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ECONLOCKHATCHEE RIVER SYSTEM: LEVEL I REPORT

by

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INTRODUCTION

BACKGROUND

The Econlockhatchee River (Econ) drains the eastern Orlando metropolitan region. The area population has grown from 453,270 in 1970 to 700,699 in 1980, an increase of 55 percent (1981 Florida Statistical Abstract). Presently the Econ receives about 17 million gallons per day (mgd) (0.75 cms) of sewage effluent via the Little Econlockhatchee River (Little Econ). Continued population growth in the Orlando area will tend to increase the pollution loading, both point and nonpoint sources.

Presently the Econ has a detrimental impact on the St. Johns River system. The Game and Fresh Water Fish Commission (1976) called it the most disruptive influence on the Upper Basin, and reported that the nutrient loading in the Econ was responsible for a massive fishkill (10 million fish) below Lake Harney in 1980. The Florida Department of Environmental Regulation (DER 1980) reports that water quality problems in the St. Johns River below the Econ relate mainly to excess nutrient levels, while above the Econ water quality problems are associated mainly with low dissolved oxygen levels. This is not surprising considering the Econ discharges 31 percent of the total sewage effluent entering the St. Johns River above Lake George, as well as large quantities of urban runoff (DER, 1982).

PURPOSE AND SCOPE

Management of the water resources requires a detailed understanding of each basin's natural and cultural characteristics. This report summarizes the available data pertaining to the Econlockhatchee River and describes its biological and chemical status prior to the operation of the Iron Bridge sewage treatment plant. Existing as well as potential problems are discussed to aid in evaluating future permit applications in this region.

LOCATION

The Econlockhatchee River originates in Orange County, Florida (latitude 28°25', longitude 81°07') and flows north into Seminole County where it enters the St. Johns River above Lake Harney (Figure 1). The river is 35.8 mi (57.6 km) long and drains 280 mi^2 (72,519 ha) of the western slope of the St. Johns River between Orlando and Bithlo. The Little Econ, the major tributary to the Econlockhatchee River, also originates in Orange County, just east of Orlando, and enters the Econlockhatchee about 2 mi (3.2 km) southeast of Oveido. The Little Econ is 14.8 mi long and drains an area of 71 mi^2 (18,389 ha) (Lichtler et al., 1968).

ELEVATION/TOPOGRAPHY

The headwater elevation for the Econlockhatchee River is about 68 ft. (20.7 m) NGVD. At its confluence with the Little Econ the elevation is about 25 ft (4.6 m) NGVD, while the mouth elevation is about 5 ft (1.5 m) NGVD. Average gradient for the Econ is 1.8 ft/mi (.34 m/km), while fall for the Little Econ is 3.5 ft/mi (.66 m/km). The headwaters of the Econ are an elongated swamp from which drainage is slow and evapotransporation losses are high (Snell and Anderson, 1970). The Econ and Little Econ drain what are topographically classified as intermediate division [35-105 ft (10.7-32 m) elevation] and lowland division areas [<35 ft (<10.7 m) elevation], as opposed to the highlands division [>105 ft (>32 m) elevation] (Lichtler, 1972). The lowlands division is generally a ground water discharge area and streamflow is well sustained because of seepage of ground water from both the watertable and artesian aquifers.

HYDROLOGY

The unit runoff for the Econlockhatchee River Basin is 1.16 cfs/mi^2 (1.27×10^{-2} cms/km^2) (Snell and Anderson, 1970). The average flow of the Econ at SR 13, for the period from 1935 to 1980, was 263 cfs (7.5 cms)

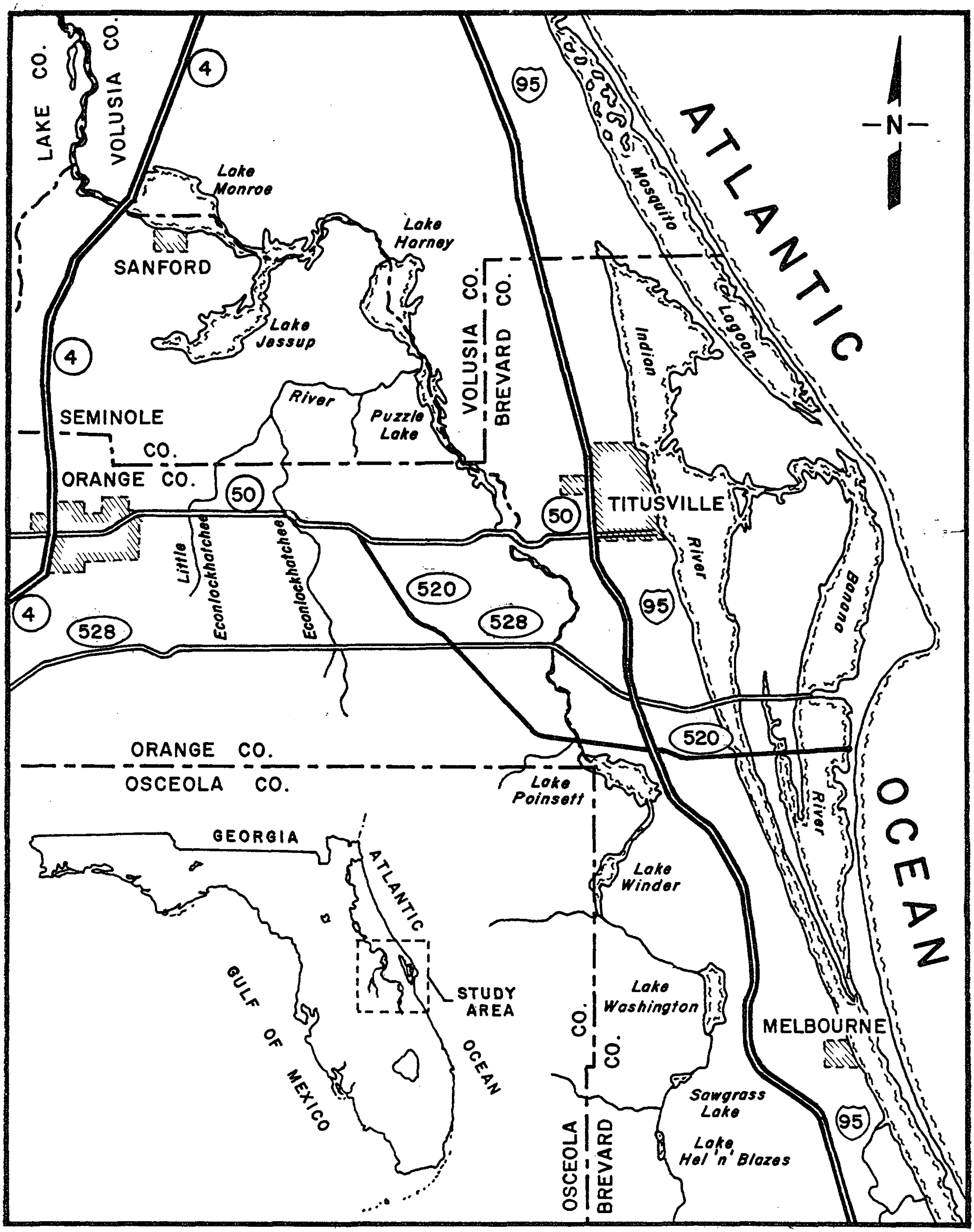

FIGURE 1. - Econlockhatchee River General Location Map.

(USGS, 1980). At SR 13, during high flows, the river derives large discharges from direct runoff as indicated by the steep slope of its flow duration curve (Figure 2). The slope is more gradual during low flow periods, indicating that most of the discharge is derived from ground water. In an average year the flow exceeds 680 cfs (19.3 cms) ten percent of the time, while flow is below 25 cfs (7.1×10^{-1} cms) only ten percent of the time (Lichtler et al., 1968). Low flow frequency curves for the Econ at SR 13 are shown in Figure 3. The Econ north of SR 50 and the Little Econ north of the Orange County line incise low-land areas and are therefore not likely to go dry in short periods of drought (Lichtler, 1972). The Upper Econ as expected has gone dry temporarily each of the past five years (USGS gage at Magnolia Ranch). The upper Little Econ has not gone dry over the past five years (USGS gage at Union Park), however, this may be explained by flow augmentation from three sewage treatment plants, Conway Manor, East Orlando, and Azalea Park, which contribute a maximum flow of about 6.9 cfs (1.95×10^{-1} cms) (DER, 1980).

