281.9	309.6	105243.7	11534.0	4.6	903.9	32.0
11	07/31/00	177.9	305.9	151.7	0.166	0.181	0.256	1.1	5.8	1.7	5.7	22.0	1.7	110.5	326.4	102.3	0.8	1.8	1.3
12	08/12/00	305.5	2673.8	877.8	0.290	1.215	0.347	1.9	41.6	9.2	1.9	113.5	5.3	270.7	2041.8	479.7	1.4	13.6	1.8
13	08/22/00	51.2	1023.1	875.6	0.111	0.140	0.130	0.7	9.8	7.6	2.0	21.6	8.1	51.9	288.3	598.2	0.6	0.7	2.4
14	08/26/00	154.8	1265.5	3284.6	0.137	0.585	0.189	0.9	18.7	11.0	3.8	56.5	14.9	82.4	955.5	1466.1	0.7	6.0	6.4
15	09/06/00	29.3	1969.4	2333.6	0.148	0.809	0.202	1.0	34.7	5.9	3.5	94.3	8.6	39.5	1214.0	768.9	0.7	8.5	2.6
16	09/07/00	39.4	6997.0	1142.3	0.185	3.378	0.321	1.2	136.1	3.3	1.2	598.4	2.1	15.4	4632.5	481.3	0.9	40.5	1.6
17	09/16/00	138.0	21888.6	28297.2	0.770	25.276	6.835	5.1	369.0	255.2	5.1	3038.1	79.7	205.2	19613.8	12120.9	3.8	101.1	44.2
18	09/27/00	51.6	17687.8	7381.9	0.294	7.818	0.971	2.0	341.1	24.6	2.0	1661.3	23.3	58.9	13094.8	3431.9	1.5	121.2	4.9
19	10/06/00	39.3	5688.8	12759.1	0.259	1.928	0.277	1.7	90.6	29.5	1.7	607.4	36.7	86.5	4178.2	6416.4	1.3	27.0	10.9
20	11/25/00	39.4	26354.2	0.0	0.286	8.159	0.000	1.9	264.4	65.2	1.9	2039.8	107.9	24.8	21703.4	12913.2	1.4	98.7	27.6
22	12/17/00	6.3	6244.8	6035.1	0.082	0.987	0.290	0.5	30.1	16.4	0.5	204.9	15.1	7.1	2048.7	2224.5	0.4	9.9	6.6
Number Storms		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
TOTAL LOADS (g)		2276	293535	97435	5.2	124.0	17.7	35.1	4907.7	574.5	52.3	15466.4	630.7	1905.7	207376.5	57815.5	26.3	1535.4	162.5
% Reduction from inflow to outflow (%efficiency)																			
Inflow to outflow				67%			86%			88%			96%			72%			89%
includes rain as input				67%			86%			88%			96%			72%			90%
TOTAL LOADS																			
(g/ac)			1397.8	464.0		0.591	0.084		23.370	2.736		73.650	3.003		987.507	275.312		7.311	0.774
(kg/ac)			1.40	0.46		0.0006	0.0001		0.0234	0.0027		0.0736	0.0030		0.9875	0.2753		0.0073	0.0008
TOTAL LOADS if all storms measured (15% more rain and runoff)																			
(g/ac-yr)			1607.5	533.6		0.68	0.10		26.88	3.15		84.70	3.45		1135.63	316.61		8.41	0.89
(kg/ac-yr)			1.61	0.53		0.0007	0.0001		0.0269	0.0031		0.0847	0.0035		1.1356	0.3166		0.0084	0.0009

Appendix E-2 (continued). Mass loading of pollutants for 2001 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 14 storm events for 28.62 inches of rain. A total of 36.72 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms that were too small to produce significant runoff. It is estimated that samples were collected for 86 per cent of all storms with runoff. One hurricane produced 9.91 inches of rain (#12) and accounts for the largest percentage of all loads measured for the year.

YEAR FOUR - MASS LOADING

Date of storm	Storm #	Aluminum grams			Cadmium grams			Chromium grams			Copper grams			Iron grams			Lead grams		
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL
03/04/01	1	153.4	6286.7	934.3	0.357	0.873	0.403	2.4	18.6	2.7	9.1	79.7	12.9	119.1	1979.1	241.6	1.8	4.4	2.0
03/29/01	2	1943.2	53365.6	14864.1	0.937	10.716	1.584	23.7	353.6	40.8	21.9	1733.8	55.9	2124.4	33648.2	4900.2	10.6	158.6	14.6
06/23/01	3	361.5	239825.4	854.2	0.642	25.143	0.489	4.3	1038.6	3.3	9.4	2669.0	24.6	53.5	127262.2	488.9	3.2	276.6	2.4
06/30/01	4	138.8	40968.2	7245.2	0.256	6.260	0.962	1.7	209.4	6.4	1.7	709.5	6.4	68.2	26361.5	705.3	1.3	62.6	4.8
07/04/01	5	17.2	760.8	8.1	0.051	0.088	0.084	0.3	4.9	0.6	0.3	10.2	0.7	13.5	601.6	56.1	0.3	1.0	0.4
07/16/01	6	45.9	119.5	401.6	0.163	0.067	0.072	1.1	0.4	1.6	1.1	0.4	3.1	65.3	49.4	258.4	0.8	0.3	0.4
07/21/01	7	35.8	2949.3	1780.2	0.181	0.425	0.191	1.2	9.1	1.3	1.2	23.5	1.3	60.3	907.5	114.4	0.9	2.1	1.0
07/23/01	8	56.6	76054.5	12953.4	0.408	12.623	4.983	2.7	391.3	33.2	2.7	1180.3	33.2	81.6	48599.1	10890.1	2.0	113.6	24.9
07/26/01	9	73.7	2731.2	7328.0	0.152	0.806	0.963	1.0	21.0	6.4	1.0	66.1	4.6	71.0	2580.7	746.1	0.8	4.0	4.8
08/05/01	10	36.8	762.5	228.4	0.104	0.599	0.245	0.7	13.6	1.6	0.7	43.1	1.6	20.7	1317.5	114.2	0.5	3.0	1.2
09/11/01	11	0.0	1517.5	3.7	0.238	0.248	0.005	1.6	9.1	0.0	1.6	39.6	0.1	63.5	1340.5	3.8	1.2	3.1	0.0
09/14/01	12	540.9	41868.4	18695.4	2.185	14.553	16.531	14.6	621.9	110.2	14.6	5280.3	2270.3	182.1	15154.3	10361.5	10.9	271.7	82.7
09/29/01	13	70.9	1737.5	91.1	0.191	0.251	0.239	1.5	9.2	1.6	1.5	39.9	2.9	58.8	801.9	141.6	1.1	2.8	1.2
10/21/01	14	98.4	874.4	202.0	0.417	0.442	0.283	2.8	13.0	1.9	2.8	106.6	10.2	34.7	912.7	164.5	2.1	4.7	1.4
Number Storms		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
TOTAL LOADS (g)		3573	469822	65589	6.28	73.10	27.03	59.57	2713.63	211.57	69.50	11982.19	2427.71	3016.8	261516.2	29186.8	37.49	908.58	141.85
% Reduction from inflow to outflow (%efficiency)																			
Inflow to outflow				86%			63%			92%			80%			89%			84%
includes rain as input				86%			66%			92%			80%			89%			85%
TOTAL LOADS																			
(g/ac)			2237.2	312.3		0.348	0.129		12.922	1.007		57.058	11.561		1245.3	139.0		4.327	0.675
(kg/ac)			2.24	0.31		0.000	0.000		0.013	0.001		0.057	0.012		1.2	0.1		0.004	0.001
TOTAL LOADS if all storms measured (14% more rain and runoff)																			
(g/ac-yr)			2550.5	356.1		0.397	0.147		14.731	1.149		65.046	13.179		1419.7	158.4		4.932	0.770
(kg/ac-yr)			2.55	0.36		0.000	0.000		0.015	0.001		0.065	0.013		1.4	0.2		0.005	0.001

Appendix E-3. Mass loading of pollutants for 1998 at the Cockroach BayAgricultural site. Flow and water quality data in the table include 25 storm events for 36 inches of rain. A total of 44 inches of rain was measured at the site for all storms greater than 0.16 inches. Manyof these were storms which were too small to produce significnt runoff. It is estimated that samples were collected for 82 per cent of all storms with runoff during 1998.

YEAR ONE - MASS LOADING

Date of storm	Storm #	Magnesium kilograms Lab Detection Limit			Manganese grams Lab Detection Limit			Nickel grams Lab Detection Limit 4.3			Silver grams Lab Detection Limit 0.1			Zinc grams Lab Detection Limit 30			TSS kilograms	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
01/06/98	1	0.2	168.0	na	5.0	468	na	4.3	12.0	na	1.0	1.0	na	84.0	84	na	46	0
01/15/98	2	0.1	113.1	55.3	2.4	1733	76	3.3	41.8	5.7	0.1	4.2	0.13	88.0	810	40	731	36
01/23/98	3	0.2	101.8	321.8	7.0	5593	220	7.1	168.2	35.2	0.2	14.3	0.51	49.5	2890	152	2594	96
02/15/98	5	0.6	407.7	371.6	3.3	5324	676	12.0	153.7	38.0	0.3	13.4	0.88	279.1	3565	265	3186	531
02/17/98	6	0.1	17.1	105.2	0.1	3260	106	1.0	69.7	10.4	0.0	8.5	0.48	18.0	1616	72	1214	37
02/19/98	7	0.4	185.4	429.5	2.1	44035	1484	11.2	928.4	60.5	0.5	126.2	3.97	150.7	22999	959	71409	583
02/28/98	9	0.2	189.7	64.6	5.2	2224	387	4.6	20.7	12.4	0.1	2.9	0.58	86.1	578	87	533	62
03/08/98	10	0.1	30.5	0.0	7.3	387	0	2.1	3.4	0.0	0.2	0.3	0.00	39.5	63	0	65	0
03/18/98	11	0.2	206.9	369.5	18.6	1925	1675	16.0	61.6	66.2	0.4	1.4	1.54	111.6	860	462	1003	203
04/20/98	12	0.0	0.4	0.0	1.0	5	0	0.8	0.2	0.0	0.0	0.0	0.00	5.4	2	0	3	0
05/28/98	13	0.0	7.1	0.0	6.1	16	0	2.3	0.5	0.0	0.1	0.0	0.00	15.9	4	0	1	0
05/30/98	14	0.1	42.6	0.0	1.4	243	0	0.8	3.0	0.0	0.0	0.3	0.00	21.0	56	0	44	0
06/23/98	15	0.0	10.5	0.0	16.4	17	0	6.0	0.8	0.0	0.1	0.0	0.00	307.8	5	0	5	0
07/06/98	16	0.0	2.1	0.0	2.8	3	0	0.7	0.2	0.0	0.0	0.0	0.00	105.2	1	0	1	0
07/10/98	17	0.0	10.2	0.0	1.9	13	0	1.2	0.8	0.0	0.0	0.0	0.00	54.8	5	0	3	0
07/17/98	18	0.1	31.6	0.0	4.1	260	0	3.8	2.3	0.0	0.1	0.1	0.00	177.9	16	0	8	0
07/21/98	19	0.0	1.6	0.0	1.6	2	0	0.7	0.1	0.0	0.0	0.0	0.00	31.1	2	0	1	0
08/16/98	20	0.1	3.4	0.0	1.2	5	0	1.5	0.3	0.0	0.0	0.0	0.00	69.2	2	0	1	0
08/17/98	21	0.1	6.0	0.0	1.4	26	0	4.9	0.6	0.0	0.0	0.0	0.00	93.6	9	0	5	0
09/02/98	22	0.9	8.0	0.0	8.2	4	0	4.4	0.6	0.0	0.1	0.0	0.00	245.9	4	0	2	0
09/06/98	23	0.3	49.1	0.0	7.2	1207	0	9.1	7.4	0.0	0.2	1.4	0.00	63.7	242	0	235	0
09/18/98	24	0.2	70.8	0.0	2.0	698	0	5.3	5.2	0.0	0.1	0.1	0.00	37.1	36	0	30	0
09/19/98	25	0.1	192.2	628.0	2.0	2791	343	5.4	20.8	7.7	0.1	0.5	0.18	37.5	145	54	33	70
09/20/98	26	0.0	190.5	355.2	0.7	1005	328	1.1	15.2	5.9	0.0	0.7	0.14	15.3	106	41	41	205
12/13/98	27	0.1	5.8	0.0	1.3	9	0	1.2	0.3	0.0	0.0	0.0	0.00	22.6	2	0	2	0
TOTAL LOADS (g)		4	1884	2701	105.34	70785	5295	106.5	1505.7	242.0	2.7	174.4	8.4	2127	34017	2132	81150	1824
% Reduction from inflow to outflow (%efficiency)																		
Inflow to outflow				-43%			93%			84%			95%			94%		98%
includes rain as input				-43%			93%			85%			95%			94%		98%
TOTAL LOADS																		
(g/ac)			8.971	12.860		337.07	25.21		7.17	1.15		0.83	0.04		161.99	10.15	386.43	8.68
(kg/ac)			0.01	0.01		0.3371	0.0252		0.0072	0.0012		0.0008	0.0000		0.1620	0.0102	0.3864	0.0087
TOTAL LOADS if all storms measured (18% more rain and runoff)																		
(g/ac-yr)			10.586	15.175		397.75	29.75		8.46	1.36		0.98	0.05		191.14	11.98	455.99	10.25
(kg/ac-yr)			0.01	0.02		0.3977	0.0298		0.0085	0.0014		0.0010	0.0000		0.1911	0.0120	0.4560	0.0102

* Does not include storm # 1 since it has no outflow data

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Appendix E-3 (continued). Mass loading of pollutants for 1999 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 25 storm events for 28.91 inches of rain. A total of 33.43 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significant runoff. It is estimated that samples were collected for 82 per cent of all storms with runoff during 1999.

YEAR TWO - MASS LOADING

Date of storm	Storm #	Magnesium kilograms Lab Detection Limit			Manganese grams Lab Detection Limit			Nickel grams Lab Detection Limit 4.3			Silver grams Lab Detection Limit 0.1			Zinc grams Lab Detection Limit 30			TSS kilograms	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
01/02/99	1	0.1	90.7	0.0	1.1	80	0	2.9	4.9	0.0	0.1	0.1	0.00	20.2	34.2	0.0	14.2	0.0
01/25/99	2	6.7	362.8	40.4	11.7	579	10	8.4	24.1	1.3	0.2	0.6	0.01	273.7	167.9	3.6	31.4	1.6
03/14/99	3	0.4	151.7	135.9	2.5	81	69	3.2	7.0	17.0	0.1	0.2	0.05	58.7	49.2	14.0	9.8	28.7
04/30/99	4	0.1	21.5	0.0	1.4	42	0	2.0	0.9	0.0	0.0	0.1	0.00	37.1	6.1	0.0	6.1	0.0
05/30/99	5	0.1	22.7	0.0	0.9	22	0	0.7	1.0	0.0	0.0	0.0	0.00	23.3	6.7	0.0	3.6	0.0
06/02/99	6	0.2	8.1	0.0	4.7	6	0	1.7	0.3	0.0	0.0	0.0	0.00	46.6	2.3	0.0	3.0	0.0
06/06/99	7	0.1	4.1	0.0	1.4	4	0	1.1	0.2	0.0	0.0	0.0	0.00	138.1	1.1	0.0	1.2	0.0
06/16/99	8	0.4	106.8	0.0	2.8	100	0	3.3	4.2	0.0	0.1	0.1	0.00	23.1	29.6	0.0	25.3	0.0
07/01/99	9	0.1	40.2	0.0	2.8	41	0	2.0	1.7	0.0	0.0	0.0	0.00	64.3	11.9	0.0	7.2	0.0
07/02/99	10	0.0	12.6	0.0	1.2	51	0	0.7	0.6	0.0	0.0	0.0	0.00	13.2	5.6	0.0	1.8	0.0
07/09/99	11	0.2	17.0	0.0	1.6	41	0	1.0	0.9	0.0	0.0	0.0	0.00	18.6	6.7	0.0	4.5	0.0
07/26/99	12	0.4	19.7	0.0	2.2	240	0	1.4	1.4	0.0	0.1	0.0	0.00	21.8	3.2	0.0	3.5	0.0
08/06/99	13	0.3	7.7	0.0	0.5	75	0	1.2	0.5	0.0	0.0	0.0	0.00	19.2	1.2	0.0	0.9	0.0
08/12/99	14	0.1	2.0	0.0	1.1	21	0	0.6	0.2	0.0	0.0	0.0	0.00	46.5	0.4	0.0	0.4	0.0
08/14/99	15	0.0	4.4	0.0	0.4	57	0	0.3	0.2	0.0	0.0	0.0	0.00	7.8	1.0	0.0	1.1	0.0
08/16/99	16	0.6	45.7	1.9	2.4	326	1	2.1	3.5	0.0	0.1	0.1	0.00	34.3	9.6	0.1	10.4	0.1
08/18/99	17	0.4	170.7	454.5	1.0	899	1231	2.5	7.1	23.1	0.1	0.3	0.24	39.8	42.7	96.2	46.1	106.0
08/22/99	18	0.5	411.8	1007.0	1.2	1569	968	3.1	12.3	13.4	0.1	0.5	0.54	49.7	73.5	214.7	53.3	165.1
08/28/99	19	0.3	8.3	23.8	0.7	43	40	0.9	0.3	0.4	0.0	0.1	0.02	29.7	1.6	2.5	0.9	5.4
09/06/99	20	1.6	272.3	2687.8	1.4	1056	1367	3.5	7.6	8.4	0.1	0.3	0.34	141.0	45.8	134.7	38.3	231.1
09/11/99	21	0.0	23.3	211.4	0.6	76	118	0.6	0.7	1.4	0.0	0.0	0.05	3.7	4.2	8.2	3.1	19.0
09/19/99	22	0.5	281.2	1493.1	3.1	1555	799	2.9	20.1	15.3	0.2	0.4	0.33	94.4	55.8	133.4	68.4	663.8
10/04/99	23	1.6	581.4	1200.2	11.6	5630	631	7.2	38.5	30.8	0.3	3.1	1.23	66.8	922.9	184.8	967.8	399.2
11/01/99	24	0.5	29.3	193.7	2.8	409	93	2.2	4.0	5.2	0.1	0.3	0.21	70.9	95.8	123.6	68.1	92.3
11/22/99	25	0.2	115.6	145.6	3.4	528	126	1.0	10.5	10.4	0.0	0.1	0.16	40.0	55.1	125.6	41.5	206.7
Number Storms		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
TOTAL LOADS		15	2721	7595	63.32	13451	5453	53.7	147.6	126.8	1.9	6.2	3.2	1362.4	1600.1	1041.4	1397.5	1919.0
% Reduction from inflow to outflow (%efficiency)																		
Inflow to outflow				-179%			59%			14%			48%			35%		-37%
includes rain as input				-178%			60%			37%			61%			65%		
TOTAL LOADS																		
(g/ac)						64.05	25.96		0.70	0.60		0.03	0.02		7.62	4.96		
(kg/ac)			12.957	36.168		0.0641	0.0260		0.0007	0.0006		0.0000	0.0000		0.0076	0.0050	6.65	9.14
TOTAL LOADS if all storms measured (14% more rain and runoff)																		
(g/ac-yr)						75.58	30.64		0.83	0.71		0.03	0.02		8.99	5.85		
(kg/ac-yr)			14.771	42.678		0.0756	0.0306		0.0008	0.0007		0.0000	0.0000		0.0090	0.0059	7.54	10.78

Appendix E-3 (continued) . Mass loading of pollutants for 2000 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 21 storm events for 28.36 inches of rain. A total of 33.27 inches of rain was measured at the site for all storms greater than 0.16 inches. Many of these were storms which were too small to produce significAnt runoff. It is estimated that samples were collected for 85 per cent of all storms with runoff

YEAR THREE - MASS LOADING

Date of storm	Storm #	Magnesium kilograms Lab Detection Limit			Manganese grams Lab Detection Limit			Nickel grams Lab Detection Limit 2.5			Silver grams Lab Detection Limit 0.1			Zinc grams Lab Detection Limit 30			TSS kilograms	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
1	02/14/00	0.01	111.0	66.6	1.7	322	38	0.8	2.9	1.7	0.0	0.1	0.07	33.4	45.4	27.2	95.9	160.3
2	03/27/00	0.01	164.7	0.0	2.3	614	0	1.2	7.3	0.0	0.0	0.3	0.00	38.1	57.9	0.0	215.0	0.0
3	04/13/00	0.01	24.5	0.0	0.5	144	0	1.3	1.9	0.0	0.1	0.1	0.00	21.2	20.5	0.0	0.0	0.0
4	06/25/00	0.00	57.3	0.0	1.0	729	0	1.1	1.5	0.0	0.0	0.1	0.00	6.3	8.6	0.0	16.1	0.0
5	06/26/00	0.02	117.0	0.0	2.0	909	0	1.0	3.6	0.0	0.0	0.1	0.00	5.9	21.3	0.0	20.1	0.0
6	07/01/00	0.02	196.8	0.0	1.8	1186	0	1.9	5.3	0.0	0.1	0.2	0.00	30.2	31.3	0.0	56.8	0.0
7	07/06/00	0.00	57.5	0.0	1.3	295	0	2.8	1.5	0.0	0.0	0.1	0.00	25.1	9.9	0.0	15.0	0.0
8	07/08/00	0.00	11.9	2.0	1.0	34	3	0.5	0.3	0.0	0.0	0.0	0.00	29.4	2.0	0.3	2.2	0.2
9	07/09/00	0.00	140.5	419.1	4.1	3532	1108	4.7	56.9	12.6	0.2	6.1	0.50	28.1	847.6	75.4	1175.7	171.9
10	07/15/00	0.69	656.7	2359.1	8.1	12137	5553	7.8	257.5	151.2	0.3	30.0	2.16	250.5	5150.6	324.0	9463.0	494.3
11	07/31/00	0.00	46.8	59.5	2.9	255	106	11.2	1.5	9.0	0.1	0.1	0.09	55.9	24.5	34.5	19.2	2.3
12	08/12/00	0.02	92.9	124.4	2.7	287	197	2.4	3.1	2.9	0.1	0.5	0.12	63.7	73.8	28.3	63.4	84.3
13	08/22/00	0.09	34.8	31.0	2.1	153	75	0.9	2.5	1.1	0.0	0.1	0.09	22.5	28.2	30.7	14.9	74.8
14	08/26/00	0.00	69.8	46.8	2.8	330	88	1.2	4.9	3.9	0.1	0.4	0.13	37.0	59.2	60.5	49.2	129.8
15	09/06/00	0.01	46.9	47.8	1.8	278	178	1.2	7.5	1.7	0.0	0.4	0.07	20.0	68.2	40.9	65.8	74.6
16	09/07/00	0.00	89.3	74.6	0.6	830	125	1.6	19.0	2.7	0.1	1.5	0.11	25.0	292.8	16.2	250.1	43.5
17	09/16/00	0.00	1441.8	1552.2	5.6	4979	597	6.5	153.4	66.4	0.3	10.2	2.77	38.9	1170.9	466.9	664.7	1520.9
18	09/27/00	0.10	146.3	408.7	1.0	1964	693	2.5	27.7	8.2	0.1	4.0	0.33	39.7	691.9	131.0	757.1	252.6
19	10/06/00	0.05	95.2	151.1	2.1	852	448	2.2	11.4	8.8	0.1	0.3	0.09	52.5	162.5	93.2	204.5	328.2
20	11/25/00	0.06	274.8	594.4	1.0	3770	244	2.4	33.8	29.2	0.1	4.1	0.75	57.8	742.7	374.8	217.0	750.3
22	12/17/00	0.08	117.2	139.7	0.5	315	61	0.7	8.9	10.3	0.0	0.2	0.10	10.9	98.7	58.0	97.0	174.5
Number Storms		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
TOTAL LOADS		1	3994	6077	46.91	33912	9514	55.9	612.5	309.7	1.9	58.9	7.4	892.3	9608.5	1761.9	13462.8	4262.7
% Reduction from inflow to outflow (%efficiency)																		
Inflow to outflow				-52%			72%			49%			88%			82%		68%
includes rain as input				-52%			72%			54%			88%			83%		
TOTAL LOADS																		
(g/ac)						161.49	45.31		2.92	1.47		0.28	0.04		45.75	8.39		
(kg/ac)			19.8	29.5		0.1615	0.0453		0.0029	0.0015		0.0003	0.0000		0.0458	0.0084	65.23	21.21
TOTAL LOADS if all storms measured (15% more rain and runoff)																		
(g/ac-yr)						185.7	52.1		3.35	1.70		0.32	0.04		52.62	9.65		
(kg/ac-yr)			22.8	34.0		0.1857	0.0521		0.0034	0.0017		0.0003	0.0000		0.0526	0.0096	75.01	24.39

Appendix E-3 (coninued). Mass loading of pollutants for 2001 at the Cockroach Bay Agricultural site. Flow and water quality data in the table include 14 storm events for 28.62 inches of rain. A total of 36.72 inches of rain was measured at the site for all storms greater than 0.16 inches. Manyof these were storms that were too small to produce significant runoff. It is estimated that samples were collected for 86 per cent of all storms with runoff. One hurricane produced 9.91 inches of rain (#12) and accounts for the largest percentage of all loads measured for the year.

YEAR FOUR (2001) - WATER QUALITY CONCENTRATIONS

Date of storm	Storm #	Magnesium kilograms Lab Detection Limit 0.006			Manganese grams Lab Detection Limit 0.6			Nickel grams Lab Detection Limit 4.3			Silver grams Lab Detection Limit 0.1			Zinc grams Lab Detection Limit 30			TSS kilograms Lab D. L. 0.05	
		RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	RAIN	INFLOW	OUTFL	INFLOW	OUTFL
03/04/01	1	0.8	291.1	171.6	6.7	949	181	3.0	7.3	3.4	0.1	0.6	0.13	333.4	116.4	20.1	176.4	2.8
03/29/01	2	0.6	977.3	517.2	25.6	5508	227	25.0	122.2	21.7	0.3	4.3	0.51	249.9	1071.6	228.5	1543.1	268.5
06/23/01	3	0.4	713.7	165.2	5.1	22629	399	5.3	201.1	6.5	0.4	9.7	0.28	85.6	2320.9	75.4	7568.0	53.0
06/30/01	4	0.2	185.0	365.5	2.7	3123	637	2.1	56.3	8.0	0.1	2.8	0.32	51.2	626.0	48.1	813.1	14.7
07/04/01	5	0.0	26.3	30.6	0.5	258	48	0.4	1.9	1.7	0.0	0.1	0.03	11.0	11.8	4.2	16.1	1.5
07/16/01	6	0.1	24.1	19.8	2.4	57	190	6.0	0.6	1.3	0.1	0.0	0.02	54.4	9.0	9.6	12.5	6.0
07/21/01	7	0.1	119.7	67.8	0.6	1143	150	1.5	8.5	4.3	0.1	0.1	0.06	24.1	21.3	9.5	32.9	6.0
07/23/01	8	0.3	605.9	1529.3	3.0	6154	2226	3.4	135.7	41.5	0.1	3.2	1.66	20.4	1262.3	249.1	2092.6	396.2
07/26/01	9	0.1	193.0	432.0	1.7	1575	628	1.3	14.0	8.0	0.1	0.5	0.21	7.6	107.5	48.1	74.9	18.4
08/05/01	10	0.1	138.5	160.7	1.5	1086	95	0.9	5.0	2.0	0.0	0.2	0.08	13.8	79.8	12.2	59.5	2.8
09/11/01	11	0.2	61.2	3.0	2.2	523	4	2.0	2.1	0.0	0.1	0.1	0.00	51.8	49.6	1.0	46.9	0.2
09/14/01	12	6.0	2797.0	2966.1	7.3	13219	4585	18.2	239.7	137.8	0.7	16.9	9.61	512.9	2343.0	1850.8	2182.9	462.9
09/29/01	13	0.1	61.8	46.2	0.7	454	103	1.8	4.5	2.0	0.1	0.2	0.08	58.8	40.4	84.9	46.4	7.0
10/21/01	14	0.3	117.5	59.2	3.3	503	160	3.5	7.9	2.4	0.1	0.3	0.09	111.1	147.2	64.7	35.3	5.8
Number Storms		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
TOTAL LOADS		9	6312	6534	63.43	57181	9632	74.40	806.81	240.68	2.37	38.86	13.09	1586.01	8206.94	2706.27	14701	1246
% Reduction from inflow to outflow (%efficiency)																		
Inflow to outflow				-4%			83%			70%			66%			67%		92%
includes rain as input				-3%			83%			73%			68%			72%		
TOTAL LOADS																		
(g/ac)						272	46		3.842	1.146		0.185	0.062		39.081	12.887		
(kg/ac)			30.1	31.1		0.272	0.046		0.004	0.001		0.000	0.000		0.039	0.013	70.0	5.9
TOTAL LOADS if all storms measured (14% more rain and runoff)																		
(g/ac-yr)						310	52		4.380	1.307		0.211	0.071		44.552	14.691		
(kg/ac-yr)			34.3	35.5		0.310	0.052		0.004	0.001		0.000	0.000		0.045	0.015	79.8	6.8

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APPENDIX F

Hydrolab measurements made at hourly intervals when deployed in the field
Rainfall included for comparison

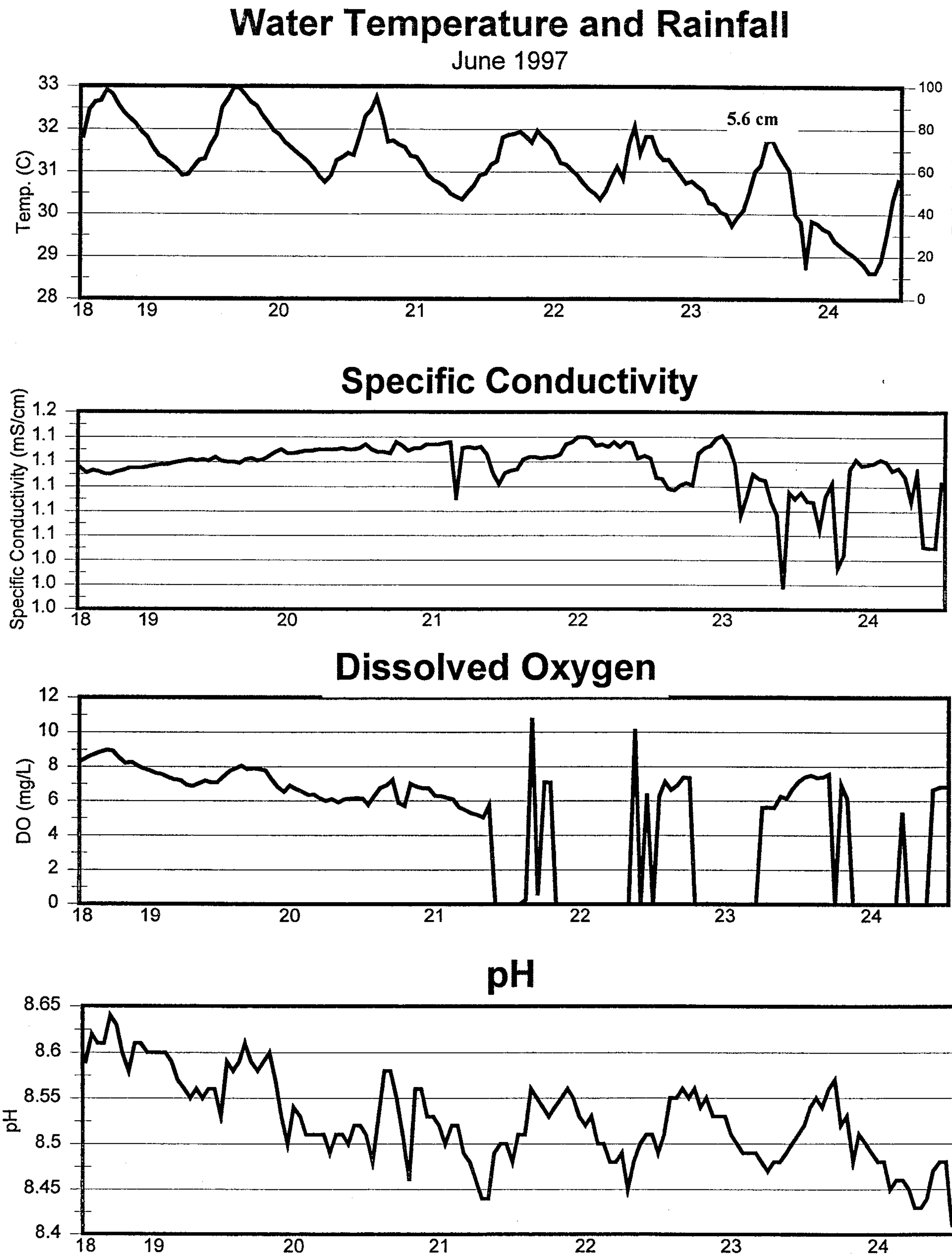


Figure 1. Weekly hydrolab data collected at the inflow of the pond.

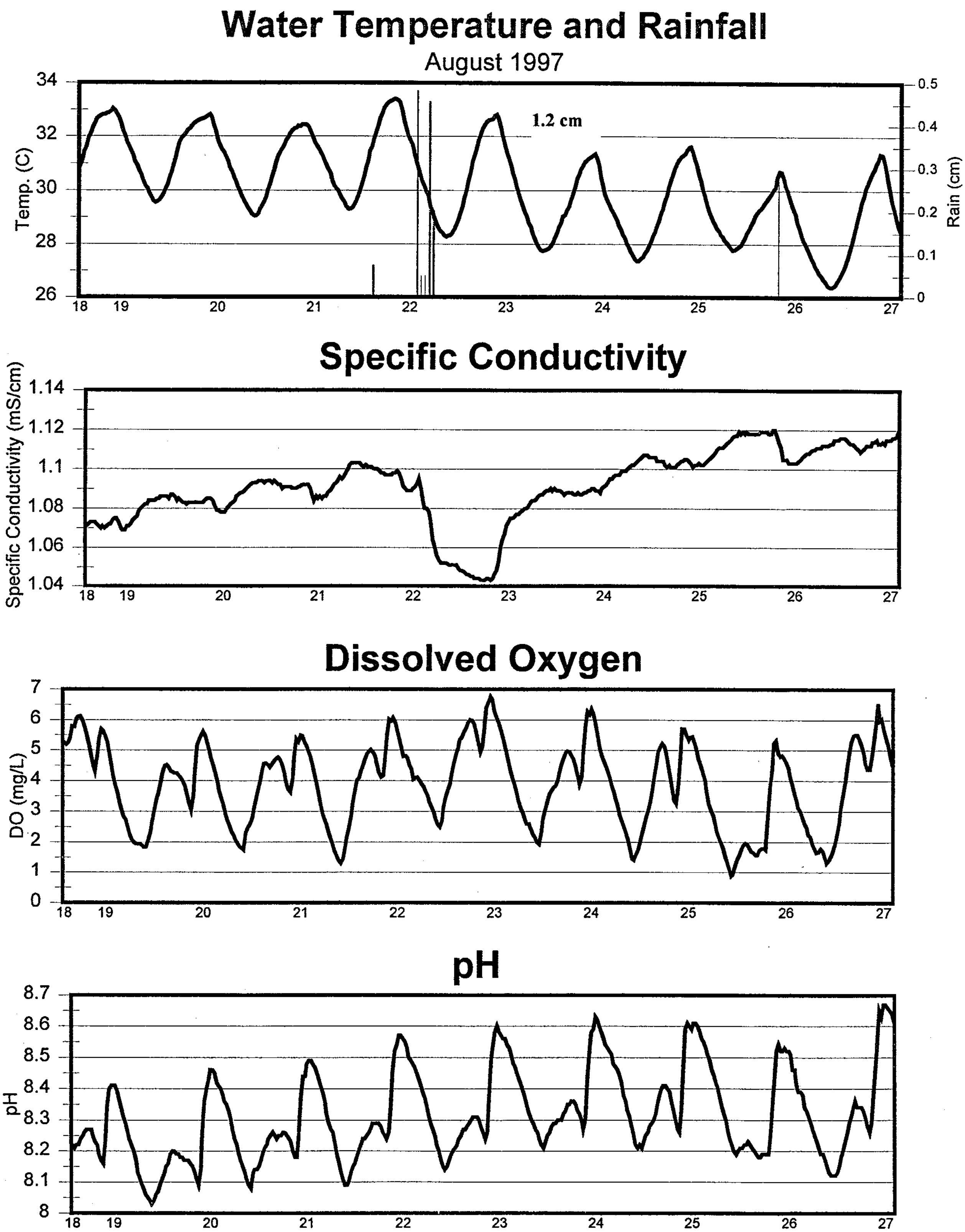


Figure 2. Weekly hydrolab data collected at the outflow of the pond.

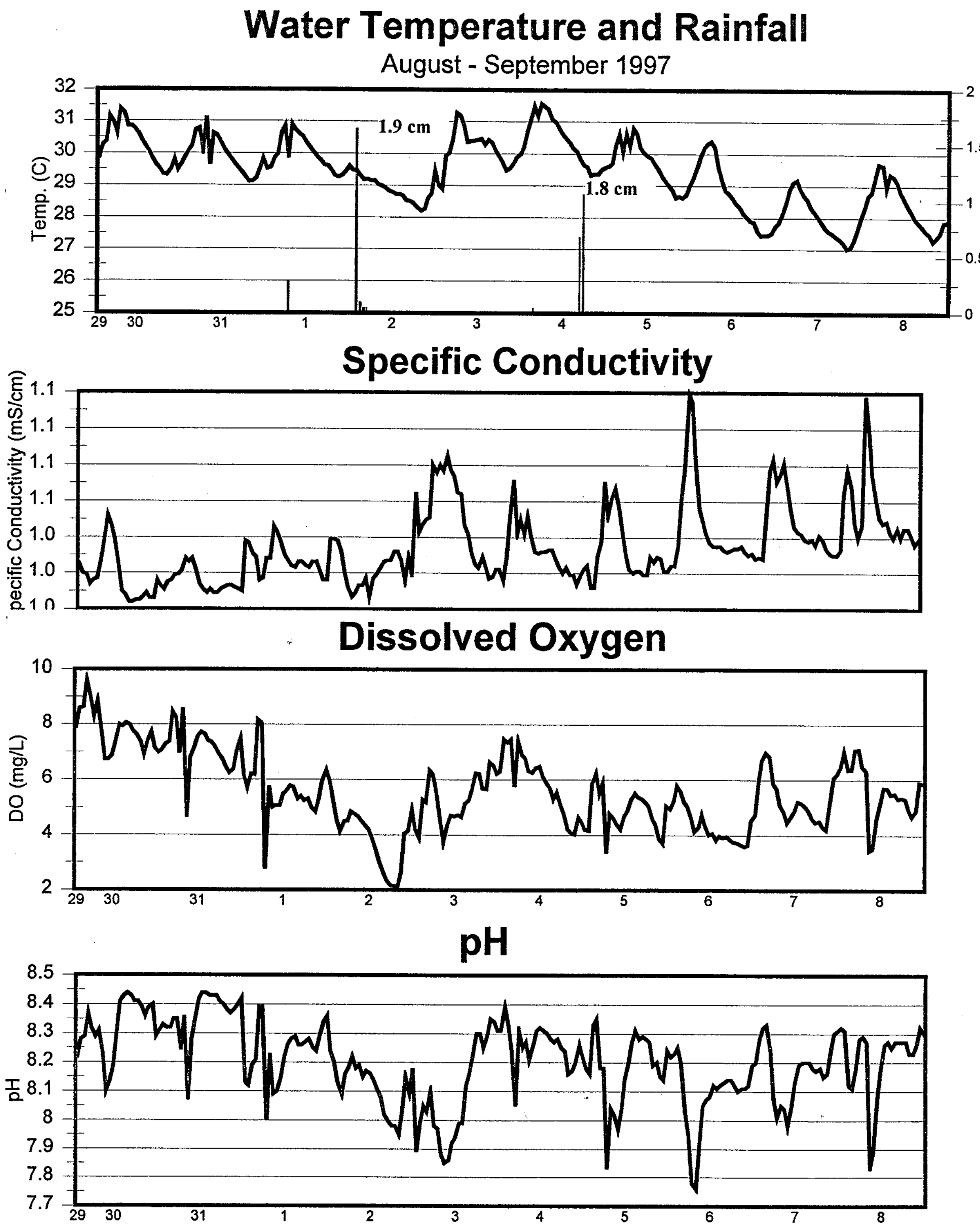


Figure 3. Weekly hydrolab data collected at the inflow of the pond.

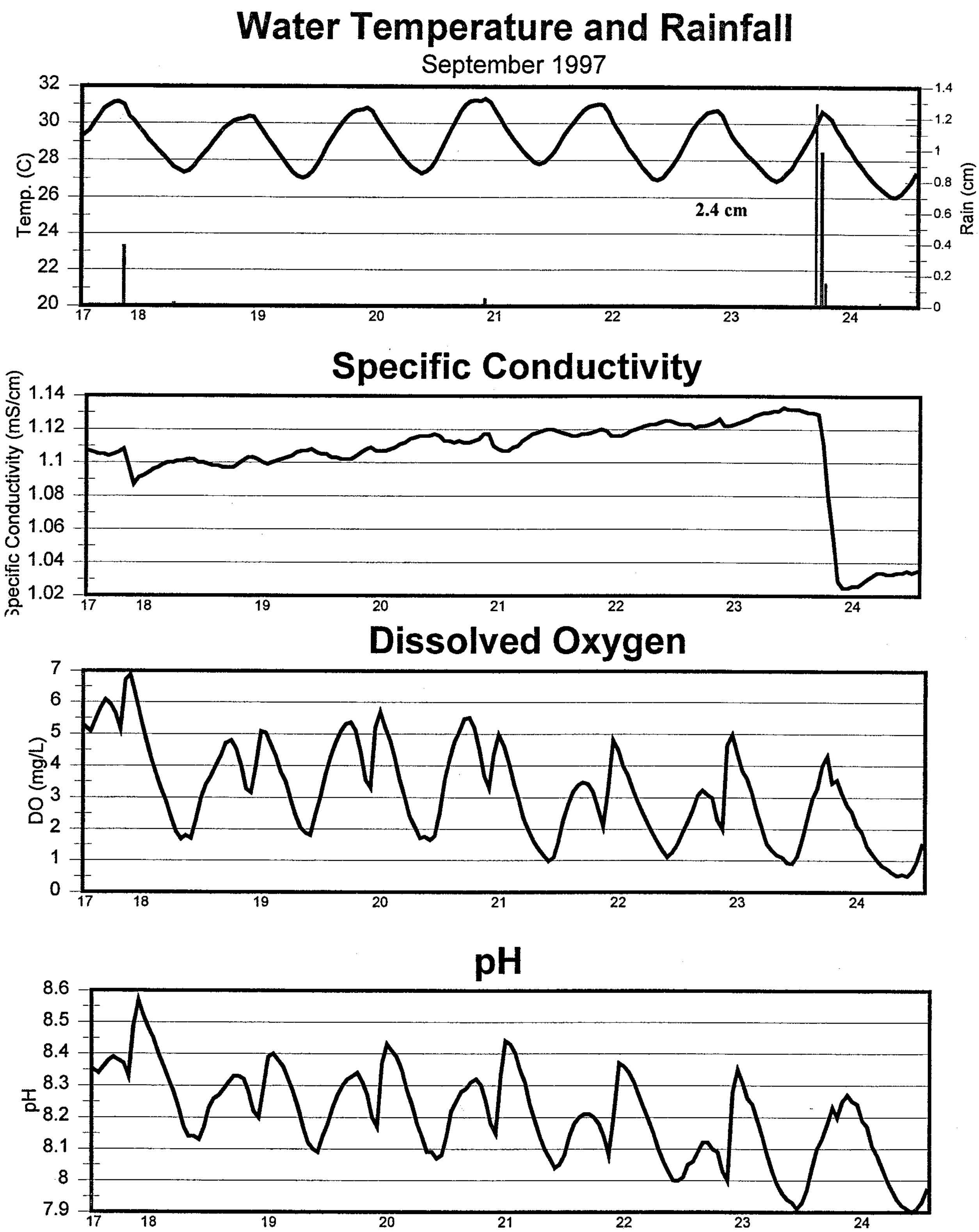


Figure 4. Weekly hydrolab data collected at the outflow of the pond.

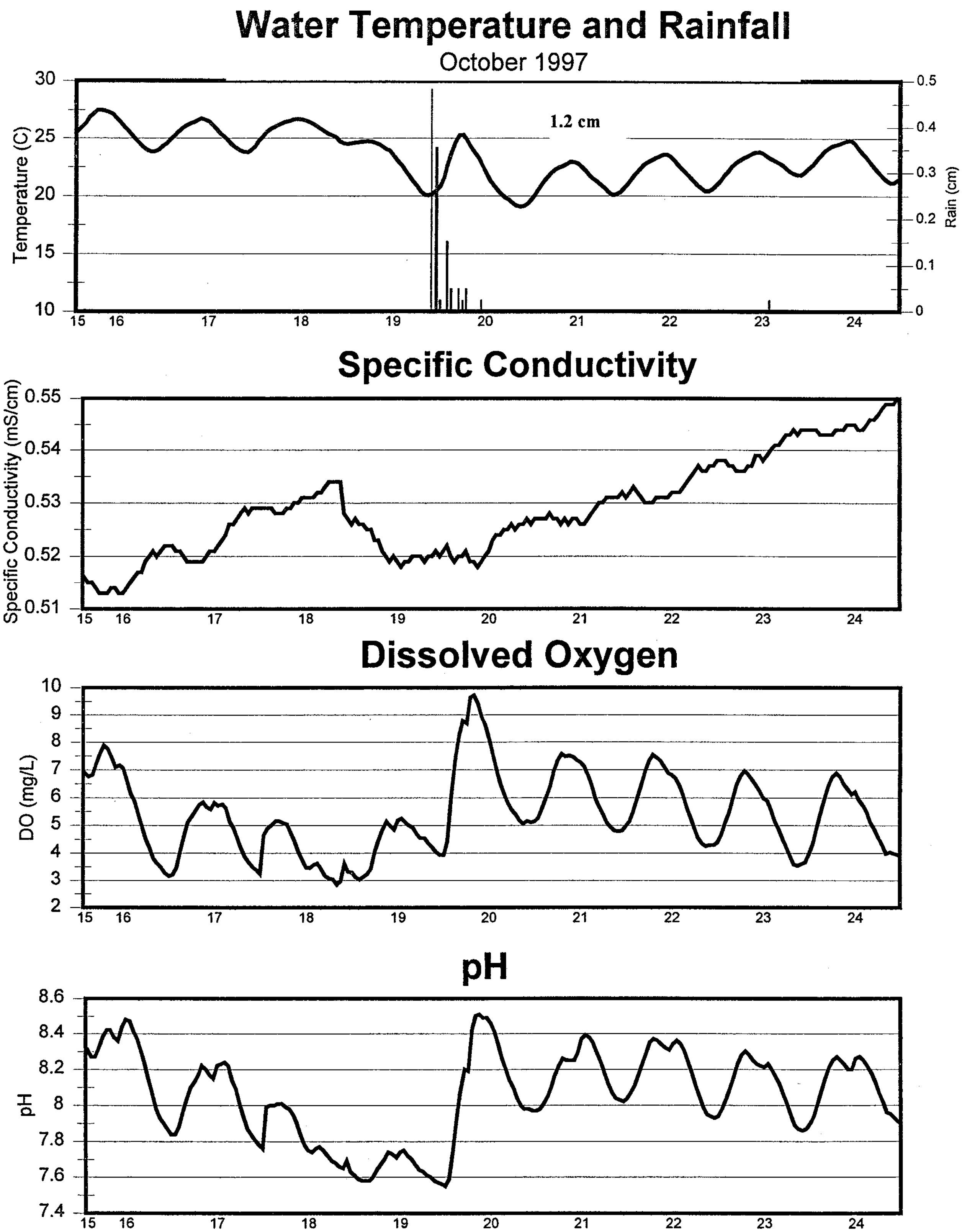


Figure 5. Weekly hydrolab data collected at the outflow of the pond.

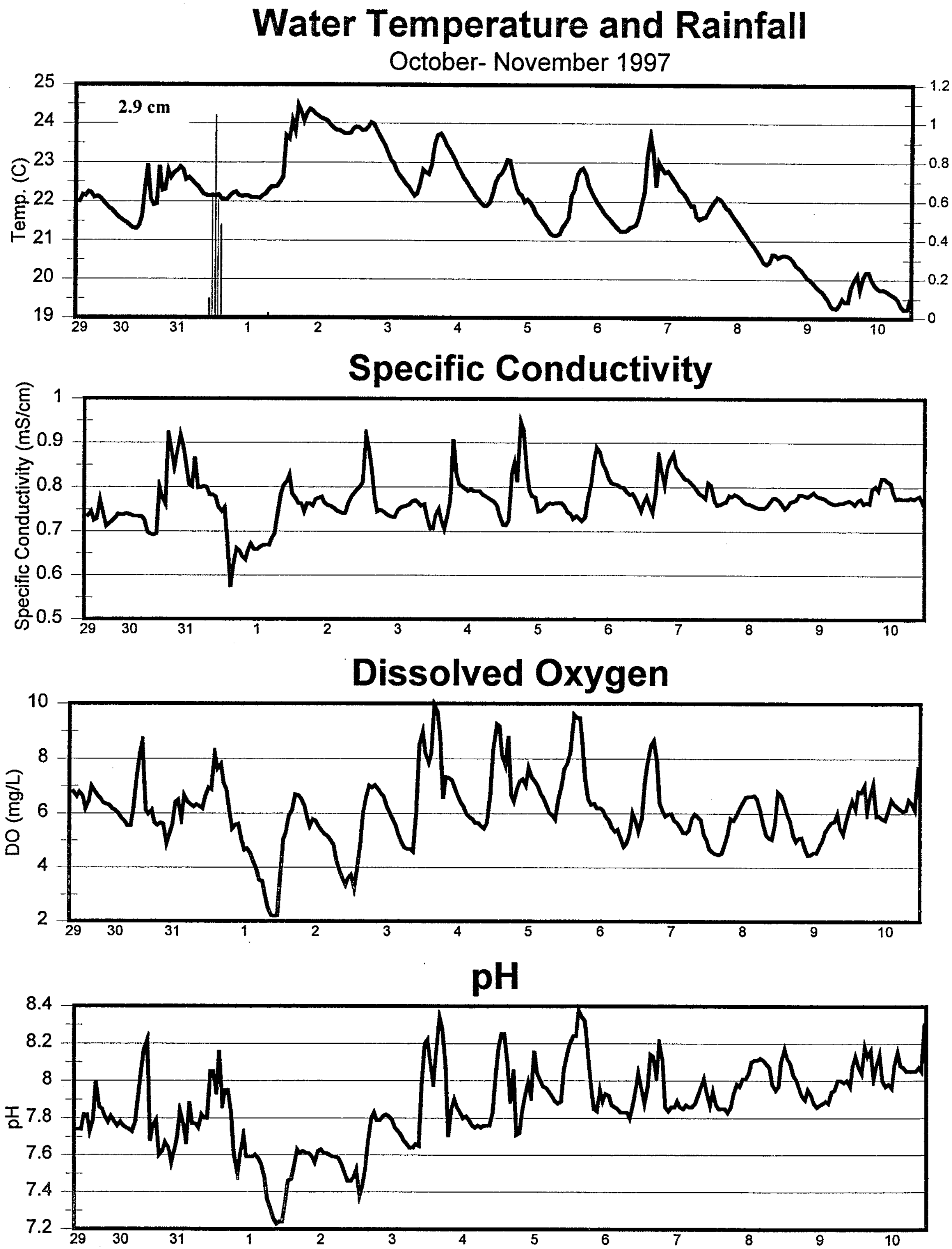


Figure 6. Weekly hydrolab data collected at the inflow of the pond.