Stage data (USGS records) for the period October 1972 to September 1978 are summarized for the Econlockhatchee at SR 13, Econlockhatchee at Magnolia Ranch, and the upper Little Econ in Table 1.

TABLE 1. -- Stage Data (NGVD) for Econlockhatchee System, October 1972 to September 1978.

	Mean	Maximum	Minimum
Little Econ at Union Park	62.54	66.17	61.24
Econ at Chuluota	5.09	16.35	2.70
Econ at Magnolia Park	59.59	61.77	57.03

The average flow of the Econlockhatchee River for the recent 5 year period 1976-1980 was 30% lower than the preceeding 40 years. Average rainfall for the region (Orlando) was 50.7 in (128.8 cm) per year from 1941 to 1975, but was 45.5 in (115.6 cm) for the 1976 to 1980 period, a 10% reduction in precipitation.

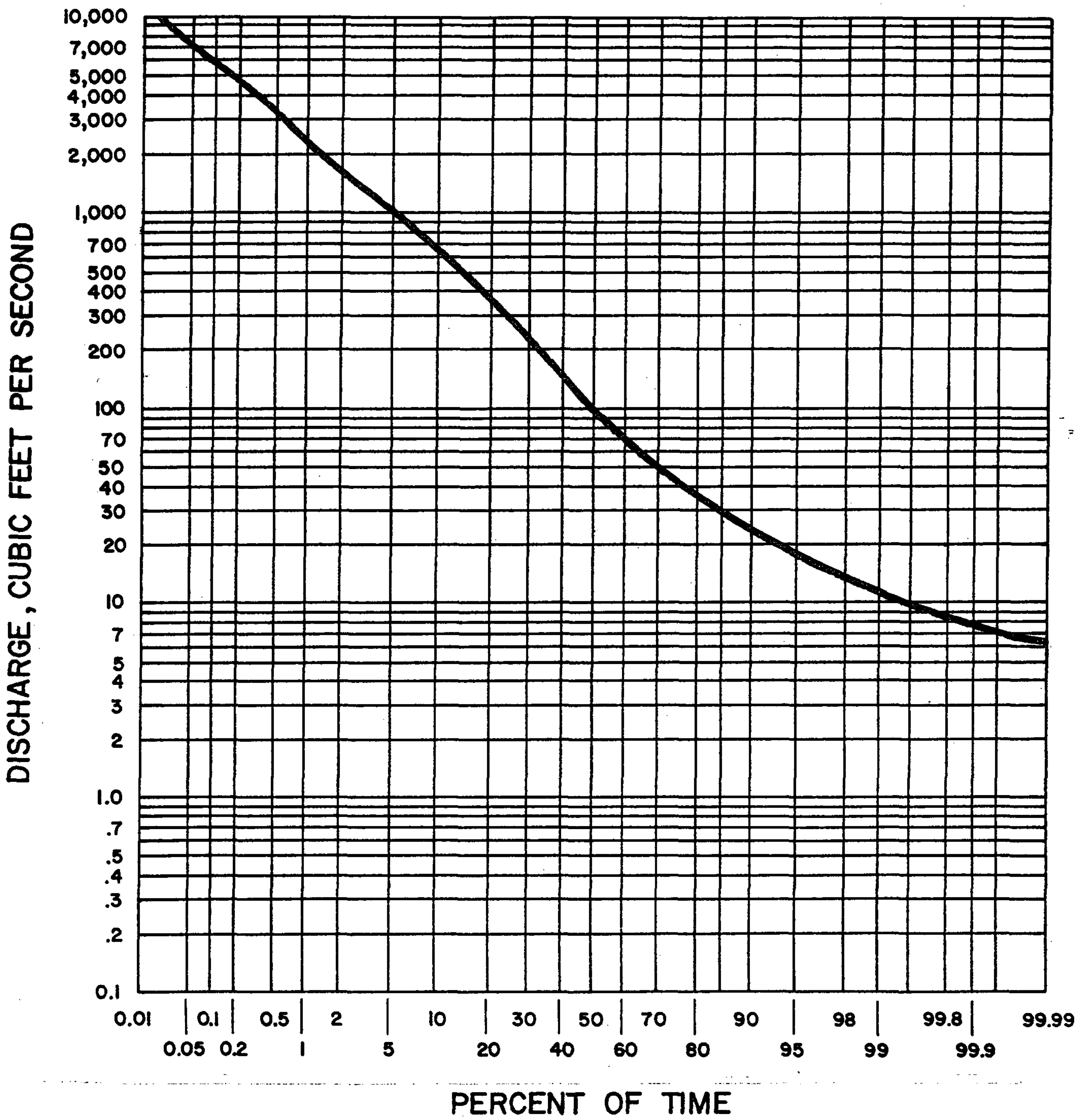

FIGURE 2. - Flow duration curve for the Econlockhatchee River at state road 13 (from Lichtler et al., 1968).

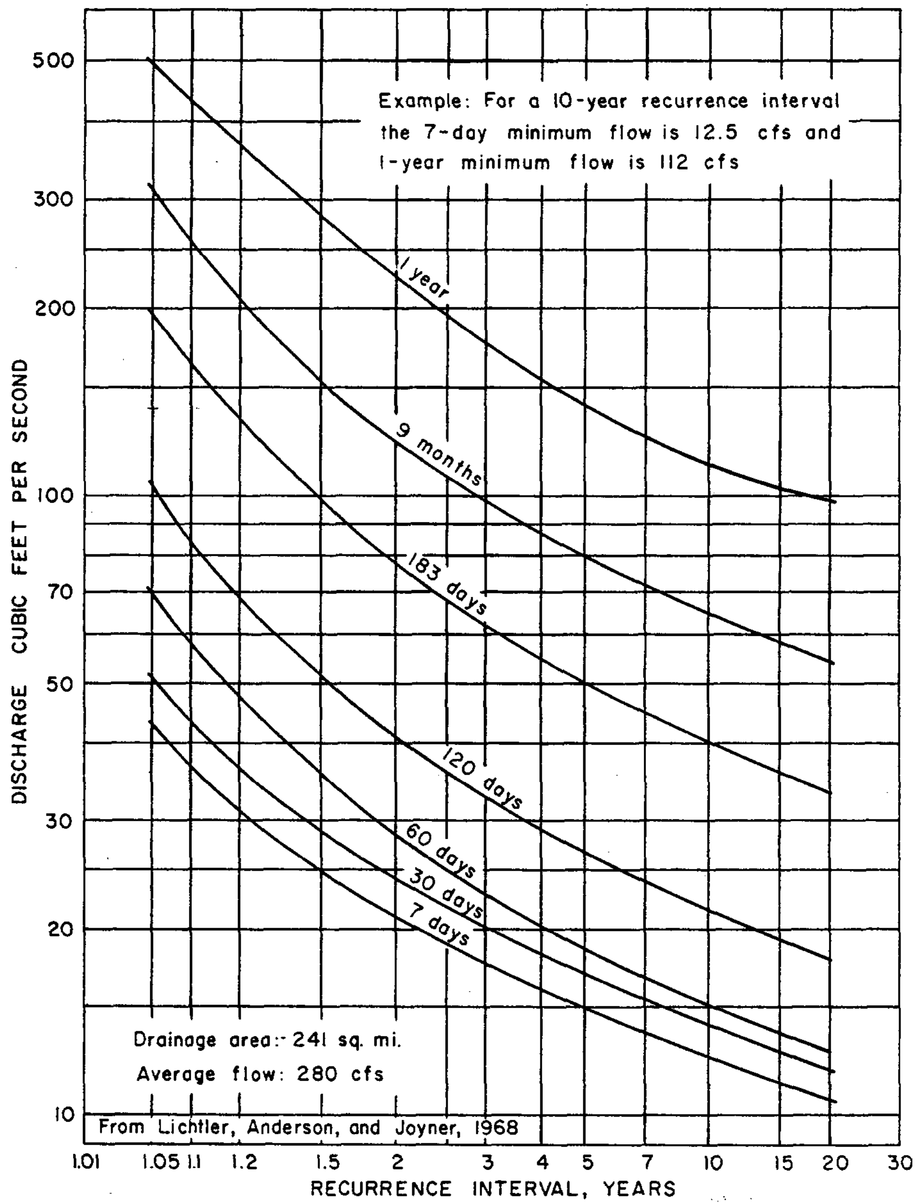

FIGURE 3. - Low flow frequency curve for the Econlockhatchee River at SR 13.