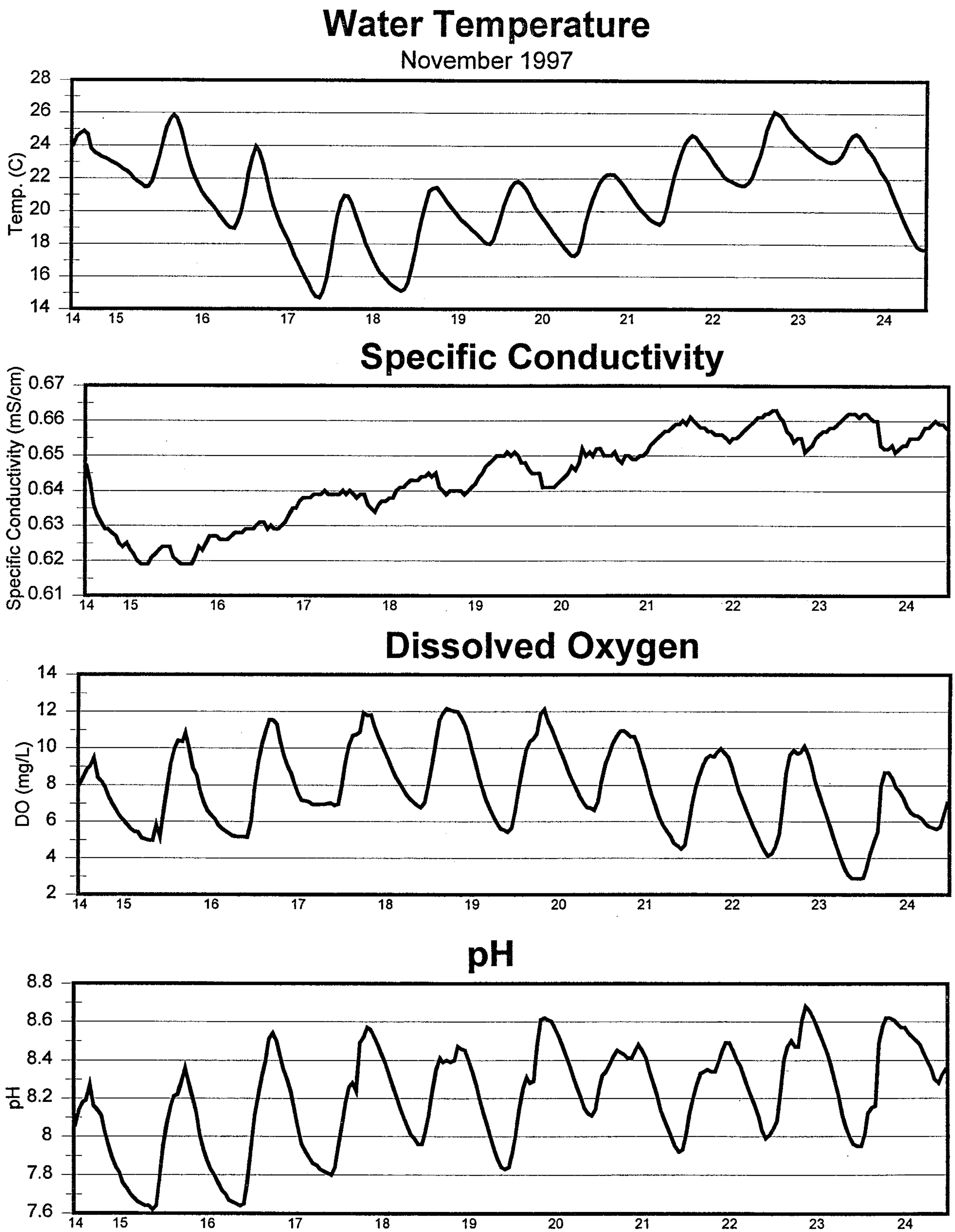
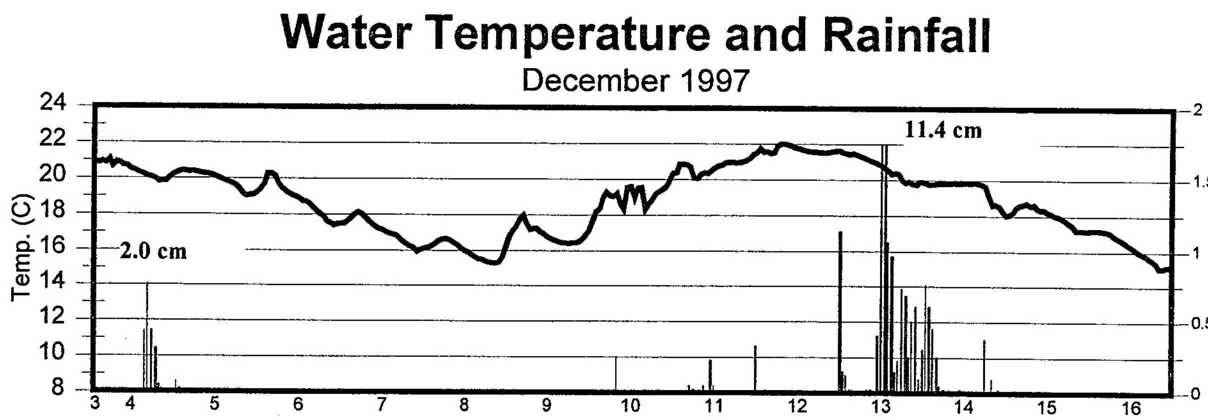
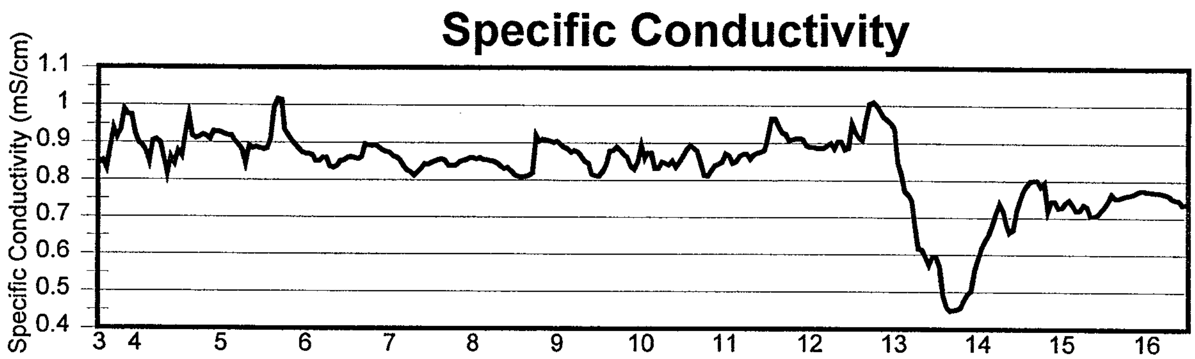
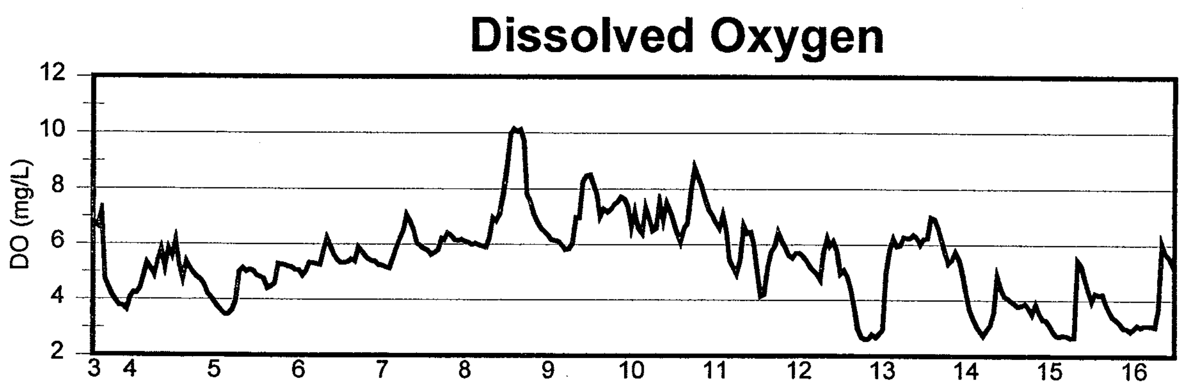


Figure7. Weekly hydrolab data collected at the outflow of the pond.







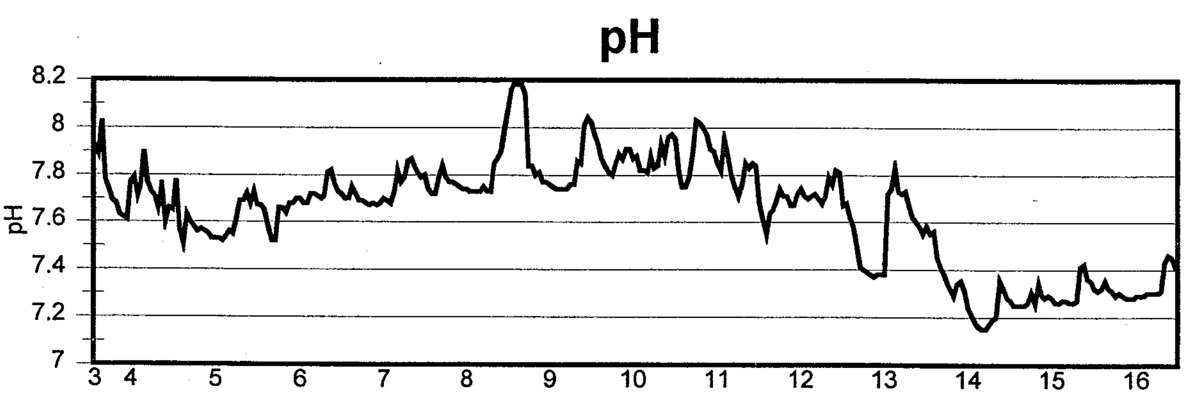


Figure 8. Weekly hydrolab data collected at the inflow from the pond.

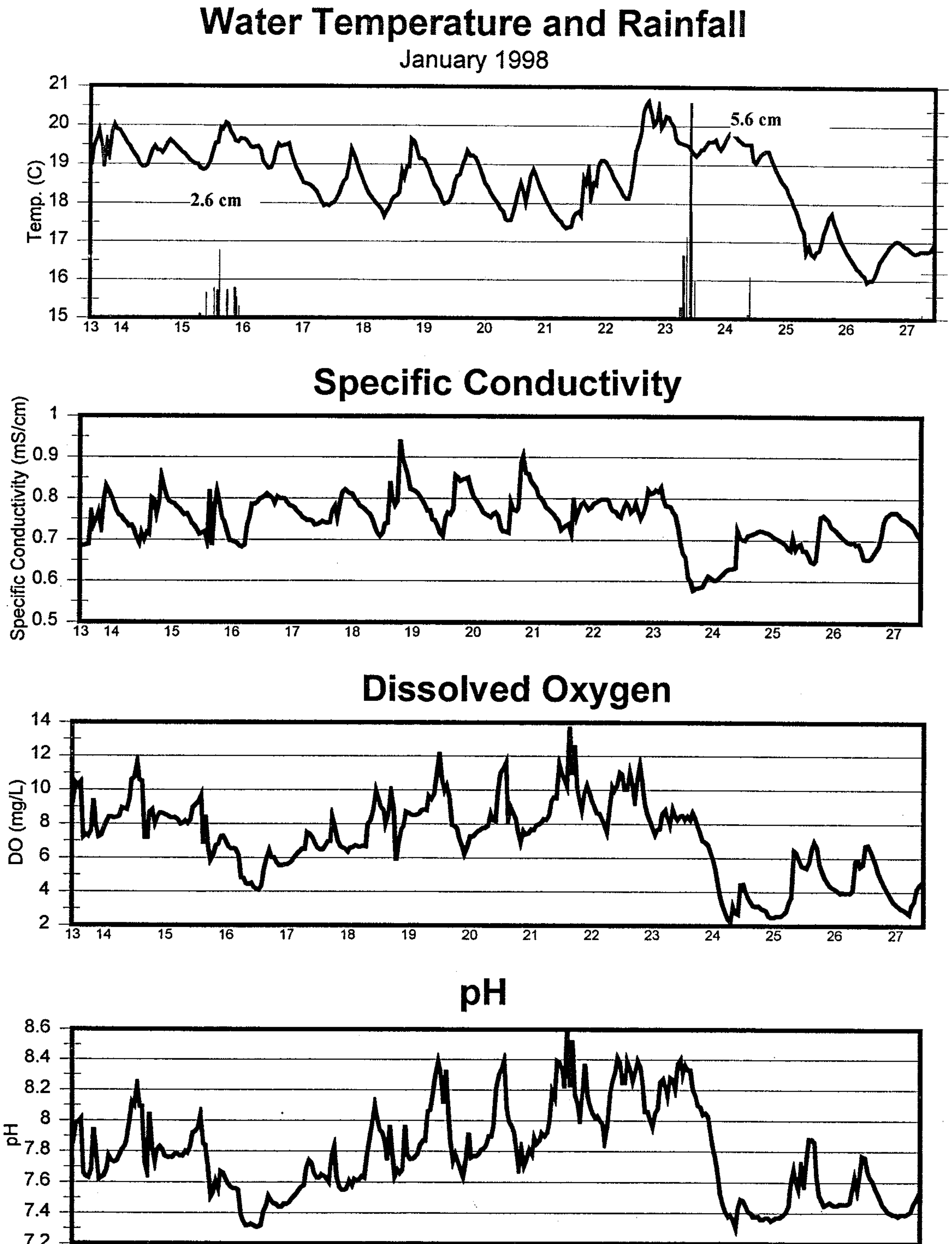


Figure 9. Weekly hydrolab data collected at the inflow of the pond.

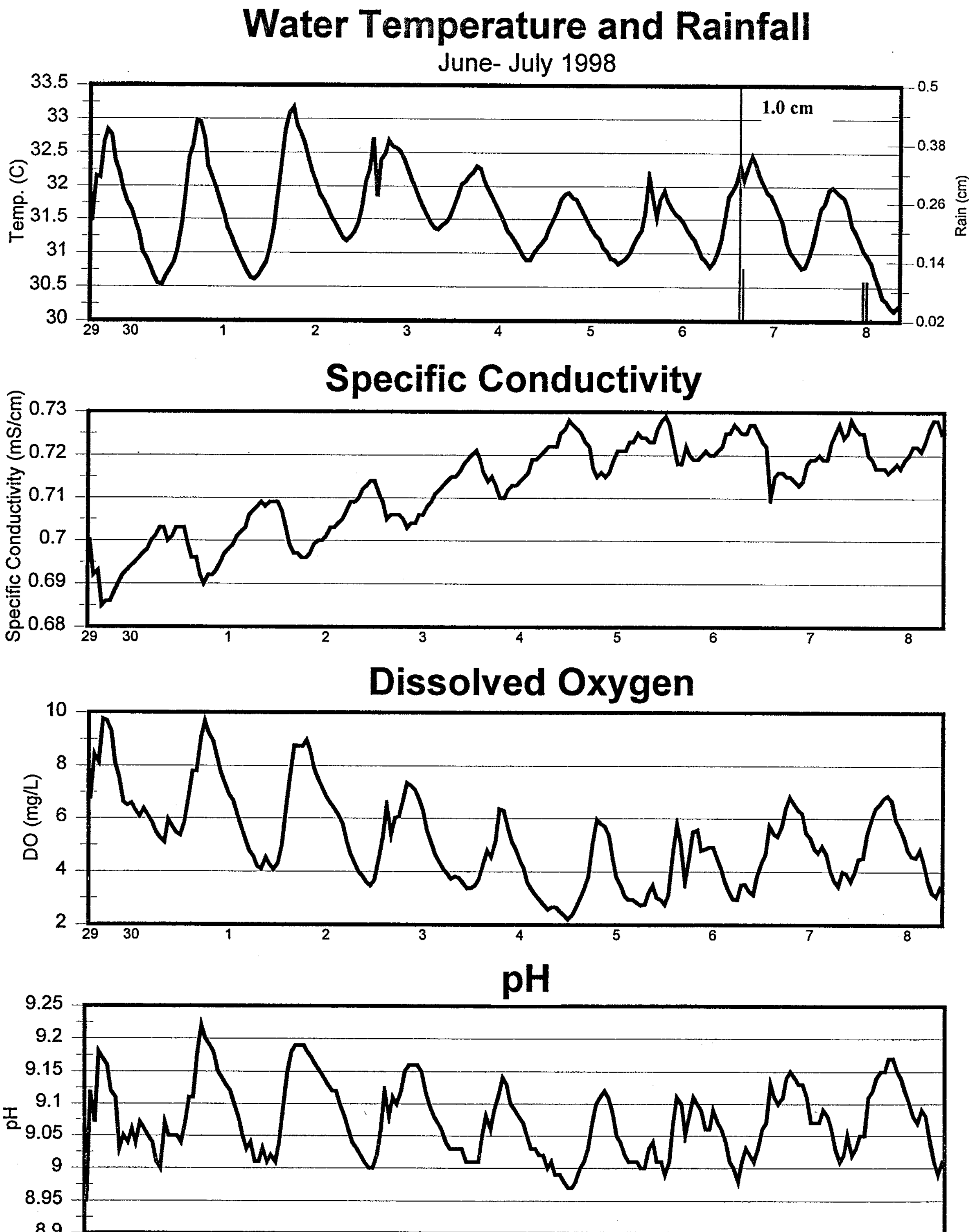


Figure 10. Weekly hydrolab data collected at the inflow of the pond.

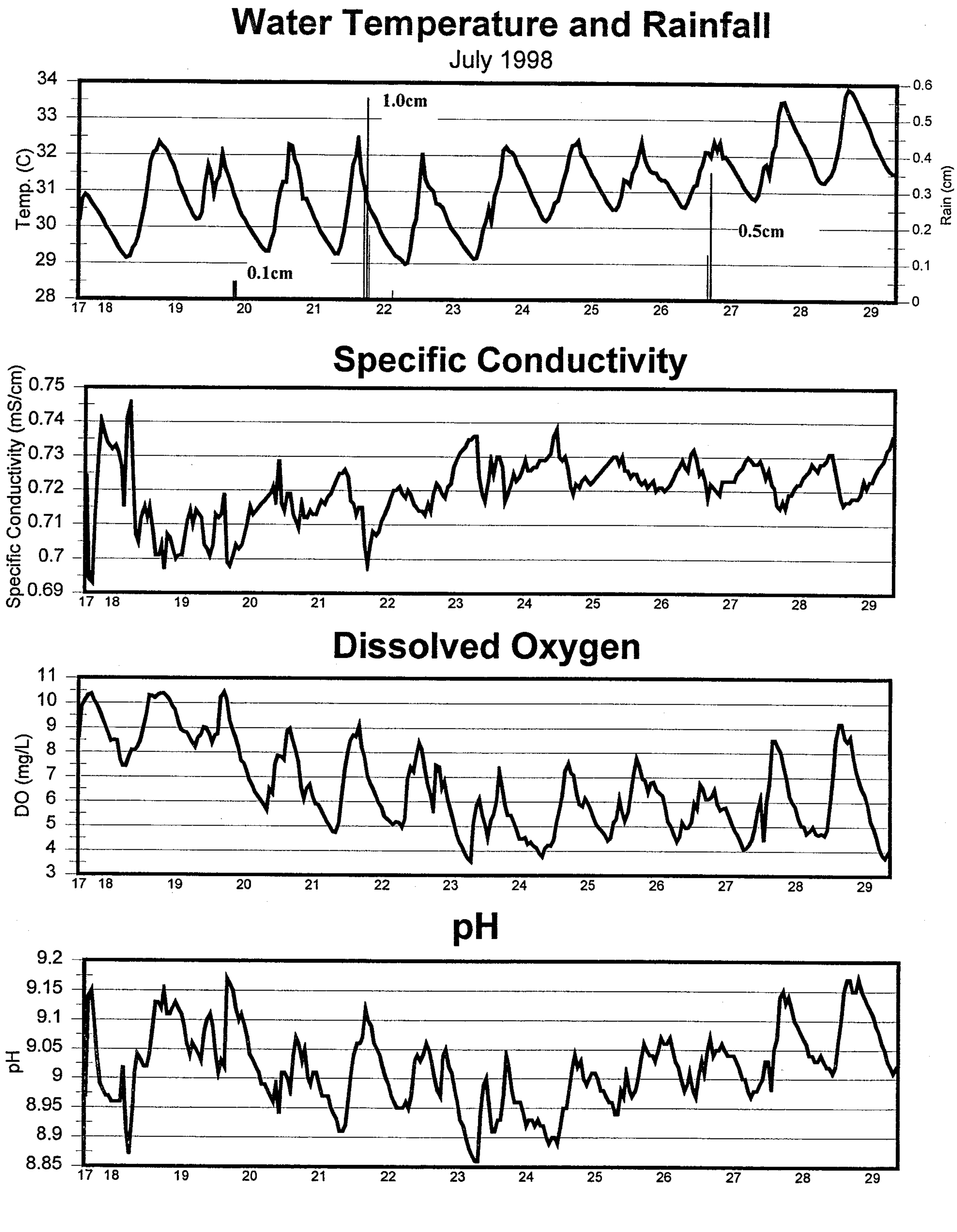


Figure11. Weeky hydrolab data collected at the inflow of the pond.

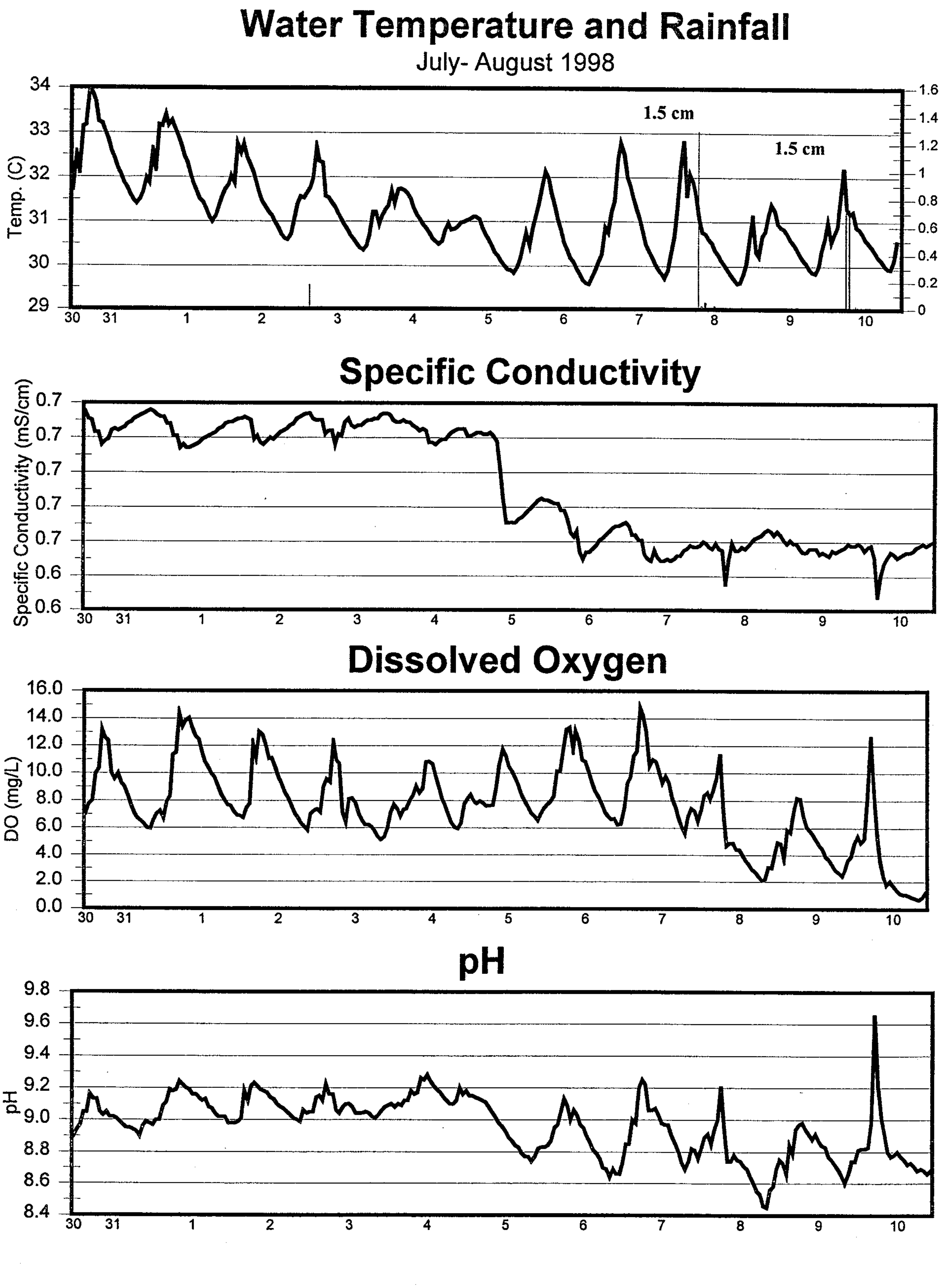


Figure 12. Weekly hydrolab data collected at the inflow of the pond.

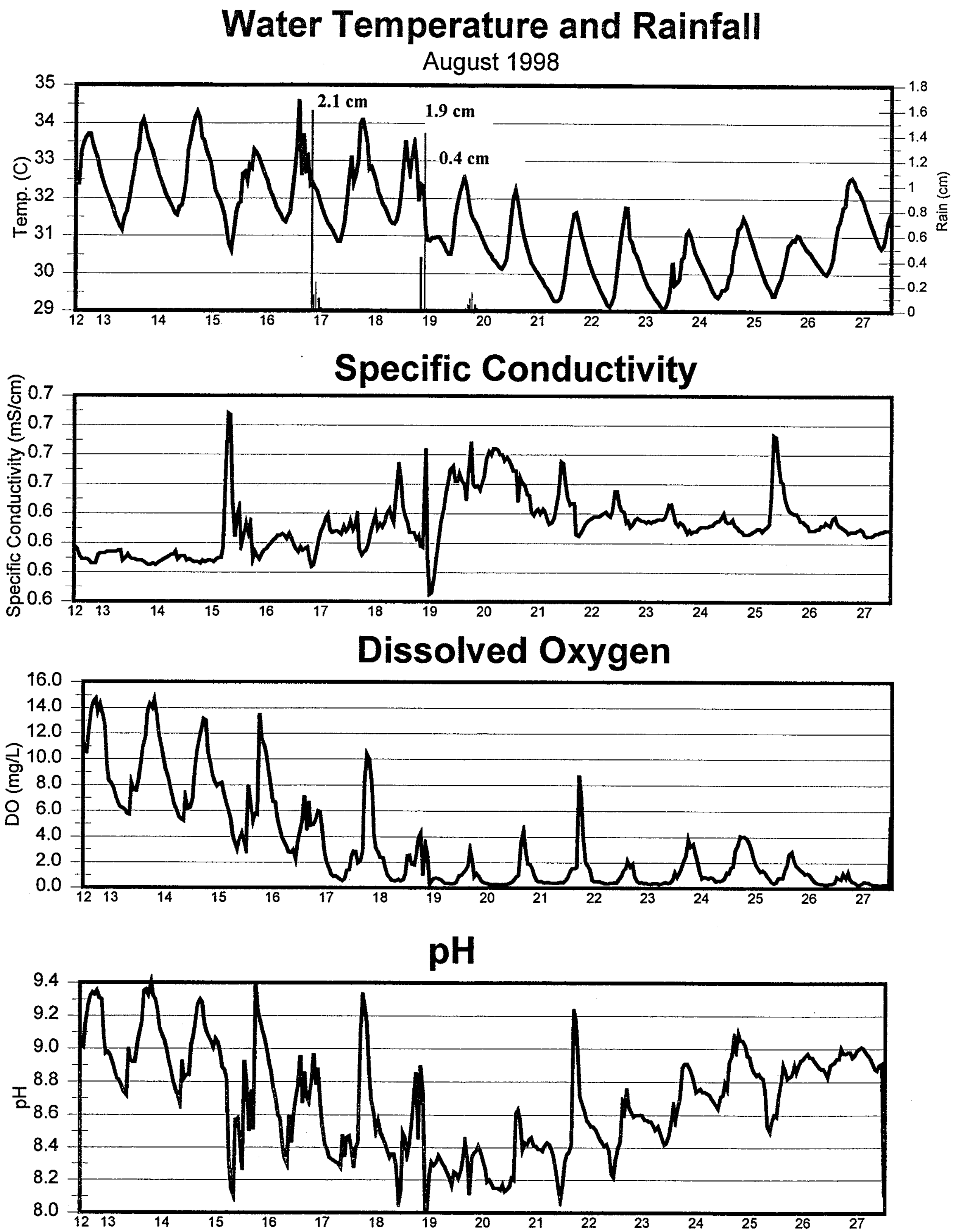


Figure 13. Weekly hydrolab data collected at the inflow of the pond.

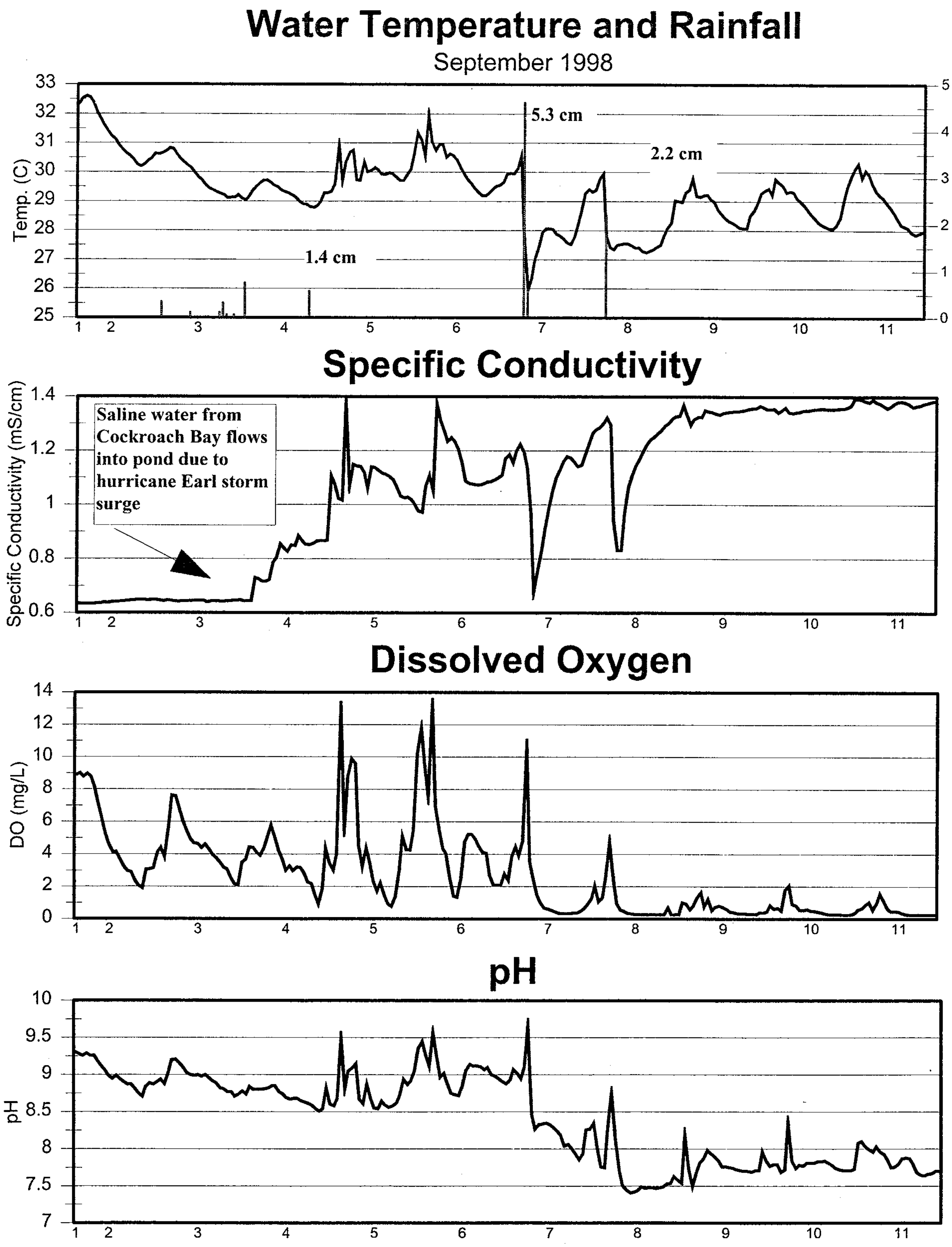
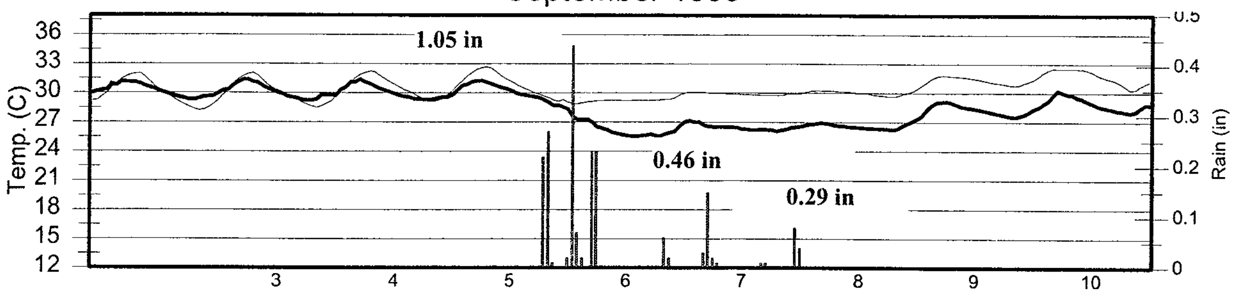


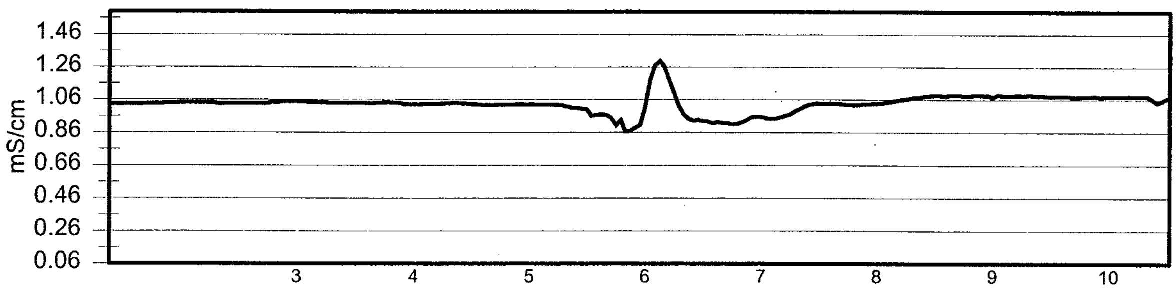
Figure 14. Weekly hydrolab data collected at the inflow of the pond.

Water Temperature and Rainfall

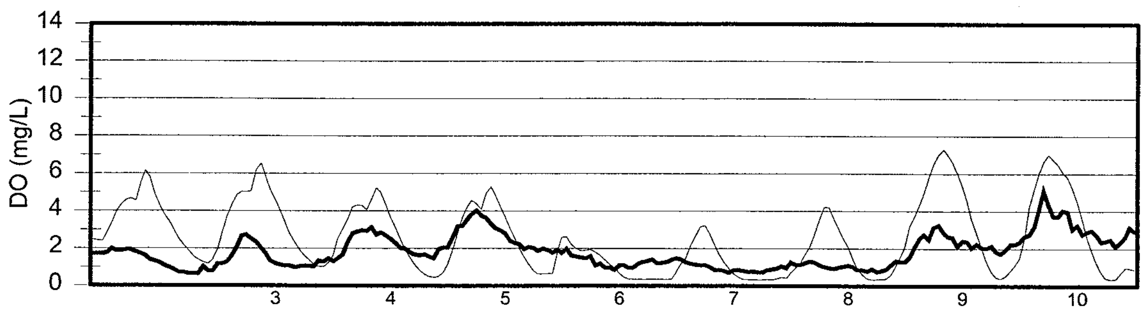
September 1999



Specific Conductivity



Dissolved Oxygen



pH

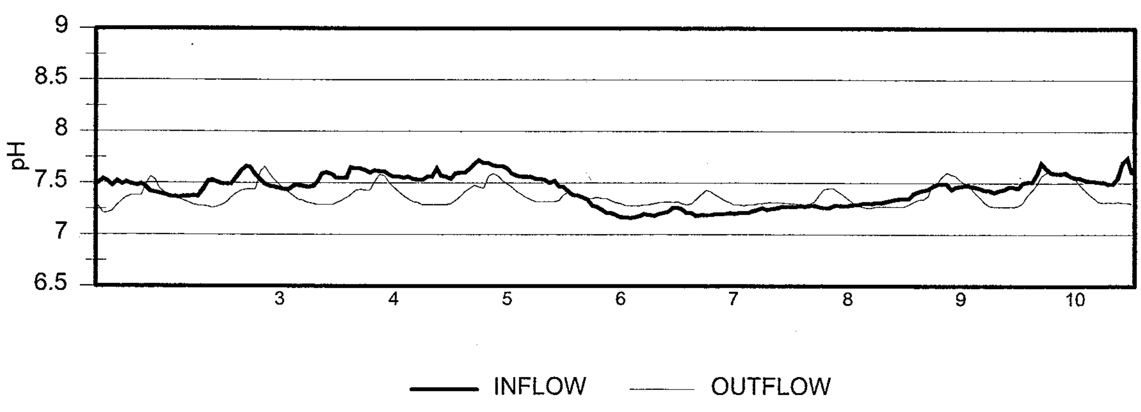


Figure 15. Weekly hydrolab data collected at both the inflow and outflow of the pond.

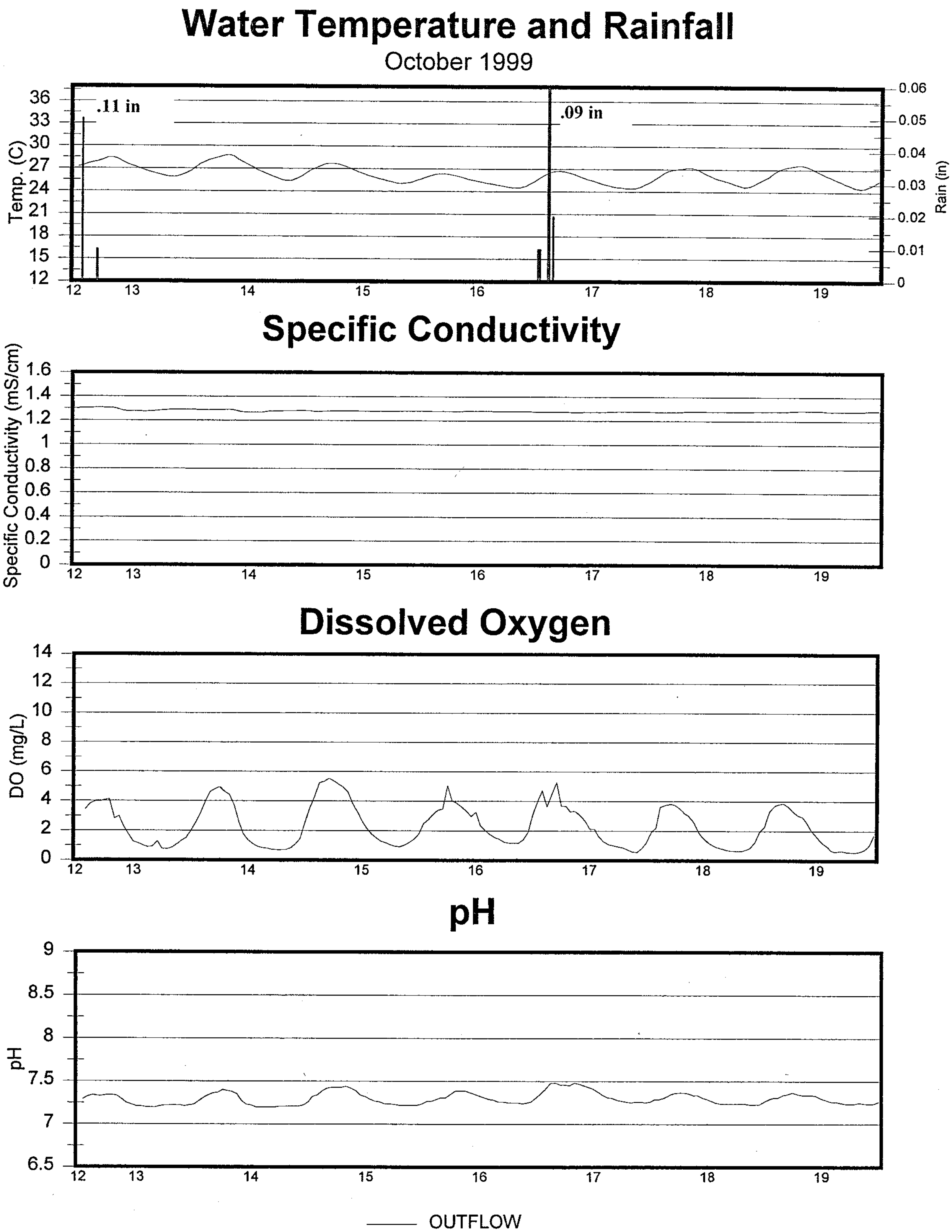


Figure 16. Weekly hydrolab data collected at the outflow of the pond.

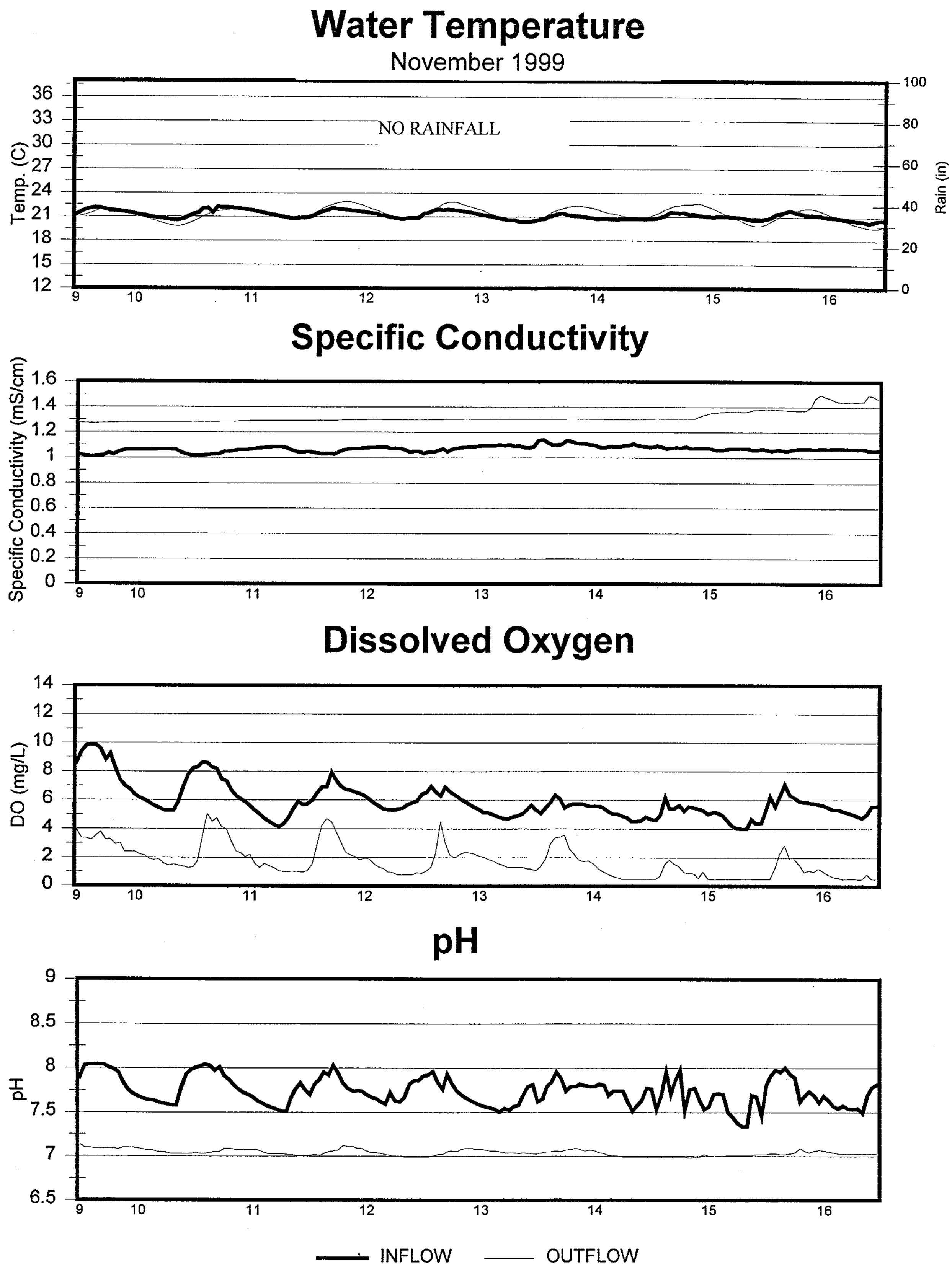


Figure 17. Weekly hydrolab data collected at both the inflow and outflow of the pond.

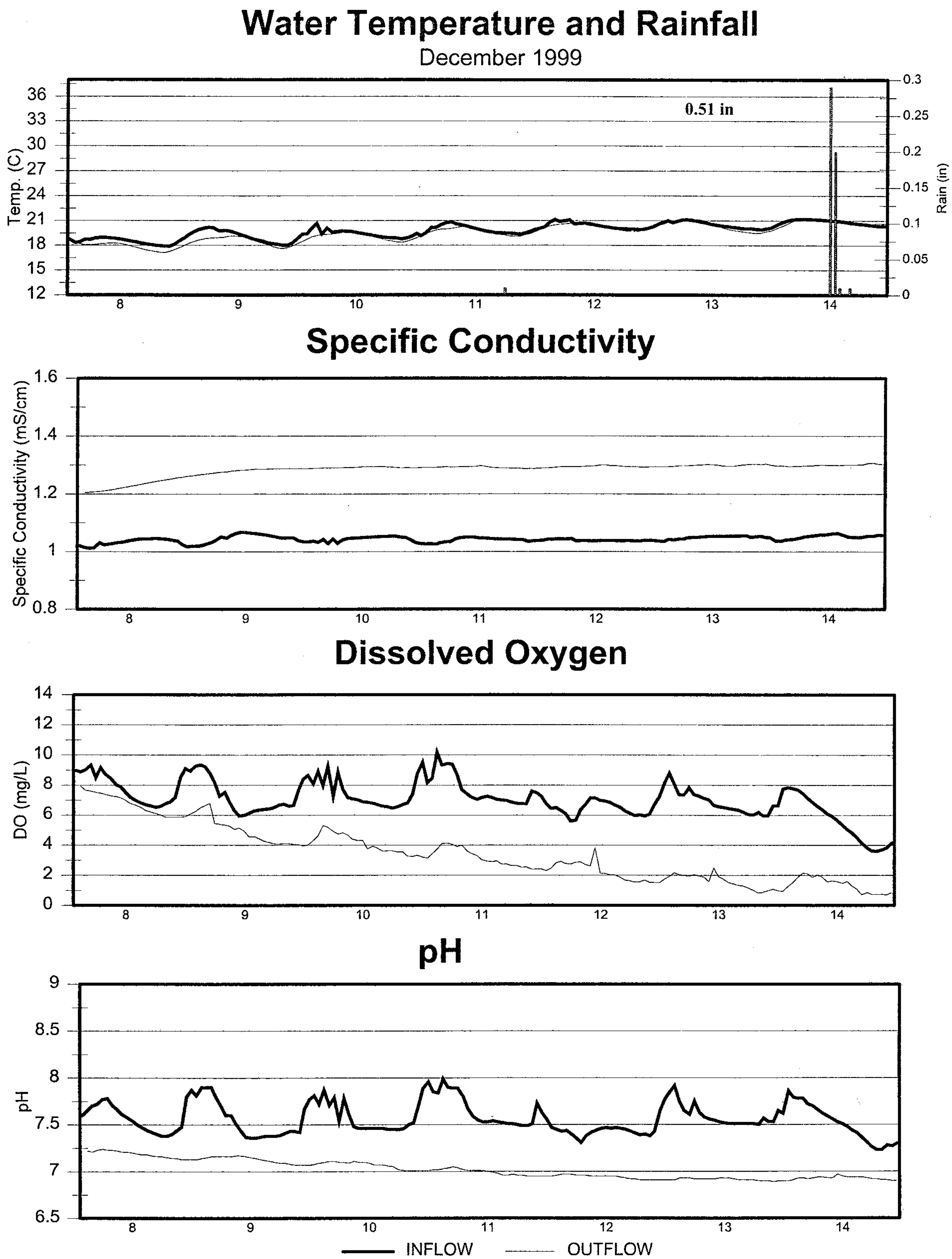


Figure 18. Weekly hydrolab data collected at both the inflow and outflow of the pond.

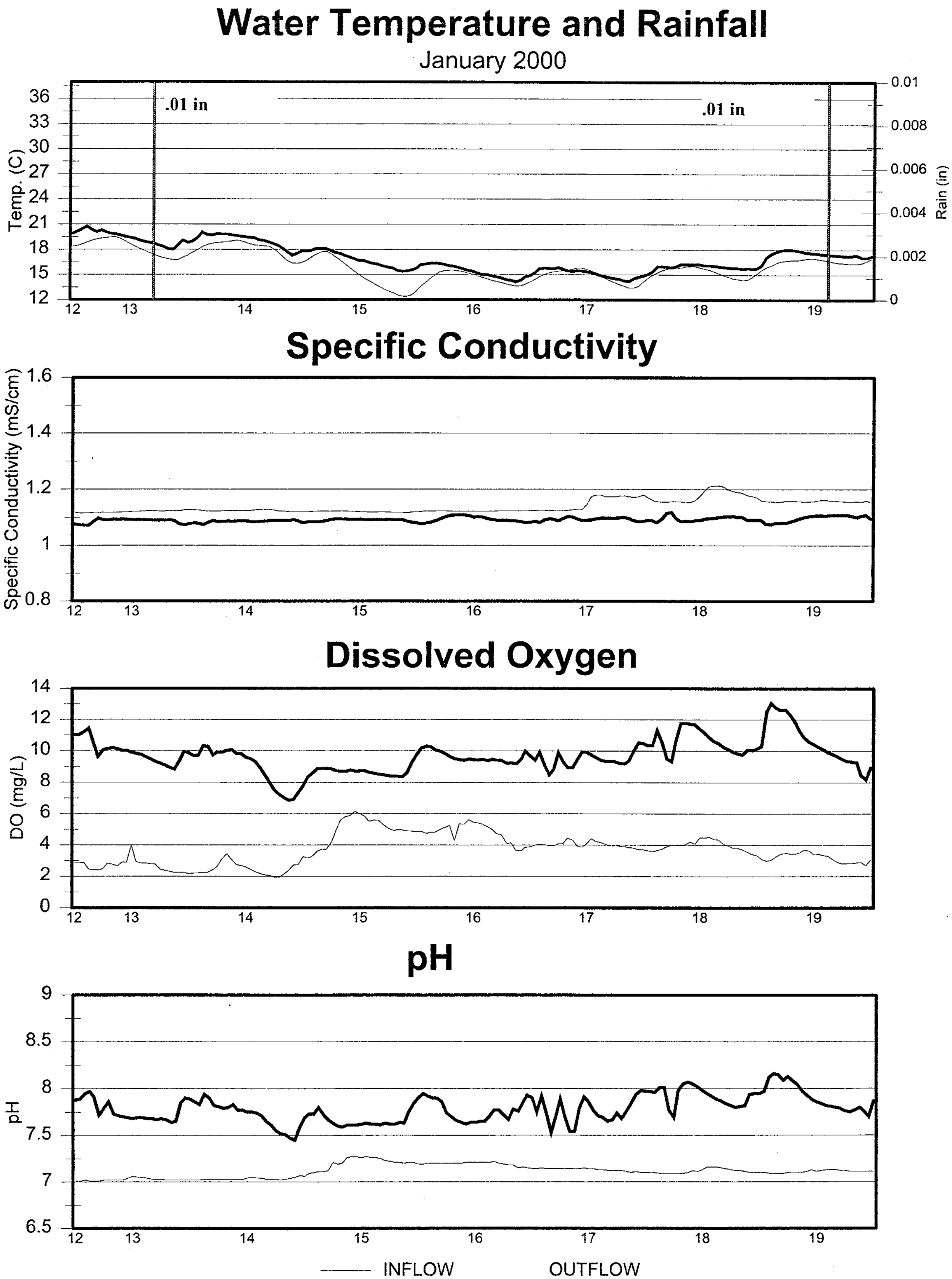


Figure 19. Weekly hydrolabd data collected at both the inflow and ouflow of the pond.

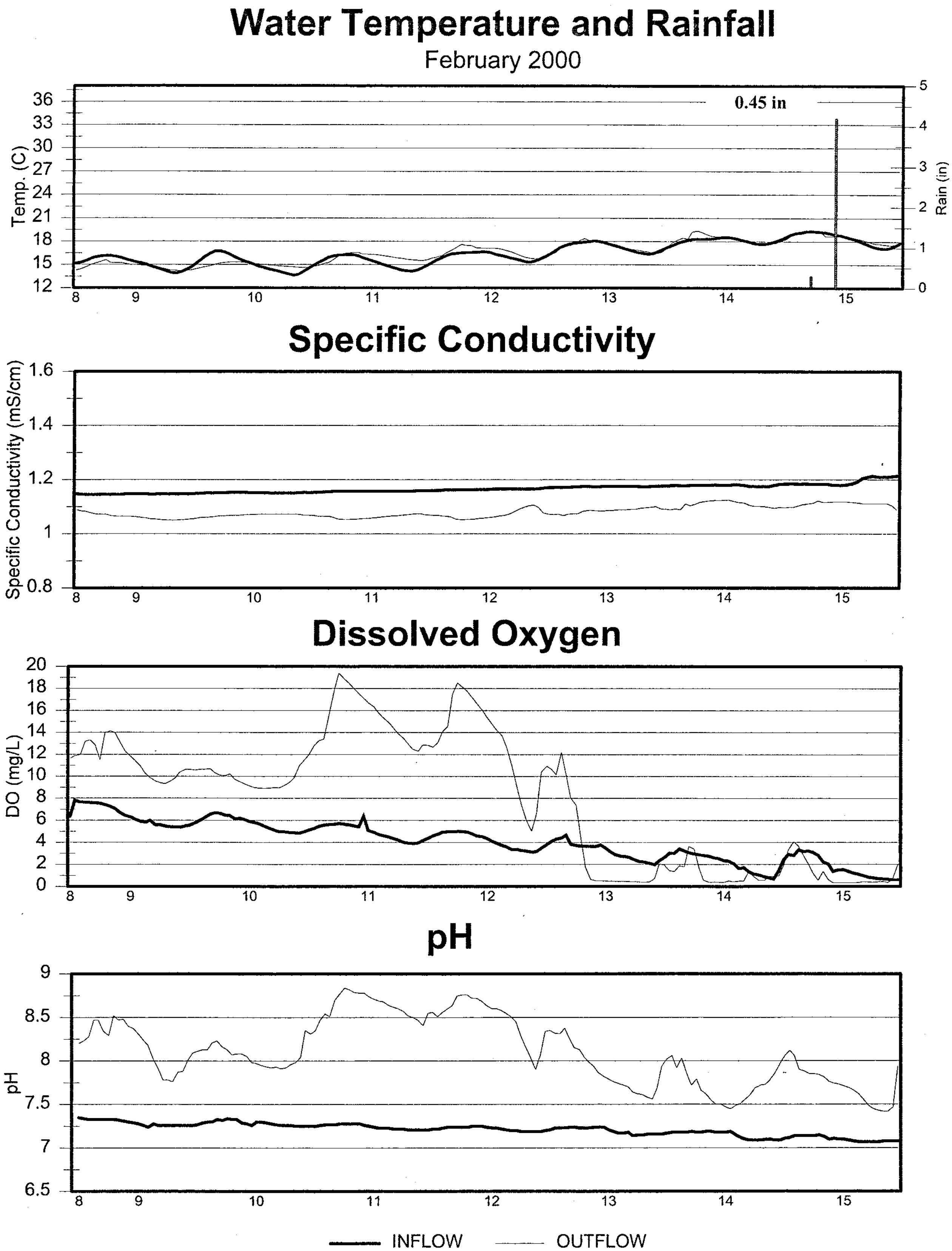


Figure 20. Weekly hydrolab data collected at both the inflow and outflow of the pond.

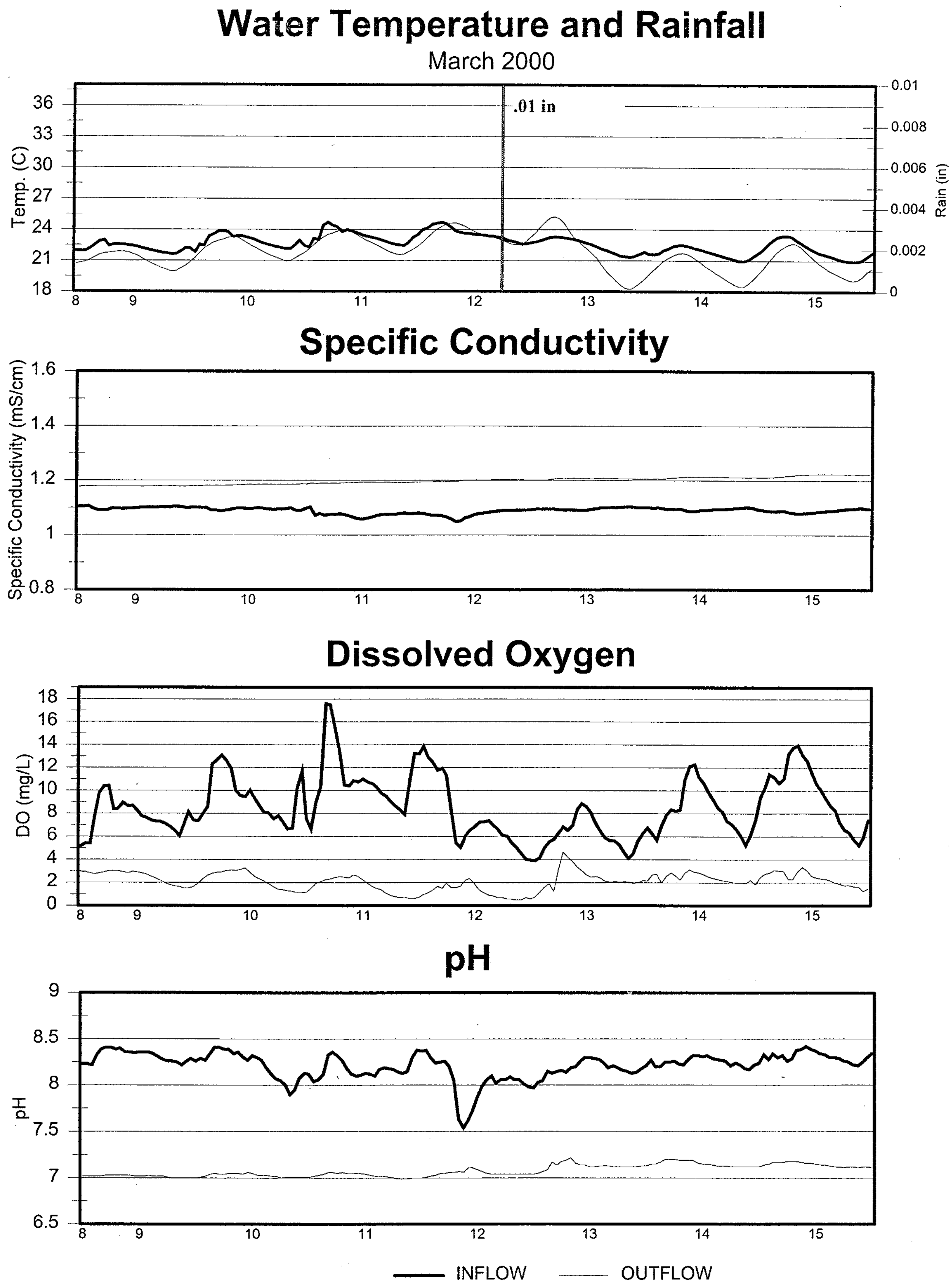


Figure 21. Weekly hydrolab data collected at both the inflow and outflow of the pond.

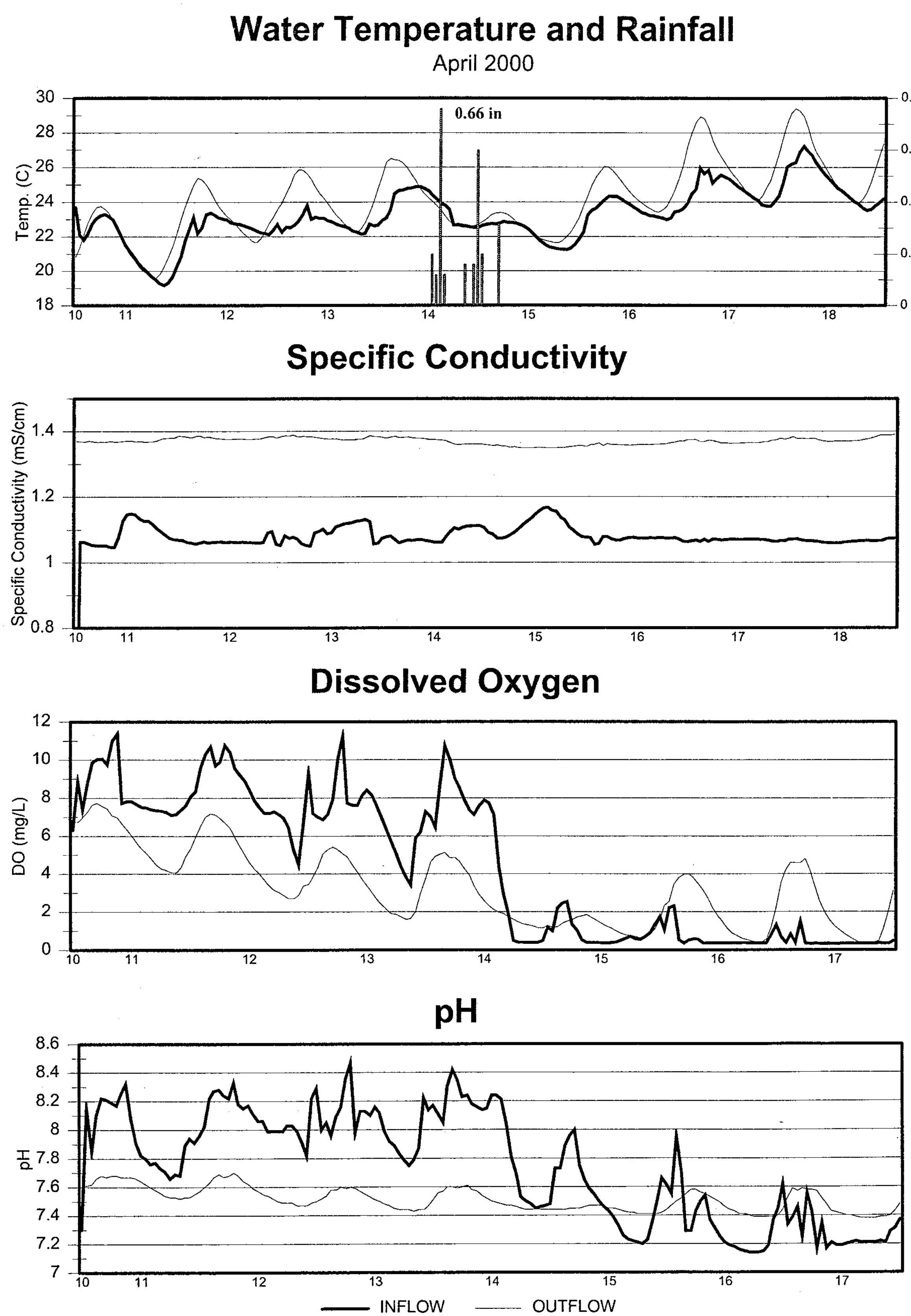


Figure 22. Weekly hydrolab data collected at both the inflow and outflow of the pond.

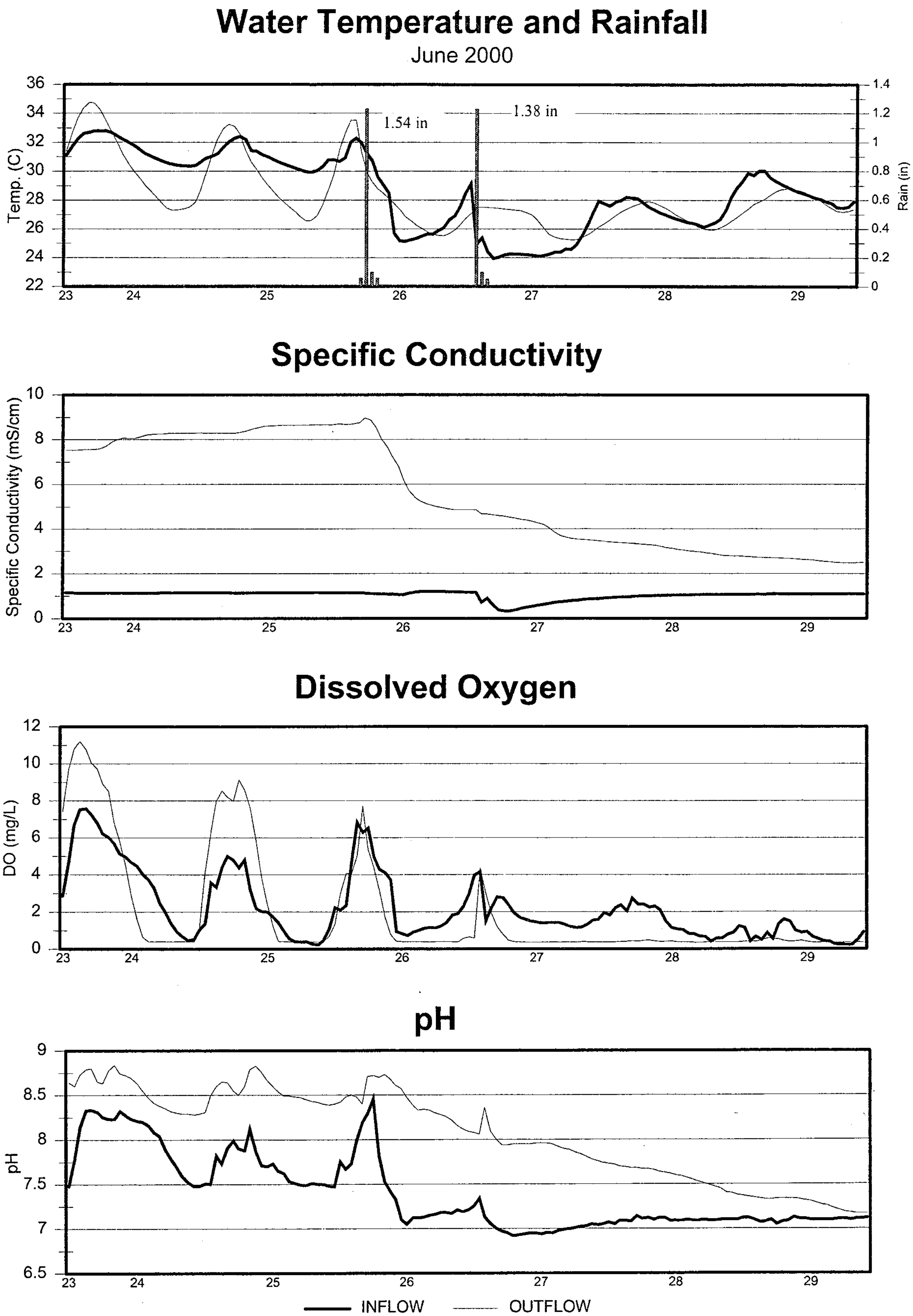


Figure 23. Weekly hydrolab data collected at both the inflow and outflow of the pond.

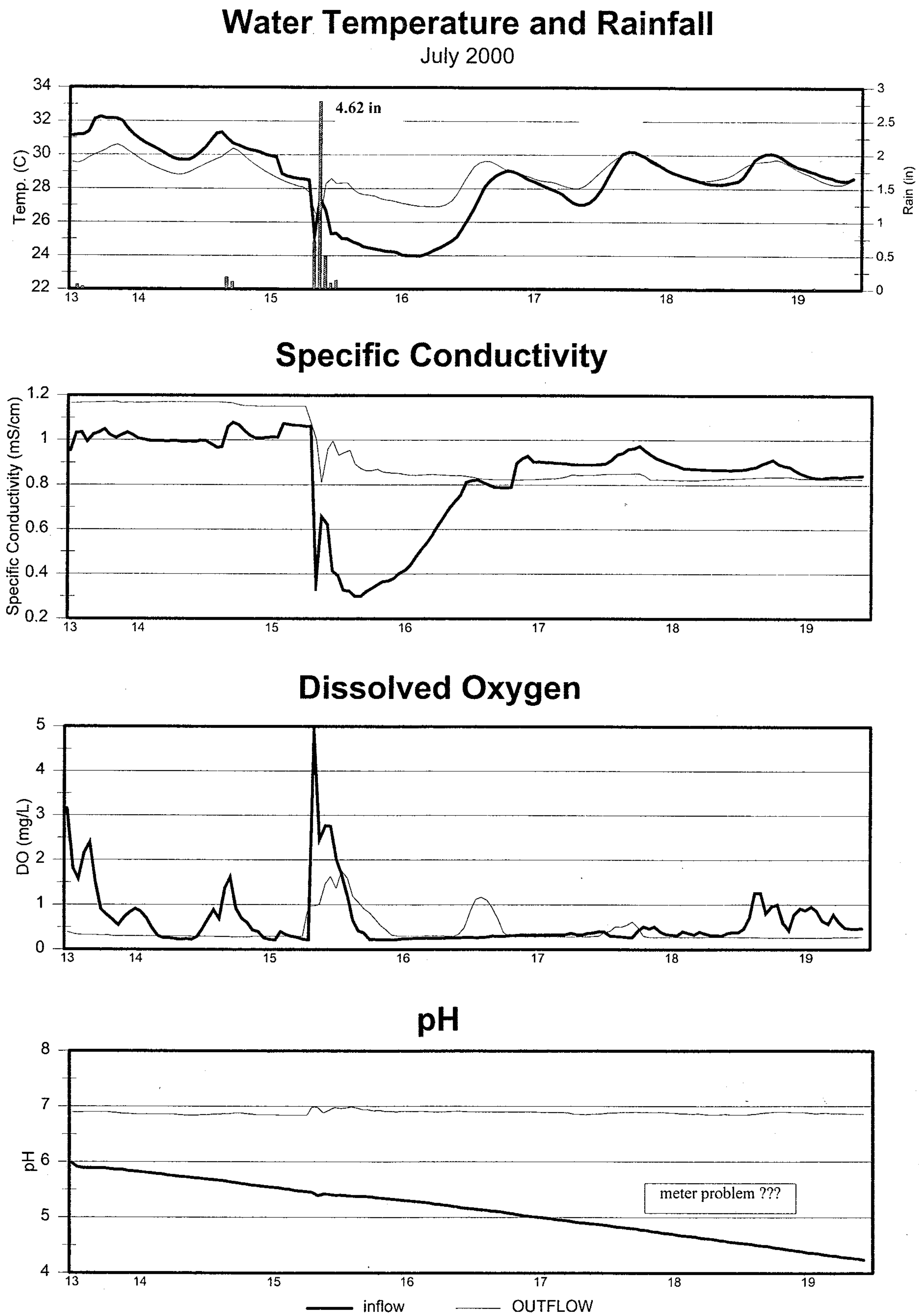


Figure 24. Weekly hydrolab data collected at both the inflow and outflow of the pond.

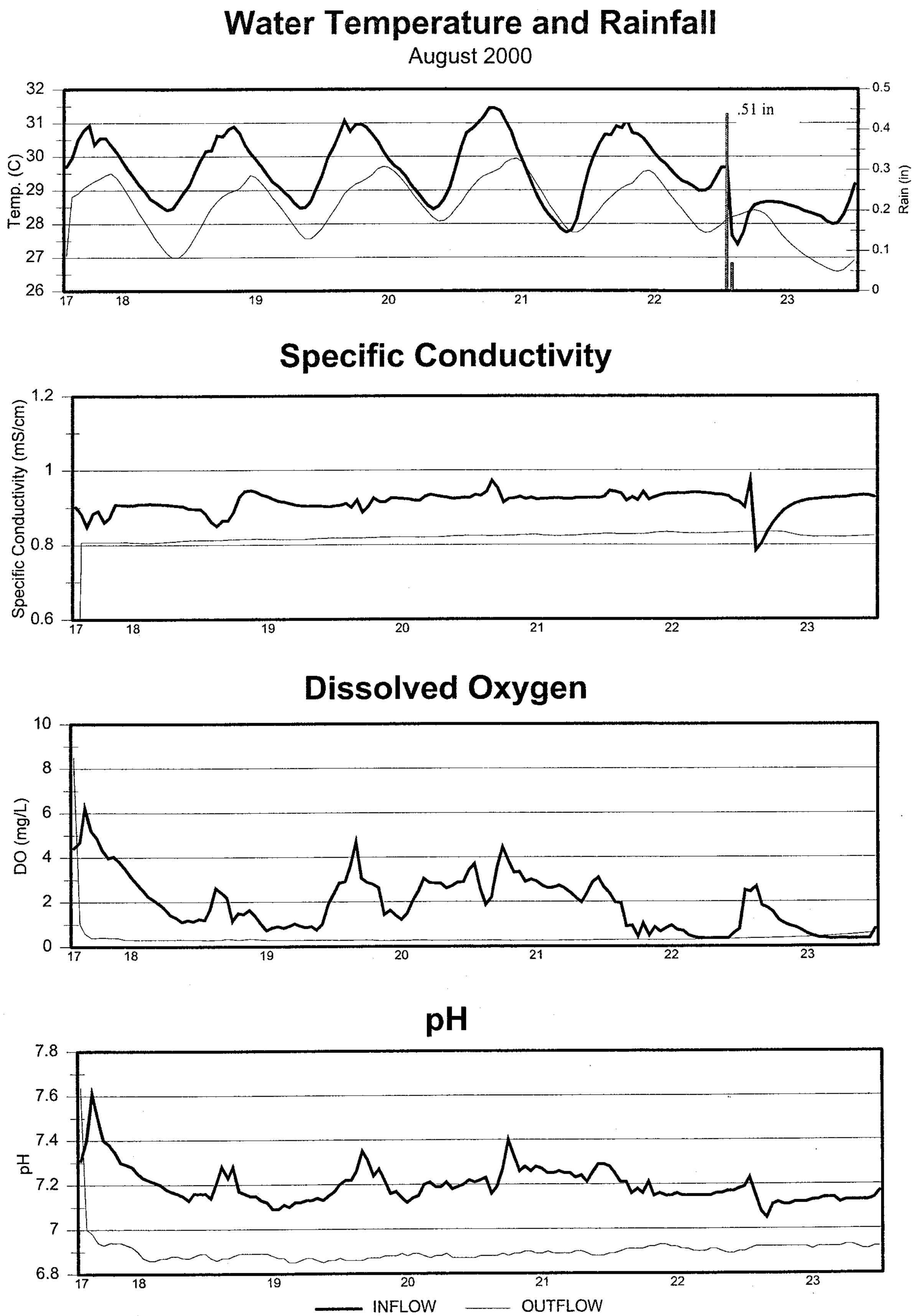
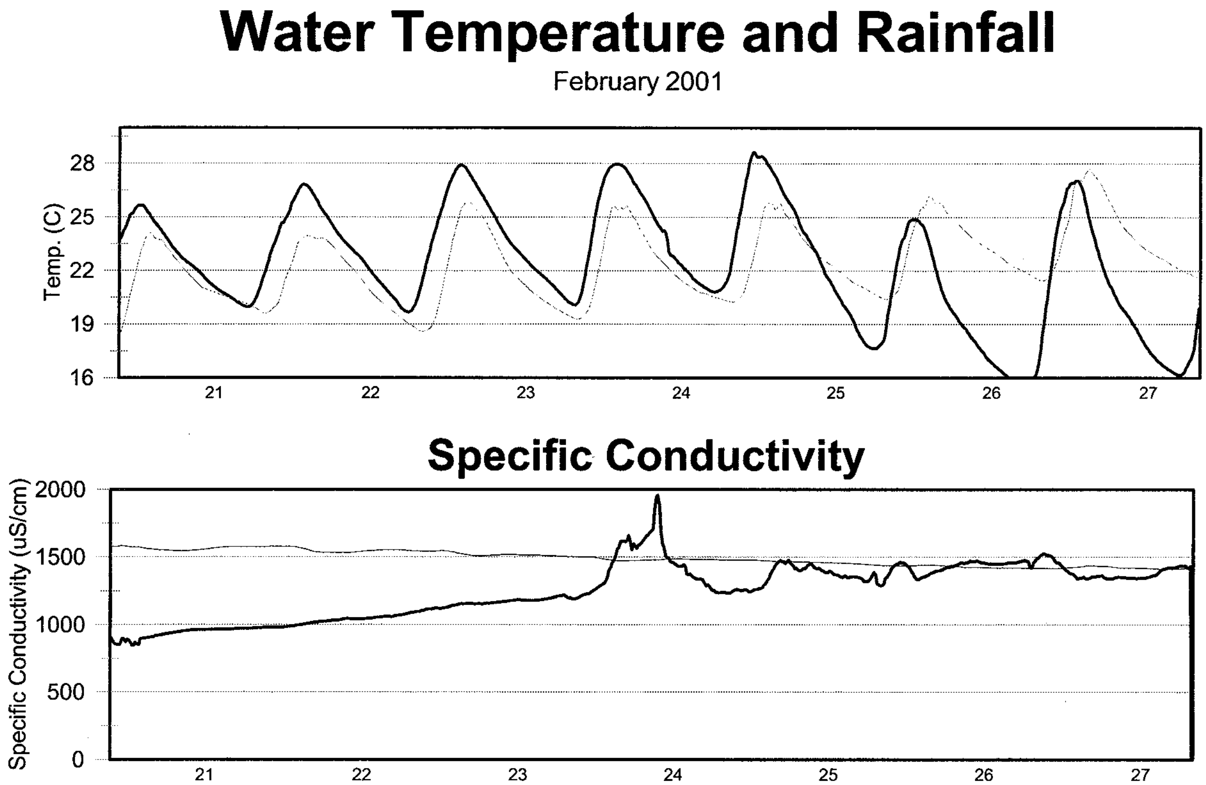


Figure 25. Weekly hydrolab data collected at both the inflow and outflow of the pond.



No dissolved oxygen data available

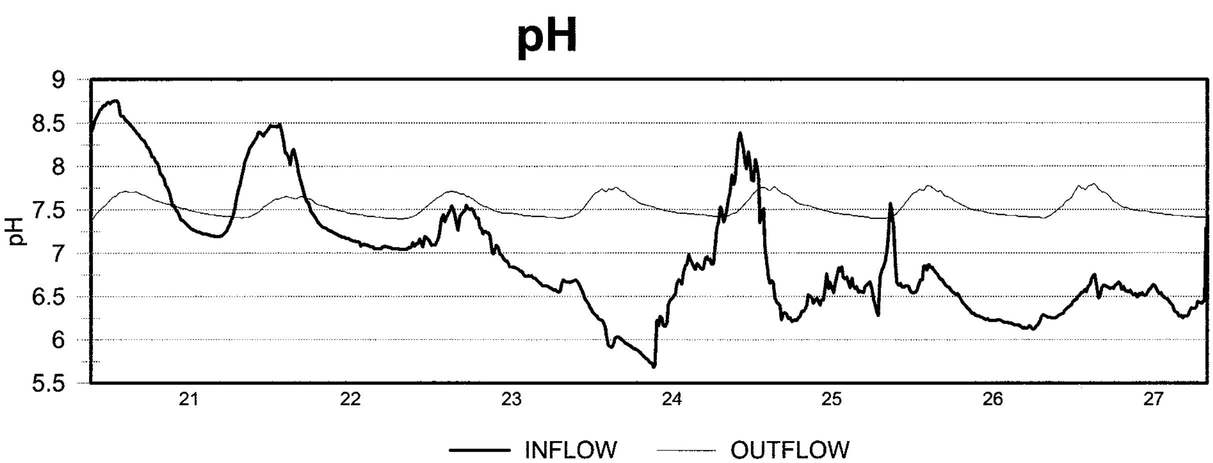


Figure 26. Weekly hydrolab data collected at both the inflow and outflow of the pond.

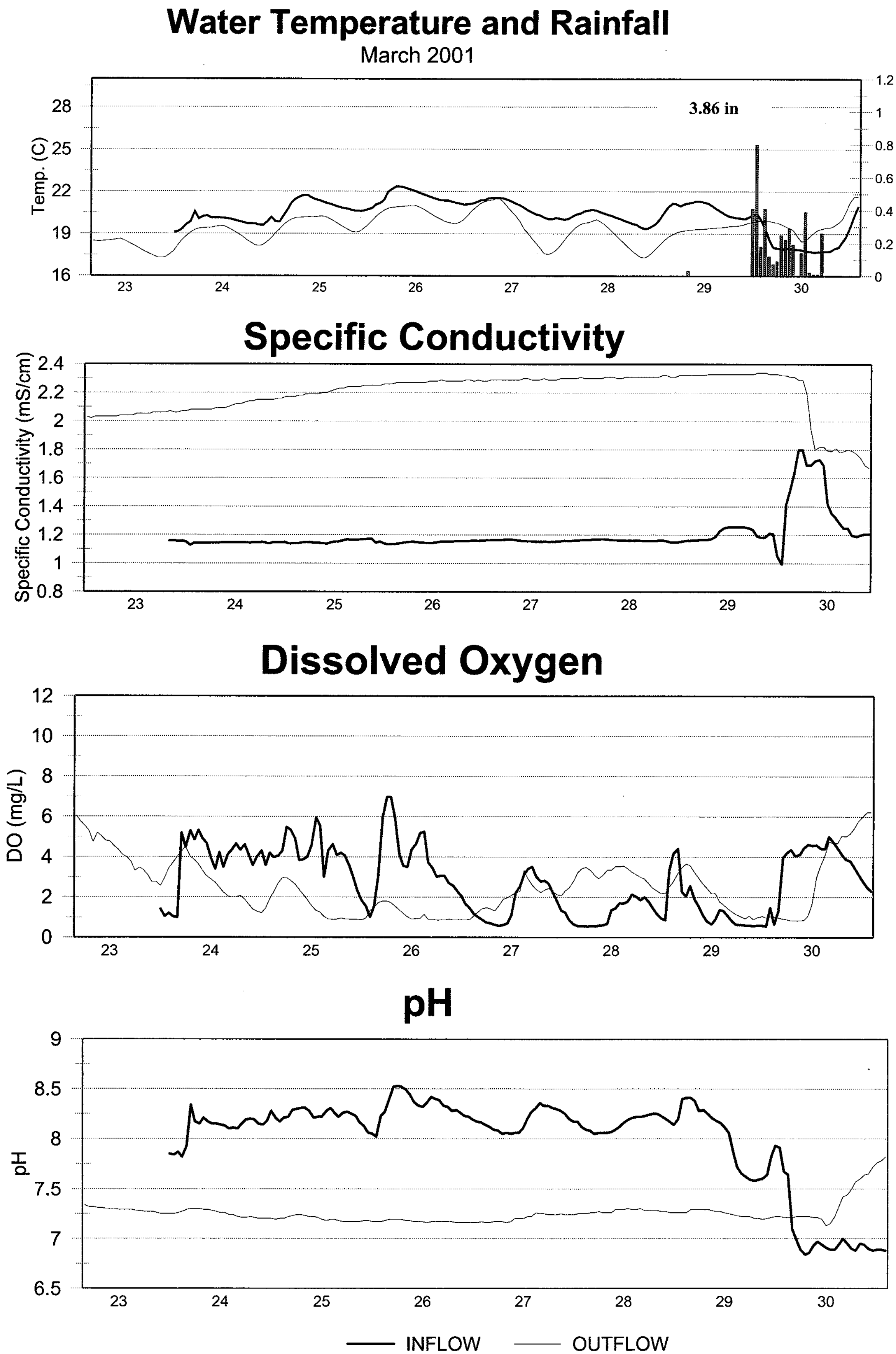


Figure 21. Weekly hydrolab data collected at both the inflow and outflow of the pond.

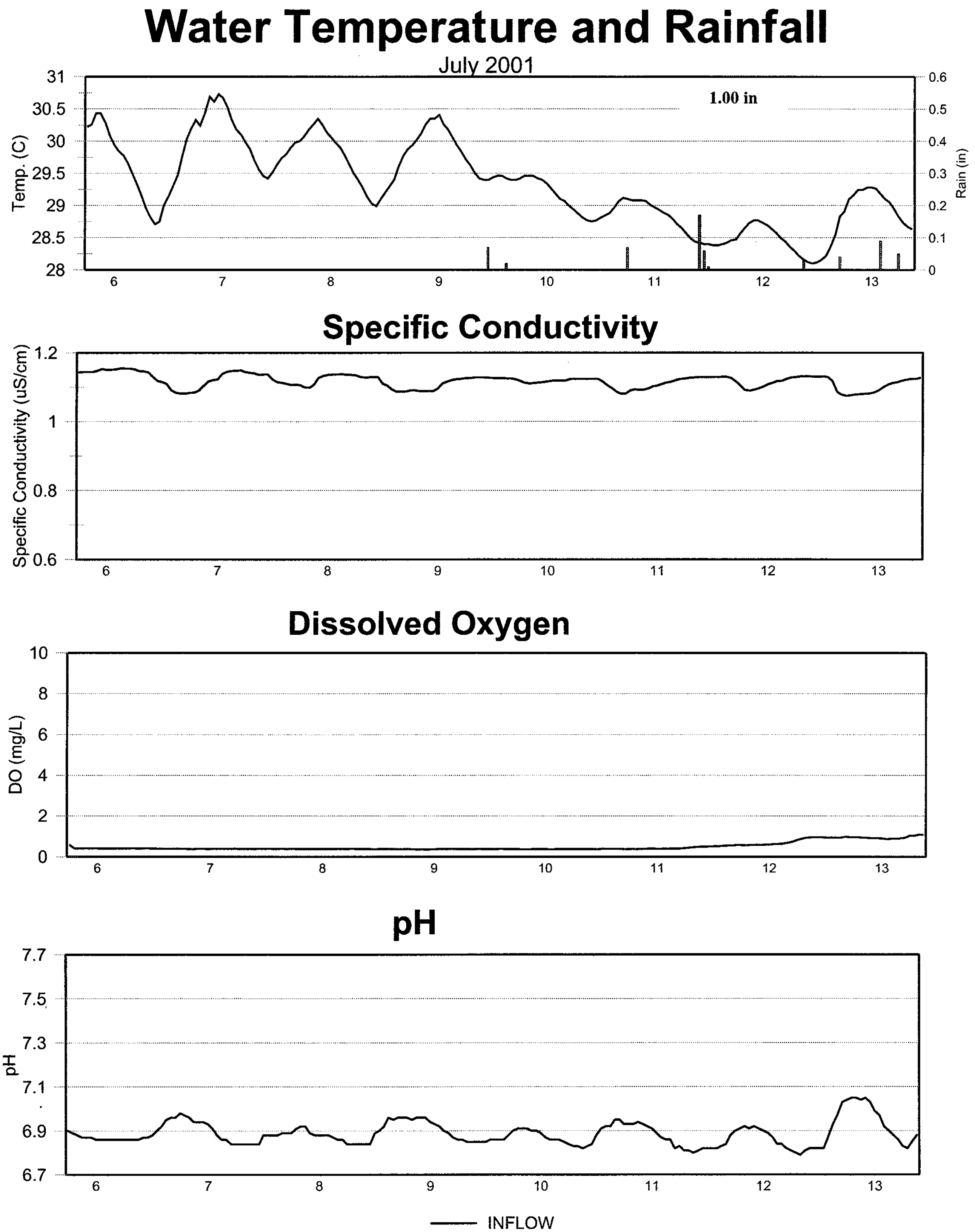


Figure 28. Weekly hydrolab data collected at the inflow of the pond.

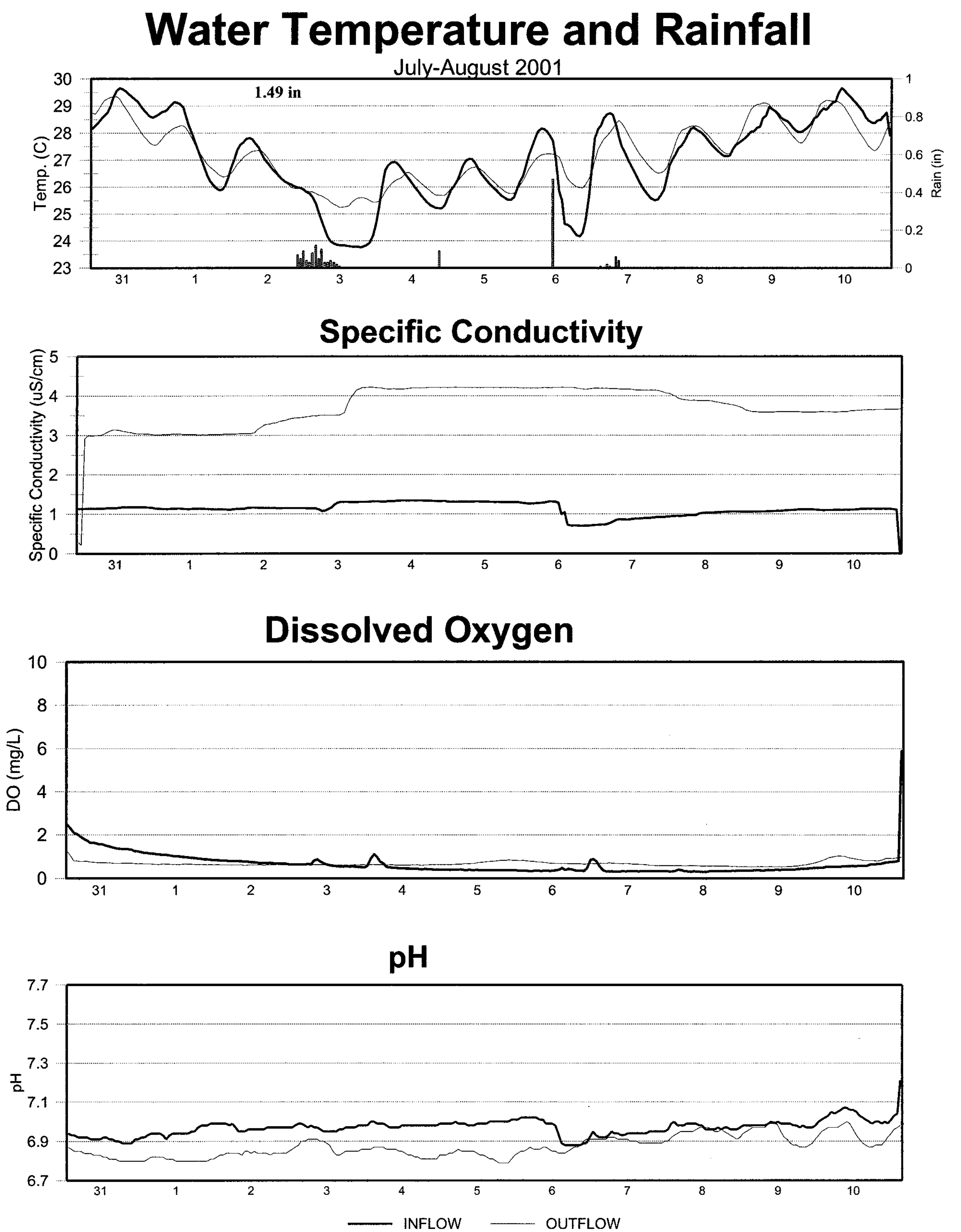


Figure 29. Weekly hydrolab data collected at both the inflow and outflow.

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APPENDIX G

Ambient Background Samples Collected in the Pre-Treatment Ditch
Tables and Figures for stations 2, 3 and 4

Station 1 was dry and no data were collected

Appendix G-1. Field parameters for pre-treatment ditch (See Fig. 2 for sampling locations).