WATER QUALITY

The Orange County Pollution Control Department collected the majority of the recent water quality data available on the Little Econ and Econ. Samples were collected on a seasonal or monthly schedule. Until September 1978, when sampling was discontinued, the U.S. Geological Survey collected water quality data at SR 13 every two months, and at two other stations in the Econ system intermittently. The Florida Department of Environmental Regulation collects water quality samples quarterly at SR 419, just downstream of the confluence of the Little Econ and the Econ. Seminole County collected samples on the lower Econ until June 1981, when Orange County took control of the program. The Florida Game and Fresh Water Fish Commission also collects water quality samples at the mouth of the Econ every other month. An examination of any of these data sources leads one to conclude that sewage effluent contributes heavily to the water quality problems of the Econ. Eleven sewage treatment plants discharge effluent at a combined rate of 17.2 MGD (26.6 cfs, 0.75 cms) into the Little Econ. This amounts to a daily discharge of 2,991 lbs (1356 kg) of nitrogen (as N) and 493 lbs (224 kg) of phosphorus (as P) (Williams, 1981). The biochemical oxygen demand (BOD) and coliform bacteria levels are also high on the Econ, as a result of the sewage effluent.

PAST STUDIES

Despite the relative abundance of water quality data available for the Econ, few studies have discussed water quality trends, loading rates, or the effects of hydrological alterations on the Econ drainage basin. Goolsby and McPherson (1970) conducted a one year investigation of the chemical and biological characteristics of the Upper St. Johns River Basin, from July 1969 through July 1970. Samples were collected on the Econ at SR 13, about five miles downstream from the confluence of the Little Econ and the Econ. They found that total phosphorus (TP) and total nitrogen (TN) levels were much higher in the Econ than in other upper St. Johns River tributaries. The average total-phosphorus concentration in the Econ was 1.7 mg/l as opposed to an average of 0.08 mg/l for other upper basin tributaries. The average total nitrogen concentration in the Econ was 3.1 mg/l versus 1.1 mg/l in other tributaries. BOD and coliform levels were high and dissolved oxygen levels were low during low flow periods.

After conducting two intensive water quality surveys of the Econ in 1976, the Florida Department of Environmental Regulation (DER) set sewage treatment plant wasteload allocations for nitrogen, phosphorus and BOD. These allocations were assigned to prevent water quality problems and algae blooms in Lake Harney. Recently (1982), based on the results of the Fixed Station Monitoring program, the DER reported that the Econ "is handling quite well the large pollution load it receives" and that it is "ecologically very well balanced".

Brezonik and Fox et al., (1976) conducted a comprehensive study of the nutrient and dissolved oxygen sources and sinks in the Middle St. Johns River Basin. The study focused on Lakes Harney, Monroe and Jessup, but included an analysis of water quality in the Econ. They concluded, based on dissolved oxygen modeling that the Econ had little effect on the dissolved oxygen levels in Lake Harney and the St. Johns River. However, it was reported that the Econ did effect nutrient concentrations and subsequent phytoplankton activity of downstream areas. The deleterious effects were most apparent during low flow periods, when the Econ contributed nearly 70 percent of the nitrogen and phosphorus entering Lake Harney.

PRESENT CONDITIONS

The Econlockhatchee River system can be divided into three distinct segments based on water quality, the Little Econ, the Upper Econ and the Lower

Econ. Water quality data for the three segments from 1979 through 1981 are shown in Table 2. Samples were collected and analyzed by the Orange County Pollution Control Department. Values for the Little Econ represent the average of three stations on the Little Econ, downstream of all sewage treatment plant effluents. The Upper Econ samples were collected just upstream of the confluence with the Little Econ. The Lower Econ samples were collected at SR 13, the same location sampled by Goolsby and McPherson (1970) (Figure 4).

As shown in Table 2, water quality in the Little Econ segment was poor. Due to the sewage discharges, dissolved oxygen levels were low and BOD, TN and TP were high. The Upper Econ, prior to the confluence, had generally good water quality. Nitrogen, phosphorus and dissolved oxygen levels were comparable to average tributary streams in the upper St. Johns River basin. In the Lower Econ, below the confluence of the Little Econ and the Upper Econ, the pollutant concentrations from the Little Econ were diluted by the relatively clean water from the Upper Econ. Pollutant loading, however, is unchanged by dilution.

Table 2. -- Mean water quality values, expressed in mg/l, for three segments of the Econlockhatchee River System. Orange County Pollution Control Data, 1979-1981.

	DO	BOD	TN	TP	n
Little Econ	1.4	8.8	7.9	1.0	19
Upper Econ	5.5	3.0	1.0	0.1	22
Lower Econ	2.7	4.3	4.0	0.7	25

DO = dissolved oxygen
BOD = biological oxygen demand, 5 day
TN = total nitrogen as N
TP = total phosphorus as P
n = number of observations

POLLUTANT LOADING CHARACTERISTICS

Loading is an important factor controlling downstream effects in the St. Johns River and Lake Harney. Table 3 shows BOD, total nitrogen (as N) and total phosphorus (as P) loading rates for three periods, 1969-1970, 1974-1975, and

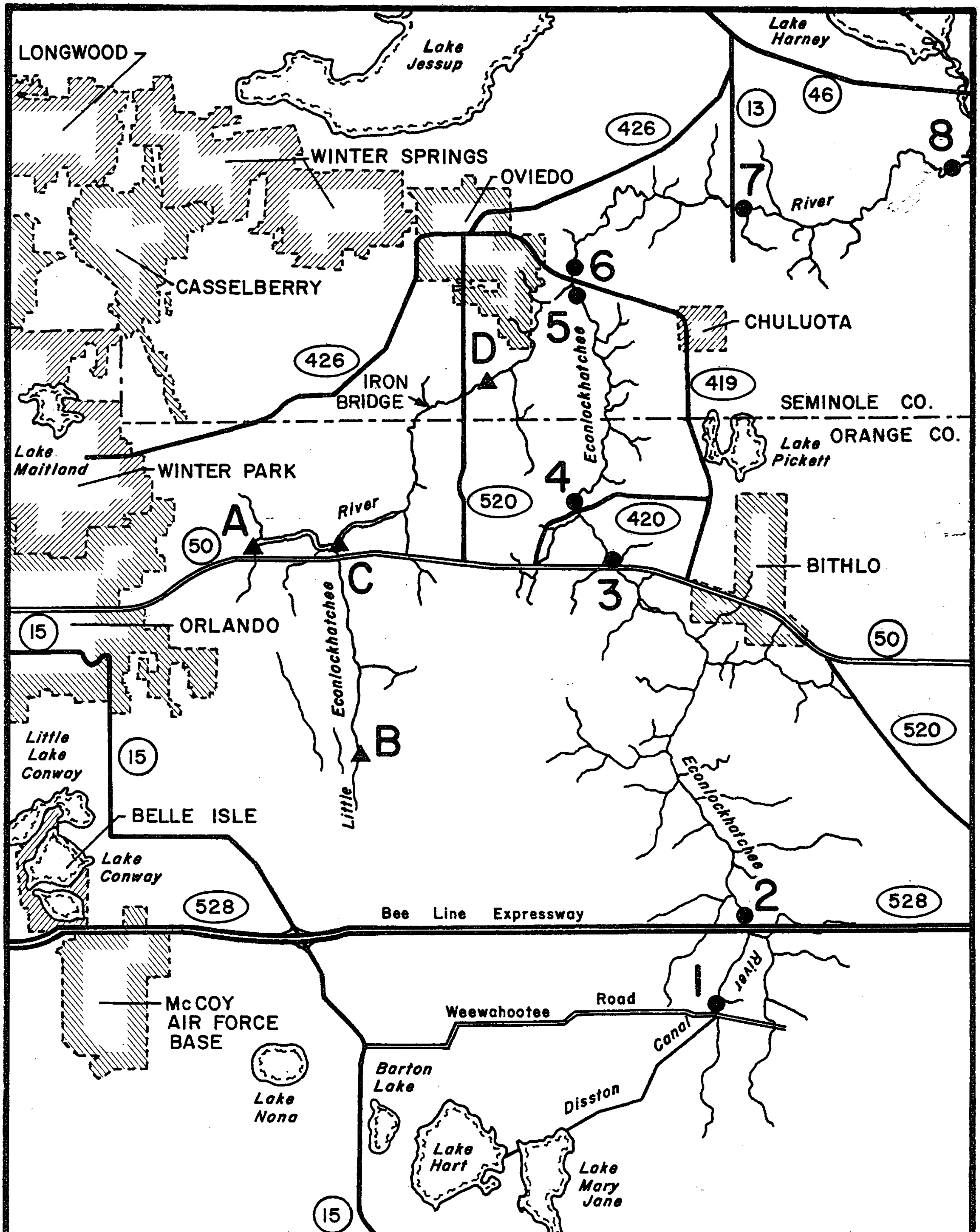

FIGURE 4. - Sampling locations on the Little Econ, Upper Econ, and Lower Econ.

1979-1981 for the Lower Econ at SR 13. These three periods were selected because during these intervals samples were collected seasonally. Thus, the data from these periods provide a reasonable mean daily loading estimate. BOD loading increased over the period. Nitrogen changed very little, and phosphorus loading decreased markedly. Values in parenthesis are averages excluding dates of high river flow (>900 cfs). Samples taken during high flow conditions are greatly affected by nonpoint source pollution (Wanielista, 1976; Novotny and Chesters, 1981). When flow in the Econ was greater than 900 cfs, for example, pollutant loading was 5 to 10 times greater than normal (Appendix 3 and 4). The 1974-1975 values do not include high flow events, thus, they are comparable to the values in parenthesis from the other periods.

Although not statistically significant, average BOD loading increased from about 3400 lbs/day in the 1969-1970 period to about 4000 lbs/day in the 1979-1981 period. In recent data BOD concentrations frequently increased with increased flow (Appendix 3), but showed no significant correlation with flow (Appendix 6). This indicates that a large portion of the BOD load in the Econ is from nonpoint sources. If sewage treatment plants were the primary source of BOD loading, concentrations in mg/l would decrease with increased river flow, i.e., increased flow would dilute the concentration of BOD.

BOD loadings fluctuate considerably in the Lower Econ, indicating the significance of nonpoint sources. For example, 30 days after Hurricane David in 1979, BOD loading was 23,435 lbs/day, ten times greater than normal for the Econ. The total loading in that 30 day period easily exceeded the total annual loading based on dry weather flow. On a statewide basis, the ratio of nonpoint to point source BOD loading is 9 to 1 (Wanielista, 1976). Although the ratio in the Econ is lower, significant nonpoint BOD loading does occur in addition to the 17 mgd of sewage effluent.

TABLE 3. -- Pollutant loading in pounds/day for BOD, TN, and TP at SR 13 on the Econlockhatchee River.

	BOD	TN	TP		
Period	lbs/day	lbs/day	lbs/day	Source	n
1969-1970	3433 (1590)*	3268 (1990)*	1253 (946)*	USGS	5
1974-1975	1639	2085	806	USGS	11
1979-1981	3990 (2318)**	2566 (1936)**	427 (328)**	OCPCD	26

* Tropical storm Jenny (Oct. 1, 1969) caused the Econ River flow to exceed 1200 cfs on the collection date. The number in parenthesis is the average excluding the sample taken during the high flow period.

** Hurricane David (Sept. 3, 1979) caused the Econ River flow to exceed 900 cfs (916 and 1450) on two collection dates. The number in parenthesis is the average excluding the two samples taken during the high flow period.

Nitrogen loading in the Lower Econ has changed little over the past decade (Table 3). Unlike BOD, concentrations of nitrogen are highest during low flow periods and generally lowest during high flow periods. There is a significant negative correlation ($r = -0.83$, $P < 0.01$) between the $\log_{10}$ of nitrogen concentrations (ppb) and the $\log_{10}$ of flow (Figure 5), indicating the significance of sewage discharges. In addition, the daily loading rates for nitrogen are considerably more stable than BOD. Coefficients of variation (standard deviation/mean) are 0.88 and 1.53 for nitrogen and BOD loadings respectively, for the 1979-1981 period. The average nonpoint source to point source ratio for nitrogen loading in Florida is about 3.5 to 1 (Wanielista, 1976). Considering that average nitrogen concentrations in the Lower Econ are about four times higher than in other St. Johns tributaries, the ratio is probably closer to one for the Lower Econ.

Total phosphorus loading has decreased markedly over the past 10 years (Table 3). A comparison of mean loading in the combined 1969-1970 and 1974-1975

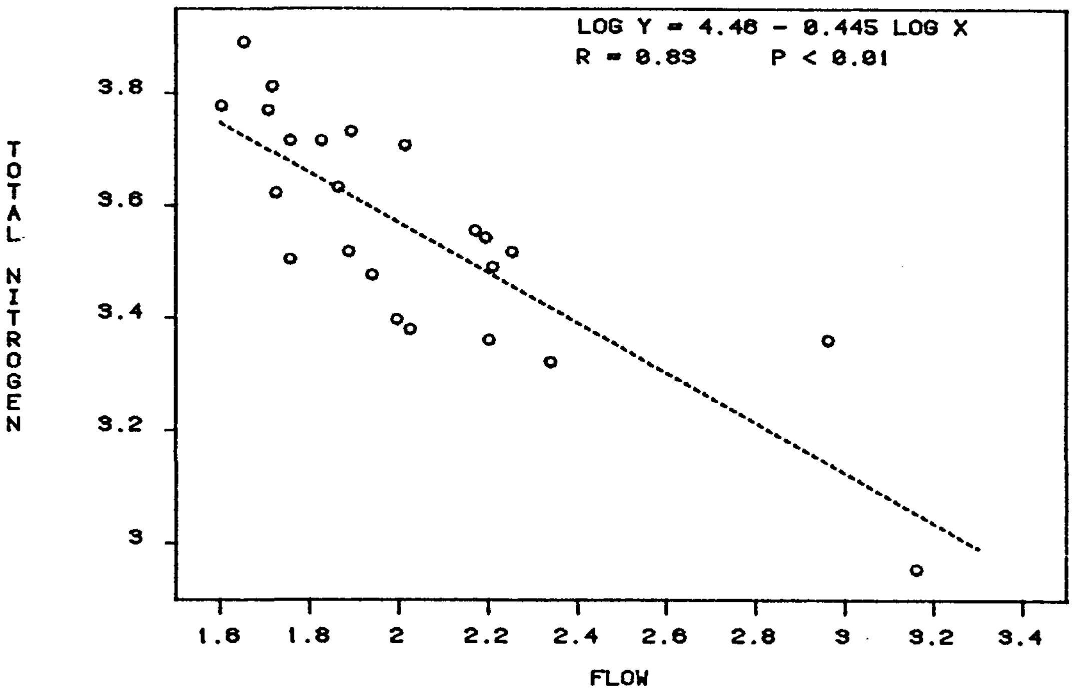

Figure 5. -- Logarithm (base 10) of total nitrogen concentration (ppb) versus logarithm (base 10) of river flow (cfs) in the Econ at SR 13.