Cockroach Bay Background Stations (2-4)

Station 2 - STA822

Parameters	Time	DO % sat	Conduct mmhos/cm	Depth m	DO mg/L	Redox mV	Salinity ppt	Temp C	pH SU
07/02/97	11:33	43.7	1.232	na	3.3	na	0.6	27.77	7.04
09/03/97	na	39.2	1.187	na	3.03	464	0.6	29.89	7.25
11/10/97	12:30	71.8	1.195	na	6.51	412	0.6	20.67	7.56
01/06/98	11:58	35.4	1.098	na	3.03	321	0.6	21.45	7.29
03/03/98	1:22	28.1	0.945	na	2.67	459	0.5	18.38	7.28
04/27/98	12:23	52.3	1.198	na	4.66	464	0.6	21.53	7.46
06/29/98	1:00	1.5	1.246	na	0.12	-160	0.7	28.99	7.13
09/11/98	12:14	4.1	1.256	na	0.54	216	0.7	26.01	7.11
11/03/98	1:55	7.4	1.317	na	0.73	-319	0.7	22.60	7.56
01/06/99	12:30	60.4	0.964	na	6.61	415	0.5	10.97	7.47
03/02/99	11:17	41.0	1.315	0.24	4.01	411	6.7	1.61	7.18
09/08/99	DEAD	BATTERY							
11/09/99	12:30	24.6	1.175	0.07	2.12	-90	6.2	20.07	7.11
01/12/00	12:40	53.1	0.011	0.13	5.05	52	6.1	17.66	7.12
03/08/00	11:45	10.9	1.157	0.21	1.08	157	6.1	18.33	7.04
05/09/00	na	na	na	na	na	na	na	na	na
07/24/00	11:00	6.6	0.883	0.25	0.45	na	0.5	26.00	7.07
09/06/00	11:15	17.5	1.016	0.16	1.38	na	0.5	27.57	7.27
04/24/01	10:10	63.3	1.319	na	na	na	na	24.19	7.56
07/17/01	10:10	7.0	1.155	na	0.5	na	0.6	26.66	6.95
09/20/01	11:05	0.4	1.300	na	0.11	na	0.7	25.07	7.00
07/16/02	10:45	na	1.100	0.15	0.37	na	0.6	27.95	6.98

Station 3 - STA823

Parameters	Time	DO % sat	Conduct mmhos/cm	Depth m	DO mg/L	Redox mV	Sal ppt	Temp C	pH SU
07/02/97	11:40	103.2	1.277	na	7.85	na	0.7	29.52	7.25
09/03/97	na	15.4	1.255	na	0.12	429	0.7	28.69	7.02
11/10/97	12:50	25.1	1.201	na	2.38	398	0.6	19.68	0.72
01/06/98	12:10	12.7	1.136	na	1.12	277	0.6	21.86	.72
03/03/98	1:45	8.0	0.829	na	0.79	360	0.4	17.53	7.26
04/27/98	12:44	65.4	1.425	na	0.54	308	0.8	25.27	7.57
06/29/98	dry	dry	dry	dry	dry	dry	dry	dry	dry
09/11/98	12:33	1.3	1.124	na	0.14	-336	0.6	26.61	7.05
11/03/98	1:40	9.4	0.985	na	0.79	-249	0.5	22.71	7.09
01/06/99	1:00	12.5	0.771	na	1.39	343	0.4	10.18	7.11
03/02/99	11:30	54.4	1.088	0.35	5.59	632	5.5	15.47	7.44
09/08/99	DEAD	BATTERY							
11/09/99	12:20	7.4	1.139	0.17	0.59	-307	0.6	18.63	6.86
01/12/00	12:20	11.3	1.104	0.29	1.04	-301	5.8	15.95	6.86
03/08/00	12:30	8.5	1.379	0.13	0.85	-217	7.3	17.41	6.83
05/09/00	na	na	na	na	na	na	na	na	na
07/24/00	11:20	12.6	1.155	0.23	0.91	na	0.6	25.98	6.96
09/06/00	11:35	2.8	0.901	0.14	0.25	na	0.5	26.73	6.99
04/24/01	10:00	2.6	1.704	na	na	na	na	20.32	6.18
07/17/01	10:00	1.8	1.876	na	0.08	na	1.0	26.05	6.77
09/20/01	11:25	0.4	2.290	na	0.04	na	1.2	27.76	6.70
07/16/02	11:15	5.0	1.274	0.5	0.49	na	0.7	28.81	6.90

Station 4 - STA824

Parameters	Time	DO % sat	Conduct mmhos/cm	Depth m	DO mg/L	Redox mV	Sal ppt	Temp C	pH SU
07/02/97	11:50	97.2	1.079	na	7.15	na	0.6	30.20	7.18
09/03/97		28.7	1.202	na	2.22	366	0.6	28.98	7.11
11/10/97	1:00	63.9	0.114	na	5.86	376	0.6	21.64	0.75
01/06/98	12:20	5.9	1.027	na	0.50	316	0.5	21.27	7.13
03/03/98	1:55	14.2	1.007	na	1.58	351	0.5	17.08	7.12
04/27/98	12:55	2.3	1.073	na	0.18	-73	0.6	19.54	7.14
06/29/98	1:20	3.5	0.161	na	0.21	-160	0.8	27.82	7.07
09/11/98	12:45	1.1	0.158	na	0.11	-427	0.8	26.59	6.71
11/03/98	1:30	2.1	0.972	na	0.19	-369	0.5	22.34	7.25
01/06/99	12:50	12.8	0.778	na	1.46	335	0.4	11.16	7.14
03/02/99	11:40	11.3	1.108	0.48	1.23	-72	5.6	14.07	7.05
09/08/99	DEAD	BATTERY							
11/09/99	12:00	2.7	0.641	0.13	0.23	-359	3.3	19.43	6.93
01/12/00	12:00	6.3	1.033	0.32	0.55	-358	5.4	17.42	6.69
03/08/00	12:00	8.6	1.219	0.19	0.75	-397	6.4	18.35	0.66
05/09/00	1:00	12.5	1.288	0.43	0.97	-424	0.7	22.86	6.66
07/24/00	11:45	79.8	1.112	0.04	6.11	na	0.6	25.67	7.99
09/06/00	11:50	3.8	0.898	0.06	0.31	na	0.5	26.33	6.91
04/24/01	9:45	4.8	1.116	na	na	na	na	21.25	6.65
07/17/01	9:45	2.6	0.983	na	0.26	na	0.5	26.65	6.75
09/20/01	11:40	15.6	0.850	na	1.22	na	0.4	27.70	6.97
07/16/02	11:25	4.3	1.302	0.5	0.41	na	0.2	29.49	7.08

Appendix G-2. Ambient water quality samples taken in the pre-treatment ditch

Station 2 -STA822

Nutrients Units	Ammonia mg/L-N	Nitrite mg/L-N	Nitrate mg/L-N	TKN mg/L-N	TN mg/L-N	Ortho P mg/L-P	Total P mg/L-P	TSS mg/L
07/01/97	0.041	*0.005*	*0.005*	0.96	0.97	0.69	0.69	4.69
09/01/97	0.011	*0.005*	*0.005*	0.99	1.00	0.21	0.33	9.82
11/01/97	*0.005*	*0.005*	0.028	0.59	0.62	1.01	1.17	10.19
01/01/98	0.107	0.029	0.183	0.65	0.86	1.11	1.18	9.24
03/01/98	0.285	0.266	1.300	0.83	2.40	1.21	1.35	1.83
04/01/98	0.038	*0.005*	*0.005*	0.50	0.51	1.38	1.70	5.02
06/01/98	*0.005*	*0.005*	0.014	1.48	1.50	2.79	3.51	7.52
09/01/98	*0.005*	*0.005*	*0.005*	0.83	0.84	2.20	2.67	16.20
11/01/98	0.051	*0.005*	*0.005*	1.99	2.00	3.73	5.42	5.00
01/01/99	0.013	*0.005*	*0.005*	0.69	0.70	1.06	1.29	2.80
03/01/99	*0.005*	*0.005*	0.012	0.63	0.65	1.79	2.13	2.21
07/01/99	0.038	*0.003*	*0.005*	0.82	0.83	1.73	2.56	40.80
09/01/99	2.270	0.190	0.071	2.24	2.50	1.51	1.67	9.37
11/01/99	0.031	NA	0.021	NA	NA	1.57	1.68	NA
01/01/00	0.143	*0.003*	0.015	1.40	1.42	1.63	1.75	95.60
03/01/00	0.096	0.010	0.055	5.45	5.51	0.82	1.51	50.60
06/01/00	*0.005*	0.009	0.002	2.19	2.20	3.98	4.58	4.00
07/24/00	0.065	0.012	*0.005*	1.98	2.00	3.64	3.89	2.68
09/06/00	0.031	*0.003*	0.014	0.74	0.78	0.59	0.64	0.70
04/24/01	0.021	*0.003*	*0.005*	2.49	2.50	1.70	2.00	39.85
07/18/01	0.022	*0.005*	*0.005*	1.79	1.80	2.87	3.35	2.04
09/20/01	0.413	0.020	0.020	1.68	1.72	0.96	2.85	2.95
07/16/02	0.132	*0.003*	0.020	1.27	1.29	1.79	4.50	4.50
No Obs	**23**	**22**	**23**	**22**	**22**	**23**	**23**	**22**
Mean	**0.167**	**0.027**	**0.078**	**1.46**	**1.57**	**1.74**	**2.28**	**14.89**
Median	**0.038**	**0.005**	**0.012**	**1.13**	**1.35**	**1.57**	**1.75**	**5.01**
max	**2.270**	**0.266**	**1.300**	**5.45**	**5.51**	**3.98**	**5.42**	**95.60**
min	**0.005**	**0.003**	**0.002**	**0.50**	**0.51**	**0.21**	**0.33**	**0.70**
Std.Dev	**0.459**	**0.065**	**0.263**	**1.06**	**1.07**	**1.01**	**1.34**	**22.27**
c.v.	**2.752**	**2.383**	**3.353**	**0.72**	**0.68**	**0.58**	**0.59**	**1.50**

Appendix G-2. Ambient water quality samples taken in the pre-treatment ditch

Station 2 -STA822

Metals Units	Aluminu ug/L	Cadmium ug/L	Chromiu ug/L	Copper ug/L	Iron ug/L	Lead ug/L	Nickel ug/L	Manganese ug/L	Zinc ug/L
07/02/97	NA	*0.15*	NA	7.1	619	*1.00*	*2.15*	117.0	*15*
09/03/97	1	*0.15*	*2.35*	10.3	506	*1.00*	NA	31.7	*15*
11/10/97	NA	*0.15*	NA	6.2	209	*1.00*	*2.15*	34.8	*15*
01/06/98	191	0.48	*2.35*	17.5	442	*1.00*	*2.15*	85.8	*15*
03/03/98	248	*0.15*	*2.35*	29.9	260	*1.00*	*2.15*	70.8	30
04/27/98	192	*0.15*	*2.35*	7.7	240	*1.00*	*2.15*	110.0	*15*
06/29/98	237	*0.15*	*2.35*	9.7	190	*1.00*	*2.15*	414.0	*15*
09/11/98	880	*0.15*	8.70	22.3	1220	2.50	*2.15*	901.0	30
11/03/98	1960	*0.15*	12.30	36.6	1600	5.40	*2.15*	4410.0	30
01/06/99	338	*0.15*	*2.35*	12.3	240	*1.00*	**30.10**	132.0	*15*
03/02/99	71	*0.15*	*2.35*	7.0	230	*1.00*	*2.15*	504.0	*15*
07/07/99	1330	0.15	13.00	31.0	1350	4.10	*1.25*	1960.0	40
09/09/99	122	*0.15*	*1.00*	14.7	160	*0.75*	4.20	93.7	20
11/09/99	1370	0.50	27.20	61.5	2450	8.90	2.80	1180.0	60
01/12/00	2400	0.30	22.70	52.0	2430	7.20	*1.25*	1200.0	50
03/01/00	3780	*0.15*	9.90	23.6	930	3.80	3.90	655.0	30
06/01/00	156	*0.15*	2.70	7.7	2260	*0.75*	NA	1400.0	*8*
07/24/00	54	*0.15*	2.50	*1.0*	80	*0.75*	3.90	239.0	*8*
09/06/00	55	*0.15*	*1.00*	*1.0*	90	*0.75*	NA	50.4	*8*
04/24/01	312	*0.15*	2.40	5.4	260	*0.75*	2.50	489.0	20
07/18/01	57	0.10	2.30	2.1	320	0.50	2.60	436.0	10
09/20/01	41	0.15	1.90	1.4	640	0.40	2.10	276.0	20
07/16/02	241	0.15	5.20	4.2	800	0.40	2.30	226.0	*8*
No Obs	**21**	**23**	**21**	**23**	**23**	**23**	**20**	**23**	**23**
Mean	**668**	**0.18**	**6.15**	**16.2**	**762**	**2.00**	**3.81**	**653**	**21**
Median	**237**	**0.15**	**2.35**	**9.7**	**442**	**1.00**	**2.15**	**276**	**15**
max	**3780**	**0.50**	**27.20**	**61.5**	**2450**	**8.90**	**30.10**	**4410**	**60**
min	**1**	**0.10**	**1.00**	**1.0**	**80**	**0.40**	**1.25**	**32**	**8**
Std.Dev	**962**	**0.10**	**7.07**	**16.0**	**746**	**2.27**	**6.08**	**947**	**13**
c.v.	**1.44**	**0.54**	**1.15**	**0.99**	**0.98**	**1.14**	**1.59**	**1.45**	**0.63**

Appendix G-3. Ambient water quality samples taken in the pre-treatment ditch

Station 3- STA823

Nutrients Units	Ammonia mg/L-N	Nitrite mg/L-N	Nitrate mg/L-N	TKN mg/L-N	TN mg/L-N	Ortho P mg/L-P	Total P mg/L-P	TSS mg/L
07/01/97	0.064	0.047	0.013	1.80	1.86	0.83	0.92	2.05
09/01/97	0.042	0.005	0.005	1.30	1.30	0.26	0.31	0.68
11/01/97	0.005	0.005	0.028	NA	0.48	1.21	1.32	2.70
01/01/98	0.087	0.012	0.209	0.61	0.83	2.97	3.34	1.24
03/01/98	1.230	0.516	2.650	2.23	5.40	2.46	2.74	1.65
04/01/98	0.080	*0.005*	*0.005*	1.00	1.00	3.82	4.91	42.00
06/01/98	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
09/01/98	0.089	0.018	0.013	1.17	1.20	3.57	4.19	15.30
11/01/98	0.066	0.005	0.005	1.93	2.00	2.73	3.63	5.30
01/01/99	0.021	0.005	0.054	0.72	0.77	1.22	1.35	14.30
03/01/99	0.005	0.005	0.084	0.37	0.45	0.57	0.83	11.00
07/01/99	0.041	0.011	0.005	1.08	1.10	2.38	2.91	8.70
09/01/99	0.991	0.202	0.085	1.21	1.50	1.22	1.49	4.40
11/01/99	0.177	NA	0.005	NA	NA	2.59	4.64	NA
01/01/00	0.135	0.003	0.050	1.10	1.15	1.24	1.24	131.60
03/01/00	0.442	0.010	0.018	NA	NA	1.82	5.12	70.80
06/01/00	0.005	*0.005*	*0.005*	1.79	1.80	2.44	2.48	5.68
07/24/00	0.020	*0.005*	*0.005*	1.20	1.20	1.75	1.94	2.38
09/06/00	0.060	0.015	0.017	2.37	2.40	2.44	2.58	6.28
04/24/01	0.329	*0.005*	*0.005*	3.59	3.60	2.26	2.67	150.33
07/18/01	0.063	0.012	0.012	1.55	1.57	2.54	2.79	9.49
09/20/01	1.440	*0.005*	*0.005*	2.88	2.89	1.80	6.27	18.19
07/16/02	0.336	0.011	0.059	2.14	2.21	0.01	NA	NA
No Obs	**22**	**21**	**22**	**19**	**20**	**22**	**21**	**20**
Mean	**0.260**	**0.043**	**0.152**	**1.58**	**1.74**	**1.91**	**2.75**	**25.20**
Median	**0.073**	**0.005**	**0.013**	**1.30**	**1.40**	**2.04**	**2.67**	**7.49**
max	**1.440**	**0.516**	**2.650**	**3.59**	**5.40**	**3.82**	**6.27**	**150.33**
min	**0.005**	**0.003**	**0.005**	**0.37**	**0.45**	**0.01**	**0.31**	**0.68**
Std.Dev	**0.404**	**0.114**	**0.547**	**0.79**	**1.14**	**0.99**	**1.56**	**41.94**
c.v.	**1.551**	**2.636**	**3.607**	**0.50**	**0.66**	**0.52**	**0.57**	**1.66**

Appendix G-3. Ambient water quality samples taken in the pre-treatment ditch

Metals Units	Aluminu ug/L	Cadmium ug/L	Chromiu ug/L	Copper ug/L	Iron ug/L	Lead ug/L	Nickel ug/L	Manganese ug/L	Zinc ug/L
07/01/97	na	0.60	na	90.2	1726	3.30	NA	145.0	50
09/01/97	14	0.15	2.35	3.2	142	0.75	*2.15*	28.5	15
11/01/97	na	0.15	na	7.7	152	0.75	NA	31.6	15
01/01/98	440	0.31	2.35	22.1	591	2.82	*2.15*	81.3	15
03/01/98	227	0.15	2.35	65.8	160	0.75	*2.15*	53.1	30
04/01/98	1510	0.70	19.90	97.0	1130	7.10	*2.15*	397.0	40
06/01/98	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
09/01/98	379	0.15	5.10	18.2	300	*0.75*	*2.15*	873.0	15
11/01/98	544	0.15	2.35	15.3	260	5.60	*2.15*	177.0	15
01/01/99	215	0.15	2.35	26.3	140	*0.75*	*2.15*	37.4	15
03/01/99	195	0.15	2.35	15.0	160	*0.75*	*2.15*	77.1	15
07/01/99	124	0.15	3.00	2.4	120	*0.75*	2.15	364.0	8
09/01/99	562	0.15	5.90	16.8	580	4.20	3.30	222.0	20
11/01/99	2630	1.10	36.10	224.0	3190	12.20	6.30	884.0	80
01/01/00	219	0.15	3.20	14.8	240	*0.75*	*1.25*	190.0	20
03/01/00	3390	1.40	44.00	278.0	2470	16.50	7.40	408.0	120
06/01/00	58	0.15	*1.00*	6.1	220	*0.75*	*1.25*	384.0	8
07/24/00	78	0.15	*1.00*	*1.0*	480	*0.75*	*1.25*	391.0	8
09/06/00	74	0.15	2.30	*1.0*	40	1.90	2.90	254.0	8
04/24/01	2390	0.90	29.20	167.0	2040	10.20	4.70	672.0	80
07/18/01	122	0.10	2.90	7.0	90	0.60	3.40	378.0	10
09/20/01	57	0.10	2.90	11.4	330	0.60	2.30	534.0	60
07/16/02	274	0.29	4.00	12.5	330	3.00	3.20	252.0	60
No Obs	**20**	**22**	**20**	**22**	**22**	**22**	**20**	**22**	**22**
Mean	**675**	**0.34**	**8.73**	**50.1**	**677**	**3.43**	**2.83**	**310.6**	**32**
Median	**223**	**0.15**	**2.90**	**15.2**	**280**	**0.75**	**2.15**	**253.0**	**15**
max	**3390**	**1.40**	**44.00**	**278.0**	**3190**	**16.50**	**7.40**	**884.0**	**120**
min	**14**	**0.10**	**1.00**	**1.0**	**40**	**0.60**	**1.25**	**28.5**	**8**
Std.Dev	**963**	**0.36**	**12.48**	**75.3**	**857**	**4.28**	**1.57**	**246.9**	**30**
c.v.	**1.43**	**1.05**	**1.43**	**1.5**	**1**	**1.25**	**0.55**	**0.8**	**1**

Appendix G-4. Ambient water quality samples taken in the pre-treatment ditch

Station 4- STA824 Nutrients Units	Ammonia mg/L-N	Nitrite mg/L-N	Nitrate mg/L-N	TKN mg/L-N	TN mg/L-N	Ortho P mg/L-P	Total P mg/L-P	TSS mg/L
07/01/97	0.051	0.005	0.005	0.83	0.84	0.52	0.55	4.30
09/01/97	0.027	0.216	0.005	1.08	1.31	0.36	0.37	6.24
11/01/97	0.363	0.220	0.216	0.34	0.78	0.68	0.74	20.68
01/01/98	0.530	0.020	0.200	1.28	1.50	3.94	4.02	2.94
03/01/98	0.788	0.132	0.068	1.70	1.90	2.10	2.54	7.00
04/01/98	0.224	0.005	0.005	1.10	1.10	5.43	6.26	14.00
06/01/98	0.398	0.019	0.005	1.88	1.90	2.84	3.57	28.00
09/01/98	0.164	0.005	0.005	1.20	1.20	3.38	3.95	12.70
11/01/98	0.005	0.005	0.010	1.99	2.00	4.48	6.20	18.40
01/01/99	0.028	0.005	0.005	0.80	0.80	1.68	2.00	13.40
03/01/99	0.005	0.005	0.005	0.91	0.91	4.48	5.20	6.90
07/01/99	0.058	0.005	0.005	0.82	0.83	2.03	2.85	12.70
09/01/99	0.054	0.005	0.005	0.15	0.16	0.25	0.33	11.80
11/01/99	0.444	NA	0.012	NA	NA	3.39	4.88	NA
01/01/00	0.850	0.005	0.005	12.00	12.01	2.60	3.19	113.40
03/01/00	0.156	0.025	0.005	9.68	9.71	2.58	6.40	414.70
05/01/00	1.980	0.005	0.005	4.29	4.30	1.29	1.48	NA
06/01/00	0.209	0.007	0.004	2.79	2.80	2.34	2.52	6.10
07/24/00	0.164	0.028	0.417	1.06	1.50	0.20	0.30	5.58
09/06/00	0.639	0.028	*0.005*	2.97	3.00	2.50	2.90	12.70
04/24/01	0.016	0.008	*0.005*	2.39	2.40	1.24	1.39	38.76
07/18/01	0.120	0.002	0.203	0.95	1.16	0.01	0.02	na
09/20/01	0.567	0.007	0.005	1.92	1.93	4.53	5.26	24.32
07/16/02	0.493	0.008	0.005	1.98	1.99	3.33	3.53	9.70
No Obs	**23**	**22**	**23**	**22**	**22**	**23**	**23**	**20**
Mean	**0.360**	**0.035**	**0.052**	**2.42**	**2.51**	**2.42**	**3.04**	**39.00**
Median	**0.209**	**0.007**	**0.005**	**1.49**	**1.70**	**2.50**	**2.90**	**12.70**
max	**1.980**	**0.220**	**0.417**	**12.00**	**12.01**	**5.43**	**6.40**	**414.70**
min	**0.005**	**0.002**	**0.004**	**0.15**	**0.16**	**0.01**	**0.02**	**2.94**
Std.Dev	**0.428**	**0.064**	**0.103**	**2.84**	**2.80**	**1.52**	**1.98**	**89.26**
c.v.	**1.189**	**1.832**	**1.965**	**1.17**	**1.12**	**0.63**	**0.65**	**2.29**

Appendix G-4. Ambient water quality samples taken in the pre-treatment ditch

Station 4- STA824

Metals Units	Aluminu ug/L	Cadmium ug/L	Chromiu ug/L	Copper ug/L	Iron ug/L	Lead ug/L	Nickel ug/L	Manganese ug/L	Zinc ug/L
07/01/97	NA	*0.15*	NA	3.3	443	*0.75*	NA	n/a	*15*
09/01/97	88	*0.15*	*2.35*	9.5	345	*0.75*	*2.15*	39.5	47
11/01/97	NA	*0.15*	NA	31.2	350	2.64	NA	62.5	30
01/01/98	42	0.43	*2.35*	27.2	135	*0.75*	*2.15*	248.0	*15*
03/01/98	585	0.80	12.40	111.0	740	6.70	*2.15*	155.0	80
04/01/98	342	0.30	7.70	31.5	550	3.30	*2.15*	360.0	*15*
06/01/98	377	*0.15*	*2.35*	28.1	820	*0.75*	5.00	901.0	300
09/01/98	218	*0.15*	*2.35*	4.7	380	*0.75*	*2.15*	585.0	80
11/01/98	512	*0.15*	6.40	28.2	300	3.40	*2.15*	381.0	*15*
01/01/99	454	*0.15*	*2.35*	27.6	530	*0.75*	*2.15*	74.6	30
03/01/99	21	*0.15*	*2.35*	6.5	150	*0.75*	*2.15*	421.0	*15*
07/01/99	82	0.15	3.00	6.5	220	*0.75*	2.15	240.0	20
09/01/99	212	*0.15*	*1.00*	*1.0*	520	2.60	*1.25*	94.9	*8*
11/01/99	2820	1.90	52.30	371.0	3530	19.90	8.70	649.0	130
01/01/00	752	0.30	12.60	54.6	700	5.40	*1.25*	317.0	40
03/01/00	22700	3.10	200.00	1180.0	10400	56.80	16.70	2060.0	350
05/01/00	1540	0.70	21.00	144.0	1410	10.50	4.40	330.0	80
06/01/00	112	0.40	2.40	27.8	370	*0.75*	3.90	529.0	30
07/24/00	298	*0.15*	*1.00*	3.3	210	*0.75*	*1.25*	17.3	*8*
09/06/00	885	*0.15*	16.30	86.4	760	5.70	6.80	279.0	50
04/24/01	375	*0.15*	4.20	17.1	260	2.30	*1.25*	153.0	30
07/18/01	30	0.10	0.40	1.0	50	0.30	2.00	0.8	20
09/20/01	1670	0.60	29.00	144.0	1860	11.30	4.80	449.0	110
07/16/02	4550	2.49	80.60	388.0	5130	32.60	10.50	386.0	250
No Obs	**22**	**23**	**22**	**23**	**23**	**23**	**22**	**23**	**23**
Mean	**1757**	**0.56**	**21.11**	**118.7**	**1292**	**7.40**	**3.96**	**379.7**	**76**
Median	**376**	**0.15**	**3.60**	**28.1**	**520**	**2.60**	**2.15**	**317.0**	**30**
max	**22700**	**3.10**	**200.00**	**1180.0**	**10400**	**56.80**	**16.70**	**2060.0**	**350**
min	**21**	**0.10**	**0.40**	**1.0**	**50**	**0.30**	**1.25**	**0.8**	**8**
Std.Dev	**4690**	**0.79**	**43.41**	**249.1**	**2264**	**12.88**	**3.69**	**420.1**	**94**
c.v.	**2.67**	**1.41**	**2.06**	**2.10**	**1.75**	**1.74**	**0.93**	**1.11**	**1.23**

APPENDIX H

Pesticides Measured in the Pre-Treatment Ditch

Appendix H-1. Pesticide data in ditch (ug/L). PCB's were undetected.

U= not detected; I=value between lab detection limit and lab practical quantitation limit; N=presumptive evidence of presence of material; J=estimated value; NM=not analyzed for.

Station 2- STA 822

	09/03/97	11/10/97	01/06/98	03/03/98	04/27/98	06/29/98	09/11/98	11/03/98	01/06/99	03/02/99	07/07/99	09/08/99	11/09/99	01/12/00	03/08/00	05/09/00	09/06/00	04/24/01	07/17/01	09/19/01
Chlorinated Pesticides																				
Aldrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Alpha - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Beta - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Delta - BHC	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Gamma - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlordane	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	**1.7**	U	U	U	U
DDD - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	**0.097i**	U	U	U	U
DDE - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	**0.38**	U	U	U	U
DDT - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	**0.077i**	U	U	U	U
Dieldrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan I	U	**0.013i**	U	U	U	U	U	U	U	U	U	U	U	U	U	**0.13**	U	U	U	U
Endosulfan II	U	**0.048i**	**0.020i**	U	U	U	U	U	U	U	U	U	U	U	**0.023i**	**0.13**	U	U	U	U
Endosulfan Sulfate	U	**0.11j**	**0.066i**	**0.043i**	**0.07i**	**0.23**	**0.033i**	U	U	U	U	U	U	**0.025i**	**0.13**	**0.48**	U	**0.057**	U	**0.066i**
Endrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endrin Aldehyde	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Heptachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Heptachlor Epoxid	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Methoxychlor	U	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Toxaphene	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Organophosphorus and Nitrogen Pesticides																				
Alachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Ametryn	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Atrazine	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Azinphos Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Bromacil	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Butylate	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Ethyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Diazinon	U	U	U	U	U	U	U	U	**0.15i**	U	U	U	U	**0.99j**	U	U	U	U	U	U
Ethion	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Ethoprop	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fenaminphos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fonofos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Malathion	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metalaxyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metolachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metribuzin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Mevinphos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Naled	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Parathion Ethyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Parathion Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Phorate	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Prometryn	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Simazine	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

Appendix H-2. Pesticide data in ditch (ug/L). PCB's were undetected.

U= not detected; I= value between lab detection limit and lab practical quantitation limit; N= presumptive evidence of presence of material; J= estimated value; NM= not analyzed for.

Station 3- STA 823

	09/03/97	11/10/97	01/06/98	03/03/98	04/27/98	06/29/98	09/11/98	11/03/98	01/06/99	03/02/99	07/07/99	09/08/99	11/09/99	01/12/00	03/08/00	05/09/00	09/06/00	04/24/01	07/17/01	09/19/01
Chlorinated Pesticides																				
Aldrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Alpha - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Beta - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Delta - BHC	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Gamma - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Chlordane	U	U	U	**0.18i**	U	U	U	U	U	U	U	U	U	U	**0.74i**	DRY	U	U	U	U
DDD - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
DDE - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
DDT - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	**0.077i**	DRY	U	U	U	U
Dieldrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Endosulfan I	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Endosulfan II	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U	U	U	U	U	U	U	U	**0.069n**	**0.023i**	**0.053i**	DRY	U	U	U	U
Endrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Endrin Aldehyde	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Heptachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Heptachlor Epoxid	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Methoxychlor	U	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Toxaphene	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Organophosphorus and Nitrogen Pesticides																DRY				
Alachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Ametryn	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Atrazine	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Azinphos Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Bromacil	U	U	U	U	U	U	U	U	**1.2i**	U	U	U	U	U	U	DRY	U	U	U	U
Butylate	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Chlorpyrifos Ethyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Chlorpyrifos Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Diazinon	U	U	U	U	U	U	U	U	**0.15i**	U	U	U	U	**0.66**	U	DRY	U	**0.11**	U	U
Ethion	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Ethoprop	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Fenaminphos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Fonofos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Malathion	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Metalaxyl	NM	U	U	U	U	U	U	U	U	U	U	U	**1.5i**	U	U	DRY	U	U	U	U
Metolachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Metribuzin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Mevinphos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Naled	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Parathion Ethyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Parathion Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Phorate	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Prometryn	U	U	U	NM	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U
Simazine	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	DRY	U	U	U	U

Appendix H-3. Pesticide data in ditch (ug/L). PCB's were undetected.

U= not detected; I=value between lab detection limit and lab practical quantitation limit; N=presumptive evidence of presence of material; J=estimated value; NM=not analyzed for.

Station 4- STA 824

	09/03/97	11/10/97	01/06/98	03/03/98	04/27/98	06/29/98	09/11/98	11/03/98	01/06/99	03/02/99	07/07/99	09/08/99	11/09/99	01/12/00	03/08/00	05/09/00	09/06/00	04/24/01	07/17/01	09/19/01
Chlorinated Pesticides																				
Aldrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Alpha - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Beta - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Delta - BHC	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Gamma - BHC	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlordane	U	U	U	**0.26i**	U	U	U	U	U	U	U	U	U	U	**0.23i**	U	U	U	U	U
DDD - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DDE - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DDT - p,p'	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Dieldrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan I	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan II	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U	U	U	U	U	U	U	U	**0.22n**	**0.072i**	**0.066i**	U	U	U	U	U
Endrin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Endrin Aldehyde	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Heptachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Heptachlor Epoxid	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Methoxychlor	U	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Toxaphene	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Organophosphorus and Nitrogen Pesticides																				
Alachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Ametryn	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Atrazine	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Azinphos Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Bromacil	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Butylate	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Ethyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Diazinon	U	U	U	U	U	U	U	U	U	U	U	U	U	**1.6**	U	**0.12i**	U	U	U	U
Ethion	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Ethoprop	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fenaminphos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fonofos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Malathion	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metalaxyl	NM	U	U	U	U	U	U	U	U	U	U	U	**1.1i**	U	U	U	U	U	U	U
Metolachlor	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metribuzin	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Mevinphos	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Naled	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Parathion Ethyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Parathion Methyl	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Phorate	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Prometryn	U	U	U	NM	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Simazine	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

APPENDIX I

Sediment Samples

Appendix I-1. Sediment samples July 1997

Nutrients	Units	Sed 1	Sed 2	Sed 3	Sed4	Sed 5	Sed 6	Sed 7
Ammonia	mg/kg	1.5	13	5.4	1.9	2	9.2	4.8
TKN	mg/kg	170	460	110	110	120	170	400
Ortho P	mg/kg	1.0	1.4	0.9	0.6	1.0	1.0	1.3
Total P	mg/kg	190	690	6900	2900	300	170	190
TON	mg/kg	169	447	105	108	118	161	395
Metals	**Units**	**Sed 1**	**Sed 2**	**Sed 3**	**Sed4**	**Sed 5**	**Sed 6**	**Sed 7**
Mercury	mg/Kg	0.03	0.029	0.018	0.015	0.017	0.015	0.027
Aluminum	mg/Kg	8200	1500	4930	2350	3210	1370	4740
Arsenic	mg/Kg	8	8	8.1	6	6	7	8
Antimony	mg/Kg	3 U	3 U	2.9 U	2 U	2 U	2 U	3 U
Barium	mg/Kg	18.8	9.2	14.4 A	5.97	5.01	2.23	7.15
Beryllium	mg/Kg	0.3 I	0.1 U	0.4 I	0.1 I	0.1 I	0.09 U	0.1 I
Cadmium	mg/Kg	1 U	1U	1 U	0.9 U	0.9 U	1 U	1 U
Calcium	mg/Kg	125000	80600	97400	61500	21300	1400 I	35800
Chromium	mg/Kg	38 I	8.3	24.5	9.7	7.6	14	11
Cobalt	mg/Kg	8 U	0.8 U	1 I	0.6 U	0.8 I	0.7 U	1 I
Copper	mg/Kg	2 U	19.8	6.2 A	1.9 I	1.8 I	28	2.9 I
Iron	mg/Kg	3970	886	4420 A	1980	1570	1130	2260
Lead	mg/Kg	5 U	4.8 U	5.1 U	4 U	3.6 U	4.4 U	5 U
Magnesiu	mg/Kg	802 J	868 J	16600	6850 J	393 J	621 J	1010 J
Manganes	mg/Kg	20	23.4	47.3 A	15	4.1	9.6	6.4
Nickel	mg/Kg	10 U	2.2	5.7 A	2	2.5	1 I	3.2
Potassium	mg/Kg	273	80	510 A	184	100	170	338
Selenium	mg/Kg	10 U	10 U	10 U	7 U	7 U	9 U	10 U
Silver	mg/Kg	0.7 U	0.6 U	0.6 U	1 U	0.4 U	0.5 U	0.6 U
Sodium	mg/Kg	1120 J	699 J	948 J	572 J	262 J	1750 J	3000 J
Strontium	mg/Kg	560 J	418 J	345 J	232 J	129 J	15 J	207 J
Thallium	mg/Kg	10 U	10 U	10 U	7 U	7 U	9 U	10 U
Vanadium	mg/Kg	20 I	5.1	39.3 A	13	8.6	2.6	15
Zinc	mg/Kg	4.0 U	14	7.2 I	2.9 U	2.9 U	17	5.4 I

A - Value reported is mean of two or more determinations
I - Value reported is less than the minimum quantitation limit and greater than or equal to the minimum detection limit
J - Estimated value
U - Material was analyed for but not detected; the value reported is the minimum detection limit

Key:

Sediment sampling at Cockroach Bay
See Figure ?? for sampling locations

Sed 1	**Ditch at inflow culvert (WQ 2)**
Sed 2	**Inflow - pond side**
Sed 3	**Middle of east pond**
Sed 4	**Middle of west pond**
Sed 5	**Outflow - pond side**
Sed 6	**Outflow - marsh side**
Sed 7	**Mouth of of tidal creek**
Sed 8	**WQ site 1 (No data 1997)**
Sed 9	**WQ site 3 (No data 1997)**
Sed 10	**WQ site 4 (No data 1997)**

Appendix I-2 Sediment Samples July 1998

	Units	Sed 1	Sed 2	Sed 3	Sed4	Sed 5	Sed 6	Sed 7	Sed 8	Sed 9	Sed 10
Ammonia	mg/kg	1.1	17.0	11.0	6.2	7.1	4.5	4.7	1.4	21.0	29.0
NO3+NO2	mg/kg	0.24 U	0.25 U	0.27 U	0.24 U	0.24 U	0.25 U	0.26 U	0.24 U	0.56 U	0.37 U
TKN	mg/kg	200	240	350	140	280	220	250	130	5700	1600
Ortho P	mg/kg	15	20	120	48	22	9.2	24	10	74	110
Total P	mg/kg	400	310	25000	4800	200	30	320	120	2300	1100
TON	mg/kg	199	223	339	134	273	216	245	129	5679	1571
Metals	**Units**	**Sed 1**	**Sed 2**	**Sed 3**	**Sed4**	**Sed 5**	**Sed 6**	**Sed 7**	**Sed 8**	**Sed 9**	**Sed 10**
		1	3	2	4	5	7	6			
Mercury	mg/Kg	0.0087 I	0.014	0.023	0.0084	0.012 I	0.013	0.012 I	0.0062 U	0.26	0.099
Aluminum	mg/Kg	281 J	355 J	5070 J	3170	997 J	552 J	1380 J	1440 J	4250 J	2800 J
Antimony	mg/Kg	0.8 U	0.7 U	1.0 I	0.8 U	0.8 U	0.7 U	0.8 U	0.7 U	2.0 U	0.9 U
Arsenic	mg/Kg	1.3 I	0.7 I	9.8	3.2	0.7 U	0.7 I	1.0 I	0.7 U	7.3	3.0 I
Barium	mg/Kg	2.39 J	3.15 J	16.7 J	7.3 J	2.24 J	1.29 J	2.92 J	3.08 J	39.5 J	19.9 J
Beryllium	mg/Kg	0.018 I	0.022 I	0.341	0.17	0.037 I	0.034 I	0.08	0.038 I	0.18	0.17
Cadmium	mg/Kg	0.21 I	0.22 I	0.77	0.26 J	0.1 U	0.2 I	0.2 I	0.1 U	2.2	0.91
Calcium	mg/Kg	3950 J	8480 J	105000 J	45100 J	3500 J	888 J	19900 J	13500 J	22600 J	86900 J
Chromium	mg/Kg	5.15 A	4.5	24.6	10.3	2.87	6.57	4.69	2.04	71.2	28.7
Cobalt	mg/Kg	0..40 U	0.36 U	1.1 I	0.40 U	0.41 U	0.37 U	0.38 U	0.37 U	0.77 U	0.46 U
Copper	mg/Kg	6.39 A	9	12.5	2.03	3.72	20.2	3.45	0.86 I	421	167
Iron	mg/Kg	455 J	369 J	4630 J	2450 J	427 J	787 J	1580 J	525 J	4580 J	3920 J
Lead	mg/Kg	2.0 I	2.2 I	3.8	2 I	1.0 I	3.6	1.0 I	1.0 I	27	12
Magnesiu	mg/Kg	114 J	110 J	13500 J	3440 J	443	476 J	538 J	129 J	1270 J	527 J
Manganese	mg/Kg	10.2 J	17.1 J	51.2 J	12.0 J	4.1 J	4.06 J	3.24 J	2.15 J	203 J	40.6 J
Nickel	mg/Kg	1.0 U	1.0 U	4.6	1.0 J	1.0 U	1.0 U	1.0 U	1.0 U	3.0 I	2.0 I
Potassium	mg/Kg	20.1 I	20.1	417	136	118	150	182	31.6	245	189
Selenium	mg/Kg	0.5 U	0.5 U	2.0 I	0.6 I	0.5 U	0.5 U	0.5 U	0.5 U	1.0 I	0.6 U
Silver	mg/Kg	0.18 U	0.16 U	0.18 U	0.18 U	0.18 U	0.17 U	0.17 U	0.17 U	0.91 I	0.32 I
Sodium	mg/Kg	60 U	54 U	300	60 U	1800	1890	1980	56 U	300 U	470
Strontium	mg/Kg	27.3 A	60.5	340	188	32.8	10.3	118	70.1	351	399
Thallium	mg/Kg	2.6 U	2.4 U	6.0 U	2.6	2.7 U	2.4 U	2.5 U	2.4 U	5.0 U	6.0 U
Vanadium	mg/Kg	0.76 J	0.88 J	37.9 J	9.74 J	1.9 J	1.6 J	4.84 J	1.7 J	8.18 J	10.9 J
Zinc	mg/Kg	9.4	11	11	4.0 U	13	15.0 I	5.6 I	3.7	138	56.2

A - Value reported is mean of two or more determinations
I - Value reported is less than the minimum quantitation limit and greater than or equal to the minimum detection limit
J - Estimated value
U - Material was analyed for but not detected; the value reported is the minimum detection limit

Appendix I-2a Pesticide concentrations in the sediments measured in July 1997. See Figure 1 and Table 3 for site locations.
Abbreviations: i=reported value is between the lab detection limit and the lab quantitation limit. j=estimated value, n=evidence of presence

	Units	Sed 1	Sed 2	Sed 3	Sed 4	Sed 5	Sed 6	Sed 7	Sed 8	Sed 9	Sed 10
Chlorinated Pesticides											
Aldrin	ug/kg	U	U	U	U	U	U	U			
Alpha - BHC	ug/kg	U	U	U	U	U	U	U			
Beta - BHC	ug/kg	U	U	U	U	U	U	U			
Delta - BHC	ug/kg	U	U	U	U	U	U	U			
Gamma - BHC	ug/kg	U	U	U	U	U	U	U			
Chlordane	ug/kg	**33 i**	**190.0**	**10 i**	**10 i**	**12 i**	**7.7 i**	**70.0**			
Chlorothalonil	ug/kg	U	U	U	U	U	U	U			
DDD - p,p'	ug/kg	**6.4**	**29.0**	U	U	U	U	U			
DDE - p,p'	ug/kg	**7.6**	**53.0**	**1.7 i**	**1.0 i**	**1.8 i**	**1.8 i**	**19.0**			
DDT - p,p'	ug/kg	U	**3.6 i**	**1.4 i**	U	U	U	U			
Dieldrin	ug/kg	U	U	U	U	U	U	U			
Endosulfan I	ug/kg	U	U	U	U	U	U	U			
Endosulfan II	ug/kg	U	U	**1.9 n**	U	U	U	U			
Endosulfan Sulfate	ug/kg	U	U	U	U	U	U	U			
Endrin	ug/kg	U	U	U	U	U	U	U			
Endrin Aldehyde	ug/kg	U	U	U	U	U	U	U			
Heptachlor	ug/kg	U	U	U	U	U	U	U			
Heptachlor Epoxide	ug/kg	U	U	U	U	U	U	U			
Methoxychlor	ug/kg	U	U	U	U	U	U	U			
Permethrin	ug/kg	U	U	U	U	U	U	U			
Toxaphene	ug/kg	U	U	U	U	U	U	U			
Organonitrogen - phosphorus											
Alachlor	ug/kg	U	U	U	U	U	U	U			
Ametryn	ug/kg	U	U	U	U	U	U	U			
Atrazine	ug/kg	U	U	U	U	U	U	U			
Azinphos Methyl	ug/kg	U	U	U	U	U	U	U			
Bromacil	ug/kg	U	U	U	U	U	U	U			
Butylate	ug/kg	U	U	U	U	U	U	U			
Chlorpyrifos Ethyl	ug/kg	U	U	U	U	U	U	U			
Chlorpyrifos Methyl	ug/kg	U	U	U	U	U	U	U			
Diazinon	ug/kg	U	U	U	U	U	U	U			
Ethion	ug/kg	U	U	U	U	U	U	U			
Ethoprop	ug/kg	U	U	U	U	U	U	U			
Fenaminphos	ug/kg	U	U	U	U	U	U	U			
Fonofos	ug/kg	U	U	U	U	U	U	U			
Malathion	ug/kg	U	U	U	U	U	U	U			
Metalaxyl	ug/kg	U	U	U	U	U	U	U			
Metolachlor	ug/kg	U	U	U	U	U	U	U			
Metribuzin	ug/kg	U	U	U	U	U	U	U			
Mevinphos	ug/kg	U	U	U	U	U	U	U			
Naled	ug/kg	U	U	U	U	U	U	U			
Parathion Ethyl	ug/kg	U	U	U	U	U	U	U			
Parathion Methyl	ug/kg	U	U	U	U	U	U	U			
Phorate	ug/kg	U	U	U	U	U	U	U			
Prometryn	ug/kg	U	U	U	U	U	U	U			
Simazine	ug/kg	U	U	U	U	U	U	U			

Appendix I-2b Pesticide concentrations in the sediments measured in June 1998. See Figure 1 and Table 3 for site locations.

Abbreviations: i=reported value is between the lab detection limit and the lab quantitation limit. j=estimated value, n=evidence of presence

	Units	Sed 1	Sed 2	Sed 3	Sed 4	Sed 5	Sed 6	Sed 7	Sed 8	Sed 9	Sed 10
Chlorinated Pesticides											
Aldrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Alpha - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Beta - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Delta - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Gamma - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlordane	ug/kg	**37 i**	**110.0**	**42 i**	**20 i**	**16 i**	**7.8 i**	**26 i**	U	**1400.0**	**690.0**
Chlorothalonil	ug/kg	U	U	U	U	U	U	U	U	U	U
DDD - p,p'	ug/kg	**1.1 i**	**14.0**	**1.1 i**	U	U	U	**1.1 i**	U	U	**5.2 i**
DDE - p,p'	ug/kg	**6.1**	**31.0**	**7.4**	U	U	U	**6.6**	U	**100.0**	**15.0**
DDT - p,p'	ug/kg	U	**3.6 i**	**1.4 i**	U	U	U	U	U	U	**2.3 i**
Dieldrin	ug/kg	U	U	U	U	U	U	U	U	**8.8**	U
Endosulfan I	ug/kg	U	U	U	U	U	U	U	U	U	U
Endosulfan II	ug/kg	**2.0 n**	**0.66 n**	**0.88 n**	U	U	U	U	U	U	U
Endosulfan Sulfate	ug/kg	U	U	U	U	U	U	U	U	U	U
Endrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Endrin Aldehyde	ug/kg	U	U	U	U	U	U	U	U	U	U
Heptachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Heptachlor Epoxide	ug/kg	U	U	U	U	U	U	U	U	U	U
Methoxychlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Permethrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Toxaphene	ug/kg	U	U	U	U	U	U	U	U	U	U
Organonitrogen - phosphorus											
Alachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Ametryn	ug/kg	U	U	U	U	U	U	U	U	U	U
Atrazine	ug/kg	U	U	U	U	U	U	U	U	U	U
Azinphos Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Bromacil	ug/kg	U	U	U	U	U	U	U	U	U	U
Butylate	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Diazinon	ug/kg	U	U	U	U	U	U	U	U	U	U
Ethion	ug/kg	U	U	U	U	U	U	U	U	U	U
Ethoprop	ug/kg	U	U	U	U	U	U	U	U	U	U
Fenaminphos	ug/kg	U	U	U	U	U	U	U	U	U	U
Fonofos	ug/kg	U	U	U	U	U	U	U	U	U	U
Malathion	ug/kg	U	U	U	U	U	U	U	U	U	U
Metalaxyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Metolachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Metribuzin	ug/kg	U	U	U	U	U	U	U	U	U	U
Mevinphos	ug/kg	U	U	U	U	U	U	U	U	U	U
Naled	ug/kg	U	U	U	U	U	U	U	U	U	U
Parathion Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Parathion Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Phorate	ug/kg	U	U	U	U	U	U	U	U	U	U
Prometryn	ug/kg	U	U	U	U	U	U	U	U	U	U
Simazine	ug/kg	U	U	U	U	U	U	U	U	U	U

Appendix I-2c. Pesticide concentrations in the sediments measured in June 2000. See Figure 1 and Table 3 for site locations.
Abbreviations: i=reported value is between the lab detection limit and the lab quantitation limit. j=estimated value

	Units	Sed 1	Sed 2	Sed 3	Sed 4	Sed 5	Sed 6	Sed 7	Sed 8	Sed 9	Sed 10
Chlorinated Pesticides											
Aldrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Alpha - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Beta - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Delta - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Gamma - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlordane	ug/kg	**18 j**	**28 i**	**350.0**	**29 i**	**12.0 i**	**20 i**	**7.7 i**	**8.4 i**	**34 i**	**25 i**
Chlorothalonil	ug/kg	U	U	U	U	U	U	U	U	U	U
DDD - p,p'	ug/kg	U	**2.1 i**	**8.4 i**	U	U	U	U	U	**1.4 i**	U
DDE - p,p'	ug/kg	U	**6.2**	**70.0**	**6.6**	**302 i**	**3.9 i**	**2.8 i**	U	U	**0.94 i**
DDT - p,p'	ug/kg	U	U	**11.0**	U	U	U	U	U	**2.4 i**	U
Dieldrin	ug/kg	**4.4 i**	U	**2.4 i**	U	U	U	U	U	**1.6 i**	U
Endosulfan I	ug/kg	U	U	U	U	U	U	U	U	U	U
Endosulfan II	ug/kg	**5.2 i**	U	U	U	U	U	U	U	U	U
Endosulfan Sulfate	ug/kg	**19.0**	U	U	U	U	U	U	U	U	U
Endrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Endrin Aldehyde	ug/kg	U	U	U	U	U	U	U	U	U	U
Heptachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Heptachlor Epoxide	ug/kg	U	U	U	U	U	U	U	U	U	U
Methoxychlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Permethrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Toxaphene	ug/kg	U	U	U	U	U	U	U	U	U	U
Organonitrogen - phosphorus											
Alachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Ametryn	ug/kg	U	U	U	U	U	U	U	U	U	U
Atrazine	ug/kg	U	U	U	U	U	U	U	U	U	U
Azinphos Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Bromacil	ug/kg	U	U	U	**65 i**	U	U	U	U	U	U
Butylate	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Diazinon	ug/kg	U	U	U	U	U	U	U	U	U	U
Ethion	ug/kg	U	U	U	U	U	U	U	U	U	U
Ethoprop	ug/kg	U	U	U	U	U	U	U	U	U	U
Fenaminphos	ug/kg	U	U	U	U	U	U	U	U	U	U
Fonofos	ug/kg	U	U	U	U	U	U	U	U	U	U
Malathion	ug/kg	U	U	U	U	U	U	U	U	U	U
Metalaxyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Metolachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Metribuzin	ug/kg	U	U	U	U	U	U	U	U	U	U
Mevinphos	ug/kg	U	U	U	U	U	U	U	U	U	U
Naled	ug/kg	U	U	U	U	U	U	U	U	U	U
Parathion Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Parathion Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Phorate	ug/kg	U	U	U	U	U	U	U	U	U	U
Prometryn	ug/kg	U	U	U	U	U	U	U	U	U	U
Simazine	ug/kg	U	U	U	U	U	U	U	U	U	U

Appendix I-2d. Pesticide concentrations in the sediments measured in July 2002. See Figure 1 and Table 3 for site locations.
Abbreviations: i=reported value is between the lab detection limit and the lab quantitation limit. j=estimated value

	Units	Sed 1	Sed 2	Sed 3	Sed 4	Sed 5	Sed 6	Sed 7	Sed 8	Sed 9	Sed 10
Chlorinated Pesticides											
Aldrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Alpha - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Beta - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Delta - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Gamma - BHC	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlordane	ug/kg	**160.0**	**110.0**	**350.0**	**100.0**	**56 j**	U	**180.0**	**270.0**	U	U
Chlorothalonil	ug/kg	U	U	U	U	U	U	U	U	U	U
DDD - p,p'	ug/kg	**17.0**	**2.4 i**	**9.0 i**	**13.0**	U	U	**5.0**	**4.9 i**	U	U
DDE - p,p'	ug/kg	**45.0**	**14.0**	**120.0**	U	**6.9**	U	U	**35.0**	U	**4.7 i**
DDT - p,p'	ug/kg	**6.4 j**	**3.8 i**	**21 j**	U	U	U	U	**11 j**	U	U
Dieldrin	ug/kg	U	**4.4 i**	U	U	U	U	U	U	U	U
Endosulfan I	ug/kg	U	U	U	U	U	U	U	U	U	U
Endosulfan II	ug/kg	U	U	U	U	U	U	U	U	U	U
Endosulfan Sulfate	ug/kg	U	U	U	U	U	U	U	U	U	U
Endrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Endrin Aldehyde	ug/kg	U	U	U	U	U	U	U	U	U	U
Heptachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Heptachlor Epoxide	ug/kg	U	U	U	U	U	U	U	U	U	U
Methoxychlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Permethrin	ug/kg	U	U	U	U	U	U	U	U	U	U
Toxaphene	ug/kg	U	U	U	U	U	U	U	U	U	U
Organonitrogen - phosphorus											
Alachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Ametryn	ug/kg	U	U	U	U	U	U	U	U	U	U
Atrazine	ug/kg	U	U	U	U	U	U	U	U	U	U
Azinphos Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Bromacil	ug/kg	U	U	U	**65 i**	U	U	U	U	U	U
Butylate	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Chlorpyrifos Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Diazinon	ug/kg	U	U	U	U	U	U	U	U	U	U
Ethion	ug/kg	U	U	U	U	U	U	U	U	U	U
Ethoprop	ug/kg	U	U	U	U	U	U	U	U	U	U
Fenaminphos	ug/kg	U	U	U	U	U	U	U	U	U	U
Fonofos	ug/kg	U	U	U	U	U	U	U	U	U	U
Malathion	ug/kg	U	U	U	U	U	U	U	U	U	U
Metalaxyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Metolachlor	ug/kg	U	U	U	U	U	U	U	U	U	U
Metribuzin	ug/kg	U	U	U	U	U	U	U	U	U	U
Mevinphos	ug/kg	U	U	U	U	U	U	U	U	U	U
Naled	ug/kg	U	U	U	U	U	U	U	U	U	U
Parathion Ethyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Parathion Methyl	ug/kg	U	U	U	U	U	U	U	U	U	U
Phorate	ug/kg	U	U	U	U	U	U	U	U	U	U
Prometryn	ug/kg	U	U	U	U	U	U	U	U	U	U
Simazine	ug/kg	U	U	U	U	U	U	U	U	U	U

APPENDIX J

Water Level Contours Calculated from Well Level Measurements
and other well level information

Appendix J-1. Well levels surrounding the wet detention pond. See figure 3 for well location

Well #	1	2	3	4	6	7	8	9	10	12
NGVD**	4.53	8.77	9.05	10.11	9.24	9.14	6.00	10.38	8.77	9.20
05/06/97	1.13	2.82	3.15	2.96	1.94	1.89	1.90	2.13	2.47	2.20
06/13/97	dry	1.67	1.85	2.41	1.74	1.59	2.00	1.98	1.97	1.70
06/25/97	1.18	2.52	2.51	3.15	2.22	1.94	2.25	2.43	2.62	2.50
07/18/97	2.19	2.92	2.95	3.11	2.69	2.19	2.61	2.61	2.97	2.65
08/04/97	2.09	4.17	3.55	3.61	2.44	2.24	2.40	2.58	2.53	3.12
08/15/97	2.13	3.12	2.95	3.16	2.64	2.59	2.60	2.68	3.07	2.80
09/03/97	1.33	2.37	2.45	2.81	2.49	2.42	2.50	2.39	2.80	2.30
10/08/97	1.13	3.02	dry	3.11	2.54	2.54	2.50	2.63	3.17	2.70
10/20/97	0.93	2.42	2.48	2.83	2.44	2.39	2.45	2.48	2.81	2.25
10/29/97	1.28	3.67	3.65	3.76	2.74	2.94	2.70	2.83	3.37	3.05
11/10/97	0.83	1.87	2.87	3.02	2.52	2.44	2.50	2.57	2.97	2.50
11/19/97	1.23	3.57	3.45	3.51	2.54	2.74	2.50	2.68	3.17	2.50
12/05/97	1.42	2.93	3.62	3.71	1.55	1.72	2.52	2.68	3.16	2.88
12/17/97	1.08	3.96	3.73	3.82	2.74	2.84	2.60	2.78	3.47	3.20
01/08/98	1.63	5.27	5.55	4.41	2.44	2.94	2.40	2.88	3.57	3.60
01/22/98	1.35	3.55	3.31	3.37	2.54	2.58	2.56	2.66	3.21	2.74
02/05/98	1.38	3.87	3.65	3.71	2.64	2.69	2.60	2.68	3.37	3.00
02/17/98	2.05	5.39	3.83	4.87	3.46	4.24	3.12	4.14	4.29	4.14
02/26/98	0.95	3.57	3.40	3.53	2.60	2.69	2.53	2.67	3.40	2.95
03/11/98	0.83	2.93	3.63	3.39	2.54	2.54	2.50	2.98	3.27	2.72
03/20/98	2.25	5.25	4.99	5.15	3.56	4.30	3.16	3.42	4.31	4.42
03/31/98	1.09	2.95	2.89	3.13	2.46	2.44	2.44	2.54	3.15	2.56
04/10/98	0.83	2.31	2.37	2.73	2.26	2.15	2.30	2.42	2.87	2.14
04/22/98	0.93	1.97	2.15	2.56	2.24	2.10	2.26	2.38	2.75	2.02
05/01/98	1.33	1.77	2.03	2.39	2.09	1.94	2.10	2.18	2.52	1.90
05/11/98	1.38	1.59	1.79	2.09	1.82	1.72	1.90	1.98	2.27	1.70
06/05/98	1.51	1.42	1.50	1.91	1.69	1.54	1.82	1.89	2.07	1.59
06/17/98	1.08	1.12	1.30	1.91	1.39	1.19	1.60	1.63	1.72	1.30
06/29/98	0.73	1.02	1.20	1.81	1.34	1.14	1.45	1.53	1.72	1.35
07/15/98	1.33	1.52	1.77	2.56	1.54	1.49	1.70	1.88	2.12	2.15
07/29/98	0.85	1.07	1.37	1.93	1.42	1.20	1.60	1.66	1.79	1.55
08/12/98	0.73	0.97	1.15	1.71	1.24	1.04	1.45	1.53	1.72	1.55
08/27/98	0.75	0.82	0.90	2.19	1.17	0.94	1.40	1.48	1.69	1.45
09/11/98	1.67	2.05	2.37	2.91	2.48	2.38	2.50	2.56	2.83	2.58
09/23/98	1.71	3.01	3.14	3.45	2.74	2.83	2.68	2.84	3.25	3.10
10/06/98	1.30	2.57	2.65	3.06	2.52	2.44	2.45	2.58	2.92	2.55
10/23/98	0.65	1.63	1.89	2.30	1.86	1.74	1.91	1.96	2.29	1.84
11/05/98	0.96	2.37	2.40	2.86	2.97	1.94	2.02	3.20	2.67	2.75
11/24/98	0.91	1.63	1.89	2.29	2.12	2.02	2.14	2.19	2.36	1.88
12/11/98	1.16	1.47	1.70	2.06	2.13	2.03	2.10	2.18	2.30	1.73
12/21/98	0.83	1.57	1.83	2.21	2.14	2.08	2.14	2.18	2.37	1.98
01/06/99	0.73	0.07	0.25	2.69	2.24	2.22	2.25	2.33	2.57	2.20
01/25/99	1.08	3.37	3.40	3.71	2.84	2.94	2.75	2.88	3.22	3.10
02/05/99	1.10	2.50	2.65	2.94	2.53	2.48	2.52	2.58	2.82	2.41
02/19/99	1.33	3.12	2.37	2.71	2.49	2.42	2.49	2.50	2.63	2.18
03/02/99	-0.07	1.92	2.15	2.49	2.29	2.21	2.30	2.33	2.37	1.95
03/16/99	0.87	2.37	2.60	2.89	2.61	2.62	2.60	2.66	2.77	2.35
04/07/99	0.88	1.67	1.87	2.19	2.33	2.19	2.33	1.68	2.27	1.84
04/19/99	0.73	1.43	1.61	1.89	1.99	1.93	2.01	2.00	2.02	1.66
05/05/99	1.18	1.52	1.67	1.89	1.71	1.62	1.78	1.78	1.89	1.65
05/19/99	0.92	1.09	1.20	1.41	1.40	1.26	1.49	1.52	1.55	1.36
06/02/99	1.07	1.06	1.12	1.31	1.12	0.97	1.25	1.28	1.41	1.34
06/14/99	1.58	1.17	1.30	1.40	1.13	0.94	1.25	1.28	1.40	1.45
07/21/99	1.63	2.17	2.37	2.78	2.48	2.33	dry	dry	2.71	2.42
08/11/99	1.73	1.92	2.02	2.25	2.34	2.23	2.36	2.39	2.48	2.23
08/25/99	1.99	3.02	3.30	3.48	2.75	2.82	2.71	2.83	3.17	3.06
09/07/99	2.44	3.12	3.38	3.47	2.78	2.89	2.77	2.93	3.23	3.31
09/23/99	1.93	2.86	3.05	3.25	2.72	2.72	2.68	2.76	3.05	2.95
10/08/99	1.46	3.48	3.68	3.74	2.82	2.89	2.74	2.86	3.33	3.22

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Appendix J-1. Well levels surrounding the wet detention pond. See figure 3 for well location

Well #	1	2	3	4	6	7	8	9	10	12
NGVD**	4.53	8.77	9.05	10.11	9.24	9.14	6.00	10.38	8.77	9.20
10/22/99	1.86	2.54	2.74	2.98	2.57	2.54	2.56	2.62	2.89	2.46
11/04/99	1.48	2.51	2.79	3.12	2.69	2.67	2.66	2.70	2.99	3.13
11/16/99	1.32	2.11	2.98	2.75	2.69	2.59	2.97	2.77	3.20	2.28
12/02/99	0.87	1.91	2.17	dry	2.50	2.43	2.47	2.51	3.12	2.20
12/14/99	0.94	2.17	2.51	3.17	2.61	2.64	2.60	2.65	3.20	2.63
12/27/99	0.93	2.28	2.67	3.56	2.68	2.61	2.65	2.68	3.09	2.39
01/11/00	0.97	2.38	2.75	3.26	2.65	2.63	2.62	2.68	3.02	2.44
01/27/00	0.83	2.23	2.62	3.41	2.66	2.61	2.62	2.63	2.91	dry
02/08/00	0.82	2.09	dry	3.21	2.55	2.48	2.51	2.51	2.76	2.14
02/24/00	0.83	2.23	2.62	3.41	2.55	2.47	dry	2.62	dry	dry
03/07/00	0.84	1.87	2.17	2.77	2.53	2.44	2.51	2.50	2.61	1.93
03/24/00	0.92	1.66	1.89	2.36	2.25	2.18	2.25	2.24	2.30	1.75
04/06/00	0.87	1.63	1.89	2.77	2.24	2.14	2.26	1.81	2.32	1.76
04/20/00	0.84	1.53	1.82	2.87	2.21	2.11	2.30	2.36	2.35	1.83
05/03/00	0.79	1.37	1.55	2.24	2.02	1.92	2.10	2.10	2.05	1.56
05/18/00	1.37	1.08	1.17	dry	1.54	1.40	1.71	1.70	1.19	0.61
05/31/00	1.14	0.74	0.82	1.17	1.09	0.93	1.35	1.37	1.36	1.06
06/13/00	0.79	0.53	0.59	0.91	0.86	0.76	1.02	1.08	1.17	0.95
06/27/00	1.74	2.43	2.72	3.10	2.35	2.46	2.43	2.62	2.83	3.00
07/13/00	2.15	2.98	3.18	3.76	2.74	2.76	2.73	2.80	3.35	2.77
07/28/00	2.07	3.24	3.48	3.54	2.69	2.74	2.66	2.75	3.48	3.02
08/09/00	1.76	2.52	2.74	3.27	2.56	2.49	2.57	2.62	3.17	2.49
08/25/00	2.01	2.36	2.55	3.11	2.58	2.51	2.57	2.62	3.08	2.46
09/07/00	1.97	2.38	2.61	3.19	2.65	2.62	2.67	2.76	3.15	2.72
10/20/00	1.91	2.17	2.42	2.97	0.64	2.53	2.66	2.77	2.97	2.29
11/09/00	2.31	2.02	2.10	2.61	2.53	2.47	2.55	2.61	2.78	2.12
12/01/00	1.06	2.08	2.42	2.95	2.63	2.63	2.60	dry	2.86	2.39
12/21/00	0.99	1.96	2.28	2.93	2.67	2.61	2.67	2.74	2.84	2.24
01/04/01	0.92	1.90	2.24	2.84	2.59	2.54	2.59	2.72	2.76	1.43
01/19/01	1.43	2.06	2.33	2.81	2.53	2.52	2.52	2.57	2.66	2.12
02/02/01	4.53	1.88	2.19	2.64	2.53	2.51	2.51	2.61	3.04	2.13
02/16/01	0.93	1.77	2.05	2.42	2.39	2.36	2.41	2.46	3.19	2.03
03/02/01	1.33	1.77	1.96	2.23	2.38	2.33	2.36	2.41	2.95	1.92
03/15/01	1.54	2.20	2.45	2.76	2.51	2.49	2.51	2.56	3.02	2.28
04/02/01	1.31	3.29	3.55	3.64	2.79	2.91	2.69	2.81	3.37	3.05
04/12/01	1.63	2.52	2.70	2.96	2.50	2.48	2.49	2.56	2.96	2.59
04/27/01	0.86	1.75	2.03	2.37	2.12	2.04	2.16	2.17	2.51	1.86
05/11/01	1.53	1.46	1.57	1.89	1.76	1.66	1.87	1.86	2.11	1.61
05/22/01	0.38	1.18	1.30	1.63	1.47	0.33	0.63	0.60	0.80	1.42
06/04/01	1.53	0.97	1.04	1.33	1.17	1.03	1.37	1.39	1.54	1.31
06/18/01	1.11	0.74	0.84	1.16	0.93	0.75	1.15	1.18	1.30	1.08
06/28/01	1.28	2.47	2.75	3.25	2.63	2.62	2.59	2.70	2.92	2.71
07/13/01	1.86	2.15	2.40	*NA*	2.49	2.43	2.51	2.58	3.58	2.55
07/25/01	1.75	3.27	3.48	3.71	2.88	3.00	2.82	2.94	3.29	3.26
08/08/01	1.43	2.90	3.11	3.41	2.73	2.73	2.70	2.84	3.15	0.93
08/24/01	1.25	1.96	2.37	2.53	2.36	2.26	2.37	2.37	2.60	2.17
09/05/01	1.50	2.59	2.90	3.09	2.46	2.59	2.43	2.56	2.87	2.96
09/16/01	1.84	4.69	4.58	4.37	3.13	3.50	2.95	3.10	3.78	3.72
09/28/01	2.38	3.14	3.32	3.47	2.63	2.66	2.59	2.69	3.15	2.88
10/12/01	2.15	2.47	2.69	2.98	2.48	2.46	2.50	2.52	2.88	2.34
11/13/01	1.60	2.04	2.34	2.67	2.32	2.29	2.32	2.33	2.61	1.79
12/07/01	1.31	1.75	2.08	2.40	2.04	2.04	2.02	2.00	2.26	1.77
12/19/01	1.34	1.77	2.12	2.43	2.07	2.24	2.05	2.03	2.30	1.79
01/02/02	1.02	1.53	1.75	2.20	1.89	1.92	1.95	1.99	2.19	1.98

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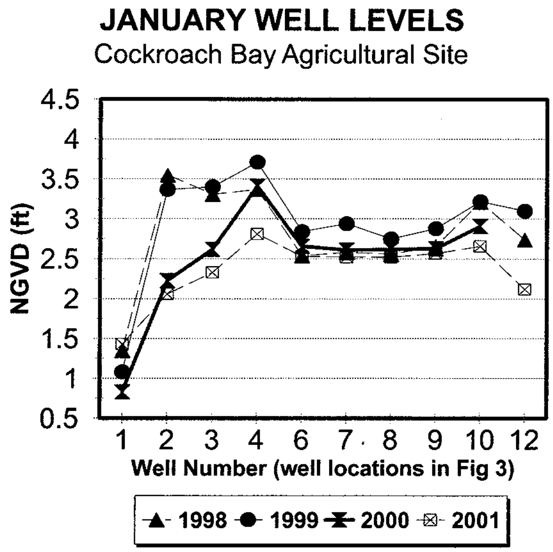

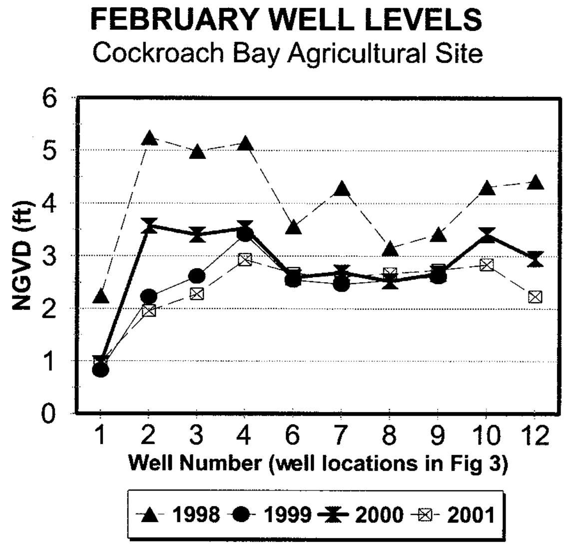

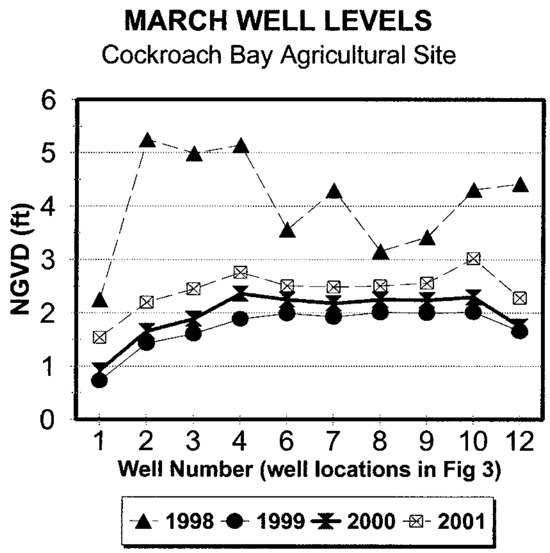

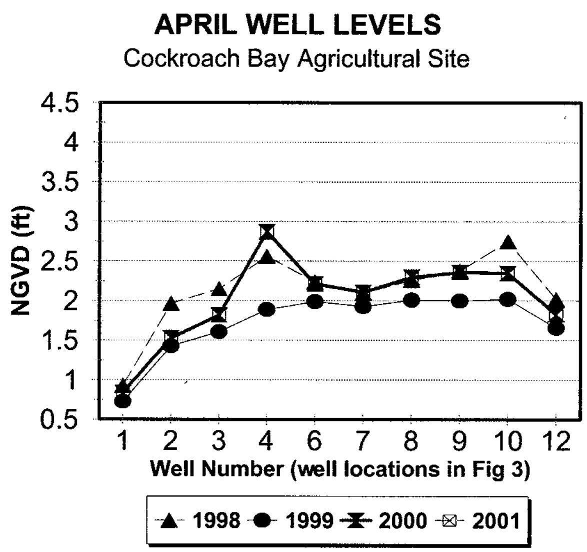

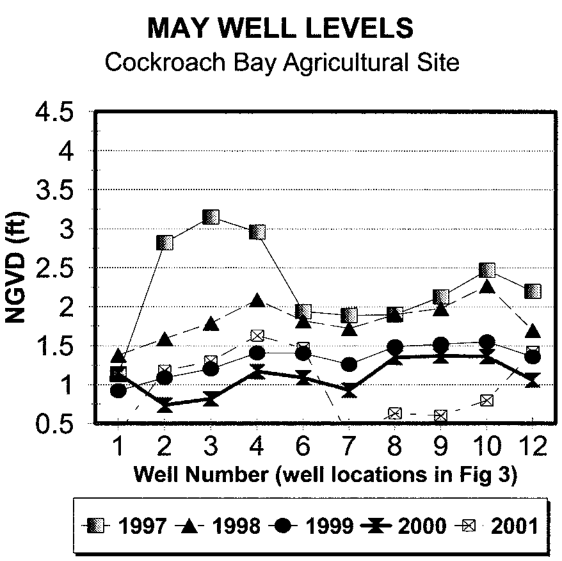

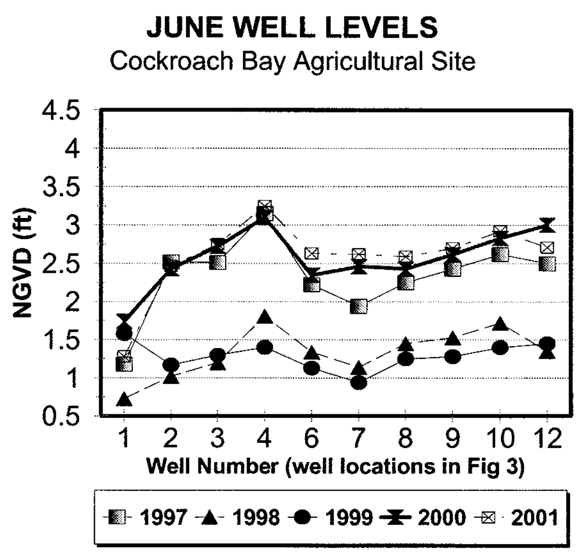

Appendix J-2. Comparison of well levels for each year. The level shown is the one taken near the end of the month.

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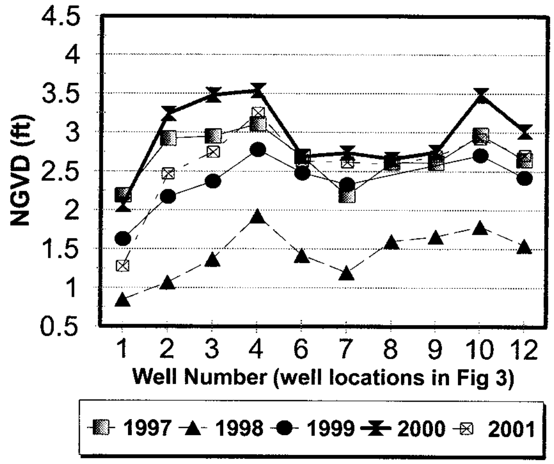
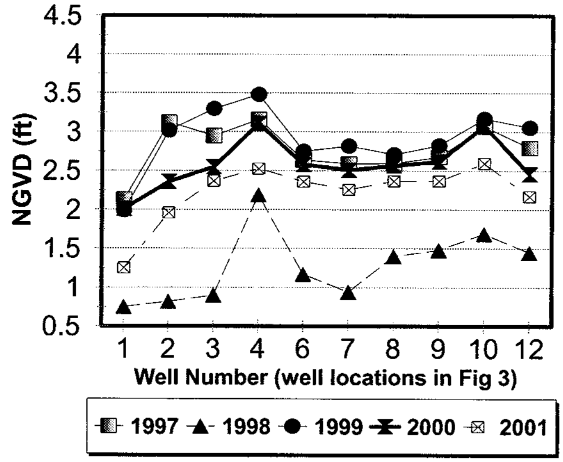
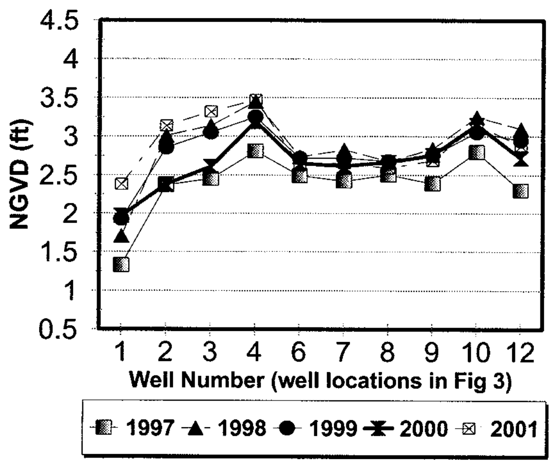
JULY WELL LEVELS
Cockroach Bay Agricultural Site



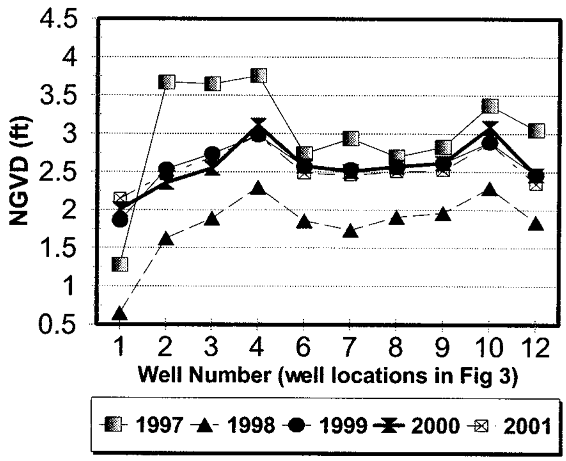
AUGUST WELL LEVELS
Cockroach Bay Agricultural Site



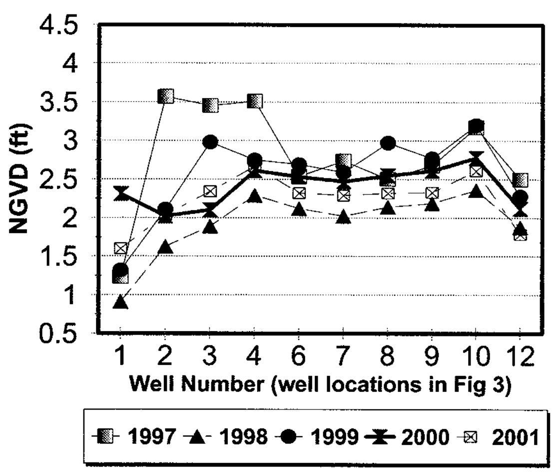
SEPTEMBER WELL LEVELS
Cockroach Bay Agricultural Site



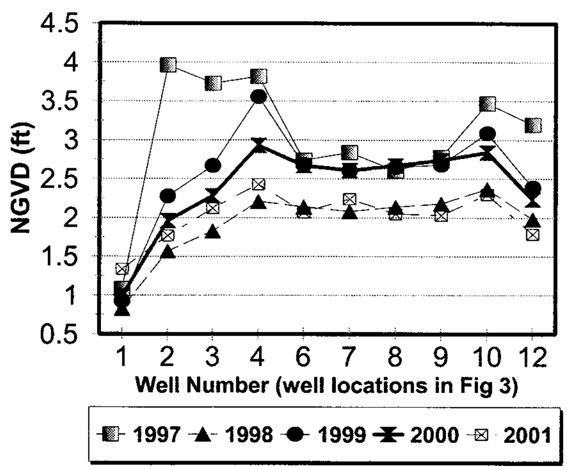
OCTOBER WELL LEVELS
Cockroach Bay Agricultural Site



NOVEMBER WELL LEVELS
Cockroach Bay Agricultural Site



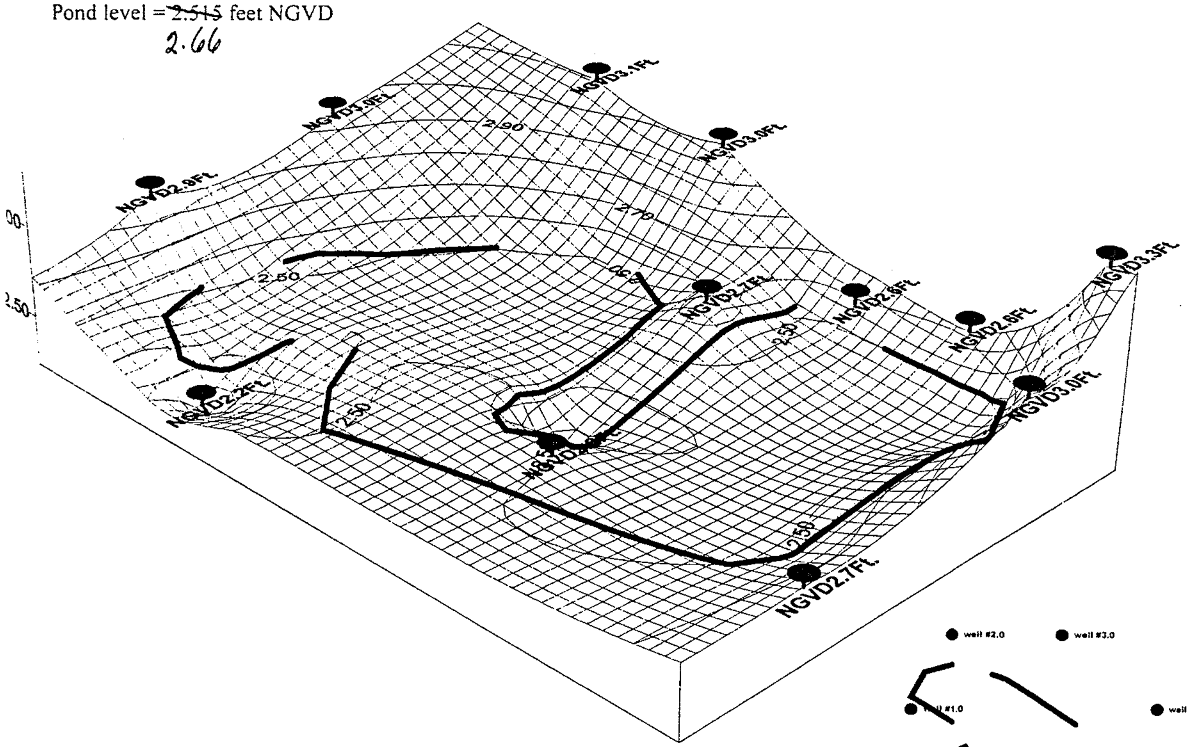
DECEMBER WELL LEVELS
Cockroach Bay Agricultural Site



Appendix J-2. Comparison of well levels for each year. The level shown is the one taken near the end of the month.

D:\CBAY\CBGWLEVlast.WB2

Figure 34. Water level contour on 7-18-97
Pond level = ~~2.515~~ feet NGVD
2.66



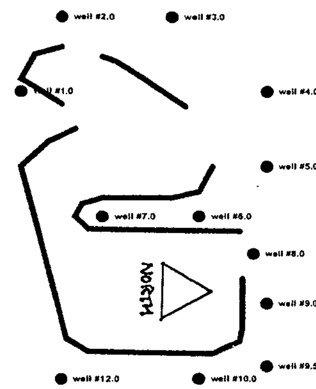


Figure 35. Water level contour on 8-4-97
Pond level = ~~2.0~~ feet NGVD
2.5

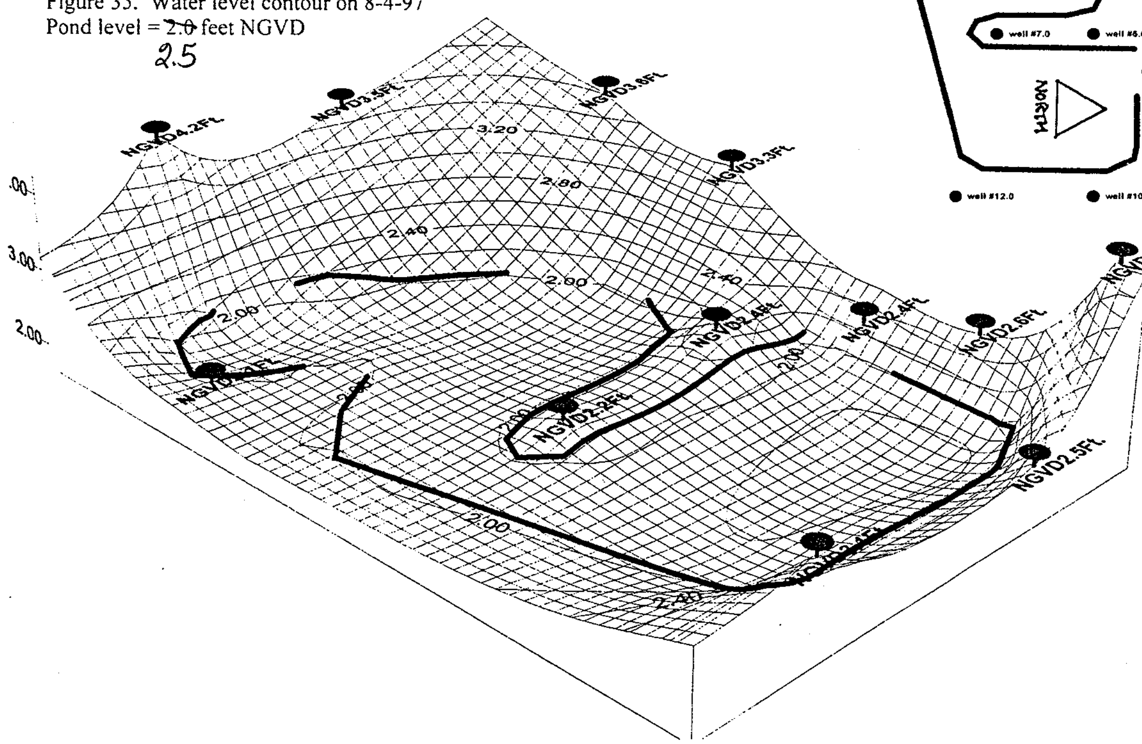
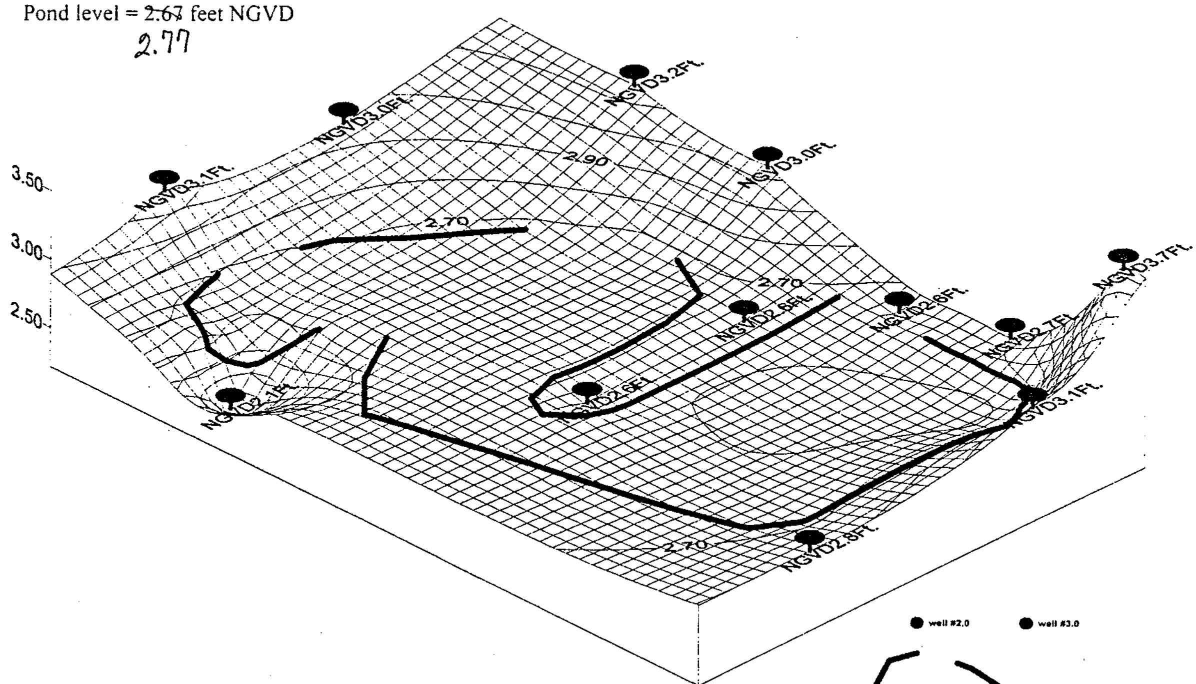


Figure 36. Water level contour on 8-15-97
Pond level = ~~2.67~~ feet NGVD
2.77



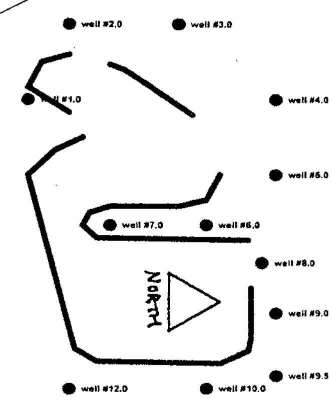


Figure 37. Water level contour on 9-3-97
Pond level = 2.67 feet NGVD

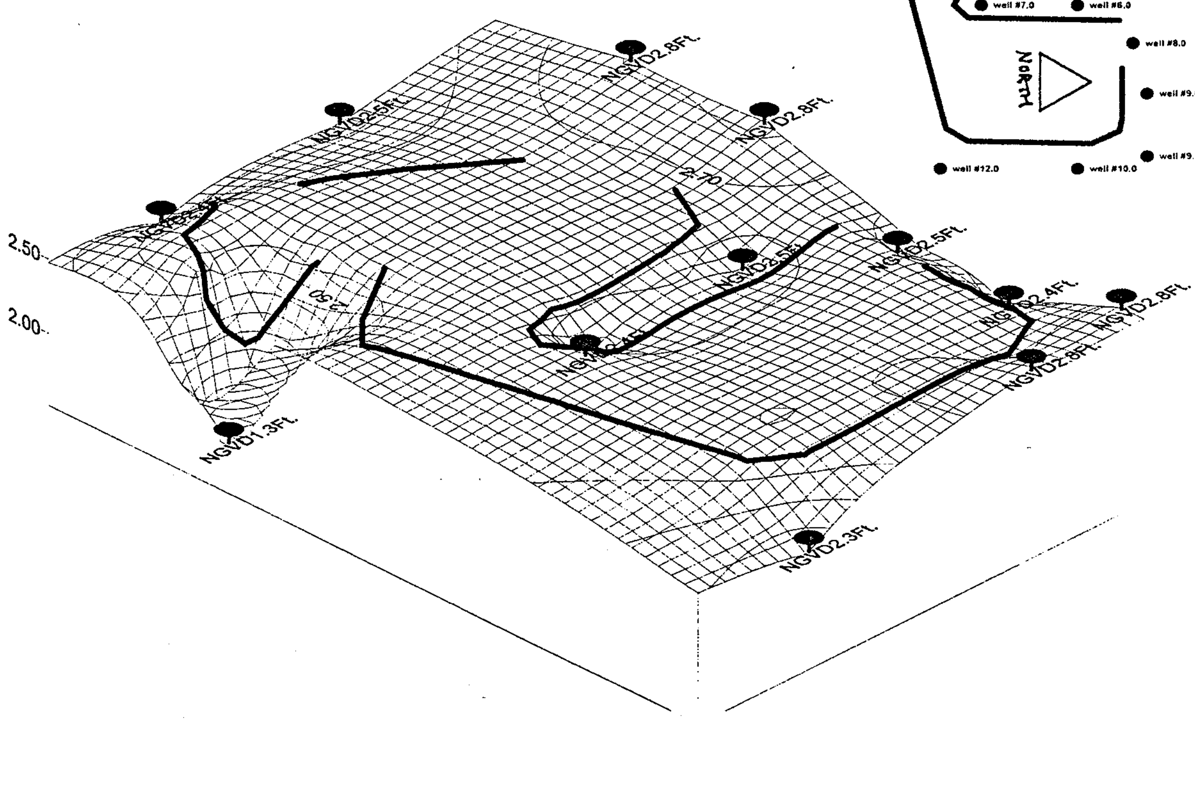
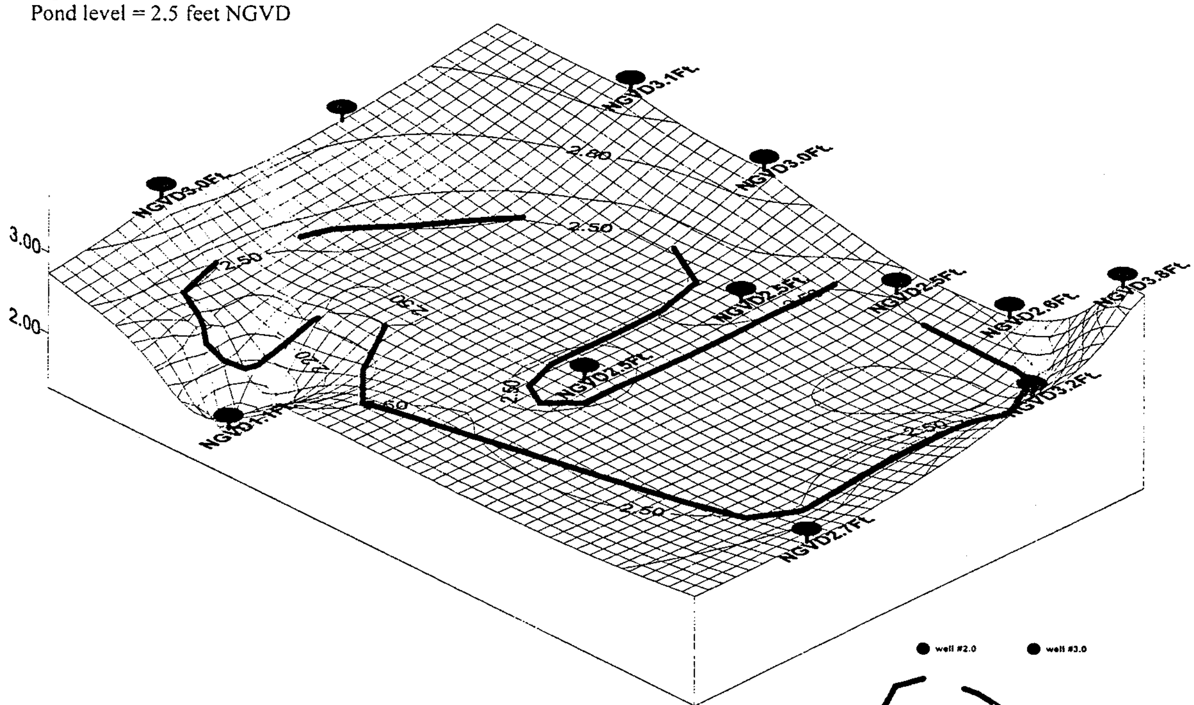


Figure 38. Water level contour on 10-8-97
Pond level = 2.5 feet NGVD



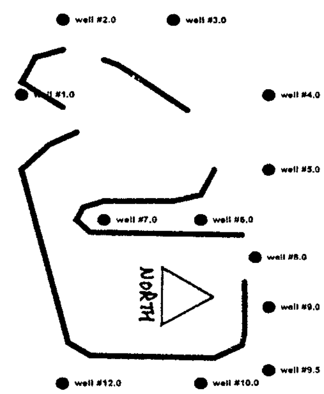


Figure 39. Water level contour on 10-20-97
Pond level = 2.51 feet NGVD

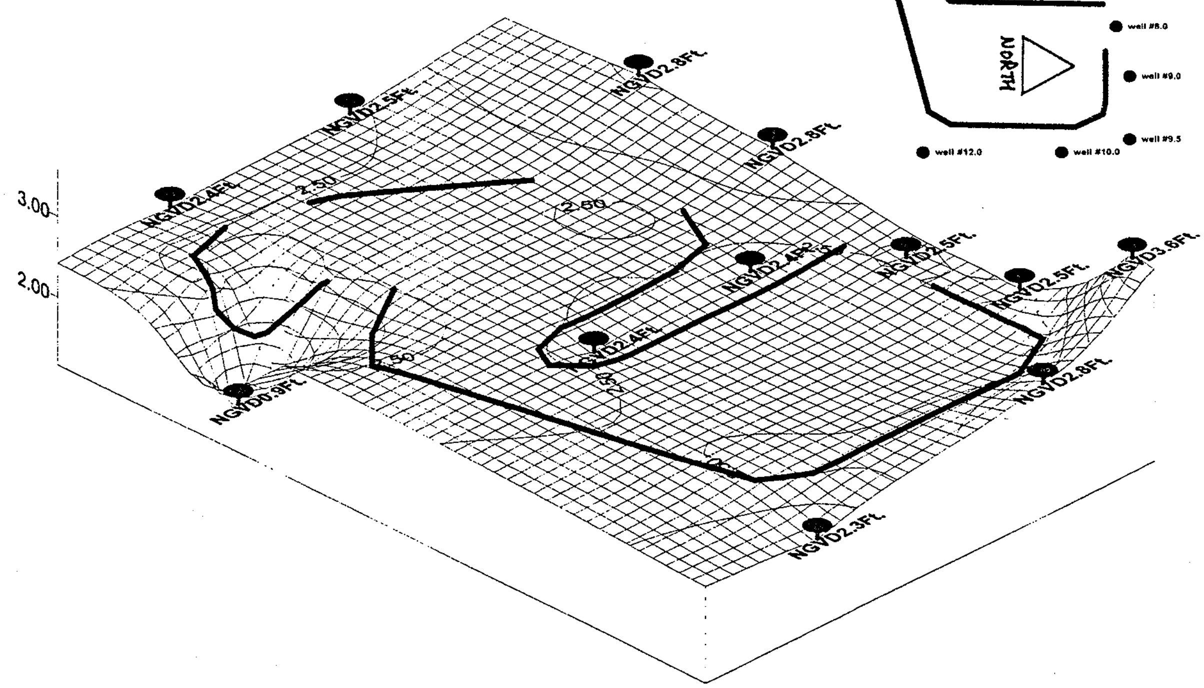
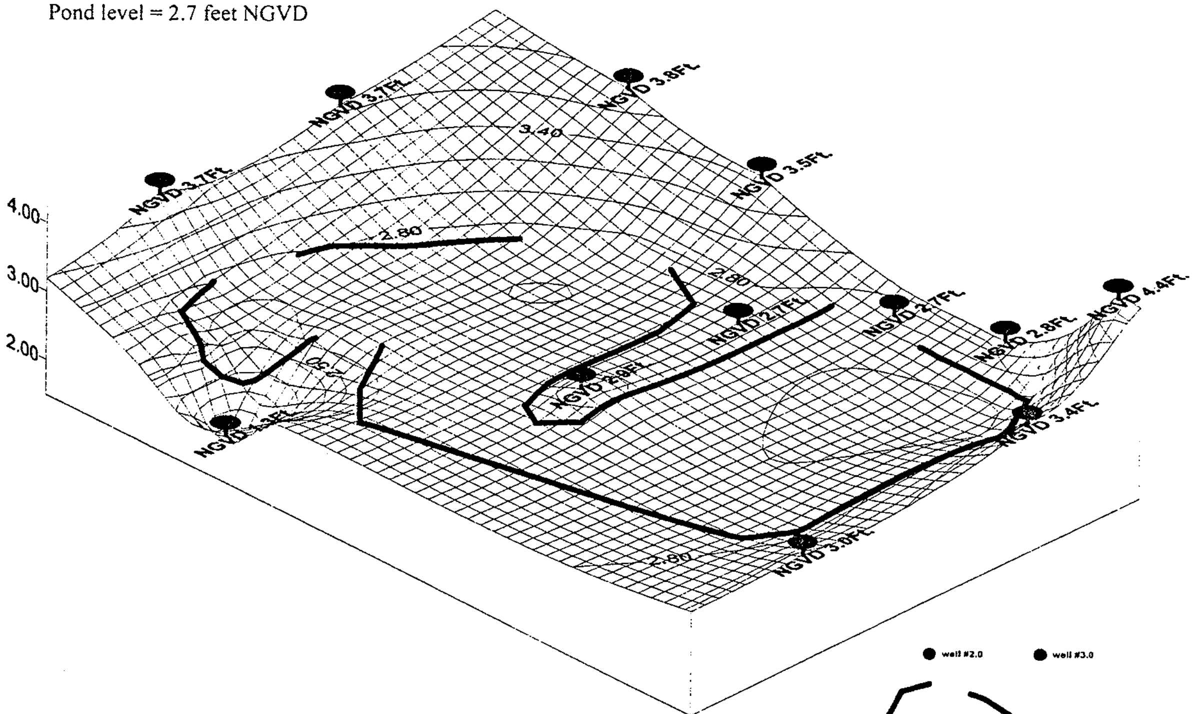


Figure 40. Water level contour on 10-29-97
Pond level = 2.7 feet NGVD



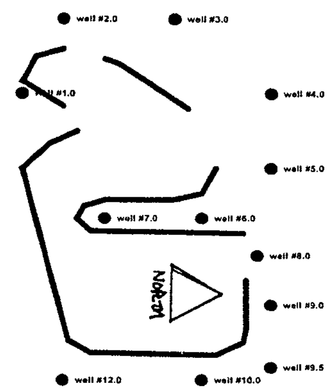


Figure 41. Water level contour on 11-10-97
Pond level = 2.66 feet NGVD

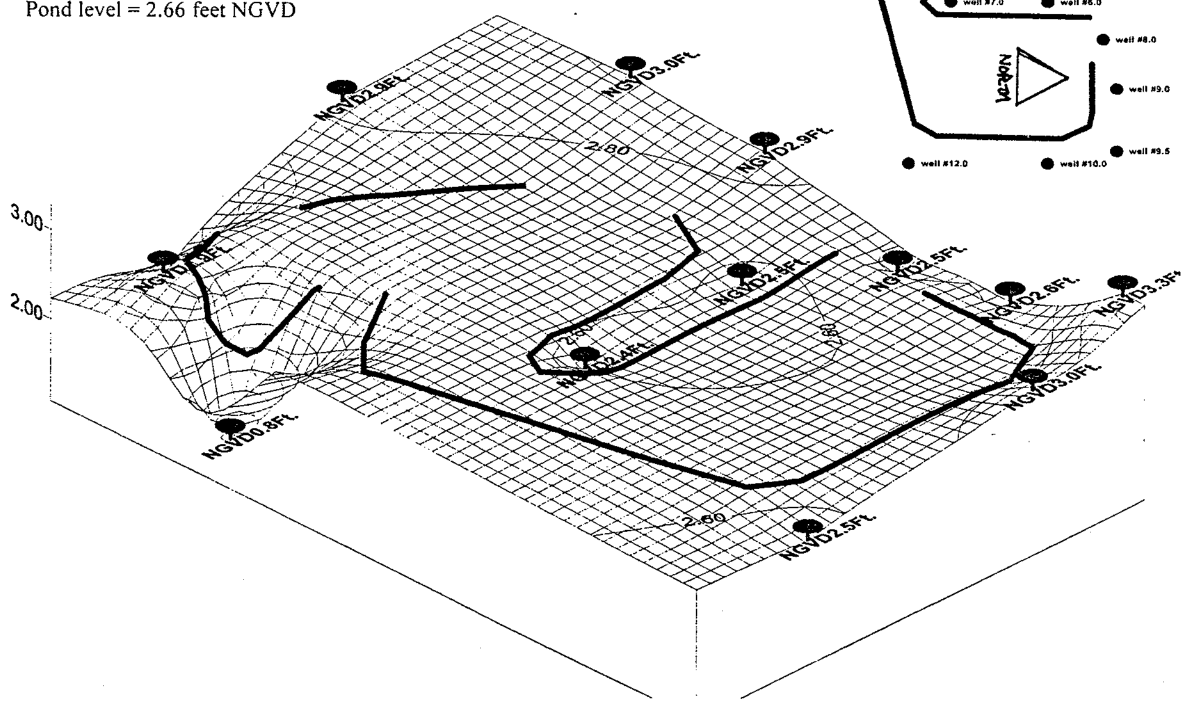
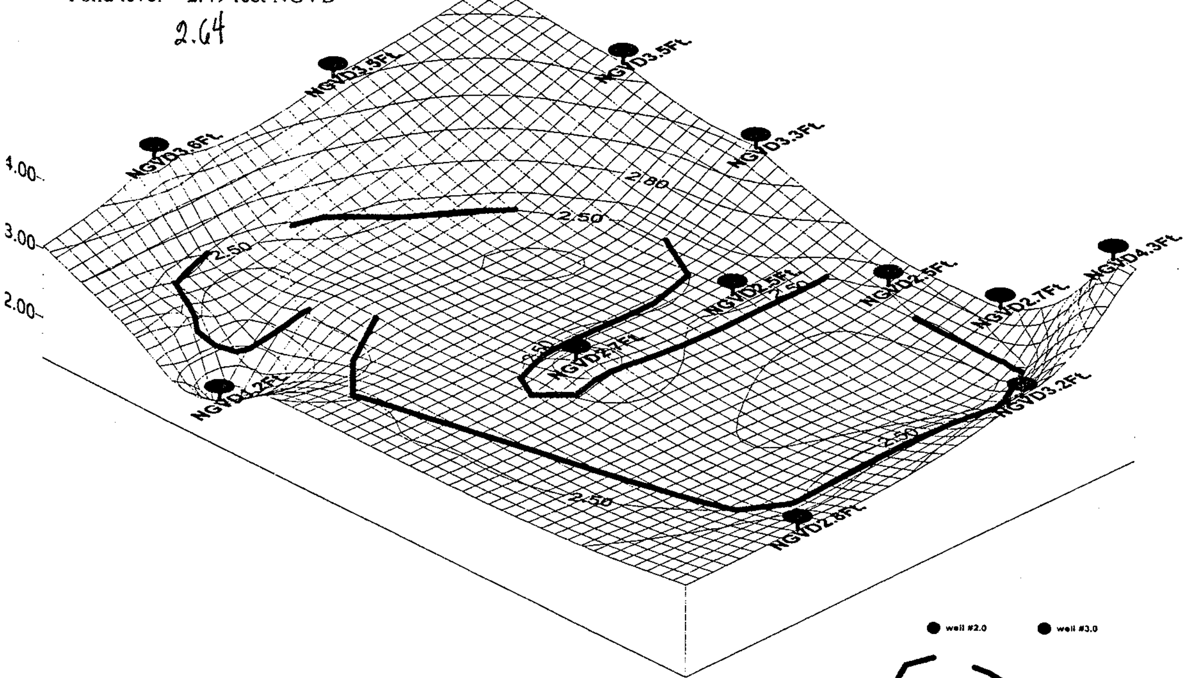