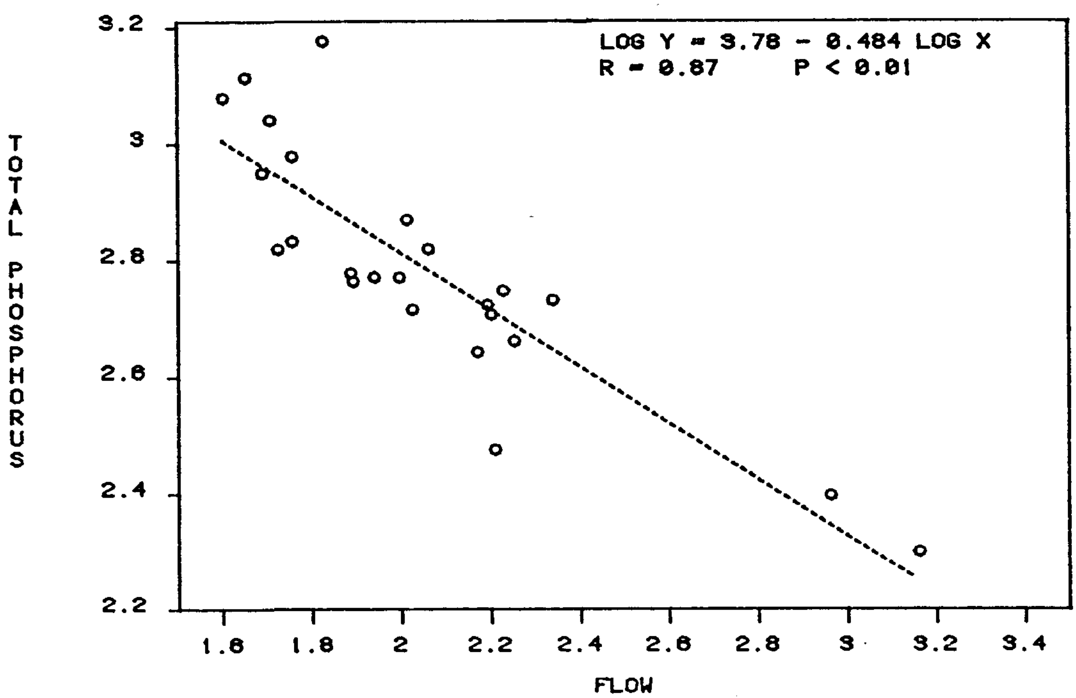

Figure 6. -- Logarithm (base 10) of total phosphorus concentration (ppb) versus logarithm (base 10) of river flow (cfs) in the Econ at SR 13.

periods versus the 1979-1981 period showed a significant decrease ($t = 8.5$, $p < 0.01$). Average loading in 1969-1970 was about 1250 lbs/day while recently (1979-1981), loading was around 427 lbs/day. For recent data, there is a negative correlation between the $\log_{10}$ of phosphorus concentrations (ppb) and the $\log_{10}$ of flow ($r = -0.87$, $P < 0.01$) (Figure 6). Daily phosphorus loading is relatively constant, with a coefficient of variation of 0.74 for the 1979-1981 period. This stability, and the negative correlation with flow, indicates that nonpoint source phosphorus plays a relatively minor role in the annual phosphorus loading. Wanielista (1976) reports, that on a statewide basis, the ratio of nonpoint to point source phosphorus loading is about 2 to 1. Considering that phosphorus concentrations in the Econ are about 10 times higher than normal tributary streams, it seems nonpoint source effects are a relatively minor problem.

DISSOLVED OXYGEN

Low dissolved oxygen levels are a problem in the Econ. The average dissolved oxygen level for samples collected during the morning hours at SR 13, for the 1979-1981 period, was 2.7 mg/l (Table 2, Appendix 3). Since plant respiration during the night generally lowers dissolved oxygen levels, the 2.7 mg/l average is probably lower than the midday mean. However, it is probably an overestimate of the average daily minimum dissolved oxygen level, which occurs just before dawn (Hynes, 1972).

The lowest oxygen levels occurred in the summer during 1979-1981 (Table 4), with the highest in winter. Summer river flows were generally low during the sampling runs (mean = 101 cfs) therefore, the sewage BOD load consumed a large portion of the available oxygen.

The relationship between dissolved oxygen levels and river flow on the Lower Econ is unusual. Most upper basin tributary streams have high dissolved oxygen levels during dry periods and temporary low dissolved oxygen levels after or during periods of increased runoff, particularly in the fall (Goolsby and McPherson, 1970). The runoff carries large quantities of organic materials, which allows bacterial respiration to increase, resulting in increased oxygen consumption. In the Lower Econ, however, dissolved oxygen levels are frequently low during dry periods, when river flow is reduced. During low flow periods, the sewage treatment plant effluents are less diluted by relatively clean runoff, and large quantities of oxygen are consumed in the oxidation of nitrogenous wastes. There is a positive correlation ($P < 0.05$) between dissolved oxygen levels and the log flow, and between dissolved oxygen percent saturation and the log flow at SR 13 (Table 5). In the Upper Econ, which is not influenced by sewage effluents, there is no correlation. In the Little Econ dissolved oxygen levels are low year round (Table 4).

TABLE 4. -- Seasonal dissolved oxygen data (mg/l) for three segments of the Econlockhatchee River System 1979 - 1981. Orange County Pollution Control Data.

Season	Lower Econ (SR 13)	Upper Econ	Little Econ
Summer	2.1 (n = 7)	4.2 (n = 7)	0.9 (n = 5)
Fall	2.6 (n = 5)	4.4 (n = 3)	1.5 (n = 4)
Winter	3.2 (n = 6)	7.8 (n = 6)	1.9 (n = 4)
Spring	2.8 (n = 7)	5.4 (n = 6)	1.4 (n = 6)

TABLE 5. -- Correlation between dissolved oxygen and log of flow, and between percent saturation of dissolved oxygen and the log of flow on the Upper and Lower Econ, 1979-1981.

Lower Econ (at SR 13, below confluence with Little Econ)

	r	F	n	DATES
DO vs Flow	+0.43*	5.1*	25	1979-1981
% sat vs Flow	+0.48*	6.95*	25	1979-1981

Upper Econ (above confluence with Little Econ)

	r	F	n	DATES
DO vs Flow	+0.32 (ns)	2.2 (ns)	22	1979-1981
% sat vs Flow	+0.33 (ns)	2.4 (ns)	22	1979-1981

r = sample correlation coefficient
F = MS regression/MS residual, analysis of variance for regression
n = number of observations
* = significant at 95% confidence level
ns = not significant

UPSTREAM - DOWNSTREAM TRENDS

As noted before, the Econlockhatchee River system can be divided into three segments based on surrounding land use and water quality. The Little Econ is heavily impacted by urban runoff and sewage discharges. The Upper Econ drains mostly marshlands and cattle pastures and receives no sewage effluent. The Lower Econ receives flow from the Little and Upper Econ and drains mostly cattle pasture land (Orange County Growth Management Policy 1980; Seminole County Comprehensive Plan 1979).

In the Little Econ, water quality degenerates downstream from the headwaters because of urban runoff and sewage effluent. Dissolved oxygen levels decrease, and BOD and nitrogen levels increase. Phosphorus levels increase initially, then decrease further downstream, suggesting that the sediments may be acting as a phosphorus sink.

TABLE 6. -- Water quality data from stations on the Upper Econ, Little Econ, and Lower Econ. Orange County Pollution Control data

Upper Econ

Station	DO	BOD	TN	TP	n	Date
1	2.5	3.8	2.0	0.2	6	1980-1981
2	1.6	4.5	1.8	0.2	6	1980-1981
3	4.8	3.7	1.1	0.2	4	1981
4	5.2	2.2	1.2	0.1	3	1980
5	5.5	3.0	1.0	0.1	24	1979-1981

Little Econ

Station	DO	BOD	TN	TP	n	Date
A*	3.4	6.0	1.2	0.2	4	1981
B	3.8	3.7	2.8	1.6	26	1979-1981
C	5.3	3.1	1.9	1.4	26	1979-1981
D	1.4	8.8	7.9	1.0	19	1979-1981

Lower Econ

Station	DO	BOD	TN	TP	n	Date
6	3.3	5.5	4.9	0.7	25	1979-1981
7(SR 13)	2.7	4.3	4.0	0.7	25	1979-1981
8	6.12**	-	3.6	0.8	17	1979-1981

*Does not receive sewage effluent
**Taken by Game and Freshwater Fish commission in afternoon, so not directly comparable with stations 6 & 7.

Unlike the Little Econ, water quality in the Upper Econ improves downstream from the headwaters. Waters draining swamps typically carry a large organic load and have low pH. This is true in the case of the Upper Econ where BOD, total nitrogen, and total phosphorus levels are high, and dissolved oxygen and pH (generally less than 5) are low near the headwaters. Wanielista (1976) found similar results at a site one mile downstream of station 1 in the Upper Econ.

Water quality in the Lower Econ also improves downstream, with dissolved oxygen levels apparently increasing and BOD levels decreasing. Nitrogen concentrations decrease downstream, but unexplainably, phosphorus levels do not.

Brezonik and Fox et al., (1976) reported similar trends for the three sections of the Econ.

SEWAGE EFFLUENT

Eleven sewage treatment plants now discharge approximately 17 million gallons of sewage per day to the Little Econ before its confluence with the Econ. This amounts to a daily loading of 2,991 lbs (1357 kg) of nitrogen and 493 lbs (224 kg) of phosphorus (Williams, 1981). The new Iron Bridge Road advanced treatment plant has the capacity to treat 24 mgd and is eventually expected to treat all sewage entering the Econ. If the plant operates as designed, nitrogen and phosphorus will be discharged at a rate of 600 and 200 lbs (272.1 kg and 90.7 kg) per day. Loading to the Little Econ would then decrease about 70% for nitrogen and phosphorus, about 50% for BOD, and would comply with the DER waste-load limitations for the Econ and Lake Harney.

In January 1982, the Iron Bridge plant began treating 12 mgd of sewage effluent formerly treated at the Bennett Road plant. The interceptor line from Bennett Road to Iron Bridge is only one of several proposed lines, but because of delays in federal funding under section 201 of PL 92-500, constructions will not be completed on the remaining interceptor lines for 1 to 2 years. All data analysis presented in this report represent conditions prior to the operation of the Iron Bridge Road plant.

BIOLOGY

BACTERIA

Total and fecal coliform bacteria levels are occasionally high in the Lower Econ, but did not exceed state standards during the 1979-1981 period (Appendix 12).

PLANKTON

There have been no published phytoplankton or zooplankton surveys of the Econ since the 1970 Upper Basin Survey by Goolsby and McPherson. They found that Upper St. Johns River tributaries had generally low concentrations of phytoplankton because of substantial shading by trees along the banks. However, despite shading, the Econ had bloom concentrations of green algae in 1970. In April 1970, green algae cells were found at a concentration of 1.6×10^6/ml. In July 1970, a concentration of 5,040 cells/ml was present at SR 13. Goolsby and McPherson collected only qualitative zooplankton samples, but they noted that rotifers were the dominant form in the Econ, while copepods and cladocerans dominated at other stations. Goolsby and McPherson noted that high rotifer concentrations were often associated with organic pollution.

During the 1979-1981 period, chlorophyll A levels in the Lower Econ were similar to levels found in other tributaries of the Upper St. Johns River Basin. Fall (1982) found a combined average chlorophyll A concentration of 3.7 ppb at Jane Green Creek and Blue Cypress Creek. Orange County Pollution Control reported that chlorophyll A levels in the Econ averaged 3.9 ppb and that brown and green algae were the dominant forms.

INVERTEBRATES

Since 1974, the Florida Department of Environmental Regulation has collected macroinvertebrates in the Econ at SR 419. The diversity of macroinvertebrates as measured by the Shannon-Weaver Index has not changed appreciably over the eight year period. However, because of the large variation between replicate samples collected on the same date, and between samples collected on different dates, a meaningful discussion of a trend in diversity is not possible. The Department of Environmental Regulation also analyzed the samples in terms of the Florida Biotic Index. The Index is based on the presence of certain organisms characteristically found in areas unaffected by organic pollution. Index values above 20 indicate an absence of organic pollution, while values from 10 to 20 indicate potential problems (DER, 1980). A comparison of the mean Index value for the 1974-1977 period versus the 1978-1981 period suggests a decline in water quality (Table 7).

TABLE 7. -- Florida Biotic index for Macroinvertebrate samples collected in the Econ at SR 419. Department of Environmental Regulation Data.

1974 - 1977		1978-1981	
Date	Biotic Index	Date	Biotic Index
11/6/74	31	4/18/78	16
3/4/75	31	8/8/78	18
6/16/75	11	3/12/79	19
9/4/75	16	10/18/79	19
2/17/76	26	6/3/80	12
1/25/77	26	7/17/80	9
Mean	23.5	1/15/81	16
		7/23/81	9
		Mean	14.7

FISH

Very little is known about the fish communities in the Econ. The Florida Game and Fresh Water Fish Commission does not sample in the Econ, nor does any other state or county agency. Williams and Bruger (1972) found that American shad (Alosa sapidissima) spawned in the Econ in 1969 and 1970, and they noted that shad did not spawn in the Wekiva River or Deep Creek. Only the Econ provided a suitable spawning habitat for shad, because of its relatively rapid flow and sandy substrate, essential requirements for the incubation of shad eggs. Dr. Frank Snelson, an ichthyologist at the University of Central Florida, (personal communication) has sampled occassionally in the Upper Econ, and says that a generally healthy, reproducing fish population exists there. He has observed fish in the Little Econ and Lower Econ, but has not collected samples. Dr. Snelson found that the Upper Econ is near the southern limit of the geographic range of two fish species, the freckled madtom (Noturus nocturnus) and the blackbanded darter (Percina nigrofasciata). The presence of these fish in the Upper Econ is an indicator of the good water quality in this section of the Econlockhatchee River. Also, since these fish may already be stressed by the natural environmental regime, they would probably be among the first to be harmed by environmental degradation in the Econ.

AQUATIC PLANTS

A variety of aquatic plants exist in the Econlockhatchee River. The more abundant, potentially nuisance plants are hydrilla (Hydrilla verticillata), alligator-weed (Alternanthera philoxeroides), water hyacinth (Eichhornia crassipes), water lettuce (Pistia stratiotes), southern naiad (Najas guadalupensis) and spatterdock (Nuphar luteum), but many other species are common depending on location and season.

Aquatic weeds are controlled by the Orange County Public Works Department and the St. Johns River Water Management District, using herbicides (2,4-D). As a result of spraying, hydrilla is becoming increasingly abundant (Larry Rowland, Orange County Weed Control Supervisor, personal communication). Herbicide control of hydrilla, because it is submerged in the relatively swift current of the Econ, is more difficult than for emergent plants. Also, because hydrilla requires 0.5 to 0.75% sunlight for photosynthisis, while native plants need at least 1.5% sunlight (Tarver et al., 1979), it has a competitive advantage in the well shaded Econ. Thus, hydrilla has become the dominant aquatic plant in many areas of the Econ, and will probably become increasingly dominant in the future.

DISCUSSION

Algae blooms and the eutrophication process in Lake Harney and the St. Johns River downstream are exacerbated by the present Econlockhatchee nutrient loading (DER, 1976; Brezonik and Fox et al., 1976; Game and Freshwater Fish Commission, 1982). The future status of water quality and nutrient loading on the Econlockhatchee River, however, is a matter of speculation, and depends on the counteracting impacts of the Iron Bridge Road sewage treatment plant and the potential increase in nonpoint urban runoff due to population growth. If the new DER stormwater discharge rules (Chapter 17-25, Florida Administrative Code) control nonpoint pollution, and Iron Bridge operates as designed, then water quality will improve and deleterious downstream effects will be reduced.

The major water quality problem in the Econlockhatchee River (excluding downstream effects) is low dissolved oxygen levels. Average dissolved oxygen levels in the Little Econ (1.4 mg/l), and the Lower Econ between the confluence and SR 13 (3.0 mg/l average), are well below the 5 mg/l standard for Florida waters (Chapter 17-3, Florida Administrative Code). The fisheries literature suggests that sportfish such as largemouth bass (*Micropterous salmoides*), black crappie (Pomoxis nigromaculatus) and channel catfish (Ictalurus punctatus) would not reproduce in these areas, even if the adults could tolerate the low oxygen levels. The combination of low mean dissolved oxygen levels, and the natural diel oxygen fluctuations, would be fatal for most fish embryos and larvae (Carlson et al., 1974; Spoor, 1977; Carlson and Herman, 1978).