Figure 42. Water level contour on 11-19-97
Pond level = ~~2.49~~ feet NGVD
2.64



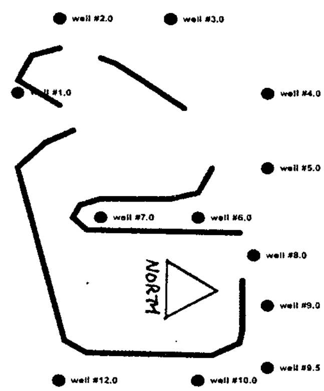


Figure 43. Water level contour on 12-5-97
Pond level = 2.5 feet NGVD

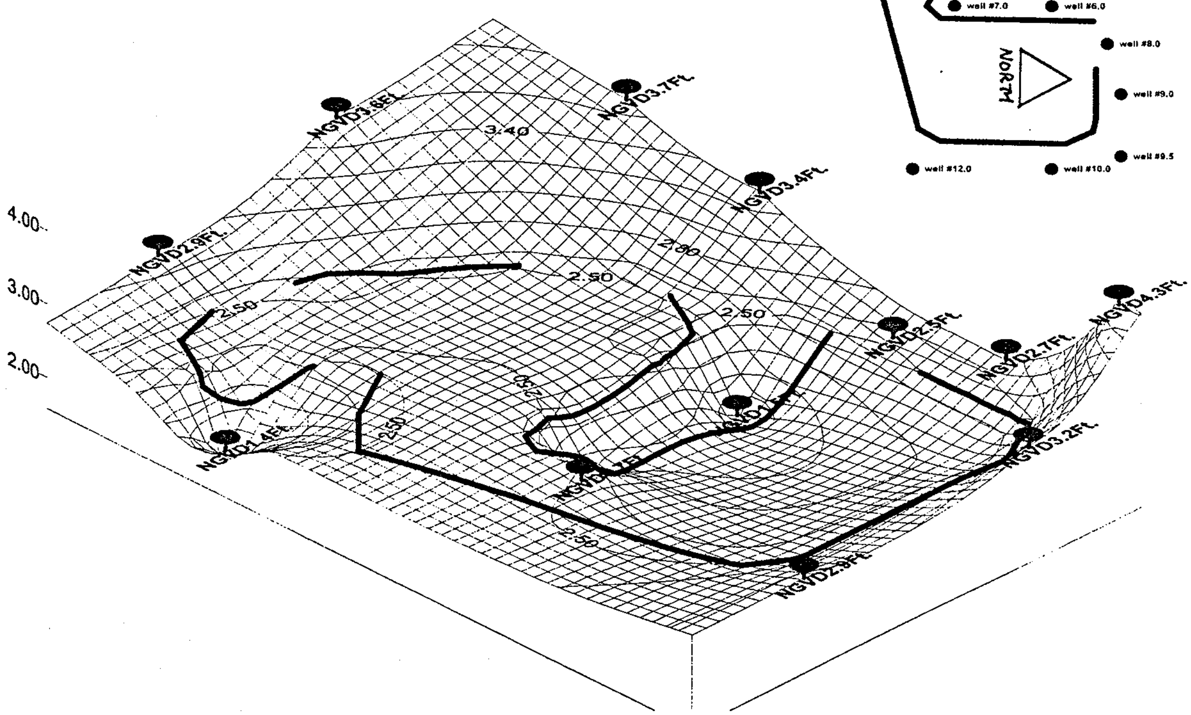
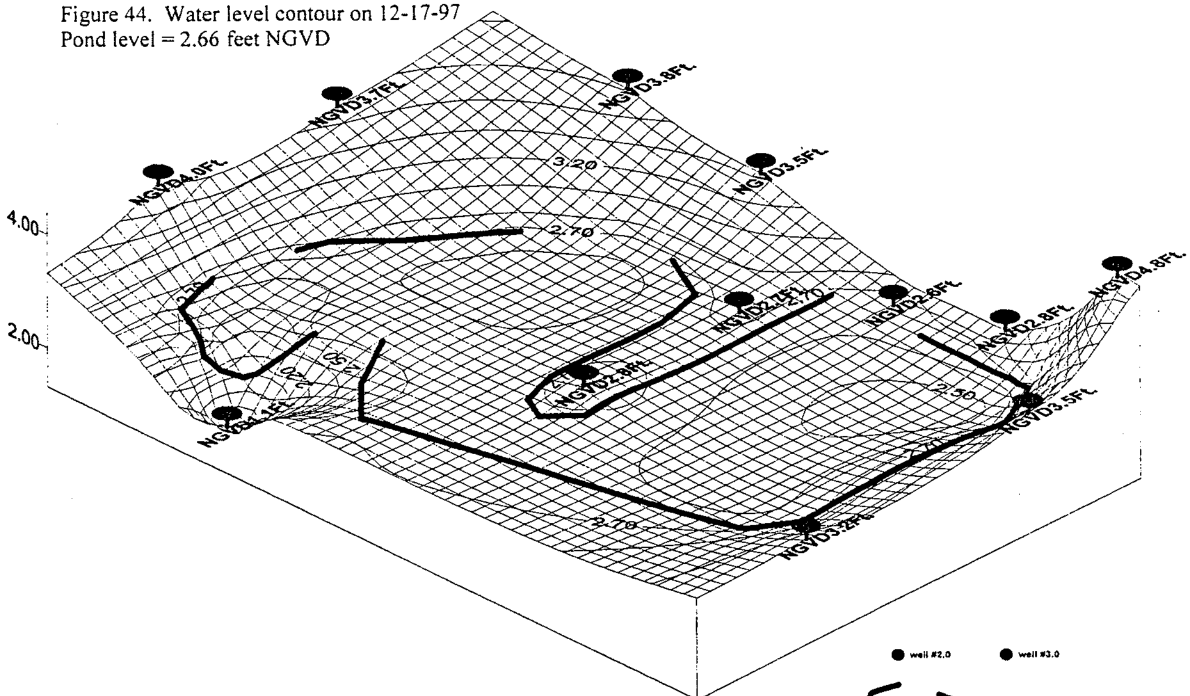


Figure 44. Water level contour on 12-17-97
Pond level = 2.66 feet NGVD



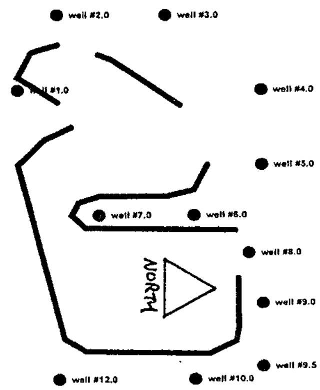


Figure 45. Water level contour on 1-22-98
Pond level = ~~2.64~~ feet NGVD
2.54

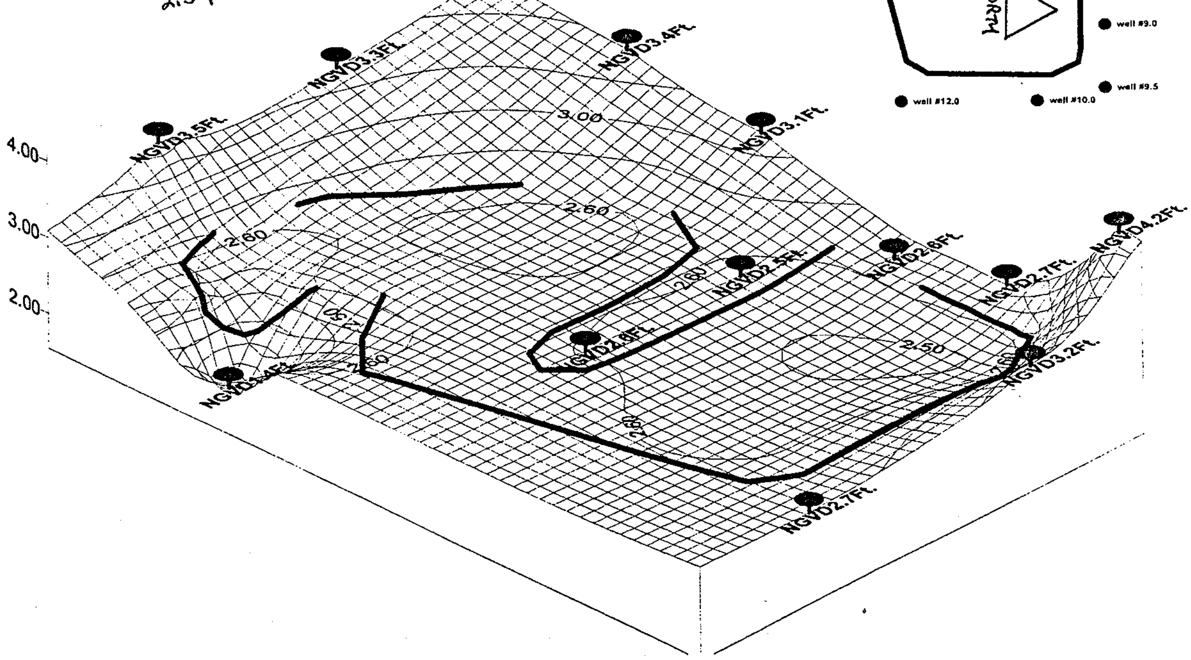
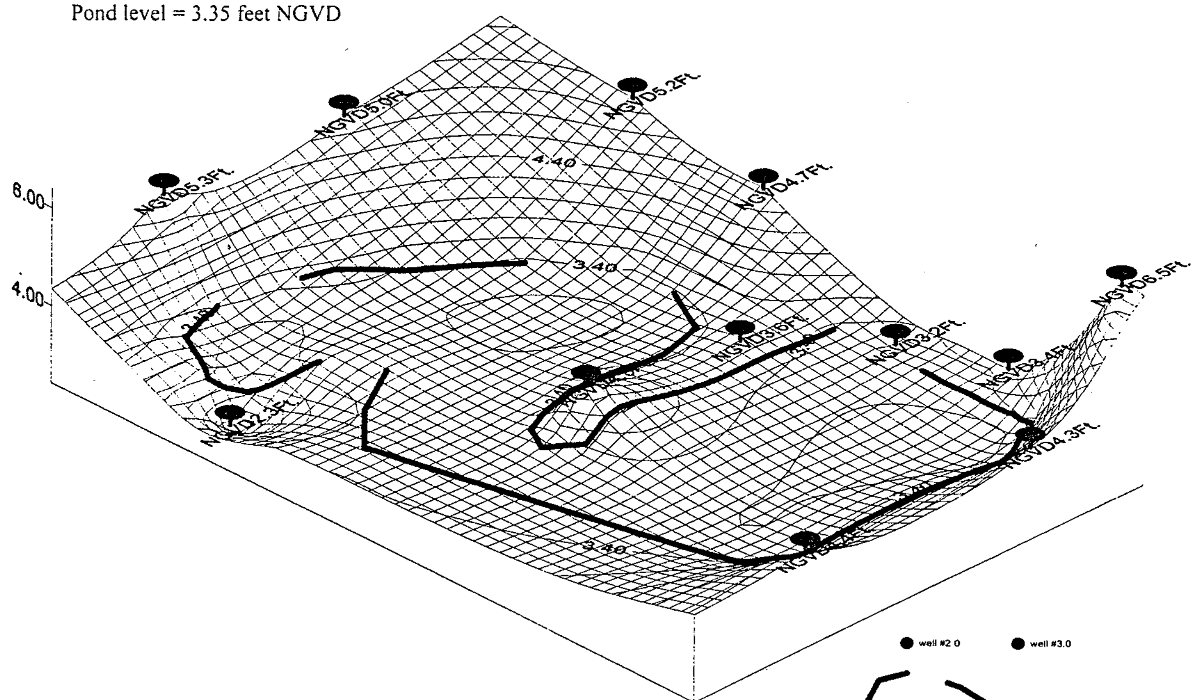


Figure 50. Water level contours on 3-20-98
Pond level = 3.35 feet NGVD



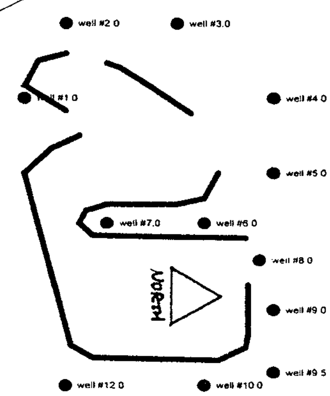


Figure 51. Water level contours on 3-31-98
Pond level = 2.47 feet NGVD

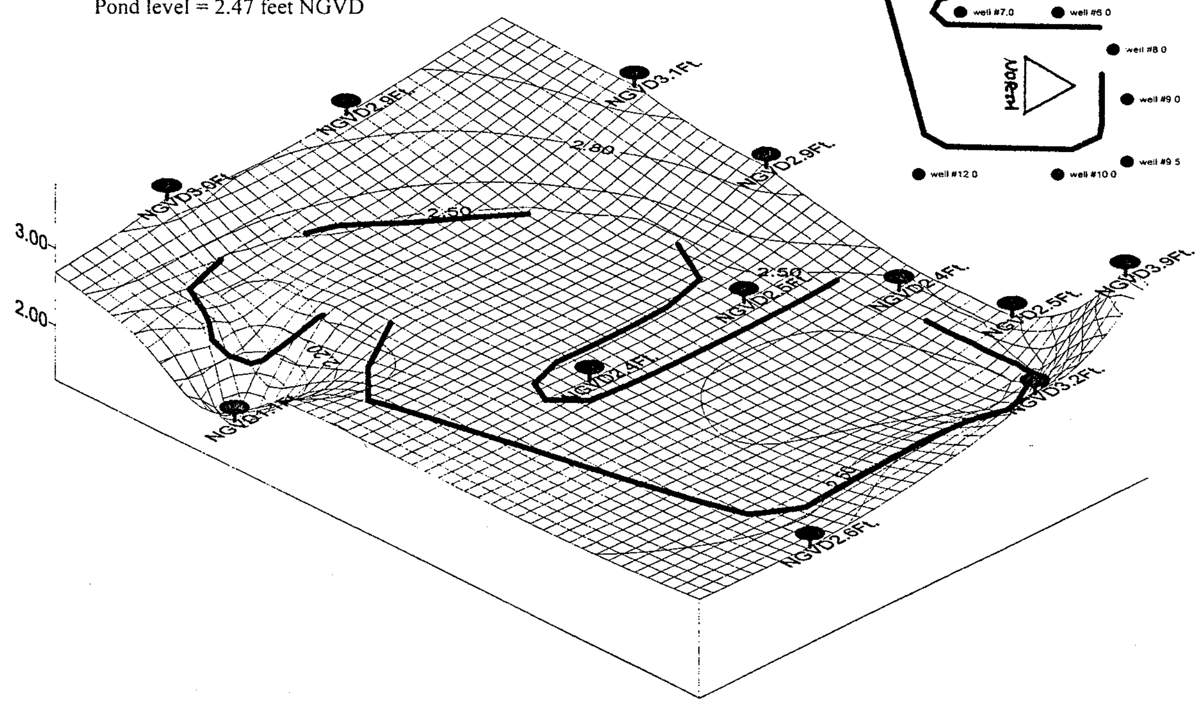
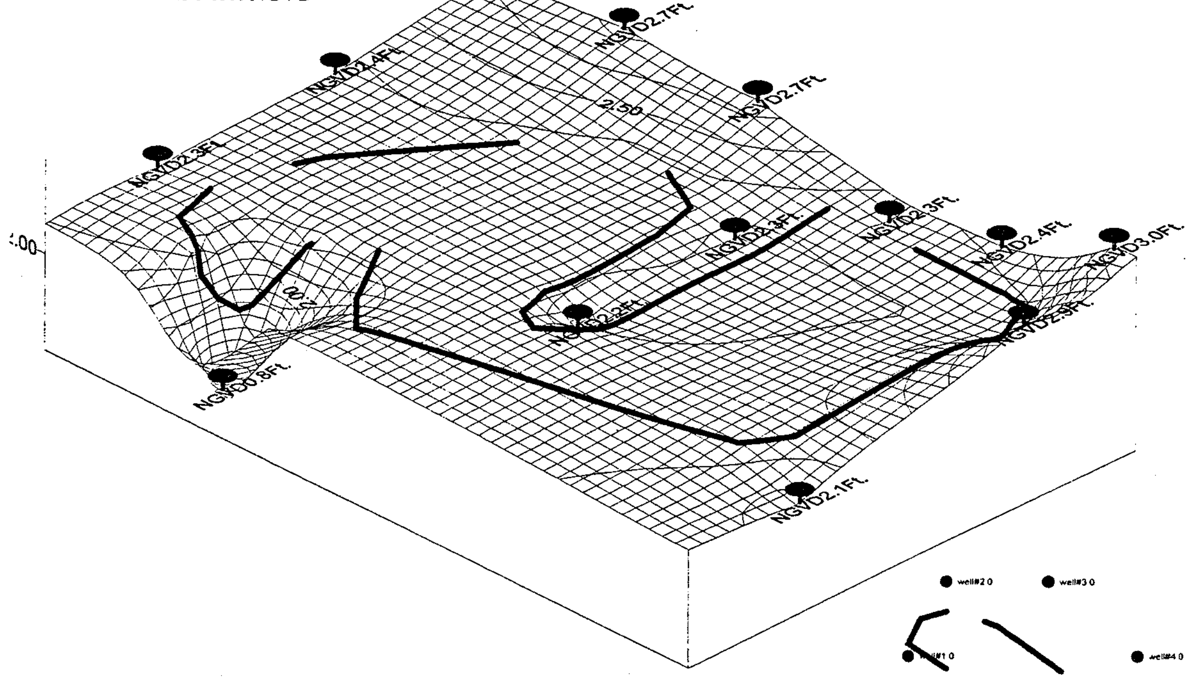


Figure 52. Water level contours on 4-10-98
Pond level = 2.36 feet NGVD



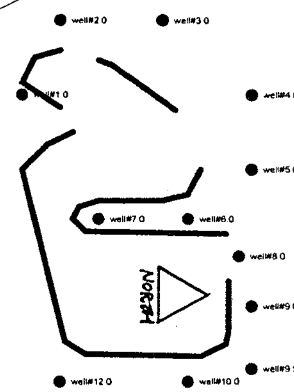


Figure 53. Water level contours on 4-22-98
Pond level = 2.3 feet NGVD

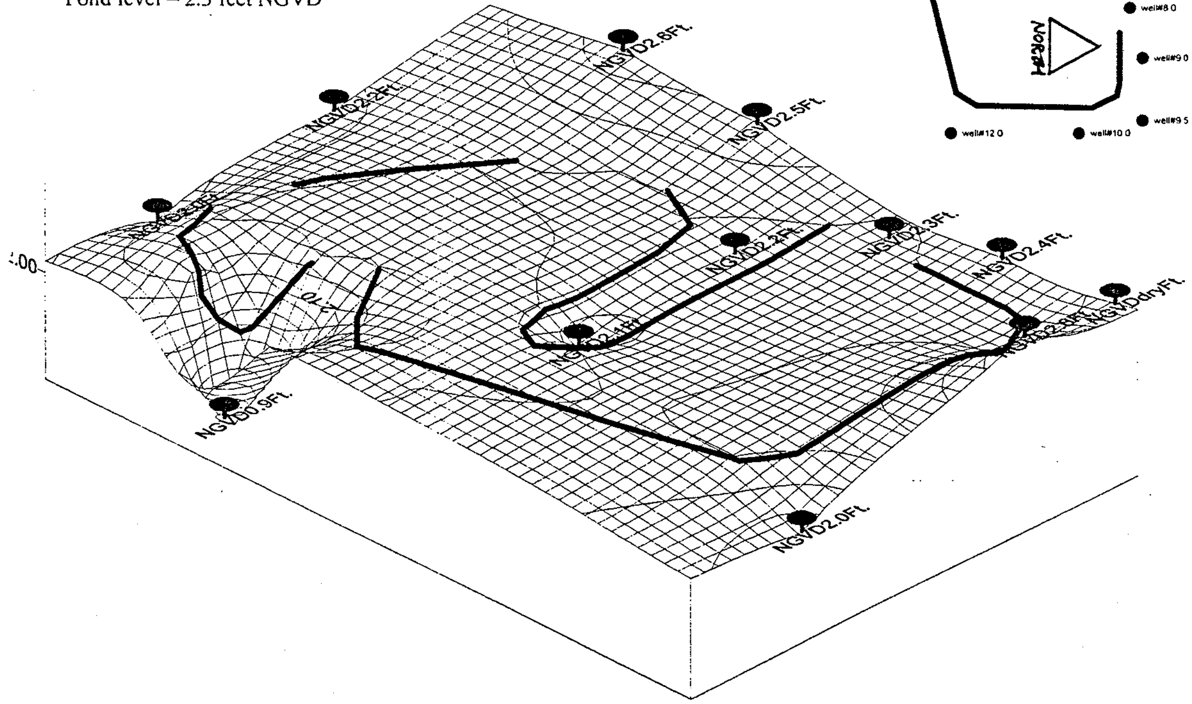
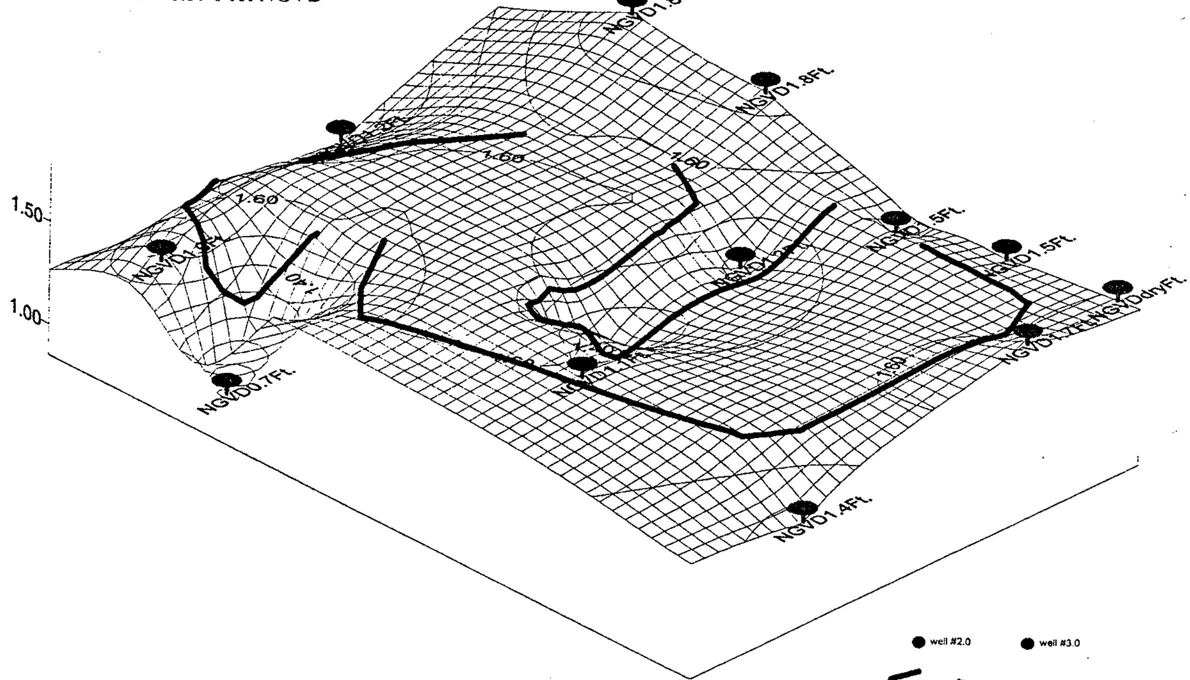


Figure 58. Water level contour on 6-29-98
Pond level = 1.59 Feet NGVD



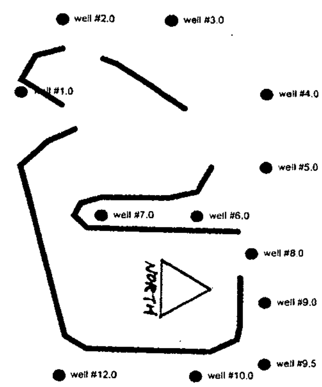


Figure 59. Water level contour on 7-15-98
Pond level = 1.67 Feet NGVD

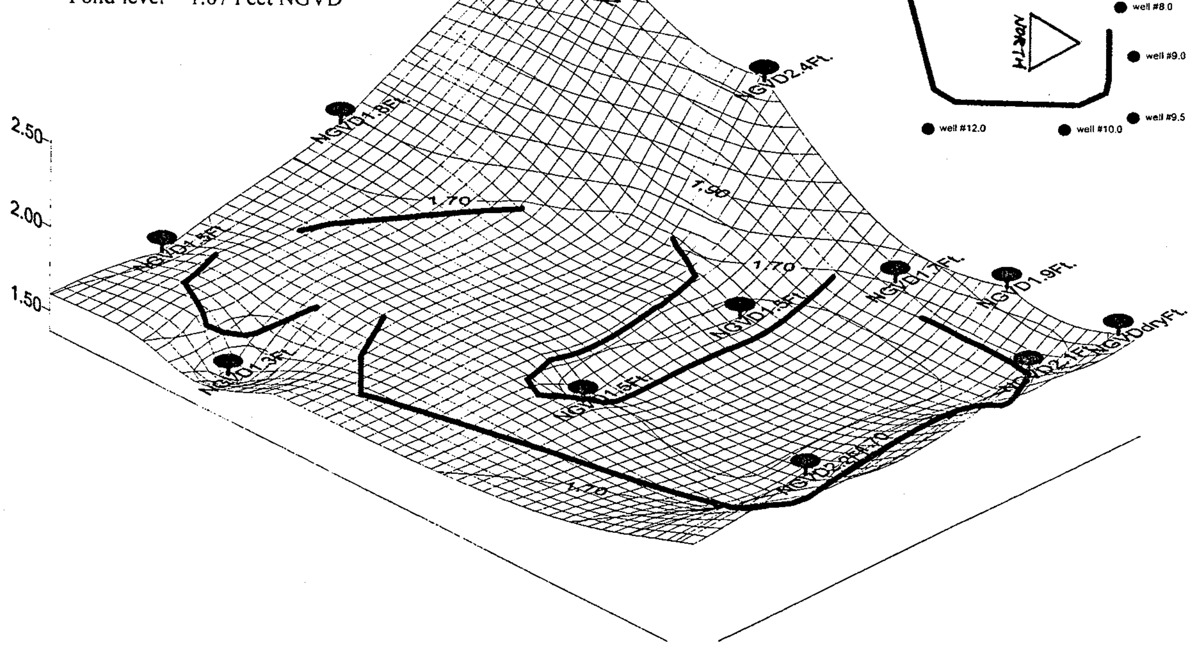
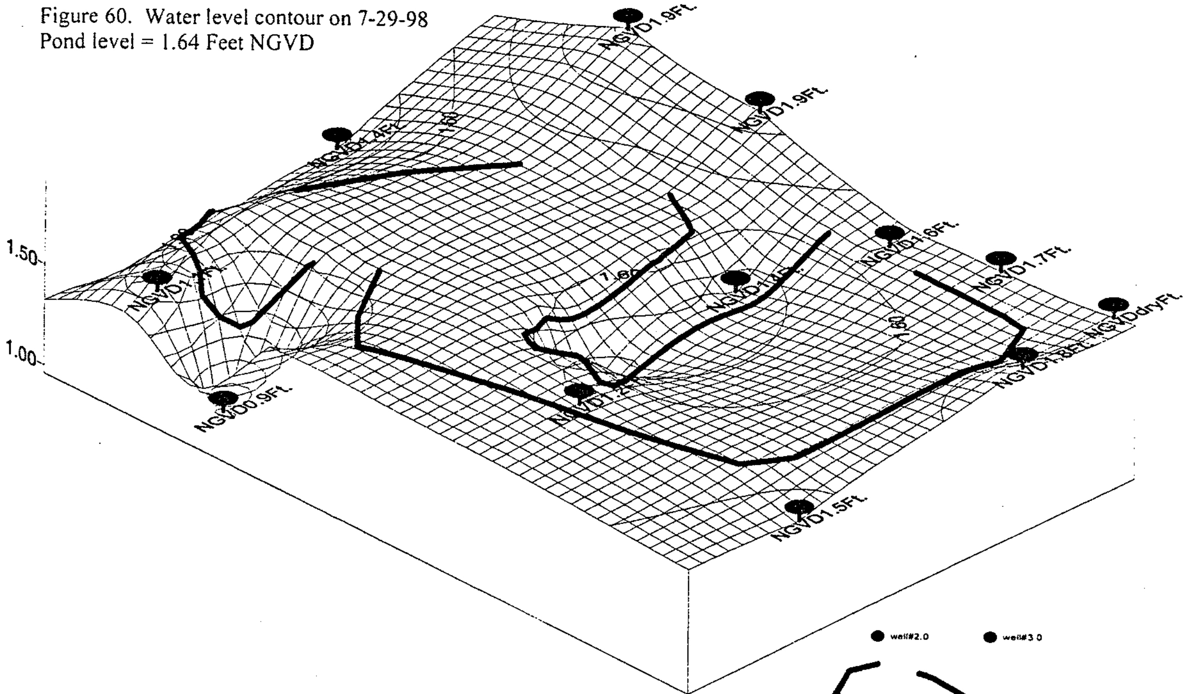


Figure 60. Water level contour on 7-29-98
Pond level = 1.64 Feet NGVD



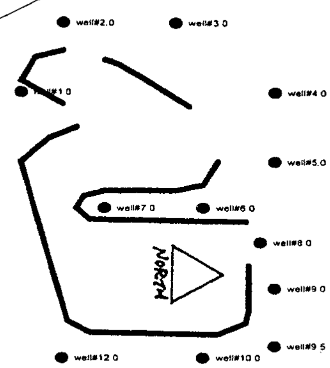
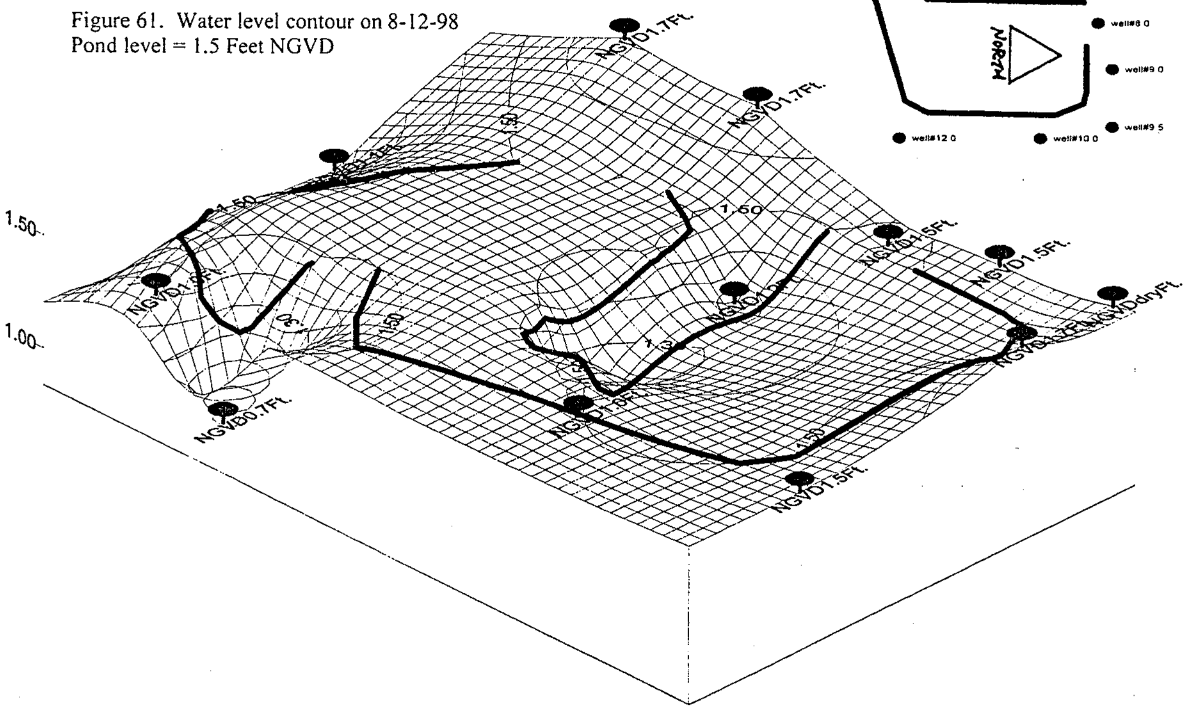


Figure 61. Water level contour on 8-12-98
Pond level = 1.5 Feet NGVD



APPENDIX K

Water Quality Measured in the Wells

Appendix K. Cockroach Bay Groundwater Well Water Quality Data (See Fig. 3 for well locations)

Parameters		Well #1 (WEL13093)		Well #2 (WEL13095)					Well #3 (WEL13100)			
		11/16/99	10/20/00	04/13/99	07/21/99	11/16/99	02/02/00	10/20/00	04/13/99	07/21/99	07/13/00	10/20/00
Nutrients	**Units**											
Ammonia	mg/L	1.19	1.02	0.355	NA	0.397	0.566	0.326	2.71	NA	0.198	2.97
Nitrite	mg/L	0.012	0.005	0.016	NA	0.01	0.044	0.011	0.015	NA	0.028	0.009
Nitrate	mg/L	0.025	0.005	0.017	NA	0.023	0.053	0.005	0.027	NA	0.256	0.005
TKN	mg/L	NA	2.3	0.577	NA	NA	0.93	1.3	3.258	NA	na	4.19
Organic N	mg/L	NA	1.27	0.222	NA	NA	0.364	0.963	0.548	NA	1.346	1.22
Total N	mg/L	NA	2.3	0.61	NA	NA	1.027	1.289	3.3	NA	1.8	4.2
Ortho P	mg/L	0.142	0.017	0.443	NA	0.198	0.391	0.258	0.337	NA	0.179	0.048
Total P	mg/L	0.958	1.91	1.074	NA	0.346	0.966	0.642	0.69	NA	0.338	0.918
Metals	**Units**											
Aluminum	ug/L	20790	18900	11700	NA	3980	15200	642	16600	NA	49400	6140
Cadmium	ug/L	0.3	0.6	*0.15*	NA	*0.15*	*0.15*	0.15	0.3	NA	0.4	*0.15*
Chromium	ug/L	51.7	72.4	28.1	NA	27.3	30.4	2.4	32.9	NA	52.8	12
Copper	ug/L	15.1	42.3	*0.5*	NA	13.1	4.4	*1*	*0.5*	NA	6.6	*1*
Iron	ug/L	14300	34300	7790	3950	5470	6300	1310	10200	5270	11400	4430
Lead	ug/L	8.1	5.5	5.2	NA	3.5	4.4	2.5	7.1	NA	7.9	2
Magnesium	mg/L	87	72.1	53.3	51.8	51.2	53.3	50.5	61	56.3	32.2	48.7
Manganese	ug/L	42.3	57.8	45.4	NA	54	31.5	79	22.2	NA	66.3	29.5
Nickel	ug/L	16.4	31	7.4	NA	5.6	6.4	*1.3*	9.3	NA	12.5	3.3
Silver	ug/L	0.1	*0.05*	*0.05*	NA	0.1	0.1	*0.05*	0.1	NA	*0.05*	*0.05*
Zinc	ug/L	40	180	*15*	NA	20	30	*0.08*	*15*	NA	20	*8*
Ions	**Units**											
Calcium	mg/L	327	159	166	172	165	171	146	166	168	143	131
Chloride	mg/L	990	763	51.7	50	49.2	50.1	54.6	57.8	52.6	42.7	42.7
Potassium	mg/L	43.7	49.1	41.7	44.2	43.1	38.8	41.9	37.8	44.9	37.9	44.2
Sodium	mg/L	402	396	35	34.7	34.1	32.5	43.4	29.1	30.8	24.7	26.2
Sulfate	mg/L	375	440	295	405	371	380	378	365	338	282	275
Hardness	mg/L	1175	693	634	643	623	646	573	666	651	490	131
TSS	mg/L	NA	NA	112	NA	NA	NA	NA	NA	NA	124.4	NA
Conduct.	umhos/c	NA	NA	1205	1269	NA	NA	NA	1266	1272	NA	NA

Appendix K (con't.) Cockroach Bay Groundwater Well Water Quality Data

Parameters		Well #4 (WEL13096)				Well #6 (WEL13098)						
		07/21/99	11/16/99	07/13/00	10/20/00	03/11/98	04/13/99	07/21/99	11/16/99	02/02/00	07/13/00	10/20/00
Nutrients	**Units**											
Ammonia	mg/L	NA	2.47	0.327	0.27	0.991	4.31	NA	6	6.1	3.06	5.76
Nitrite	mg/L	NA	0.018	0.025	0.01	*0.005*	*0.005*	NA	0.026	0.018	0.078	*0.005*
Nitrate	mg/L	NA	0.018	*0.005*	0.012	0.019	*0.005*	NA	*0.005*	0.015	2.83	*0.005*
TKN	mg/L	NA	NA	NA	1.18	1.181	4.4	NA	NA	NA	NA	5.99
Organic N	mg/L	NA	NA	1.968	0.48	0.19	0.09	NA	NA	NA	0.91	0.23
Total N	mg/L	NA	NA	2.3	1.2	1.2	4.4	NA	NA	NA	6.8	6
Ortho P	mg/L	NA	0.386	0.08	0.289	0.388	0.537	NA	0.087	0.478	0.227	0.109
Total P	mg/L	NA	1.03	1.85	1.28	0.453	0.556	NA	0.625	0.51	0.32	0.332
Metals	**Units**											
Aluminum	ug/L	NA	5630	46900	11500	115	329	NA	3320	4970	441	437
Cadmium	ug/L	NA	*0.15*	0.4	*0.15*	*0.15*	*0.15*	NA	*0.15*	*0.15*	*0.15*	*0.15*
Chromium	ug/L	NA	12.4	92.5	31.6	*2.35*	*2.35*	NA	13.6	14.8	2.9	3.2
Copper	ug/L	NA	18.2	14.8	2.8	7.5	*0.5*	NA	26.9	*1*	*1*	*1*
Iron	ug/L	3120	4520	14000	4030	160	5880	6110	6350	7990	2210	2540
Lead	ug/L	NA	2	17.2	4	*1*	*1*	NA	2	2	*0.75*	*0.75*
Magnesium	mg/L	47.3	56.6	30.4	44.1	12	37.3	39.2	42.3	44.7	36.2	42.4
Manganese	ug/L	NA	27.7	75.3	79.6	19.4	34.6	NA	47.4	32.3	18.9	23.9
Nickel	ug/L	NA	2.8	23.5	6.4	*2.15*	4.8	NA	4.6	5.4	*1.25*	*1.25*
Silver	ug/L	NA	*0.05*	0.1	*0.05*	*0.05*	*0.05*	NA	*0.05*	0.1	*0.05*	*0.05*
Zinc	ug/L	NA	*7.5*	50	20	*15*	*15*	NA	*7.5*	*7.5*	*7.5*	*7.5*
Ions	**Units**											
Calcium	mg/L	155	162	155	137	93.1	171	204	193	207	184	178
Chloride	mg/L	31.1	53.3	40.3	42.1	16.7	46	49.9	53.1	52.6	68.2	70.8
Potassium	mg/L	18	44	18.3	19.6	8.47	16.8	21.8	20.2	18.4	29	24.8
Sodium	mg/L	18.8	32	23.2	21.5	8.09	22	30.8	31.5	29.7	33.9	39.5
Sulfate	mg/L	284	307	312	308	20	155	243	251	286	211	310
Hardness	mg/L	582	638	512	137	282	580	671	656	701	609	619
TSS	mg/L	NA	NA	285	NA	0.59	12.5	NA	NA	NA	15.671	NA
Conduct.	umhos/	1059	NA	NA	NA	NA	1094	1286	NA	NA	NA	NA

Appendix K. (con't.) Cockroach Bay Groundwater Well Water Quality Data

Parameters		Well #7 (WEL13099)						Well #9						
		04/13/99	07/21/99	11/16/99	02/02/00	07/13/00	10/20/00	03/11/98	04/13/99	07/21/99	11/16/99	02/02/00	07/13/00	10/20/00
Nutrients	**Units**													
Ammonia	mg/L	1.26	NA	0.975	1.79	0.266	0.423	0.947	0.779	NA	0.881	0.917	0.741	0.794
Nitrite	mg/L	0.026	NA	0.015	0.04	0.372	0.039	0.03	*0.005*	NA	0.006	0.006	0.017	0.005
Nitrate	mg/L	0.025	NA	0.029	0.055	11.1	0.574	0.194	*0.005*	NA	0.015	*0.005*	1	0.005
TKN	mg/L	1.85	NA	NA	1.80	na	1.59	0.98	0.85	NA	NA	1.00	na	1.39
Organic N	mg/L	0.589	NA	NA	0.027	1.634	1.164	0.029	0.071	NA	NA	0.083	0.359	0.596
Total N	mg/L	1.9	NA	NA	1.895	13	2.2	1.2	0.85	NA	NA	1.011	2.1	1.4
Ortho P	mg/L	0.132	NA	0.198	0.188	0.07	0.075	1.17	0.06	NA	1.074	NA	0.193	0.112
Total P	mg/L	0.271	NA	0.293	0.408	0.1	0.421	1.89	0.498	NA	1.53	NA	0.324	0.195
Metals	**Units**													
Aluminum	ug/L	4870	NA	8780	11000	2510	15300	4030	801	NA	3040	262	625	22
Cadmium	ug/L	*0.15*	NA	*0.15*	*0.15*	*0.15*	*0.15*	0.7	*0.15*	NA	0.4	*0.15*	*0.15*	*0.15*
Chromium	ug/L	10.4	NA	18	18.2	5.7	27.5	12.4	*2.35*	NA	13.4	*1*	2.8	*1*
Copper	ug/L	*0.5*	NA	15.5	*1*	5.9	4.5	14.6	*0.5*	NA	5.6	*1*	10	*1*
Iron	ug/L	2890	3560	3940	5610	890	4410	4680	3310	2840	5070	3100	2770	2960
Lead	ug/L	2.6	NA	3.3	3.4	*0.75*	4.3	*1*	*1*	NA	2	*0.75*	*0.75*	*0.75*
Magnesium	mg/L	51.9	58	59.3	71.1	42.4	42.1	34.9	40.5	38.6	41.2	44.2	26.5	41.4
Manganese	ug/L	38.7	NA	43.7	51.2	16.4	19.3	35.5	23.4	NA	38.8	21.5	19.6	28
Nickel	ug/L	8.3	NA	11.2	10.8	13.1	30.6	5.3	*2.15*	NA	4.6	*1.25*	*1.25*	*1.25*
Silver	ug/L	*0.05*	NA	*0.05*	0.1	*0.05*	*0.05*	*0.05*	0.1	NA	0.1	0.1	*0.05*	*0.05*
Zinc	ug/L	*15*	NA	20	20	*7.5*	*7.5*	*15*	*15*	NA	20	*7.5*	*7.5*	*7.5*
Ions	**Units**													
Calcium	mg/L	256	273	271	326	222	212	170	205	195	200	227	203	176
Chloride	mg/L	77.5	73	74	80.9	41.9	49.1	35.5	54.3	53.4	47	46.6	50.4	50.5
Potassium	mg/L	23.5	30.6	27.8	28	30.9	28	12.2	14.3	14.7	15.4	14.8	16.6	17.5
Sodium	mg/L	45.8	53.6	57.3	62.9	41.2	37.4	23	26.8	28.4	29.6	28.6	29.8	32.1
Sulfate	mg/L	343	239	351	417	303	277	297	366	345	364	399	386	379
Hardness	mg/L	853	921	921	1107	729		568	679	646	669	749	616	610
TSS	mg/L	68	NA	NA	NA	99	NA	138	25	NA	NA	NA	70.4	NA
Conduct.	umho	1633	1710	NA	NA	NA	NA	NA	1249	1255	NA	NA	NA	NA

Appendix K. (con't.) Cockroach Bay Groundwater Well Water Quality Data

Parameters		Well #10 (WEL13091)							Well #12 (WEL13092)				
		03/11/98	04/13/99	07/21/99	11/16/99	02/02/00	07/13/00	10/20/00	04/13/99	07/21/99	11/16/99	07/13/00	10/20/00
Nutrients	**Units**												
Ammonia	mg/L	13.3	15.6	NA	15.2	7.16	14.1	15.4	4.64	NA	5.34	*0.005*	7.43
Nitrite	mg/L	*0.005*	0.013	NA	0.01	0.006	0.007	0.006	0.017	NA	0.009	0.005	0.019
Nitrate	mg/L	0.028	*0.05*	NA	0.027	0.011	*0.005*	0.039	0.013	NA	0.024	*0.005*	0.007
TKN	mg/L	13.972	15.987	NA	NA	7.5	na	18.95	4.67	NA	NA	NA	8.374
Organic N	mg/L	0.672	0.387	NA	NA	0.343	-0.105	0.1	0.03	NA	NA	2.89	0.944
Total N	mg/L	14	16	NA	NA	7.52	14	19	4.7	NA	NA	2.9	8.4
Ortho P	mg/L	1.39	1.304	NA	0.21	NA	0.335	1.35	0.268	NA	0.195	0.127	0.07
Total P	mg/L	1.56	1.593	NA	1.63	NA	1.67	1.41	0.835	NA	0.626	0.454	1.32
Metals	**Units**												
Aluminum	ug/L	1350	3160	NA	2800	650	4880	892	3790	NA	14290	4530	7740
Cadmium	ug/L	*0.15*	*0.15*	NA	*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	NA	0.3	*0.15*	*0.15*
Chromium	ug/L	*2.35*	9.1	NA	8.2	2.4	10.7	3.2	9.8	NA	38.3	11.4	16.4
Copper	ug/L	10.6	*0.5*	NA	*1*	*1*	2.4	*1*	1.3	NA	17.2	3	*1*
Iron	ug/L	910	1710	510	1130	400	1890	650	7480	6160	14700	7000	7700
Lead	ug/L	*1*	2.1	NA	*0.75*	*0.75*	*1.7*	*0.75*	2.8	NA	5.9	2	2.1
Magnesiu	mg/L	52.1	53.7	49	48.3	59.7	35.5	67.2	25.6	24.5	27.1	27.3	23.5
Manganes	ug/L	35.7	9.1	NA	5.9	4.7	11.6	7.6	47.3	NA	66.7	50.7	28.6
Nickel	ug/L	*2.15*	*2.15*	NA	*1.25*	*1.25*	3.4	*1.25*	4.5	NA	9.5	3.6	3.3
Silver	ug/L	*0.05*	*0.05*	NA	*0.05*	0.1	*0.05*	*0.05*	*0.05*	NA	0.1	*0.05*	*0.05*
Zinc	ug/L	*15*	*15*	NA	*7.5*	20	*7.5*	*7.5*	*15*	NA	20	*7.5*	20
Ions	**Units**												
Calcium	mg/L	175	143	150	140	181	161	184	189	178	196	198	176
Chloride	mg/L	58.6	57	49.7	40.9	51.1	65.2	167	35.4	33.4	30.2	28.4	29.1
Potassium	mg/L	14.1	15.2	16	15	15	15.7	17.7	9.75	9.6	10.3	10.9	10.6
Sodium	mg/L	48.3	32.2	37.7	34	35.9	38.2	78.8	23.5	26.2	26.9	25.9	25.2
Sulfate	mg/L	255	234	223	221	209	193	219	246	190	248	209	182
Hardness	mg/L	651	578	576	548	698	548	736	577	545	601	607	536
TSS	mg/L	21	76	NA	NA	NA	29.964	NA	40.6	NA	NA	48.11	NA
Conduct.	umhos/	NA	1293	1228	NA	NA	NA	NA	1024	1066	NA	NA	NA

APPENDIX L

Statistical Analysis

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Appendix L. Summary statistics 1998 for the hydrology and water quality data used for statistical analysis*

Variable	Label	Units	N	N Miss	Mean	Std Error	Min	Max	Skew-ness	Kurtosis
1998										
RAIN	Rain Amount	in	25	0	1.440	0.252	0.290	5.120	1.523	1.984
AVGI	Average Rain Intensity	in/hr	25	0	0.440	0.088	0.080	1.810	1.852	3.022
ANTE	Inter-event dry period	hours	25	0	218.357	52.432	0.670	917.500	1.879	2.832
RAPD	Rain on Pond	cu ft	25	0	69018	13513	11746	265800	1.557	1.993
INFL	Inflow	cu ft	25	0	204393	61238	2108	1023261	1.878	2.659
OUFL	Outflow	cu ft	25	0	152860	61544	0	1099770	2.378	4.902
RANH	Ammonia in rain	mg/l	25	0	0.366	0.072	0.031	1.410	1.635	1.884
INNH	Ammonia at inflow	mg/l	25	0	0.100	0.013	0.005	0.286	0.764	1.106
OUNH	Ammonia at outflow	mg/l	9	16	0.066	0.016	0.005	0.137	0.260	-1.378
RANOX	Nitrate+ in rain	mg/l	25	0	0.406	0.100	0.036	2.450	3.113	11.538
INNOX	Nitrate + at inflow	mg/l	25	0	0.427	0.156	0.005	3.235	3.051	8.935
OUNOX	Nitrate + at outflow	mg/l	9	16	0.194	0.062	0.010	0.492	0.818	-0.641
RAON	Organic nitrogen in rain	mg/l	25	0	0.657	0.136	0.054	2.888	2.016	4.174
INON	Organic nitrogen at in	mg/l	25	0	1.110	0.135	0.525	3.590	2.514	7.437
OUON	Organic nitrogen at out	mg/l	9	16	0.828	0.094	0.370	1.390	0.543	1.663
RATN	Total nitrogen in rain	mg/l	25	0	1.125	0.209	0.090	3.900	1.707	2.280
INTN	Total nitrogen at inflow	mg/l	25	0	1.210	0.141	0.630	3.700	2.359	6.450
OUTN	Total nitrogen at outflow	mg/l	9	16	0.893	0.089	0.480	1.400	0.492	0.731
RAOP	Ortho-phos in rain	mg/l	25	0	0.060	0.024	0.005	0.510	3.286	10.473
INOP	Ortho-phos at inflow	mg/l	25	0	0.945	0.169	0.005	3.380	1.721	2.943
OUOP	Ortho-phos at outflow	mg/l	9	16	0.623	0.059	0.272	0.778	-1.201	0.501
RATP	Total phosphorus rain	mg/l	25	0	0.094	0.035	0.001	0.681	2.597	6.048
INTP	Total phos at inflow	mg/l	25	0	1.842	0.392	0.005	8.650	2.238	5.618
OUTP	Total phos at outflow	mg/l	9	16	0.807	0.071	0.390	1.040	-0.729	0.428
RAAL	Aluminum in rain	ug/l	24	1	167.7	27.7	10.5	528.0	1.017	0.644
INAL	Aluminum at inflow	ug/l	25	0	3474.2	1461.0	153.0	30000.0	2.856	8.071
OUAL	Aluminum at outflow	ug/l	9	16	1298.7	421.6	345.0	4540.0	2.570	7.129
RACD	Cadmium in rain	ug/l	24	1	0.350	0.073	0.150	1.600	2.457	6.474
INCD	Cadmium at inflow	ug/l	25	0	1.342	0.603	0.150	13.300	3.284	11.149
OUCD	Cadmium at outflow	ug/l	9	16	0.161	0.011	0.150	0.253	3.000	9.000
RACR	Chromium in rain	ug/l	24	1	2.350	0.000	2.350	2.350	.	.
INCR	Chromium at inflow	ug/l	25	0	55.068	26.703	2.350	545.000	3.126	9.304
OUCR	Chromium at outflow	ug/l	9	16	4.703	0.849	2.350	9.600	0.712	-0.053
RACU	Copper in rain	ug/l	24	1	3.96	0.89	0.50	16.00	1.363	1.194
INCU	Copper at inflow	ug/l	25	0	117.44	50.51	3.00	1100.00	3.223	10.530
OUCU	Copper at outflow	ug/l	9	16	16.79	3.23	4.40	32.70	0.451	-0.929
RAFE	Iron in rain	ug/l	24	1	33.96	11.13	15.00	280.00	4.339	20.017
INFE	Iron at inflow	ug/l	25	0	2224.52	1001.70	70.00	21500.00	3.169	10.115
OUFE	Iron at outflow	ug/l	9	16	471.89	82.39	134.00	810.00	-0.148	-1.533
RAPB	Lead in rain	ug/l	24	1	1.000	0.000	1.000	1.000	.	.
INPB	Lead at inflow	ug/l	25	0	16.557	8.476	1.000	178.000	3.295	10.437
OUPB	Lead at ouflow	ug/l	9	16	1.618	0.334	1.000	3.460	1.303	0.016
RAMG	Magnesium in rain	ug/l	21	4	0.110	0.021	0.020	0.460	2.719	9.225
INMG	Manesium at inflow	ug/l	25	0	22.244	1.894	5.980	39.400	-0.544	-0.691
OUMG	Magnesium at outflow	ug/l	10	15	45.147	18.306	11.200	175.000	1.876	2.300
RAMN	Manganese in rain	ug/l	25	0	3.176	0.589	0.300	13.300	2.098	5.123
INMN	Manganese at inflow	ug/l	25	0	254.844	71.869	14.300	1570.000	2.829	8.322
OUMN	Manganese at outflow	ug/l	10	15	53.674	10.289	21.670	120.000	1.124	0.543
RANI	Nickel in rain	ug/l	25	0	2.486	0.247	2.150	7.800	3.916	15.661
INNI	Nickel at inflow	ug/l	25	0	5.183	1.540	2.150	33.100	2.889	8.093
OUNI	Nickel at ouflow	ug/l	10	15	2.282	0.132	2.150	3.470	3.162	10.000
RAAG	Mercury in rain	ug/l	25	0	0.060	0.006	0.050	0.200	3.887	16.193
INAG	Mercury at inflow	ug/l	25	0	0.506	0.208	0.050	4.500	3.152	10.065
OUAG	Mercury at outflow	ug/l	10	15	0.069	0.010	0.050	0.141	1.515	1.277
RAZN	Zinc in rain	ug/l	25	0	69.422	15.202	15.000	320.000	2.149	4.821
INZN	Zinc at inflow	ug/l	25	0	98.640	38.277	15.000	820.000	3.064	9.399
OUZN	Zinc at outflow	ug/l	10	15	16.910	1.910	15.000	34.100	3.162	10.000
INSS	Suspended solids in	mg/l	25	0	155.289	101.350	3.400	2546.000	4.745	23.110
OUSS	Suspended solids out	mg/l	10	15	20.315	6.495	6.600	75.000	2.505	6.760

* For values below the laboratory detection limit one half the detection limit was used in the calculations.

Appendix L. Summary statistics 1999 for the hydrology and water quality data used for statistical analysis*

Variable	Label	Units	N	N Miss	Mean	Std Error	Min	Max	Skew-ness	Kurtosis
1999										
RAIN	Rain Amount	in	25	0	1.156	0.167	0.180	3.950	1.788	4.321
AVGI	Average Rain Intensity	in/hr	24	1	0.668	0.143	0.080	2.520	1.795	2.515
ANTE	Inter-event dry period	hours	25	0	229.990	49.694	18.250	1186.500	2.657	8.876
RAPD	Rain on Pond	cu ft	25	0	52125.8	9005.8	9344.5	205060.6	2.006	4.768
INFL	Inflow	cu ft	25	0	128289.7	46369.7	2076.6	1098728.3	3.367	13.216
OUFL	Outflow	cu ft	25	0	90664.4	38674.6	0.0	880170.0	3.211	11.818
RANH	Ammonia in rain	mg/l	25	0	0.162	0.035	0.005	0.639	1.662	2.553
INNH	Ammonia at inflow	mg/l	25	0	0.053	0.018	0.005	0.473	4.373	20.504
OUNH	Ammonia at outflow	mg/l	14	11	0.034	0.005	0.005	0.089	1.430	3.322
RANOX	Nitrate+ in rain	mg/l	25	0	0.189	0.041	0.005	0.958	2.413	7.747
INNOX	Nitrate + at inflow	mg/l	25	0	0.131	0.093	0.005	2.355	4.924	24.468
OUNOX	Nitrate + at outflow	mg/l	14	11	0.007	0.001	0.005	0.018	2.654	7.589
RAON	Organic nitrogen in rain	mg/l	24	1	0.152	0.029	-0.005	0.515	1.265	1.034
INON	Organic nitrogen at in	mg/l	24	1	0.902	0.109	-0.083	2.527	0.834	2.681
OUON	Organic nitrogen at out	mg/l	13	12	1.139	0.182	0.016	2.390	0.178	-0.333
RATN	Total nitrogen in rain	mg/l	24	1	0.498	0.075	0.100	1.800	2.128	6.207
INTN	Total nitrogen at inflow	mg/l	24	1	0.985	0.120	0.080	3.000	1.540	5.219
OUTN	Total nitrogen at outflow	mg/l	13	12	1.182	0.178	0.110	2.400	0.199	-0.465
RAOP	Ortho-phos in rain	mg/l	24	1	0.014	0.004	0.005	0.088	3.424	13.754
INOP	Ortho-phos at inflow	mg/l	24	1	0.796	0.088	0.143	1.718	0.139	-0.416
OUOP	Ortho-phos at outflow	mg/l	13	12	0.200	0.035	0.005	0.354	-0.554	-0.922
RATP	Total phosphorus rain	mg/l	25	0	0.023	0.005	0.005	0.097	2.357	5.077
INTP	Total phos at inflow	mg/l	24	1	0.957	0.094	0.261	1.950	0.190	-0.532
OUTP	Total phos at outflow	mg/l	14	11	0.331	0.051	0.043	0.662	-0.156	-0.613
RAAL	Aluminum in rain	ug/l	24	1	131.800	23.687	37.200	479.000	2.252	4.908
INAL	Aluminum at inflow	ug/l	25	0	321.892	62.143	86.100	1520.000	2.623	8.759
OUAL	Aluminum at outflow	ug/l	14	11	1084.357	269.968	133.000	3390.000	1.455	1.352
RACD	Cadmium in rain	ug/l	24	1	0.183	0.017	0.150	0.500	2.836	8.474
INCD	Cadmium at inflow	ug/l	25	0	0.184	0.023	0.150	0.700	4.135	18.236
OUCD	Cadmium at outflow	ug/l	14	11	0.150	0.000	0.150	0.150	.	.
RACR	Chromium in rain	ug/l	24	1	1.243	0.139	0.200	2.350	0.867	-0.615
INCR	Chromium at inflow	ug/l	24	1	2.419	0.642	1.000	16.500	4.230	19.240
OUCR	Chromium at outflow	ug/l	14	11	6.400	2.339	1.000	35.200	3.109	10.589
RACU	Copper in rain	ug/l	24	1	1.527	0.236	0.050	4.500	1.189	0.639
INCU	Copper at inflow	ug/l	25	0	8.244	2.385	0.500	52.700	2.798	8.151
OUCU	Copper at outflow	ug/l	14	11	3.092	0.596	1.000	9.100	1.670	3.334
RAFE	Iron in rain	ug/l	24	1	36.313	8.859	12.500	230.000	4.160	19.009
INFE	Iron at inflow	ug/l	25	0	245.600	38.022	80.000	950.000	2.661	7.999
OUFE	Iron at outflow	ug/l	14	11	481.536	106.574	110.000	1350.000	1.426	1.121
RAPB	Lead in rain	ug/l	24	1	0.833	0.025	0.750	1.000	0.755	-1.568
INPB	Lead at inflow	ug/l	25	0	1.068	0.179	0.750	5.200	4.487	21.106
OUPB	Lead at ouflow	ug/l	14	11	1.459	0.284	0.750	3.800	1.631	1.627
RAMG	Magnesium in rain	ug/l	21	4	0.321	0.075	0.060	1.710	3.545	14.428
INMG	Manesium at inflow	ug/l	25	0	41.263	2.210	9.180	54.300	-1.253	1.838
OUMG	Magnesium at outflow	ug/l	14	11	130.043	25.404	46.400	399.000	1.929	4.391
RAMN	Manganese in rain	ug/l	24	1	1.997	0.275	0.500	6.000	1.289	1.983
INMN	Manganese at inflow	ug/l	25	0	174.972	28.571	24.600	561.000	1.352	1.410
OUMN	Manganese at outflow	ug/l	14	11	95.350	17.615	22.500	256.000	1.360	1.812
RANI	Nickel in rain	ug/l	24	1	1.625	0.093	1.250	2.150	0.361	-2.048
INNI	Nickel at inflow	ug/l	25	0	2.120	0.150	1.250	3.800	0.423	-0.484
OUNI	Nickel at ouflow	ug/l	14	11	3.254	1.221	1.250	18.300	3.153	10.609
RAAG	Mercury in rain	ug/l	24	1	0.053	0.002	0.050	0.100	3.573	12.541
INAG	Mercury at inflow	ug/l	25	0	0.067	0.011	0.050	0.300	3.983	17.197
OUAG	Mercury at outflow	ug/l	14	11	0.050	0.000	0.050	0.050	.	.
RAZN	Zinc in rain	ug/l	23	2	46.923	10.753	7.500	260.000	3.476	14.100
INZN	Zinc at inflow	ug/l	24	1	12.825	1.204	7.500	30.000	1.069	1.402
OUZN	Zinc at outflow	ug/l	13	12	15.000	2.610	7.500	40.000	1.607	3.321
INSS	Suspended solids in	mg/l	23	2	10.832	1.475	2.800	31.460	1.304	1.750
OUSS	Suspended solids out	mg/l	14	11	26.286	7.009	6.580	99.500	2.098	4.384

* For values below the laboratory detection limit one half the detection limit was used in the calculations.

Appendix L . Summary statistics 2000 for the hydrology and water quality data used for statistical analysis*

Variable	Label	Units	N	N Miss	Mean	Std Error	Min	Max	Skew-ness	Kurtosis
2000										
RAIN	Rain Amount	in	21	0	1.285	0.224	0.250	4.260	1.868	3.349
AVGI	Average Rain Intensity	in/hr	21	0	0.355	0.060	0.040	1.020	1.138	0.558
ANTE	Inter-event dry period	hours	21	0	142.405	31.124	4.500	492.500	1.199	0.659
RAPD	Rain on Pond	cu ft	21	0	62004.0	11820.6	12978.5	221154.0	1.978	3.557
INFL	Inflow	cu ft	21	0	274734.0	103848.6	8622.0	1805397.9	2.752	6.882
OUFL	Outflow	cu ft	21	0	221694.1	100637.3	0.0	1627400.0	2.753	6.673
RANH	Ammonia in rain	mg/l	21	0	0.092	0.022	0.005	0.410	2.076	4.220
INNH	Ammonia at inflow	mg/l	21	0	0.172	0.048	0.006	0.943	2.720	7.685
OUNH	Ammonia at outflow	mg/l	17	4	0.086	0.018	0.005	0.261	1.409	1.449
RANOX	Nitrate+ in rain	mg/l	21	0	0.204	0.037	0.005	0.557	0.654	-0.629
INNOX	Nitrate + at inflow	mg/l	21	0	0.417	0.113	0.005	2.113	1.944	4.679
OUNOX	Nitrate + at outflow	mg/l	17	4	0.045	0.026	0.005	0.464	4.002	16.290
RAON	Organic nitrogen in rain	mg/l	19	2	0.254	0.071	-0.224	1.271	1.947	6.005
INON	Organic nitrogen at in	mg/l	21	0	1.653	0.209	0.056	4.366	1.258	2.813
OUON	Organic nitrogen at out	mg/l	17	4	2.117	0.238	0.816	4.727	1.381	1.967
RATN	Total nitrogen in rain	mg/l	19	2	0.517	0.090	0.060	1.500	1.341	1.055
INTN	Total nitrogen at inflow	mg/l	21	0	2.242	0.209	0.520	4.448	0.234	0.328
OUTN	Total nitrogen at outflow	mg/l	17	4	2.235	0.249	0.910	4.850	1.234	1.215
RAOP	Ortho-phos in rain	mg/l	21	0	0.007	0.001	0.005	0.018	1.492	1.551
INOP	Ortho-phos at inflow	mg/l	21	0	0.797	0.061	0.294	1.300	0.219	-0.775
OUOP	Ortho-phos at outflow	mg/l	17	4	0.355	0.037	0.017	0.612	-0.107	0.273
RATP	Total phosphorus rain	mg/l	21	0	0.018	0.003	0.005	0.068	2.330	5.569
INTP	Total phos at inflow	mg/l	21	0	1.424	0.099	0.868	2.640	1.131	1.386
OUTP	Total phos at outflow	mg/l	17	4	0.630	0.079	0.067	1.400	0.382	1.196
RAAL	Aluminum in rain	ug/l	21	0	76.324	12.329	11.500	193.000	0.812	-0.637
INAL	Aluminum at inflow	ug/l	21	0	2130.333	881.586	127.000	19200.000	4.126	18.043
OUAL	Aluminum at outflow	ug/l	17	4	1386.000	429.681	0.000	6920.000	2.184	5.385
RACD	Cadmium in rain	ug/l	21	0	0.144	0.006	0.015	0.150	-4.583	21.000
INCD	Cadmium at inflow	ug/l	21	0	0.448	0.080	0.015	1.400	1.090	0.726
OUCD	Cadmium at outflow	ug/l	17	4	0.133	0.011	0.000	0.150	-2.626	5.576
RACR	Chromium in rain	ug/l	21	0	1.000	0.000	1.000	1.000	.	.
INCR	Chromium at inflow	ug/l	21	0	17.395	3.873	1.000	69.500	1.482	2.381
OUCR	Chromium at outflow	ug/l	17	4	5.064	1.023	1.000	16.000	1.072	1.130
RACU	Copper in rain	ug/l	21	0	1.710	0.278	1.000	5.200	1.673	1.784
INCU	Copper at inflow	ug/l	21	0	68.086	15.104	1.000	250.000	1.290	1.009
OUCU	Copper at outflow	ug/l	17	4	6.587	1.254	1.000	19.900	1.228	1.382
RAFE	Iron in rain	ug/l	21	0	55.405	7.920	12.500	140.000	0.666	-0.131
INFE	Iron at inflow	ug/l	21	0	921.714	147.817	270.000	2660.000	1.544	1.850
OUFE	Iron at outflow	ug/l	17	4	724.441	209.782	60.000	3480.000	2.275	6.064
RAPB	Lead in rain	ug/l	21	0	0.750	0.000	0.750	0.750	.	.
INPB	Lead at inflow	ug/l	21	0	5.393	1.252	0.750	21.300	1.420	1.599
OUPB	Lead at ouflow	ug/l	17	4	2.117	0.399	0.750	5.900	1.088	0.313
RAMG	Magnesium in rain	ug/l	16	5	0.033	0.012	0.000	0.140	1.455	0.794
INMG	Manesium at inflow	ug/l	21	0	35.857	2.754	11.600	56.200	-0.535	-0.524
OUMG	Magnesium at outflow	ug/l	15	6	50.713	4.355	33.680	81.000	0.665	-0.883
RAMN	Manganese in rain	ug/l	21	0	1.605	0.189	0.500	3.100	0.330	-1.279
INMN	Manganese at inflow	ug/l	21	0	236.110	26.918	98.500	632.000	1.953	4.707
OUMN	Manganese at outflow	ug/l	15	6	86.087	14.796	13.100	243.000	1.377	3.080
RANI	Nickel in rain	ug/l	21	0	1.764	0.423	1.250	10.000	4.241	18.497
INNI	Nickel at inflow	ug/l	21	0	2.743	0.326	1.250	6.000	0.690	-0.367
OUNI	Nickel at ouflow	ug/l	15	6	2.476	0.419	1.250	5.300	0.810	-1.117
RAAG	Mercury in rain	ug/l	21	0	0.055	0.003	0.050	0.100	2.975	7.562
INAG	Mercury at inflow	ug/l	21	0	0.202	0.040	0.050	0.700	1.357	1.233
OUAG	Mercury at outflow	ug/l	15	6	0.061	0.005	0.050	0.100	1.615	0.772
RAZN	Zinc in rain	ug/l	21	0	28.695	3.841	7.500	80.000	1.183	2.284
INZN	Zinc at inflow	ug/l	21	0	37.686	6.600	7.500	120.000	1.252	1.356
OUZN	Zinc at outflow	ug/l	15	6	23.649	4.121	7.500	50.000	0.631	-1.006
INSS	Suspended solids in	mg/l	20	1	44.485	10.928	7.085	220.470	2.693	8.846
OUSS	Suspended solids out	mg/l	15	6	59.377	13.020	1.360	176.000	0.869	0.226

* For values below the laboratory detection limit one half the detection limit was used in the calculations.

Appendix L. Summary statistics 2001 for the hydrology and water quality data used for statistical analysis*

Variable	Label	Units	N	N Miss	Mean	Std Error	Min	Max	Skew-ness	Kurtosis
2001										
RAIN	Rain Amount	in	14	0	2.044	0.668	0.230	9.910	2.746	8.291
AVGI	Average Rain Intensity	in/hr	14	0	0.411	0.063	0.130	0.860	0.890	-0.480
ANTE	Inter-event dry period	hours	14	0	186.821	88.704	16.750	1316.500	3.489	12.614
RAPD	Rain on Pond	cu ft	14	0	106127.2	34704.1	11940.2	514468.6	2.746	8.291
INFL	Inflow	cu ft	14	0	508573.7	241137.3	15861.7	3425798.9	2.980	9.613
OUFL	Outflow	cu ft	14	0	452556.3	276454.2	1122.0	3891466.0	3.278	11.164
RANH	Ammonia in rain	mg/l	12	2	0.116	0.026	0.019	0.326	1.364	1.845
INNH	Ammonia at inflow	mg/l	13	1	0.231	0.059	0.032	0.630	1.024	-0.494
OUNH	Ammonia at outflow	mg/l	14	0	0.076	0.032	0.005	0.453	2.932	9.138
RANOX	Nitrate+ in rain	mg/l	12	2	0.183	0.032	0.026	0.354	0.202	-1.126
INNOX	Nitrate + at inflow	mg/l	13	1	0.741	0.358	0.005	4.190	1.899	3.451
OUNOX	Nitrate + at outflow	mg/l	14	0	0.076	0.049	0.005	0.672	3.080	9.830
RAON	Organic nitrogen in rain	mg/l	12	2	0.230	0.090	0.000	0.922	1.854	2.205
INON	Organic nitrogen at in	mg/l	13	1	1.991	0.266	0.825	4.363	1.412	2.117
OUON	Organic nitrogen at out	mg/l	14	0	1.468	0.159	0.757	2.848	1.004	0.841
RATN	Total nitrogen in rain	mg/l	12	2	0.524	0.114	0.050	1.400	1.308	1.422
INTN	Total nitrogen at inflow	mg/l	13	1	2.956	0.442	1.350	6.600	1.256	0.948
OUTN	Total nitrogen at outflow	mg/l	14	0	1.619	0.183	0.821	2.920	0.926	-0.339
RAOP	Ortho-phos in rain	mg/l	12	2	0.007	0.002	0.005	0.023	2.679	7.099
INOP	Ortho-phos at inflow	mg/l	13	1	1.407	0.161	0.481	2.290	-0.023	-1.109
OUOP	Ortho-phos at outflow	mg/l	14	0	0.888	0.125	0.326	2.140	1.426	3.212
RATP	Total phosphorus rain	mg/l	12	2	0.012	0.002	0.005	0.032	1.596	2.274
INTP	Total phos at inflow	mg/l	12	2	2.068	0.331	0.769	5.170	1.883	4.854
OUTP	Total phos at outflow	mg/l	14	0	1.044	0.137	0.366	2.370	1.343	2.698
RAAL	Aluminum in rain	ug/l	12	2	73.386	22.390	20.800	311.000	3.047	9.919
INAL	Aluminum at inflow	ug/l	13	1	2246.965	948.068	191.000	12400.000	2.597	7.058
OUAL	Aluminum at outflow	ug/l	14	0	545.349	144.735	14.400	1520.898	0.795	-1.062
RACD	Cadmium in rain	ug/l	12	2	0.148	0.002	0.130	0.150	-3.464	12.000
INCD	Cadmium at inflow	ug/l	13	1	0.342	0.101	0.150	1.300	2.027	3.548
OUCD	Cadmium at outflow	ug/l	14	0	0.151	0.001	0.150	0.162	3.742	14.000
RACR	Chromium in rain	ug/l	12	2	1.233	0.233	1.000	3.800	3.464	12.000
INCR	Chromium at inflow	ug/l	13	1	11.693	4.119	1.000	53.700	2.291	5.334
OUCR	Chromium at outflow	ug/l	14	0	1.398	0.273	1.000	4.171	2.399	4.603
RACU	Copper in rain	ug/l	12	2	1.542	0.302	1.000	3.800	1.710	1.477
INCU	Copper at inflow	ug/l	13	1	41.248	11.586	1.000	138.000	1.352	1.058
OUCU	Copper at outflow	ug/l	14	0	4.330	1.408	0.716	20.600	2.522	7.455
RAFE	Iron in rain	ug/l	12	2	62.292	25.821	12.500	340.000	3.194	10.661
INFE	Iron at inflow	ug/l	13	1	1335.092	517.088	110.000	6580.000	2.290	5.225
OUFE	Iron at outflow	ug/l	14	0	177.530	42.398	70.000	540.000	1.780	1.818
RAPB	Lead in rain	ug/l	12	2	0.829	0.079	0.750	1.700	3.464	12.000
INPB	Lead at inflow	ug/l	13	1	3.542	1.160	0.750	14.300	1.802	2.766
OUPB	Lead at ouflow	ug/l	14	0	0.803	0.053	0.750	1.494	3.742	14.000
RAMG	Magnesium in rain	ug/l	12	2	0.147	0.032	0.100	0.410	2.117	3.095
INMG	Manesium at inflow	ug/l	13	1	38.079	2.649	19.200	53.600	-0.325	-0.028
OUMG	Magnesium at outflow	ug/l	14	0	54.850	5.762	26.914	98.500	0.853	0.497
RAMN	Manganese in rain	ug/l	12	2	1.633	0.309	0.500	4.100	1.092	1.267
INMN	Manganese at inflow	ug/l	13	1	337.558	75.812	126.000	1170.000	2.643	8.083
OUMN	Manganese at outflow	ug/l	14	0	104.788	23.985	23.209	396.000	2.939	9.867
RANI	Nickel in rain	ug/l	12	2	1.833	0.404	1.250	5.500	2.288	4.347
INNI	Nickel at inflow	ug/l	13	1	3.652	0.789	1.250	10.400	1.476	1.597
OUNI	Nickel at ouflow	ug/l	14	0	1.769	0.212	1.250	3.400	1.195	-0.111
RAAG	Mercury in rain	ug/l	12	2	0.058	0.006	0.050	0.100	2.055	2.640
INAG	Mercury at inflow	ug/l	13	1	0.152	0.039	0.050	0.500	1.828	2.578
OUAG	Mercury at outflow	ug/l	14	0	0.054	0.004	0.033	0.087	1.663	2.854
RAZN	Zinc in rain	ug/l	12	2	37.517	10.099	7.500	140.000	2.568	7.777
INZN	Zinc at inflow	ug/l	13	1	39.358	8.952	7.500	120.000	1.710	2.511
OUZN	Zinc at outflow	ug/l	14	0	18.093	3.693	7.500	53.239	1.404	1.877
INSS	Suspended solids in	mg/l	12	2	67.281	30.860	11.600	391.300	2.968	9.328
OUSS	Suspended solids out	mg/l	14	0	7.134	1.990	1.060	27.469	1.875	3.454

* For values below the laboratory detection limit one half the detection limit was used in the calculations.

STORMWATER POND TREATING AGRICULTURAL RUNOFF IN RUSKIN, FLORIDA

Obs	MO	DA	YR	NO	RAIN	AVGI	ANTE	RAPD	INFL	OUFL	RANH	INNH	OUNH	RANOX	INNOX	OUNOX	RAON
1	1	6	98	1	1.36	0.23	243.50	70603.15	200000.00	0	0.22200	0.1490	.	0.306	0.68000	.	0.77800
2	1	15	98	2	1.07	0.08	169.25	55548.07	176350.75	95000	0.16500	0.1010	0.11000	0.139	0.35500	0.49200	0.64500
3	1	23	98	3	2.27	0.35	175.00	117844.97	444864.72	362500	0.10700	0.0650	0.07500	0.162	0.16700	0.24400	0.21500
4	2	15	98	5	3.84	0.17	45.25	199350.08	795651.13	631930	0.20300	0.0500	0.05700	0.238	0.38200	0.13900	0.89700
5	2	17	98	6	0.31	0.25	13.00	16093.37	101235.08	172360	0.22000	0.2860	0.02700	0.187	2.60000	0.22400	0.33000
6	2	19	98	7	3.58	0.84	79.50	185852.42	1001698.00	1004570	0.19500	0.2200	0.13700	0.110	0.29500	0.47700	0.21000
7	2	28	98	9	1.48	1.01	131.75	76832.84	343896.35	206030	0.24200	0.1300	0.11500	0.143	0.29600	0.11400	0.34800
8	3	8	98	10	0.68	0.68	190.50	35301.58	56349.08	8870	0.40100	0.1330	.	0.220	0.37700	.	0.44900
9	3	18	98	11	5.12	0.11	236.25	265800.11	1023260.58	1099770	0.05500	0.1340	0.04800	0.111	0.65600	0.03100	0.23500
10	4	20	98	12	0.30	0.17	740.00	12933.93	2587.00	0	0.81700	0.0220	.	0.286	0.06600	.	1.18300
11	5	28	98	13	0.88	0.15	907.25	37939.51	8622.62	0	0.87200	0.1100	.	0.450	3.23500	.	0.42800
12	5	30	98	14	0.29	0.39	44.50	12502.79	49580.05	0	1.41000	0.0270	.	2.450	0.30700	.	1.16900
13	6	23	98	15	1.02	1.36	337.25	43976.20	12933.07	0	1.03000	0.0580	.	0.912	0.13100	.	2.88800
14	7	6	98	16	0.39	0.31	300.25	11745.92	2710.60	0	0.94300	0.0130	.	1.010	0.01600	.	1.99000
15	7	10	98	17	0.65	0.12	91.50	19576.54	12950.63	0	0.34900	0.0310	.	0.752	0.01900	.	0.44800
16	7	17	98	18	2.11	1.81	0.67	63548.45	37647.19	0	0.14300	0.1000	.	0.345	0.04100	.	0.23500
17	7	21	98	19	0.41	0.18	147.50	12348.28	2108.24	0	0.51800	0.0050	.	0.175	0.00500	.	1.72500
18	8	16	98	20	0.82	0.18	168.25	24696.56	4216.49	0	0.19000	0.1470	.	0.425	0.07600	.	0.22500
19	8	17	98	21	0.74	0.27	20.75	22287.14	10240.04	0	0.18800	0.1220	.	0.777	0.13300	.	0.52300
20	9	2	98	22	1.41	0.13	347.25	73198.86	9486.00	0	0.22900	0.1240	.	0.258	0.02400	.	0.31200
21	9	6	98	23	2.92	1.04	59.50	151589.12	123468.79	9540	0.20900	0.0620	.	0.229	0.41600	.	0.65100
22	9	18	98	24	1.70	0.32	32.25	88253.94	86864.87	5180	0.16700	0.1050	.	0.059	0.11900	.	0.21100
23	9	19	98	25	1.72	0.14	12.00	89292.22	344953.21	128160	0.03100	0.1480	0.01600	0.036	0.15000	0.01000	0.05400
24	9	20	98	26	0.35	0.41	48.50	18169.93	252864.00	97580	0.10900	0.1340	0.00500	0.087	0.11800	0.01500	0.14300
25	12	13	98	27	0.58	0.29	917.50	20172.26	5286.52	0	0.12400	0.0130	.	0.283	0.01000	.	0.13300
26	1	2	99	1	1.38	0.46	315.00	47996.06	81384.62	0	0.03500	0.0580	.	0.212	0.02700	.	0.03800
27	1	25	99	2	2.69	0.63	336.25	139648.88	399878.18	8530	0.14100	0.4730	0.02500	0.143	2.35500	0.01800	0.19700
28	3	14	99	3	1.01	0.29	1186.50	52433.22	117029.34	33250	0.00500	0.0350	0.02800	0.032	0.01000	0.01000	0.06800
29	4	30	99	4	1.10	1.10	304.75	33129.80	14577.11	0	0.23400	0.0670	.	0.338	0.12800	.	0.34200
30	5	30	99	5	1.02	0.41	260.00	20797.89	15904.26	0	0.61900	0.0210	.	0.428	0.00500	.	0.05300
31	6	2	99	6	0.92	1.23	69.00	27708.56	5541.71	0	0.28500	0.0200	.	0.248	0.00500	.	0.00700
32	6	6	99	7	0.63	2.52	71.50	18974.34	2710.62	0	0.63900	0.0170	.	0.958	0.00500	.	0.20300
33	6	16	99	8	1.83	0.21	214.25	55115.94	70476.12	0	0.14300	0.0380	.	0.113	0.00500	.	0.08400
34	7	1	99	9	1.09	0.29	20.00	32828.62	28250.68	0	0.11000	0.0220	.	0.005	0.00500	.	0.51500
35	7	2	99	10	0.39	0.78	18.25	11746.02	9938.94	0	0.23800	0.0330	.	0.065	0.00500	.	0.05700
36	7	9	99	11	0.55	0.58	117.00	16564.90	12047.20	0	0.25400	0.0120	.	0.187	0.00500	.	0.25900
37	7	26	99	12	0.75	2.49	273.75	38935.56	15262.74	0	0.14700	0.0050	.	0.037	0.00700	.	0.09600
38	8	6	99	13	0.66	0.18	170.50	34263.30	5606.72	0	0.00500	0.0170	.	0.100	0.09800	.	-0.00500
39	8	12	99	14	0.32	0.08	138.25	16612.51	2076.56	0	0.05500	0.1230	0.03600	0.180	0.03700	0.00600	0.20500
40	8	14	99	15	0.18	1.80	58.25	9344.54	4983.75	0	0.16600	0.0550	0.01800	0.382	0.07200	0.00500	0.11200
41	8	16	99	16	1.18	0.91	44.75	61258.62	45869.08	600	0.40800	0.0480	0.05400	0.295	0.03000	0.00500	0.03700
42	8	18	99	17	1.37	0.32	30.25	71122.29	203250.18	171760	0.05700	0.0050	0.04400	0.384	0.10600	0.00700	0.04900
43	8	22	99	18	1.71	0.12	87.00	88773.08	350175.62	383430	0.02400	0.0350	0.02200	0.051	0.01300	0.00500	0.15500
44	8	28	99	19	0.51	0.22	142.00	26476.18	7397.48	11810	0.04100	0.0520	0.08900	0.030	0.00500	0.00500	0.29900
45	9	6	99	20	1.94	0.13	197.75	100713.32	218066.00	240580	0.01400	0.0050	0.02700	0.025	0.00500	0.00500	0.22100
46	9	11	99	21	0.34	0.23	97.50	17650.79	20023.50	38910	0.16200	0.0460	0.03300	0.081	0.00800	0.00500	0.45700
47	9	19	99	22	1.62	0.22	192.00	84100.82	265686.89	238270	0.01200	0.0050	0.03800	0.101	0.02400	0.00500	0.04700
48	10	4	99	23	3.95	0.38	300.75	205060.63	1098728.29	880170	0.08900	0.0350	0.04500	0.101	0.14800	0.00500	0.06700
49	11	1	99	24	1.22	.	624.00	63335.18	114069.39	147200	0.00500	0.0670	0.01600	0.023	0.05600	0.00900	.
50	11	22	99	25	0.55	0.44	480.50	28552.75	98307.00	112100	0.15700	0.0300	0.00500	0.201	0.11400	0.00500	0.07300
51	2	14	0	1	0.46	0.12	297.50	23880.48	80985.97	48520	0.00500	0.9430	0.05600	0.019	0.05000	0.05000	0.27500
52	3	28	0	2	0.79	0.09	4.50	34059.07	103471.20	0	0.09100	0.0440	0.00500	0.199	0.03800	0.01200	0.13900
53	4	14	0	3	0.73	0.04	414.50	37897.28	24399.62	0	0.01800	0.1560	0.05800	0.005	0.49600	0.00500	0.24700
54	6	26	0	4	1.46	0.39	141.25	29769.52	41187.97	0	0.30700	0.1590	.	0.307	0.00500	.	-0.22400
55	6	27	0	5	1.38	0.46	16.50	28138.32	101542.62	0	0.06900	0.0730	.	0.147	0.03500	.	0.14400
56	7	5	0	6	1.13	0.17	14.50	58662.91	149097.25	0	0.02300	0.1010	.	0.062	0.01700	.	-0.02500
57	7	6	0	7	0.57	0.31	12.75	29591.03	43504.00	0	0.20400	0.0891	.	0.514	0.02200	.	0.48200
58	7	9	0	8	0.25	0.10	88.25	12978.52	8622.00	1197	0.06200	0.0310	0.02000	0.440	0.02700	0.03300	.
59	7	10	0	9	2.55	1.02	23.25	132380.91	427546.82	354890	0.41000	0.1780	0.08400	0.374	0.29500	0.02000	0.31600
60	7	16	0	10	4.26	0.42	14.25	221154.00	1515605.69	1525656	0.04800	0.1190	0.01400	0.125	0.09700	0.00500	0.03700
61	7	31	0	11	0.76	0.13	173.75	39454.70	43177.00	60886	0.13400	0.6250	0.06500	0.261	0.56700	0.02900	0.06500
62	8	12	0	12	1.33	0.80	60.75	69045.73	86810.55	82718	0.15300	0.0930	0.05900	0.557	0.03100	0.00500	.
63	8	23	0	13	0.51	0.68	175.25	26476.18	33216.00	30961	0.02000	0.0055	0.23400	0.005	0.52800	0.46400	0.49500
64	8	27	0	14	0.63	0.11	97.75	32705.87	69640.25	44945	0.07500	0.1350	0.12100	0.381	0.96400	0.00500	0.54400
65	9	7	0	15	1.53	0.14	126.25	79428.55	220516.89	171905	0.04400	0.0860	0.15600	0.090	1.05000	0.00500	0.19600
66	9	8	0	16	0.85	0.30	26.00	44126.97	172340.89	76400	0.03200	0.1180	0.04900	0.240	0.37100	0.00500	0.17800
67	9	17	0	17	3.58	0.35	202.75	183256.71	1805397.89	1627400	0.02100	0.3310	0.06000	0.027	2.11300	0.03000	0.03200
68	9	28	0	18	1.35	0.36	171.50	70084.01	349009.00	231261	0.09200	0.1330	0.06000	0.247	0.79200	0.04100	0.13100
69	10	6	0	19	1.19	0.30	70.00	61777.76	114785.42	65850	0.05700	0.1540	0.26100	0.172	0.86400	0.00500	1.27100
70	11	26	0	20	1.31	0.87	366.75	68007.45	291399.57	264685	0.02500	0.0170	0.12316	0.046	0.21100	0.02626	0.16900
71	12	17	0	21	0.37	0.30	492.50	19208.21	87158.00	68302	0.04400	0.0160	0.04100	0.058	0.19300	0.02000	0.34800
72	3	4	1	1	1.62	0.36	1316.50	84100.82	205544.27	94800	0.32600	0.5340	0.01100	0.152	2.09000	0.00500	0.92200
73	3	29	1	2	4.25	0.23	259.75	220634.85	756778.68	345100	0.23900	0.1970	0.03592	0.144	4.19000	0.67179	0.06700
74	6	23	1	3	2.91	0.31	48.00	151069.98	682936.24	115100	0.06000	0.0320	0.45350	0.304	0.00500	0.08275	0.11600
75	6	30	1	4	1.16	0.34	175.00	60220.34	245605.67	226400	0.08700	0.1260	0.02200	0.266	0.04400	0.00500	0.11700
76	7	4	1	5	0.23	0.13	90.50	11940.24	20826.00	19800	.	0.6300	0.01400	.	0.01700	0.00500	.
77	7	16	1	6	0.74	0.37	123.75	38416.42	15861.72	16900	0.14300	0.0540	0.18600	0.354	0.00500	0.00500	0.07300
78	7	21	1	7	0.82	0.15	108.75	42569.55	100136.58	44900	0.12100	0.0990	0.03200	0.203	0.00500	0.00500	0.83600
79	7	23	1	8	1.85	0.72	26.25	96041.05	1114331.41	1173000	0.01900	0.0580	0.08611	0.026	0.00500	0.00500	0.00500
80	7	26	1	9	0.69	0.79	69.50	35820.72	189846.82	226600	0.08500	0.1800	0.04441	0.173	0.00500	0.01242	0.00000
81	8	5	1	10	0.47	0.31	71.50	24399.62	140974.02	57600	0.13500	0.0460	0.06700	0.101	0.00500	0.00500	0.23400
82	9	11	1	11	1.08	0.86	115.25	56067.21	58435.15	1122	.	0.5650	0.00500	.	0.04700	0.00500	.
83	9	14	1	12	9.91	0.61	16.75	514468.57	3425798.92	3891466	0.02054	0.3280	0.01495	0.031	1.77908	0.24663	0.14186
84	9	29	1	13	1.00	0.31	30.75	51914.08	58994.13	56300	0.05600	.	0.05065	0.340	.	0.00500	0.19400
85	10	21	1	14	1.89	0.26	163.25	98117.62	103962.38	66700	0.10200	0.1510	0.03796	0.104	1.43000	0.00500	0.05420

Obs	INON	OUON	RATN	INTN	OUTN	RAOP	INOP	OUOP	RATP	INTP	OUTP	RAAL	INAL	OUAL	RACD
1	1.4510	.	1.0000	1.6000	.	0.022	1.0100	.	0.02200	1.2000	.	10.500	169.00	.	0.150
2	1.2990	0.37000	0.8100	1.4000	0.48000	0.033	3.1040	0.77600	0.03500	5.0500	1.01000	71.900	8610.00	345.00	0.150
3	0.6950	0.89700	0.3220	0.7600	0.93700	0.005	3.3800	0.70600	0.00500	5.5600	0.75700	11.800	8340.00	537.00	0.150
4	1.1500	0.94300	1.1000	1.2000	1.00000	0.020	0.6380	0.64500	0.00100	2.6500	0.87400	120.000	7240.00	4540.00	0.150
5	2.5140	0.80300	0.5500	2.8000	0.83000	0.015	0.7280	0.68700	0.02600	8.6500	0.75700	46.300	21800.00	753.00	0.150
6	0.7800	0.98300	0.4050	1.0000	1.11800	0.023	0.5400	0.77800	0.02000	2.3500	1.03900	27.200	30000.00	1169.00	0.150
7	1.0700	0.75500	0.5900	1.2000	0.87000	0.005	1.4900	0.56700	0.00500	2.0600	0.76000	26.900	1963.00	1363.00	0.150
8	1.1670	.	0.8500	1.3000	.	0.005	1.4400	.	0.00500	1.8900	.	102.000	1370.00	.	0.150
9	1.1660	0.62600	0.2900	1.3000	0.70000	0.510	0.0050	0.77200	0.68100	0.0050	1.04000	56.600	1220.00	793.00	0.150
10	0.6780	.	2.0000	0.7000	.	0.019	0.9630	.	0.52100	2.1130	.	125.000	160.00	.	0.700
11	3.5900	.	1.3000	3.7000	.	0.073	0.7170	.	0.09700	1.4330	.	71.800	698.00	.	0.400
12	1.1730	.	3.9000	1.2000	.	0.047	0.7690	.	0.04600	1.0300	.	.	176.00	.	.
13	0.6620	.	3.8000	0.7200	.	0.098	0.5140	.	0.10200	0.6740	.	528.000	455.00	.	1.600
14	0.6770	.	3.0000	0.6900	.	0.021	0.3320	.	0.02800	0.4870	.	283.000	392.00	.	1.100
15	0.6290	.	1.2000	0.6600	.	0.019	0.3080	.	0.01500	0.4400	.	381.000	322.00	.	0.500
16	0.7300	.	0.5800	0.8300	.	0.026	0.6800	.	0.11700	0.8860	.	162.000	300.00	.	0.400
17	0.6500	.	1.9000	0.6500	.	0.368	0.4030	.	0.40400	0.5070	.	207.000	272.00	.	0.300
18	1.1530	.	0.6500	1.3000	.	0.032	0.1030	.	0.02800	0.2220	.	199.000	194.00	.	0.150
19	0.7180	.	1.3000	0.8400	.	0.055	0.5250	.	0.05700	0.8920	.	335.000	313.00	.	0.300
20	1.2760	.	0.5700	1.4000	.	0.032	0.0230	.	0.06500	0.1130	.	380.000	153.00	.	0.150
21	1.6380	.	0.8800	1.7000	.	0.027	0.8380	.	0.02400	1.7600	.	240.000	1430.00	.	0.150
22	0.5250	.	0.2700	0.6300	.	0.017	0.8220	.	0.02800	1.0670	.	181.000	432.00	.	0.150
23	0.6720	0.68400	0.0900	0.8200	0.70000	0.012	1.8500	0.27200	0.00500	2.1200	0.39000	147.000	245.00	828.00	0.400
24	1.0660	1.39000	0.2300	1.2000	1.40000	0.005	1.8100	0.40700	0.00500	2.0300	0.63600	79.600	186.00	1360.00	0.150
25	0.6270	.	0.5400	0.6400	.	0.022	0.6300	.	0.01900	0.8690	.	231.000	414.00	.	0.600
26	1.0420	.	0.2500	1.1000	.	0.005	0.6280	.	0.01400	0.7540	.	69.500	354.00	.	0.150
27	2.5270	1.46200	0.3400	3.0000	1.50000	0.005	0.8710	0.35400	0.01000	1.0400	0.42500	86.500	178.00	384.00	0.150
28	0.3750	1.17200	0.1000	0.4100	1.20000	0.005	0.4780	0.19300	0.00500	0.5540	0.49400	109.000	275.00	2980.00	0.150
29	1.4330	.	0.6800	1.5000	.	0.012	0.8200	.	0.01700	1.0090	.	185.000	725.00	.	0.150
30	0.8940	.	1.1000	0.9200	.	0.024	0.1430	.	0.05700	0.3170	.	.	503.00	.	.
31	0.7950	.	0.5400	0.8200	.	0.027	0.1910	.	0.03400	0.2610	.	213.000	463.00	.	0.150
32	0.7780	.	1.8000	0.8000	.	0.088	0.2270	.	0.09200	0.3570	.	224.000	435.00	.	0.300
33	1.0570	.	0.3400	1.1000	.	0.022	0.1760	.	0.03000	0.3670	.	95.000	381.00	.	0.150
34	1.3730	.	0.6300	1.4000	.	0.023	0.2480	.	0.02200	0.3440	.	128.000	219.00	.	0.150
35	0.8120	.	0.3600	0.8500	.	0.005	1.0700	.	0.01300	1.5100	.	111.000	149.00	.	0.150
36	1.1830	.	0.7000	1.2000	.	0.005	0.3640	.	0.02000	0.5300	.	82.800	275.00	.	0.150
37	0.3680	.	0.2800	0.3800	.	0.029	0.8540	.	0.09700	1.0700	.	479.000	118.00	.	0.150
38	0.9850	.	0.1000	1.1000	.	0.005	0.8730	.	0.00500	0.9870	.	62.300	118.00	.	0.500
39	1.1400	1.75800	0.4400	1.3000	1.80000	0.005	0.6590	0.01700	0.01600	0.8560	0.05900	141.000	88.20	133.00	0.150
40	1.0730	1.77700	0.6600	1.2000	1.80000	0.005	0.8660	0.00500	0.01100	1.0060	0.04300	43.800	115.00	143.00	0.150
41	1.3220	1.64000	0.7400	1.4000	1.70000	0.005	0.8340	0.01000	0.02400	0.8670	0.04700	115.000	161.00	223.00	0.150
42	-0.0830	0.48900	0.4900	0.0800	0.54000	0.012	1.3000	0.14600	0.00500	1.4400	0.19700	67.500	182.00	1190.00	0.150
43	0.4730	0.91400	0.2300	0.5100	0.94100	0.005	1.0200	0.27100	0.00500	1.0410	0.33300	55.100	86.10	559.00	0.150
44	0.0630	0.01600	0.3700	0.1200	0.11000	0.005	0.9980	0.29200	0.01500	1.2970	0.40600	41.300	103.00	783.00	0.150
45	0.7500	0.51800	0.2600	0.7600	0.55000	0.005	1.5200	0.33300	0.01000	1.6780	0.40600	37.200	144.00	929.00	0.150
46	0.9460	0.89200	0.7000	1.0000	0.93000	0.014	0.9280	0.23400	0.01500	1.1040	0.35200	79.300	95.00	641.00	0.150
47	1.3710	1.16700	0.1600	1.4000	1.22500	0.005	1.2200	0.33900	0.01400	1.4200	0.58000	105.000	172.00	1920.00	0.300
48	0.4970	0.61500	0.2570	0.6800	0.66500	0.005	1.0990	0.21000	0.00900	.	0.36800	133.100	1520.00	958.00	0.300
49	.	.	.	.	.	0.013	1.7180	0.20000	0.01500	1.9500	0.26700	38.800	583.00	948.00	0.150
50	0.4700	2.39000	0.4310	0.6140	2.40000	.	.	.	0.01700	1.2100	0.66200	461.000	605.00	3390.00	0.150
51	1.8570	1.84400	0.2990	2.8500	1.95000	0.005	0.4180	0.27300	0.01000	0.8910	0.55500	47.500	387.00	3330.00	0.015
52	4.3660	1.57500	0.4290	4.4480	1.59200	0.014	0.2940	0.01700	0.01600	0.8680	0.06800	101.000	1310.00	185.00	0.150
53	1.8480	2.03700	0.2700	2.5000	2.10000	0.005	0.7550	0.24700	0.01800	1.3700	0.35100	72.200	997.00	274.00	0.150
54	1.7360	.	0.3900	1.9000	.	0.012	1.3000	.	0.01800	1.6600	.	32.100	179.00	.	0.150
55	1.1210	.	0.3600	1.2200	.	0.005	0.9740	.	0.05500	1.2880	.	140.000	214.00	.	0.150
56	0.9820	.	0.0600	1.1000	.	0.005	1.2000	.	0.01900	1.5100	.	68.800	127.00	.	0.150
57	0.4089	.	1.2000	0.5200	.	0.018	1.2000	.	0.06800	1.5800	.	193.000	19200.00	.	0.150
58	0.6820	1.44700	.	0.7400	1.50000	0.010	0.6790	0.60100	0.01400	0.9100	0.84500	92.200	298.00	228.00	0.150
59	2.2270	1.34300	1.1000	2.7000	1.45000	0.005	0.9990	0.39400	0.02400	2.6400	0.68600	79.300	3070.00	906.00	0.150
60	1.3840	1.58100	0.2100	1.6000	1.60000	0.010	0.4640	0.38900	0.01300	2.2500	0.50700	50.100	3170.00	486.00	0.150
61	1.1080	0.81600	0.4600	2.3000	0.91000	0.011	0.9440	0.53800	0.01500	1.2100	0.60600	161.000	253.00	89.00	0.150
62	1.6760	1.23600	.	1.8000	1.30000	0.005	0.9640	0.61200	0.01000	1.1700	0.70200	158.000	1100.00	379.00	0.150
63	1.3665	2.55800	0.5200	1.9000	3.03000	0.005	0.7490	0.33500	0.01400	0.9880	0.06700	69.000	1100.00	1010.00	0.150
64	1.6010	4.72700	1.0000	2.7000	4.85000	0.005	0.8190	0.31400	0.02200	1.1800	0.92500	169.000	649.00	2610.00	0.150
65	1.7640	3.13900	0.3300	2.9000	3.30000	0.005	0.5800	0.33300	0.01000	1.3000	0.69400	29.600	1460.00	1730.00	0.150
66	2.3110	1.68700	0.4500	2.8000	1.75000	0.005	0.6490	0.18300	0.00500	1.3200	0.42900	31.900	1450.00	534.00	0.150
67	0.0560	1.59000	0.0800	2.5000	1.68000	0.005	1.1990	0.44000	0.02000	1.5070	0.57000	26.900	433.00	621.00	0.150
68	1.7750	1.89900	0.4700	2.7000	2.00000	0.010	0.6180	0.33200	0.00500	1.6500	0.61100	26.300	1810.00	1140.00	0.150
69	1.5820	2.73400	1.5000	2.6000	3.00000	0.005	0.7410	0.50900	0.00500	1.6100	1.40000	22.700	1770.00	6920.00	0.150
70	3.5720	3.62858	0.2400	3.8000	3.77800	0.005	0.6250	0.23546	0.00500	2.0100	1.06754	20.700	3230.00	0.00	0.150
71	1.2910	2.13900	0.4500	1.5000	2.20000	0.005	0.5580	0.28500	0.00500	0.9820	0.62800	11.500	2530.00	3120.00	0.150
72	2.6760	1.18400	1.4000	5.3000	1.20000	0.023	0.4810	0.40700	0.03200	0.7690	0.47600	64.400	1080.00	348.00	0.150
73	2.2130	1.72680	0.4500	6.6000	2.43452	0.005	0.9190	0.32634	0.01100	1.6500	0.53792	311.000	2490.00	1520.90	0.150
74	4.3630	2.30502	0.4800	4.4000	2.84127	0.005	2.1700	1.41957	0.00500	5.1700	1.73345	84.500	12400.00	262.04	0.150
75	3.2300	1.37300	0.4700	3.4000	1.40000	0.005	1.0200	0.87000	0.01000	.	1.20000	81.400	5890.00	1130.00	0.150
76	1.7530	1.28100	.	2.4000	1.30000	.	2.0400	0.74500	.	2.7000	0.94300	.	1290.00	14.40	.
77	2.0010	1.68900	0.5700	2.0600	1.88000	0.005	0.8490	2.14000	0.00600	0.9840	2.37000	42.200	266.00	839.00	0.150
78	1.6960	1.60300	1.1600	1.8000	1.64000	0.005	2.2900	1.03000	0.01900	2.5800	1.17000	29.700	1040.00	1400.00	0.150
79	1.2870	1.08162	0.0500	1.3500	1.17273	0.005	0.6970	0.59158	0.01000	1.2100	0.78692	20.800	2410.00	389.93	0.150
80	1.1650	1.06535	0.1900	1.3500	1.12218	0.005	1.5200	0.85133	0.02100	1.8500	0.93402	72.700	508.00	1141.92	0.150
81	1.7390	2.84800	0.4700	1.7900	2.92000	0.005	1.4700	0.79700	0.00500	1.7400	0.91500	53.200	191.00	140.00	0.150
82	1.6480	1.89000	.	2.2600	1.90000	.	1.8100	0.34500	.	2.4600	0.36600	.	917.00	115.00	.
83	0.8250	0.75664	0.1934	2.8444	1.01823	0.005	1.5259	0.95576	0.00708	1.9388	1.10938	37.128	431.55	169.64	0.150
84	.	0.76581	0.5900	.	0.82146	0.005	.	1.03235	0.00500	.	1.07028	48.200	.	57.12	0.130
85	1.2920	0.97907	0.2602	2.8730	1.02203	0.013	1.5000	0.92630	0.01000	1.7600	0.99846	35.400	297.00	106.94	0.150