CONCLUSIONS

1) The Econlockhatchee River System can be divided into three distinct segments based on water quality:

   a) Little Econ: This segment has poor water quality because of urban runoff and sewage inputs.

   b) Upper Econ: This segment has good water quality. It does not recieve sewage, and nonpoint source pollution has not had a significantly negative impact.

   c) Lower Econ: Water quality in this segment is intermediate between the Upper Econ and Little Econ. Dissolved oxygen levels are frequently low, especially during the warm months and during low flow periods.

2) Recent data (1979-1981) suggests nonpoint source BOD has a significantly negative impact on water quality in the Little Econ and Lower Econ. Nonpoint source pollution should be reduced to the greatest possible extent.

3) Sewage effluent causes dissolved oxygen problems in the Little Econ and Lower Econ and results in increased eutrophication of Lake Harney.

4) Floodplain trees and vegetation remove nutrients from the river during periods of high water. The trees also shade the river, retarding the growth of noxious algae and aquatic weeds. Any development which causes a removal of floodplain trees should be avoided.

5) Water from the Upper Econ dilutes the pollutants from the Little Econ. Any development causing a reduction in Upper Econ flow will degrade water quality in the Lower Econ.

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Appendix 1. Raw data used in Table 2 and Table 6 for Little Econ, 1970-1981. Orange County Pollution Control Department Data.

Station	Date	Concentrations mg/l DO	BOD	TN	TP
LEZH	3/11/80	1.9	4.5	8.5	1.10
LEZH	6/10/80	1.4	8.3	6.4	0.91
LEZH	9/3/80	1.1	8.3	7.4	1.13
LEZH	12/9/80	1.7	6.9	8.3	1.2
LEZH	1/5/81	2.4	12.6	13.1	1.0
LEZH	4/6/81	2.0	15.0	10.3	1.05
LEZH	7/6/81	0.9	4.4	11.02	1.1
LEZH	10/12/81	1.7	13.0	6.3	-
LEZI	7/6/81	0.8	14.0	10.05	1.1
LEZI	4/6/81	1.0	14.5	9.3	1.2
LEZI	10/12/81	1.5	7.5	6.2	-
LEZF	3/27/79	1.4	3.3	5.1	0.81
LEZF	6/29/79	1.2	1.8	4.2	0.81
LEZF	9/25/79	1.6	4.2	1.97	0.53
LEZF	12/10/79	1.3	4.4	6.46	0.96
LEZF	3/19/80	1.2	4.2	7.0	1.1
LEZF	6/3/80	-	-	-	0.88
LEZF	1/5/81	2.2	6.2	11.3	0.97
LEZF	4/6/81	0.6	13.5	8.6	1.25
LEZF	7/6/81	0.3	21	9.42	1.0
	Mean	1.4	8.8	7.9	1.0

Stations LEZH, LEZI and LEZF are Orange County Station Codes. Station D in Table 6 is the combination of these three stations.

Appendix 2. Raw data used in Table 2 and Table 6 for Upper Econ, 1979-1981. Orange County Pollution Control Department Data.

Station	Date	Concentrations mg/l DO	BOD	TN	TP
5	1/3/79	6.4	2.2	-	0.09
5	2/6/79	7.7	1.0	0.77	0.05
5	3/6/79	5.6	1.8	0.98	0.08
5	4/3/79	-	0.9	0.76	0.10
5	5/1/79	4.9	3.0	0.62	0.07
5	6/4/79	4.2	1.7	0.89	0.11
5	7/2/79	3.9	1.8	2.16	0.07
5	8/7/79	4.8	2.4	0.92	0.08
5	11/6/79	5.3	1.0	1.16	0.12
5	12/4/79	7.5	0.9	0.88	0.08
5	1/30/80	7.7	1.2	0.90	0.10
5	3/19/80	5.9	1.8	0.82	0.10
5	4/1/80	5.4	1.5	0.77	0.15
5	5/6/80	5.0	3.2	0.73	0.11
5	6/3/80	5.6	1.6	1.18	0.11
5	7/1/80	5.0	2.1	0.63	0.09
5	8/5/80	5.2	2.4	0.71	0.14
5	10/20/80	3.5	1.7	0.56	0.07
5	11/3/80	4.5	-	1.31	0.07
5	12/2/80	8.0	2.0	0.93	0.07
5	1/6/81	9.7	0.4	0.56	0.04
5	4/7/81	5.6	3.6	0.93	0.07
5	7/7/81	0.8	11.0	1.70	0.20
5	10/13/82	-	19.0	1.32	-
	Mean	5.5	3.0	1.0	0.1

Station 5 is Orange County Station Code BEC.

Appendix 3. Raw data used in Table 2, 3 and 6, for Lower Econ (SR 13), 1979-1981 Orange County Pollution Control Department data. Means in parenthesis exclude measurements taken 9/4/79 and 10/2/79.

		Concentrations mg/l				Flow	Loading lbs/day		
Station	Date	DO	BOD	TN	TP	CFS	BOD	TN	TP
7 (SR-13)	1/3/79	5.6	2.9	-	0.56	169	2635	-	509
7	2/6/79	1.0	6.4	3.1	0.30	162	5602	2714	263
7	3/6/79	4.3	3.6	3.3	0.46	179	3481	3191	445
7	4/3/79	3.3	2.7	5.4	0.58	78	1125	2251	243
7	5/1/79	2.2	5.1	5.2	0.95	57	1573	1604	293
7	6/4/79	3.0	1.5	2.52	0.59	99	800	1345	315
7	7/2/79	2.2	1.5	2.3	0.51	159	1288	1975	438
7	8/7/79	1.4	6.0	3.5	0.53	156	5052	2947	446
7	9/4/79	4.1	5.0	2.28	0.25	916	24,677	11,253	1234
7	10/2/79	3.5	3.0	0.91	0.20	1450	23,435	7109	1562
7	11/6/79	2.9	1.4	3.57	0.44	148	1120	2857	352
7	12/4/79	4.0	3.6	3.0	0.59	87	1681	1401	275
7	1/30/80	3.8	5.0	-	0.66	115	3085	-	407
7	3/19/80	3.0	6.0	5.1	0.74	103	3301	2806	407
7	4/1/80	2.6	6.3	5.2	1.5	67	2258	1864	538
7	5/6/80	2.8	4.2	5.9	1.1	51	1156	1623	303
7	6/3/80	3.5	3.9	3.3	0.60	77	1626	1376	250
7	7/1/80	2.1	3.9	3.2	0.68	57	1203	987	210
7	8/5/80	1.2	4.5	2.4	0.52	106	2551	1361	295
7	10/20/80	1.2	2.1	6.0	1.2	40	455	1300	260
7	11/3/80	1.5	0.45	7.8	1.3	45	109	1886	314
7	12/2/80	2.5	6.2	2.09	0.54	218	7288	2457	635
7	1/6/81	2.6	5.3	4.17	0.66	53	1502	1182	187
7	4/7/81	1.6	8.6	-	0.89	49	2294	-	237
7	7/7/81	1.0	6.6	6.5	0.93	52	1871	1842	264
7	10/13/81	-	6.6	4.3	-	73	2586	1685	-
	Mean	2.7	4.3	4.0	0.7	183	3990	2566	427
						(100)	(2318)	(1936)	(328)

Appendix 4. Raw data used in Table 3 for the Econ (SR 13), 1969-1970 and 1974-1975. USGS Data.