Obs	INCD	OUCD	RACR	INCR	OUCR	RACU	INCU	OUCU	RAFE	INFE	OUFE	RAPB	INPB	OUPB	RAMG	INMG
1	0.358	.	2.35	2.35	.	0.50	16.60	.	15.0	333.0	.	1.00	1.00	.	0.1200	30.00
2	3.030	0.15000	2.35	68.60	2.3500	0.50	168.00	7.2300	15.0	3710.0	134.00	1.00	9.23	1.00000	0.0400	22.90
3	3.010	0.15000	2.35	135.00	6.2300	0.50	291.00	28.5000	15.0	5850.0	154.00	1.00	36.00	1.00000	0.0740	8.17
4	1.500	0.15000	2.35	69.80	6.2000	0.50	120.00	22.4000	15.0	3030.0	810.00	1.00	17.30	3.10000	0.1000	18.30
5	8.000	0.15000	2.35	420.00	2.3500	1.10	712.00	19.2000	15.0	14200.0	700.00	1.00	128.00	1.00000	0.2100	6.02
6	13.300	0.25300	2.35	545.00	9.6000	0.50	1100.00	32.7000	15.0	21500.0	639.00	1.00	178.00	3.46000	0.0800	6.61
7	0.700	0.15000	2.35	19.70	5.3000	0.50	54.10	13.1000	15.0	1220.0	470.00	1.00	7.70	2.00000	0.0900	19.70
8	0.700	.	2.35	16.80	.	8.50	44.10	.	40.0	800.0	.	1.00	4.90	.	0.1400	19.30
9	0.150	0.15000	2.35	11.60	2.3500	7.10	54.40	14.4000	60.0	540.0	300.00	1.00	3.30	1.00000	0.0300	7.22
10	0.150	.	2.35	2.35	.	3.90	9.00	.	15.0	70.0	.	1.00	1.00	.	0.0600	5.98
11	0.300	.	2.35	14.00	.	0.50	129.00	.	15.0	580.0	.	1.00	4.20	.	.	29.60
12	0.150	.	.	2.35	.	.	24.40	.	.	130.0	.	.	1.00	.	0.2000	30.70
13	0.150	.	2.35	2.35	.	16.00	11.20	.	280.0	210.0	.	1.00	1.00	.	.	28.90
14	0.150	.	2.35	2.35	.	11.90	19.00	.	30.0	210.0	.	1.00	1.00	.	.	27.70
15	0.150	.	2.35	2.35	.	10.50	5.90	.	50.0	190.0	.	1.00	1.00	.	0.0700	28.10
16	0.150	.	2.35	2.35	.	8.80	15.40	.	60.0	280.0	.	1.00	1.00	.	0.0400	30.00
17	0.150	.	2.35	2.35	.	5.40	7.80	.	40.0	150.0	.	1.00	1.00	.	.	27.70
18	0.150	.	2.35	2.35	.	0.50	3.00	.	15.0	110.0	.	1.00	1.00	.	0.1100	28.60
19	0.150	.	2.35	2.35	.	3.20	19.10	.	15.0	290.0	.	1.00	2.80	.	0.1400	20.80
20	0.150	.	2.35	2.35	.	4.80	6.80	.	15.0	70.0	.	1.00	1.00	.	0.4600	30.30
21	0.400	.	2.35	36.00	.	3.10	55.40	.	15.0	1090.0	.	1.00	8.50	.	0.0700	14.20
22	0.150	.	2.35	7.30	.	1.30	15.30	.	15.0	350.0	.	1.00	1.00	.	0.0700	29.10
23	0.150	0.15000	2.35	2.35	2.3500	1.10	20.40	4.4000	15.0	210.0	370.00	1.00	1.00	1.00000	0.0200	19.90
24	0.150	0.15000	2.35	2.35	5.6000	2.10	29.00	9.2000	15.0	280.0	670.00	1.00	1.00	1.00000	0.0500	26.90
25	0.150	.	2.35	2.35	.	2.20	5.20	.	15.0	210.0	.	1.00	1.00	.	0.1300	39.40
26	0.150	.	2.35	2.35	.	0.50	6.50	.	15.0	150.0	.	1.00	1.00	.	0.1000	39.80
27	0.150	0.15000	2.35	2.35	8.6000	2.10	15.40	1.2000	15.0	130.0	200.00	1.00	1.00	1.00000	1.7100	32.40
28	0.150	0.15000	2.35	2.35	35.2000	0.50	4.20	6.0000	15.0	80.0	1350.00	1.00	1.00	3.80000	0.3000	46.30
29	0.150	.	2.35	2.35	.	0.50	8.10	.	30.0	350.0	.	1.00	1.00	.	0.0900	52.60
30	0.150	.	.	2.35	.	.	2.40	.	.	190.0	.	.	1.00	.	.	50.90
31	0.150	.	2.35	2.35	.	0.50	1.20	.	50.0	260.0	.	1.00	1.00	.	0.2100	52.40
32	0.150	.	2.35	2.35	.	0.05	0.50	.	35.0	260.0	.	1.00	1.00	.	0.1500	54.30
33	0.150	.	0.80	1.90	.	2.70	5.00	.	30.0	170.0	.	1.00	1.00	.	.	54.10
34	0.150	.	0.60	1.20	.	3.30	2.70	.	40.0	110.0	.	1.00	1.00	.	0.0600	50.80
35	0.150	.	0.50	1.90	.	1.00	7.20	.	60.0	140.0	.	0.75	0.75	.	0.0800	45.10
36	0.150	.	1.00	1.00	.	2.80	2.20	.	30.0	150.0	.	0.75	0.80	.	0.4800	50.50
37	0.150	.	1.00	1.00	.	3.80	4.90	.	230.0	130.0	.	0.75	0.75	.	0.3300	46.10
38	0.700	.	1.00	1.00	.	1.00	1.00	.	40.0	330.0	.	0.75	0.75	.	0.3100	49.30
39	0.150	0.15000	1.00	1.00	1.0000	1.00	2.80	1.0000	12.5	90.0	110.00	0.75	0.75	0.75000	0.3000	33.70
40	0.150	0.15000	1.00	1.00	1.0000	2.30	3.10	2.9000	12.5	150.0	120.00	0.75	0.75	0.75000	0.1100	31.60
41	0.150	0.15000	1.00	1.00	1.0000	1.00	4.60	1.0000	12.5	210.0	150.00	0.75	0.75	0.75000	0.3700	35.60
42	0.150	0.15000	0.20	2.80	7.6000	1.00	7.60	1.9300	12.5	290.0	560.00	0.75	0.75	1.80000	0.1900	30.00
43	0.150	0.15000	1.00	1.00	2.1000	1.00	3.90	3.5000	30.0	190.0	304.00	0.75	0.75	0.76900	0.2200	42.00
44	0.150	0.15000	1.00	1.00	3.9000	1.00	2.60	2.2600	12.5	180.0	350.00	0.75	0.80	1.70000	0.3500	40.00
45	0.300	0.15000	1.00	1.00	3.5000	1.00	2.50	1.0000	12.5	180.0	510.00	0.75	0.75	0.75000	0.5700	44.60
46	0.150	0.15000	1.00	1.00	2.1000	2.10	4.80	2.9000	30.0	150.0	340.00	0.75	0.75	0.75000	.	41.60
47	0.150	0.15000	0.64	2.20	5.0000	1.00	2.50	3.3000	30.0	290.0	815.00	0.75	0.75	2.00000	0.2200	37.80
48	0.300	0.15000	1.00	16.50	6.1000	1.00	52.70	4.1000	36.5	950.0	307.50	0.75	5.20	0.90000	0.2800	18.90
49	0.150	0.15000	1.00	.	3.2000	1.00	24.80	3.1000	40.0	660.0	355.00	0.75	1.90	1.00000	0.3100	9.18
50	0.150	0.15000	1.00	5.10	9.3000	4.50	32.90	9.1000	40.0	350.0	1270.00	0.75	0.75	3.70000	.	42.00
51	0.015	0.01500	1.00	3.40	8.0000	1.00	15.50	5.3000	50.0	300.0	1250.00	0.75	0.75	3.00000	.	48.40
52	0.150	0.15000	1.00	10.50	1.0000	1.00	14.70	9.4000	70.0	860.0	70.00	0.75	2.30	0.75000	.	56.20
53	0.400	0.15000	1.00	17.60	1.0000	1.00	43.60	2.6000	110.0	850.0	200.00	0.75	5.30	0.75000	.	35.50
54	0.150	.	1.00	2.10	.	1.00	7.30	.	12.5	540.0	.	0.75	0.75	.	0.0000	49.10
55	0.150	.	1.00	1.00	.	1.00	14.30	.	100.0	588.0	.	0.75	0.75	.	0.0300	40.70
56	0.150	.	1.00	1.00	.	1.00	1.00	.	40.0	630.0	.	0.75	0.75	.	0.0100	46.60
57	0.150	.	1.00	2.00	.	3.20	3.50	.	60.0	640.0	.	0.75	0.75	.	0.0000	46.70
58	0.150	0.15000	1.00	1.00	1.0000	1.00	34.30	4.7000	12.5	300.0	80.00	0.75	0.75	2.30000	.	48.60
59	1.000	0.15000	1.00	46.30	1.0000	2.10	99.50	3.8000	60.0	1880.0	360.00	0.75	15.30	1.62500	0.0000	11.60
60	1.400	0.15000	1.00	69.50	2.9000	1.00	133.00	6.6000	50.0	2480.0	270.00	0.75	21.30	0.75000	0.1100	15.30
61	0.150	0.15000	1.00	4.80	1.0000	5.20	18.20	1.0000	100.0	270.0	60.00	0.75	1.50	0.75000	0.0000	38.30
62	0.500	0.15000	1.00	17.10	3.9820	1.00	46.70	2.3030	140.0	840.0	207.10	0.75	5.60	0.76450	0.0100	37.80
63	0.150	0.15000	1.00	10.50	8.8000	2.70	23.20	9.4000	70.0	310.0	690.00	0.75	0.75	2.80000	0.1200	37.00
64	0.300	0.15000	1.00	9.60	8.7500	4.20	29.00	11.8750	90.0	490.0	1165.00	0.75	3.10	5.10000	0.0000	35.40
65	0.600	0.15000	1.00	25.70	4.4000	3.50	69.90	6.4000	40.0	900.0	570.00	0.75	6.30	1.90000	.	34.40
66	0.700	0.15000	1.00	28.20	1.5500	1.00	124.00	1.0000	12.5	960.0	225.00	0.75	8.40	0.75000	0.0000	18.30
67	0.500	0.15000	1.00	7.30	5.6000	1.00	60.10	1.7500	40.0	388.0	266.00	0.75	2.00	0.97000	0.0000	28.20
68	0.800	0.15000	1.00	34.90	3.8000	1.00	170.00	3.6000	30.0	1340.0	530.00	0.75	12.40	0.75000	0.0500	14.80
69	0.600	0.15000	1.00	28.20	16.0000	1.00	189.00	19.9000	50.0	1300.0	3480.00	0.75	8.40	5.90000	0.0300	29.30
70	1.000	0.00000	1.00	32.40	8.8000	1.00	250.00	14.5560	13.0	2660.0	1742.40	0.75	12.10	3.72800	0.0300	33.30
71	0.400	0.15000	1.00	12.20	8.5000	1.00	83.00	7.8000	13.0	830.0	1150.00	0.75	4.00	3.40000	0.1400	47.50
72	0.150	0.15000	1.00	3.20	1.0000	3.80	13.70	4.8000	50.0	340.0	90.00	0.75	0.75	0.75000	0.3500	50.00
73	0.500	0.16209	3.80	16.50	4.1709	3.50	80.90	5.7153	340.0	1570.0	501.39	1.70	7.40	1.49447	0.1000	45.60
74	1.300	0.15000	1.00	53.70	1.0000	2.20	138.00	7.5452	12.5	6580.0	150.00	0.75	14.30	0.75000	0.1000	36.90
75	0.900	0.15000	1.00	30.10	1.0000	1.00	102.00	1.0000	40.0	3790.0	110.00	0.75	9.00	0.75000	0.1000	26.60
76	0.150	0.15000	.	8.30	1.0000	.	17.30	1.2000	.	1020.0	100.00	.	1.70	0.75000	.	44.60
77	0.150	0.15000	1.00	1.00	3.4000	1.00	1.00	6.5000	60.0	110.0	540.00	0.75	0.75	0.75000	0.1000	53.60
78	0.150	0.15000	1.00	3.20	1.0000	1.00	8.30	1.0000	50.0	320.0	90.00	0.75	0.75	0.75000	0.1000	42.20
79	0.400	0.15000	1.00	12.40	1.0000	1.00	37.40	1.0000	30.0	1540.0	327.82	0.75	3.60	0.75000	0.1000	19.20
80	0.150	0.15000	1.00	3.90	1.0000	1.00	12.30	0.7155	70.0	480.0	116.26	0.75	0.75	0.75000	0.1000	35.90
81	0.150	0.15000	1.00	3.40	1.0000	1.00	10.80	1.0000	30.0	330.0	70.00	0.75	0.75	0.75000	0.1000	34.70
82	0.150	0.15000	.	5.50	1.0000	.	23.90	2.3000	.	810.0	120.00	.	1.90	0.75000	.	37.00
83	0.150	0.15000	1.00	6.41	1.0000	1.00	54.43	20.6000	12.5	156.2	94.02	0.75	2.80	0.75000	0.4096	28.83
84	.	0.15000	1.00	.	1.0000	1.00	.	1.8385	40.0	.	88.83	0.75	.	0.75000	0.1000	.
85	0.150	0.15000	1.00	4.40	1.0000	1.00	36.20	5.4055	12.5	310.0	87.11	0.75	1.60	0.75000	0.1000	39.90

Obs	OUMG	RAMN	INMN	OUMN	RANI	INNI	OUNI	RAAG	INAG	OUAG	RAZN	INZN	OUZN	INSS	OUSS
1	.	2.520	83.60	.	2.15	2.150	.	0.050	0.186	.	15.00	15.00	.	8.13	.
2	20.800	1.550	351.00	28.500	2.15	8.470	2.1500	0.050	0.859	0.05000	56.60	164.00	15.0000	148.00	13.520
3	31.700	2.120	449.00	21.670	2.15	13.500	3.4700	0.050	1.150	0.05000	15.00	232.00	15.0000	208.25	9.470
4	21.000	0.600	239.00	38.200	2.15	6.900	2.1500	0.050	0.600	0.05000	50.00	160.00	15.0000	143.00	30.000
5	21.800	0.300	1150.00	22.000	2.15	24.600	2.1500	0.100	3.000	0.10000	40.00	570.00	15.0000	428.25	7.770
6	15.270	0.412	1570.00	52.770	2.15	33.100	2.1500	0.097	4.500	0.14100	28.95	820.00	34.1000	2546.00	20.740
7	11.200	2.400	231.00	67.000	2.15	2.150	2.1500	0.050	0.300	0.10000	40.00	60.00	15.0000	55.40	10.700
8	.	7.400	245.00	.	2.15	2.150	.	0.200	0.200	.	40.00	40.00	.	41.20	.
9	12.000	2.500	67.20	54.400	2.15	2.150	2.1500	0.050	0.050	0.05000	15.00	30.00	15.0000	35.00	6.600
10	12.700	2.800	67.30	36.600	2.15	2.150	2.1500	0.050	0.500	0.05000	15.00	30.00	15.0000	39.00	9.850
11	.	5.700	65.60	.	2.15	2.150	.	0.050	0.050	.	15.00	15.00	.	6.00	.
12	.	3.900	175.00	.	2.15	2.150	.	0.050	0.200	.	60.00	40.00	.	31.50	.
13	.	13.300	47.70	.	4.90	2.150	.	0.050	0.050	.	250.00	15.00	.	12.70	.
14	.	8.600	34.40	.	2.15	2.150	.	0.050	0.050	.	320.00	15.00	.	13.70	.
15	.	3.500	35.00	.	2.15	2.150	.	0.050	0.050	.	100.00	15.00	.	8.60	.
16	.	2.300	247.00	.	2.15	2.150	.	0.050	0.050	.	100.00	15.00	.	8.00	.
17	.	4.500	33.80	.	2.15	2.150	.	0.050	0.050	.	90.00	40.00	.	9.90	.
18	.	1.800	45.10	.	2.15	2.150	.	0.050	0.050	.	100.00	15.00	.	12.20	.
19	.	2.200	90.50	.	7.80	2.150	.	0.050	0.050	.	150.00	30.00	.	16.00	.
20	.	4.000	14.30	.	2.15	2.150	.	0.050	0.050	.	120.00	15.00	.	7.70	.
21	.	1.700	349.00	.	2.15	2.150	.	0.050	0.400	.	15.00	70.00	.	68.00	.
22	.	0.800	287.00	.	2.15	2.150	.	0.050	0.050	.	15.00	15.00	.	12.50	.
23	175.000	0.800	289.00	95.600	2.15	2.150	2.1500	0.050	0.050	0.05000	15.00	15.00	15.0000	3.40	19.500
24	130.000	1.400	142.00	120.000	2.15	2.150	2.1500	0.050	0.100	0.05000	30.00	15.00	15.0000	5.80	75.000
25	.	2.300	62.60	.	2.15	2.150	.	0.050	0.050	.	40.00	15.00	.	14.00	.
26	.	0.800	35.00	.	2.15	2.150	.	0.050	0.050	.	15.00	15.00	.	6.21	.
27	169.000	3.000	51.70	41.100	2.15	2.150	5.6000	0.050	0.050	0.05000	70.00	15.00	15.0000	2.80	6.600
28	146.000	1.700	24.60	73.900	2.15	2.150	18.3000	0.050	0.050	0.05000	40.00	15.00	15.0000	3.00	30.800
29	.	1.500	102.00	.	2.15	2.150	.	0.050	0.130	.	40.00	15.00	.	15.00	.
30	.	.	49.30	.	.	2.150	.	.	0.050	.	.	15.00	.	19.50	.
31	.	6.000	38.90	.	2.15	2.150	.	0.050	0.050	.	60.00	15.00	.	19.10	.
32	.	2.600	53.80	.	2.15	2.150	.	0.050	0.050	.	260.00	15.00	.	15.50	.
33	.	1.800	50.70	.	2.15	2.150	.	0.050	0.050	.	15.00	15.00	.	12.80	.
34	.	3.100	52.30	.	2.15	2.150	.	0.050	0.050	.	70.00	15.00	.	9.10	.
35	.	3.500	182.00	.	2.15	2.150	.	0.050	0.050	.	40.00	20.00	.	6.37	.
36	.	3.500	123.00	.	2.15	2.700	.	0.050	0.050	.	40.00	20.00	.	13.20	.
37	.	2.000	561.00	.	1.25	3.300	.	0.100	0.050	.	20.00	7.50	.	8.10	.
38	.	0.500	480.00	.	1.25	3.100	.	0.050	0.050	.	20.00	7.80	.	5.65	.
39	89.700	2.300	363.00	89.500	1.25	3.200	1.2500	0.050	0.050	0.05000	100.00	7.50	7.5000	6.30	7.660
40	84.600	1.400	408.00	72.500	1.25	1.250	1.2500	0.050	0.050	0.05000	30.00	7.50	7.5000	7.77	6.780
41	112.000	1.400	254.00	72.700	1.25	2.700	1.2500	0.050	0.050	0.05000	20.00	7.50	7.5000	.	6.580
42	94.500	0.500	158.00	256.000	1.25	1.250	4.8000	0.050	0.050	0.05000	20.00	7.50	20.0000	.	22.040
43	93.800	0.500	160.00	90.200	1.25	1.250	1.2500	0.050	0.050	0.05000	20.00	7.50	20.0000	5.44	15.380
44	72.100	1.000	207.00	120.000	1.25	1.250	1.2500	0.050	0.300	0.05000	40.00	7.50	7.5000	4.42	16.480
45	399.000	0.500	173.00	203.000	1.25	1.250	1.2500	0.050	0.050	0.05000	50.00	7.50	20.0000	6.28	34.300
46	194.000	1.200	135.00	108.000	1.25	1.250	1.2500	0.050	0.050	0.05000	7.50	7.50	7.5000	5.56	17.450
47	223.800	1.300	209.00	119.700	1.25	2.700	2.3000	0.080	0.050	0.05000	40.10	7.50	20.0000	9.19	99.500
48	48.700	2.020	183.00	25.600	1.25	1.250	1.2500	0.050	0.100	0.05000	11.63	30.00	7.5000	31.46	16.200
49	47.000	1.600	128.00	22.500	1.25	1.250	1.2500	0.050	0.100	0.05000	.	.	.	21.31	22.400
50	46.400	4.200	192.00	40.200	1.25	3.800	3.3000	0.050	0.050	0.05000	50.00	20.00	40.0000	15.08	65.840
51	48.500	2.500	142.00	28.200	1.25	1.250	1.2500	0.050	0.050	0.05000	50.00	20.00	20.0000	42.30	118.000
52	.	2.400	212.00	.	1.25	2.500	.	0.050	0.100	.	40.00	20.00	.	74.20	.
53	.	0.500	211.00	.	1.25	2.800	.	0.100	0.200	.	20.00	30.00	.	.	.
54	.	1.200	632.00	.	1.25	1.250	.	0.050	0.050	.	7.50	7.50	.	14.00	.
55	.	2.600	319.80	.	1.25	1.250	.	0.050	0.050	.	7.50	7.50	.	7.09	.
56	.	1.200	284.00	.	1.25	1.250	.	0.050	0.050	.	20.00	7.50	.	13.61	.
57	.	1.600	242.00	.	3.30	1.250	.	0.050	0.050	.	30.00	8.00	.	12.15	.
58	58.000	2.800	139.00	100.000	1.25	1.250	1.2500	0.050	0.050	0.05000	80.00	8.00	7.5000	8.96	6.734
59	41.700	1.100	295.00	111.500	1.25	4.700	1.2500	0.050	0.500	0.05000	7.50	70.00	7.5000	97.10	17.100
60	54.600	1.300	286.00	130.000	1.25	6.000	3.5000	0.050	0.700	0.05000	40.00	120.00	7.5000	220.47	11.440
61	34.500	2.600	211.00	61.900	10.00	1.250	5.2000	0.050	0.050	0.05000	50.00	20.00	20.0000	15.70	1.360
62	53.110	1.400	118.00	85.000	1.25	1.250	1.2500	0.050	0.200	0.05000	32.60	30.00	12.1000	25.80	36.000
63	35.400	2.800	164.00	86.300	1.25	2.700	1.2500	0.050	0.100	0.10000	30.00	30.00	35.0000	15.80	85.360
64	36.800	3.100	169.00	70.000	1.25	2.500	3.1000	0.100	0.200	0.10000	40.00	30.00	47.5000	24.94	102.000
65	35.000	1.800	206.00	132.000	1.25	5.500	1.2500	0.050	0.300	0.05000	20.00	50.00	30.0000	48.24	54.657
66	34.500	0.500	172.00	58.300	1.25	3.900	1.2500	0.050	0.300	0.05000	20.00	60.00	7.5000	51.24	20.127
67	33.680	1.100	98.50	13.100	1.25	3.000	1.4400	0.050	0.200	0.06000	7.50	22.90	10.1300	13.00	33.000
68	62.400	0.500	201.00	107.000	1.25	2.800	1.2500	0.050	0.400	0.05000	20.00	70.00	20.0000	76.60	38.570
69	81.000	1.200	265.00	243.000	1.25	3.500	4.7000	0.050	0.100	0.05000	30.00	50.00	50.0000	62.90	176.000
70	79.300	0.500	462.00	32.900	1.25	4.100	3.9000	0.050	0.500	0.10000	30.00	90.00	50.0000	26.30	100.100
71	72.200	1.000	129.00	32.100	1.25	3.600	5.3000	0.050	0.100	0.05000	20.00	40.00	30.0000	39.30	90.200
72	63.900	2.800	163.00	67.500	1.25	1.250	1.2500	0.050	0.100	0.05000	140.00	20.00	7.5000	30.30	1.060
73	52.920	4.100	257.00	23.209	4.00	5.700	2.2158	0.050	0.200	0.05242	40.00	50.00	23.3839	72.00	27.469
74	50.685	1.200	1170.00	122.524	1.25	10.400	1.9990	0.100	0.500	0.08471	20.00	120.00	23.1190	391.30	16.254
75	57.000	1.600	449.00	99.300	1.25	8.100	1.2500	0.050	0.400	0.05000	30.00	90.00	7.5000	116.90	2.290
76	54.600	.	437.00	85.500	.	3.200	3.1000	.	0.100	0.05000	.	20.00	7.5000	27.30	2.620
77	41.400	2.200	126.00	396.000	5.50	1.250	2.8000	0.050	0.050	0.05000	50.00	20.00	20.0000	.	12.510
78	53.300	0.500	403.00	118.000	1.25	3.000	3.4000	0.050	0.050	0.05000	20.00	7.50	7.5000	11.60	4.747
79	46.038	1.100	195.00	67.004	1.25	4.300	1.2500	0.050	0.100	0.05000	7.50	40.00	7.5000	66.31	11.926
80	67.317	1.700	293.00	97.841	1.25	2.600	1.2500	0.100	0.100	0.03252	7.50	20.00	7.5000	13.94	2.860
81	98.500	2.200	272.00	58.200	1.25	1.250	1.2500	0.050	0.050	0.05000	20.00	20.00	7.5000	14.90	1.730
82	95.000	.	316.00	141.000	.	1.250	1.2500	.	0.050	0.05000	.	30.00	30.0000	28.32	4.750
83	26.914	0.500	136.25	41.601	1.25	2.471	1.2500	0.050	0.174	0.08717	35.20	24.15	16.7936	22.50	4.200
84	28.983	0.500	.	64.849	1.25	.	1.2500	0.050	.	0.05000	40.00	.	53.2387	.	4.385
85	31.345	1.200	171.00	84.505	1.25	2.700	1.2500	0.050	0.100	0.05000	40.00	50.00	34.2654	12.00	3.075

Correlation of inflow hydrology and water quality parameters

The CORR Procedure

18 Variables:	INNH	INNOX	INON	INTN	INOP	INTP	INAL
	INCD	INCU	INFE	INMN	INZN	INSS	RAIN
	AVGI	ANTE	RAPD	INFL			

INFLOW CONCENTRATIONS AND RAINFALL CHARACTERISTICS

Variable	N	Mean	Std Dev	Median	Minimum	Maximum
INNH ammonia	84	0.12404	0.16184	0.07000	0.00500	0.94300
INNOX nitrate+	84	0.38506	0.76407	0.06900	0.00500	4.19000
INON organic N	83	1.32533	0.85788	1.16500	-0.08300	4.36600
INTN total N	83	1.67939	1.17688	1.30000	0.08000	6.60000
INOP ortho P	83	0.93672	0.61265	0.83400	0.00500	3.38000
INTP total P	82	1.50894	1.26512	1.21000	0.00500	8.65000
INAL aluminum	84	2010	4754	432.50000	86.10000	30000
INCD cadmium	84	0.61920	1.70770	0.15000	0.01500	13.30000
INCU copper	84	60.81221	147.51759	16.05000	0.50000	1100
INFE iron	84	1172	2914	330.00000	70.00000	21500
INMN manganese	84	239.18993	246.05295	182.50000	14.30000	1570
INZN zinc	83	49.11867	110.84924	20.00000	7.50000	820.00000
INSS TSS	80	72.85556	289.26058	15.04000	2.80000	2546
RAIN rainfall	85	1.41788	1.40016	1.07000	0.18000	9.91000
AVGI avg int.	84	0.47881	0.48415	0.31000	0.04000	2.52000
ANTE inter-event	85	197.81965	245.74197	126.25000	0.67000	1317
RAPD rain pond	85	68429	74284	43976	9345	514469
INFL inflow	85	249488	488239	86865	2077	3425799

Correlation of inflow hydrology and water quality parameters

The CORR Procedure

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

INNH	INNH	INTN	INNOX	INCU	INON	INTP
INNH	1.00000	0.55005	0.52282	0.42422	0.38949	0.35644
		<.0001	<.0001	<.0001	0.0003	0.0010
	84	83	84	84	83	82

INNOX	INNOX	INCU	INNH	INZN	INTN	INCD
INNOX	1.00000	0.67880	0.52282	0.49616	0.47073	0.44842
		<.0001	<.0001	<.0001	<.0001	<.0001
	84	84	84	83	83	84

INON	INON	INTN	INSS	INFE	INZN	INNH
INON	1.00000	0.90734	0.44371	0.43485	0.40168	0.38949
		<.0001	<.0001	<.0001	0.0002	0.0003
	83	83	79	83	83	83

INTN	INTN	INON	INNH	INCU	INNOX	INZN
INTN	1.00000	0.90734	0.55005	0.48073	0.47073	0.45123
		<.0001	<.0001	<.0001	<.0001	<.0001
	83	83	83	83	83	83

Correlation of inflow hydrology and water quality parameters

The CORR Procedure

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

INOP	INOP	INTP	INMN	INFL	INFE	INNH
INOP	1.00000	0.75193	0.51920	0.34882	0.24558	0.22495
		<.0001	<.0001	0.0012	0.0252	0.0409
	83	81	83	83	83	83
INTP	INTP	INOP	INMN	INFE	INCU	INFL
INTP	1.00000	0.75193	0.67532	0.61918	0.57364	0.54519
		<.0001	<.0001	<.0001	<.0001	<.0001
	82	81	82	82	82	82
INAL	INAL	INFE	INSS	INZN	INCU	INCD
INAL	1.00000	0.82584	0.80922	0.76322	0.73800	0.65128
		<.0001	<.0001	<.0001	<.0001	<.0001
	84	84	80	83	84	84
INCD	INCD	INFE	INCU	INZN	INAL	INSS
INCD	1.00000	0.74349	0.70460	0.68330	0.65128	0.59726
		<.0001	<.0001	<.0001	<.0001	<.0001
	84	84	84	83	84	80
INCU	INCU	INZN	INFE	INAL	INCD	INSS
INCU	1.00000	0.80784	0.75696	0.73800	0.70460	0.68082
		<.0001	<.0001	<.0001	<.0001	<.0001
	84	83	84	84	84	80
INFE	INFE	INAL	INCU	INSS	INCD	INZN
INFE	1.00000	0.82584	0.75696	0.74907	0.74349	0.64122
		<.0001	<.0001	<.0001	<.0001	<.0001
	84	84	84	80	84	83
INMN	INMN	INTP	INFE	INOP	INCD	ANTE
INMN	1.00000	0.67532	0.57239	0.51920	0.42004	-0.36698
		<.0001	<.0001	<.0001	<.0001	0.0006
	84	82	84	83	84	84
INZN	INZN	INSS	INCU	INAL	INCD	INFE
INZN	1.00000	0.83589	0.80784	0.76322	0.68330	0.64122
		<.0001	<.0001	<.0001	<.0001	<.0001
	83	79	83	83	83	83
INSS	INSS	INZN	INAL	INFE	INCU	INCD
INSS	1.00000	0.83589	0.80922	0.74907	0.68082	0.59726
		<.0001	<.0001	<.0001	<.0001	<.0001
	80	79	80	80	80	80
RAIN	RAIN	RAPD	INFL	INCD	INFE	INCU
RAIN	1.00000	0.93948	0.72234	0.36259	0.34723	0.33047
		<.0001	<.0001	0.0007	0.0012	0.0021
	85	85	85	84	84	84

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

AVGI	AVGI	RAIN	INAL	ANTE	INSS	INMN
AVGI	1.00000	0.15387	0.13821	-0.12522	0.12339	0.10268
		0.1623	0.2127	0.2564	0.2786	0.3556
	84	84	83	84	79	83

ANTE	ANTE	INMN	INTP	INOP	INFE	INNOX
ANTE	1.00000	-0.36698	-0.23227	-0.15829	-0.15134	0.14401
		0.0006	0.0357	0.1529	0.1694	0.1913
	85	84	82	83	84	84

RAPD	RAPD	RAIN	INFL	INCD	INCU	INFE
RAPD	1.00000	0.93948	0.79882	0.44663	0.42015	0.41566
		<.0001	<.0001	<.0001	<.0001	<.0001
	85	85	85	84	84	84

INFL	INFL	RAPD	RAIN	INCU	INFE	INTP
INFL	1.00000	0.79882	0.72234	0.57871	0.57267	0.54519
		<.0001	<.0001	<.0001	<.0001	<.0001
	85	85	85	84	84	82

Correlation of outflow hydrology and water quality parameters

The CORR Procedure

18 Variables:	OUNH	OUNOX	OUON	OUTN	OUOP	OUTP	OUAL
	OUCD	OUCU	OUFE	OUMN	OUZN	OUSS	RAIN
	AVGI	ANTE	RAPD	OUFL			

OUTFLOW CONCENTRATIONS AND RAINFALL CHARACTERISTICS

Variable	N	Mean	Std Dev	Median	Minimum	Maximum
OUNH ammonia	54	0.06660	0.07651	0.04470	0.00500	0.45350
OUNOX nitrate+	54	0.06787	0.14462	0.00650	0.00500	0.67179
OUON organic-N	53	1.48660	0.85512	1.37300	0.01600	4.72700
OUTN total-N	53	1.58601	0.90039	1.40000	0.11000	4.85000
OUOP ortho-P	53	0.50356	0.37845	0.38900	0.00500	2.14000
OUTP total P	54	0.68933	0.42803	0.63200	0.04300	2.37000
OUAL aluminum	54	1075	1275	768.00000	0	6920
OUCD cadmium	54	0.14685	0.03100	0.15000	0	0.25300
OUCU copper	54	6.79674	7.24224	4.25000	0.71553	32.70000
OUFE iron	54	477.58197	568.84853	305.75000	60.00000	3480
OUMN manganese	53	87.35799	66.96548	72.70000	13.10000	396.00000
OUZN zinc	52	18.69482	12.54195	15.00000	7.50000	53.23875
OUSS TSS	53	29.46573	36.80428	16.20000	1.06000	176.00000
RAIN rainfall	85	1.41788	1.40016	1.07000	0.18000	9.91000
AVGI avg int.	84	0.47881	0.48415	0.31000	0.04000	2.52000
ANTE inter-event	85	197.81965	245.74197	126.25000	0.67000	1317
RAPD rain/pond	85	68429	74284	43976	9345	514469
OUFL outflow	85	200935	518590	30961	0	3891466

Correlation of outflow hydrology and water quality parameters

The CORR Procedure

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

OUNH	OUNH	OUTP	OUSS	OUZN	OUFE	OUOP
OUNH	1.00000	0.35655	0.30238	0.28537	0.27606	0.20576
		0.0081	0.0293	0.0424	0.0433	0.1394
	54	54	52	51	54	53

OUNOX	OUNOX	OUCU	OUMN	OUFL	OUZN	RAIN
OUNOX	1.00000	0.50881	-0.45852	0.31043	0.21171	0.20458
		<.0001	0.0006	0.0223	0.1359	0.1378
	54	54	52	54	51	54

OUON	OUON	OUTN	OUFL	OUSS	RAPD	RAIN
OUON	1.00000	0.99278	-0.33461	0.31738	-0.29476	-0.29320
		<.0001	0.0143	0.0232	0.0321	0.0331
	53	53	53	51	53	53

OUTN	OUTN	OUON	OUSS	OUFL	OUZN	RAPD
OUTN	1.00000	0.99278	0.33308	-0.29372	0.26395	-0.24075
		<.0001	0.0169	0.0328	0.0613	0.0825
	53	53	51	53	51	53

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

OUOP	OUOP	OUTP	OUSS	OUFE	OUFL	OUNH
OUOP	1.00000	0.84114	-0.44166	-0.29769	0.26660	0.20576
		<.0001	0.0012	0.0304	0.0536	0.1394
	53	53	51	53	53	53

OUTP	OUTP	OUOP	OUNH	OUCU	OUFL	OUZN
OUTP	1.00000	0.84114	0.35655	0.29562	0.29361	0.22241
		<.0001	0.0081	0.0300	0.0312	0.1167
	54	53	54	54	54	51

OUAL	OUAL	OUFE	OUSS	OUCU	OUFL	OUZN
OUAL	1.00000	0.73811	0.63188	0.30481	0.27682	0.24111
		<.0001	<.0001	0.0250	0.0427	0.0883
	54	54	52	54	54	51

OUCD	OUCD	RAPD	RAIN	OUON	OUOP	OUAL
OUCD	1.00000	0.25988	0.25766	-0.16882	0.16865	0.14782
		0.0577	0.0600	0.2269	0.2274	0.2861
	54	54	54	53	53	54

OUCU	OUCU	OUNOX	OUZN	OUFE	OUSS	OUAL
OUCU	1.00000	0.50881	0.50080	0.47899	0.39789	0.30481
		<.0001	0.0002	0.0002	0.0035	0.0250
	54	54	51	54	52	54

OUFE	OUFE	OUSS	OUAL	OUCU	OUZN	OUOP
OUFE	1.00000	0.86985	0.73811	0.47899	0.47568	-0.29769
		<.0001	<.0001	0.0002	0.0004	0.0304
	54	52	54	54	51	53

OUMN	OUMN	OUNOX	ANTE	OUCU	OUFL	RAIN
OUMN	1.00000	-0.45852	-0.35121	-0.23206	-0.21712	-0.09013
		0.0006	0.0099	0.0978	0.1184	0.5210
	53	52	53	52	53	53

OUZN	OUZN	OUCU	OUFE	OUSS	OUNH	OUTN
OUZN	1.00000	0.50080	0.47568	0.47388	0.28537	0.26395
		0.0002	0.0004	0.0004	0.0424	0.0613
	52	51	51	52	51	51

OUSS	OUSS	OUFE	OUAL	OUZN	OUOP	OUCU
OUSS	1.00000	0.86985	0.63188	0.47388	-0.44166	0.39789
		<.0001	<.0001	0.0004	0.0012	0.0035
	53	52	52	52	51	52

RAIN	RAIN	RAPD	OUFL	OUON	OUCD	OUTN
RAIN	1.00000	0.93948	0.51094	-0.29320	0.25766	-0.23914
		<.0001	<.0001	0.0331	0.0600	0.0846
	85	85	85	53	54	53

AVGI	AVGI	RAIN	ANTE	OUTN	OUON	OUOP
AVGI	1.00000	0.15387	-0.12522	0.12037	0.10962	0.09992
		0.1623	0.2564	0.3906	0.4346	0.4810
	84	84	84	53	53	52

Correlation of outflow hydrology and water quality parameters

The CORR Procedure

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

ANTE	ANTE	OUMN	OUZN	OUAL	OUFE	OUSS
ANTE	1.00000	-0.35121	0.21933	0.21601	0.21034	0.17583
		0.0099	0.1182	0.1167	0.1269	0.2079
	85	53	52	54	54	53

RAPD	RAPD	RAIN	OUFL	OUON	OUCD	OUTN
RAPD	1.00000	0.93948	0.65140	-0.29476	0.25988	-0.24075
		<.0001	<.0001	0.0321	0.0577	0.0825
	85	85	85	53	54	53

OUFL	OUFL	RAPD	RAIN	OUON	OUNOX	OUTN
OUFL	1.00000	0.65140	0.51094	-0.33461	0.31043	-0.29372
		<.0001	<.0001	0.0143	0.0223	0.0328
	85	85	85	53	54	53

Correlation of hydrology and rain water quality concentrations

The CORR Procedure

10 Variables: RANH RANOX RAON RATN RAZN RAIN AVGI ANTE RAPD OUFL

RAINFALL CONCENTRATIONS AND CHARACTERISITICS

Variable	N	Mean	Std Dev	Median	Minimum	Maximum
RANH ammonia	83	0.19893	0.25129	0.13400	0.00500	1.41000
RANOX nitrate+	83	0.25716	0.32342	0.18000	0.00500	2.45000
RAON organic N	80	0.34551	0.47634	0.20400	-0.22400	2.88800
RATN total N	80	0.70233	0.71512	0.47000	0.05000	3.90000
RAZN zinc	81	47.74790	54.48184	32.60000	7.50000	320.00000
RAIN rainfall	85	1.41788	1.40016	1.07000	0.18000	9.91000
AVGI avg. int.	84	0.47881	0.48415	0.31000	0.04000	2.52000
ANTE inter-event	85	197.81965	245.74197	126.25000	0.67000	1317
RAPD rain/pond	85	68429	74284	43976	9345	514469
OUFL outflow	85	200935	518590	30961	0	3891466

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

RANH	RANH	RATN	RANOX	OUFL	RAON	RAPD
RANH	1.00000	0.76176	0.64374	-0.42119	0.39707	-0.30236
		<.0001	<.0001	<.0001	0.0003	0.0055
	83	80	83	83	80	83
RANOX	RANOX	RATN	RANH	OUFL	RAZN	RAPD
RANOX	1.00000	0.72355	0.64374	-0.39115	0.29498	-0.28594
		<.0001	<.0001	0.0003	0.0075	0.0088
	83	80	83	83	81	83
RAON	RAON	RATN	RANH	RAZN	RAIN	RAPD
RAON	1.00000	0.72065	0.39707	0.31859	-0.26866	-0.23437
		<.0001	0.0003	0.0042	0.0160	0.0364
	80	80	80	79	80	80
RATN	RATN	RANH	RANOX	RAON	OUFL	RAPD
RATN	1.00000	0.76176	0.72355	0.72065	-0.42006	-0.39910
		<.0001	<.0001	<.0001	0.0001	0.0002
	80	80	80	80	80	80
RAZN	RAZN	RATN	RAON	RAPD	RANOX	RAIN
RAZN	1.00000	0.38958	0.31859	-0.30085	0.29498	-0.28007
		0.0004	0.0042	0.0064	0.0075	0.0113
	81	79	79	81	81	81
RAIN	RAIN	RAPD	OUFL	RATN	RAZN	RAON
RAIN	1.00000	0.93948	0.51094	-0.35108	-0.28007	-0.26866
		<.0001	<.0001	0.0014	0.0113	0.0160
	85	85	85	80	81	80

Correlation of hydrology and rain water quality concentrations

The CORR Procedure

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

AVGI	AVGI	RANH	RAON	RAIN	RANOX	ANTE
AVGI	1.00000	0.30153	-0.18213	0.15387	0.14607	-0.12522
		0.0059	0.1059	0.1623	0.1904	0.2564
	84	82	80	84	82	84

ANTE	ANTE	AVGI	RANOX	RAON	RAZN	OUFL
ANTE	1.00000	-0.12522	-0.11343	0.11236	0.06660	-0.05318
		0.2564	0.3073	0.3211	0.5547	0.6288
	85	84	83	80	81	85

RAPD	RAPD	RAIN	OUFL	RATN	RANH	RAZN
RAPD	1.00000	0.93948	0.65140	-0.39910	-0.30236	-0.30085
		<.0001	<.0001	0.0002	0.0055	0.0064
	85	85	85	80	83	81

OUFL	OUFL	RAPD	RAIN	RANH	RATN	RANOX
OUFL	1.00000	0.65140	0.51094	-0.42119	-0.42006	-0.39115
		<.0001	<.0001	<.0001	0.0001	0.0003
	85	85	85	83	80	83

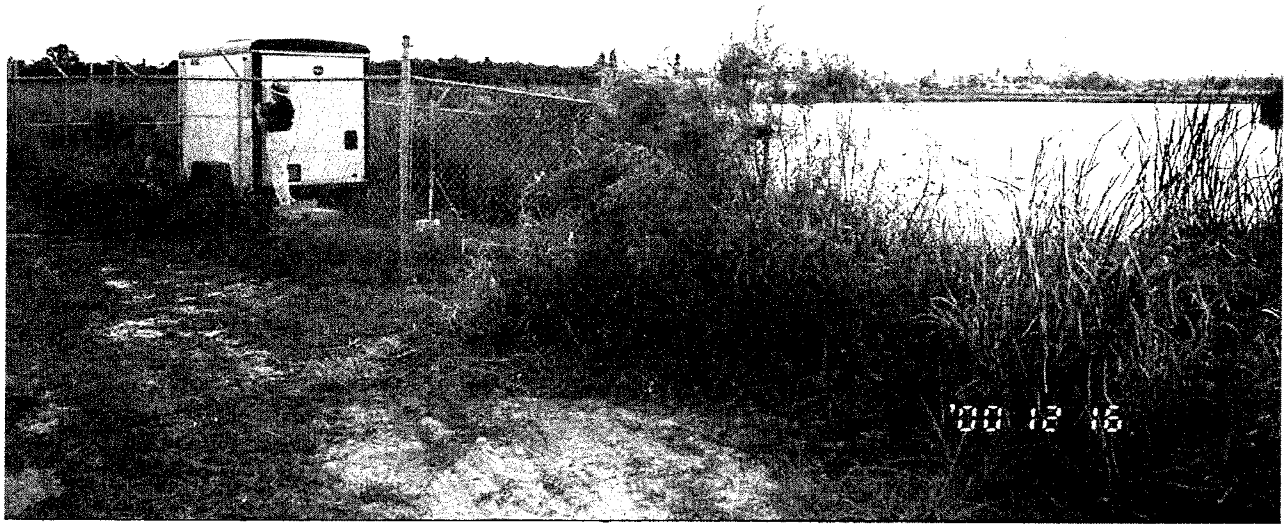
APPENDIX M

Pictures

Irrigating fields

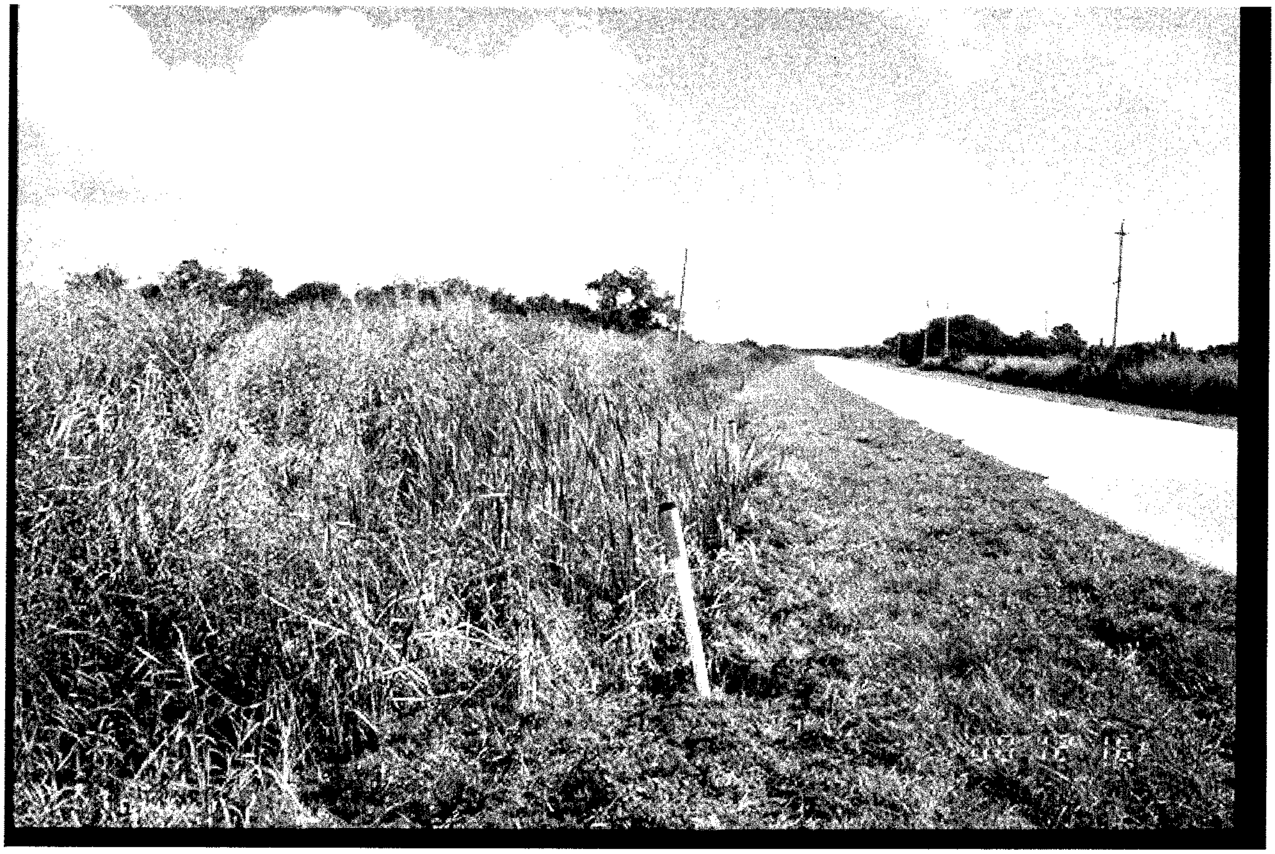
Irrigating fields

Row crop farming of winter vegetables showing raised beds and drainage feature.



Pond and the inflow instrument shelter

Tomato Fields



Ditch at station (site 2 SED1). Right before runoff flows under the road and into the pond. Shows the overgrown vegetation in the ditch.