	Concentrations mg/l				Flow	Loading lbs/day		
Date	DO	BOD	TN	TP	CFS	BOD	TN	TP
7/25/69	3.0	-	3.1	1.3	111	-	1853	777
10/27/69	5.8	1.3	1.2	0.36	1280	8962	8341	2482
1/29/70	7.1	1.9	2.3	0.75	248	2538	3112	1001
5/2/70	4.8	3.4	4.2	2.7	48	888	1100	705
7/24/70	2.8	3.2	4.6	3.1	78	1344	1932	1302
Mean	4.7	2.5	3.1	1.7	353	3433	3268	1253
2/20/74	4.6	3.8	5.7	2.3	54	1109	1663	671
4/29/74	7.2	4.8	7.7	4.0	32	840	1348	700
6/25/74	2.8	1.3	2.92	1.8	91	639	1436	885
8/26/74	5.0	1.4	1.72	0.5	454	3420	4201	1221
10/25/74	4.1	2.2	2.67	0.92	141	1669	2026	698
12/16/74	4.2	7.4	6.48	2.7	62	2468	2160	900
2/7/75	5.5	3.2	4.71	2.7	52	907	1335	765
3/28/75	5.5	5.4	7.09	3.6	41	1126	1478	750
6/1275	4.6	2.9	3.87	1.8	86	1330	1774	825
8/13/75	3.8	2.8	2.53	0.82	210	3175	2869	930
12/10/75	4.5	3.1	6.1	1.2	80	1344	2644	520
Mean	4.7	3.5	4.7	2.0	118	1639	2085	806

Appendix 5. Raw data used in Table 6, station 8, for the mouth of Econlockhatchee River, 1979-1981. Game and Fresh Water Fish Commission data.

Date	Flow (cfs)	Concentrations mg/l		
		DO	TN	TP
2/13/79	143	6.2	2.47	0.41
5/1/79	57	6.5	3.36	0.91
6/11/79	83	7.5	2.65	0.57
8/8/79	176	3.1	2.03	0.46
10/9/79	428	3.9	1.93	0.42
12/4/79	87	5.4	3.99	0.81
2/26/80	93	6.6	3.93	0.55
4/29/80	54	7.7	3.87	0.85
6/24/80	68	8.0	3.02	0.71
8/26/80	145	5.5	4.64	0.81
10/14/80	43	6.8	3.80	1.07
12/8/80	69	6.0	3.39	0.86
2/9/81	94	6.8	3.67	0.78
4/28/81	33	9.3	5.12	0.88
6/30/81	57	6.0	5.27	1.31
8/18/81	47	3.7	4.7	1.11
10/27/81	78	5.2	3.26	0.75
Mean	103	6.1	3.6	0.78

Appendix 6. Correlation between $\log_{10}$ BOD, TN and and TP concentration (ppb) versus $\log_{10}$ of river flow in the Econlockhatchee River. Orange County Pollution Control Data.

	r	F	n	
BOD * Flow	-0.032	0.03	26	1979-1981
TN * Flow	-0.83**	45.3**	23	1979-1981
TP * Flow	-0.87**	73.1**	25	1979-1981

r = sample correlation coefficient,
F = MS Regression/MS Residual, analysis of variance for regression
n = number of observations
** = $P < 0.01$

Appendix 7. Raw data used in Table 6, for station 6, on the Lower Econ, 1979-1981. Orange County Pollution Control Department Data.

Station	Date	Concentrations mg/l			
		DO	BOD	TN	TP
6	1/3/79	5.3	3.6	-	0.47
6	2/26/79	6.1	1.6	2.5	0.30
6	3/6/79	4.4	4.0	6.2	0.46
6	4/3/79	2.9	4.5	5.6	0.67
6	5/1/79	2.4	6.9	4.7	1.04
6	6/5/79	2.1	4.2	2.39	0.64
6	7/2/79	1.9	2.7	3.0	0.58
6	8/7/79	2.0	4.5	3.4	0.55
6	9/4/79	3.5	1.8	1.4	0.07
6	10/2/79	-	2.7	0.72	0.16
6	11/6/79	3.7	2.0	3.7	0.43
6	12/4/79	4.2	4.4	3.7	0.62
6	1/30/80	4.5	4.7	4.5	0.66
6	3/19/80	-	-	5.1	-
6	4/1/80	2.7	3.8	-	0.95
6	5/6/80	2.6	9.6	6.9	1.3
6	6/3/80	2.9	9.3	4.1	0.65
6	7/1/80	2.1	7.5	5.0	0.80
6	8/5/80	4.0	6.8	8.6	0.61
6	10/20/80	1.7	2.0	8.1	1.3
6	11/3/80	2.1	1.5	10.8	1.4
6	12/2/80	5.8	5.1	4.29	0.47
6	1/6/81	5.0	12.0	7.0	0.80
6	4/7/81	2.4	12.6	-	1.1
6	2/2/81	1.5	10.2	-	1.0
6	10/13/81	-	8.9	6.6	-
	Mean	3.3	5.5	4.9	0.71

Station 6 is Orange County Station Code BED.

Appendix 8. Raw data used in Table 6, for Little Econ station A, 1981. Orange County Pollution Control Data.

Station	Date	DO	BOD	TN	TP
A	1/5/81	7.2	8.8	0.6	0.33
A	4/6/81	4.4	3.4	1.72	0.2
A	7/6/81	0.5	2.6	1.2	0.05
A	10/12/81	1.4	9.0	1.2	-
	Mean	3.4	6.0	1.2	0.2

Station A is Orange County Station Code LEM.

Appendix 9. Raw data used in Table 6, for Little Econ station B, 1979-1981. Orange County Pollution Control Data.

Station	Date	DO	BOD	TN	TP
B	1/3/79	4.8	5.2	-	1.1
B	2/6/79	3.9	3.0	2.02	0.85
B	3/6/79	2.7	4.8	2.9	1.3
B	4/3/79	3.1	-	2.46	1.3
B	5/1/79	1.9	6.8	4.5	2.3
B	6/5/79	3.9	3.0	2.03	1.1
B	7/2/79	3.5	1.7	1.26	0.56
B	8/7/79	2.0	2.4	1.5	0.62
B	9/4/79	3.3	3.0	1.6	0.33
B	10/2/79	0.8	3.6	2.3	0.41
B	11/6/79	3.6	5.4	3.67	0.88
B	12/4/79	3.3	7.4	2.9	1.2
B	1/30/80	5.1	3.4	3.0	1.4
B	3/19/80	3.7	3.3	4.97	1.9
B	4/1/80	4.8	4.8	3.62	1.8
B	5/6/80	3.6	2.4	2.4	2.4
B	6/3/80	4.3	2.4	3.8	1.8
B	7/1/80	4.8	1.6	1.8	1.5
B	8/5/80	5.4	2.6	0.64	2.4
B	9/9/80	4.5	2.0	1.62	1.9
B	10/20/80	3.0	2.0	2.8	3.7
B	11/3/80	3.8	1.1	3.7	3.3
B	12/2/80	4.5	6.1	1.53	1.7
B	1/5/81	5.5	4.2	11.9	2.8
B	4/6/81	4.7	5.2	2.18	2.1
B	7/6/81	4.5	5.0	1.56	1.6
B	10/12/81	4.1	3.5	1.55	-
	Mean	3.8	3.7	2.8	1.6

Station B is Orange County Station Code LET

Appendix 10. Raw data used in Table 6, for Little Econ Station C, 1979-1981. Orange County Pollution Control Data.

Station	Date	DO	BOD	TN	TP
C	1/3/79	6.2	6.2	-	1.0
C	2/6/79	6.7	1.8	1.26	0.6
C	3/6/79	4.7	3.2	1.89	0.83
C	4/3/79	5.6	1.6	2.89	0.97
C	5/1/79	5.0	4.0	2.54	1.9
C	6/5/79	4.9	2.1	1.4	0.86
C	7/2/79	4.0	0.9	1.8	0.56
C	8/7/79	4.3	3.6	1.26	0.54
C	9/4/79	4.3	4.1	2.34	0.69
C	10/2/69	3.6	3.0	1.19	0.34
C	11/6/79	5.4	1.8	2.42	0.80
C	12/4/79	5.3	4.3	2.38	0.98
C	1/30/80	6.7	3.2	1.77	1.1
C	3/19/80	5.1	3.8	1.93	1.3
C	4/1/80	5.6	0.9	1.67	1.5
C	5/6/80	5.5	3.0	1.64	2.0
C	6/3/80	4.8	4.8	4.2	1.4
C	7/1/80	5.3	2.7	1.7	1.4
C	8/5/80	5.4	3.2	0.61	2.0
C	9/9/80	4.5	4.3	0.8	1.8
C	10/20/80	4.5	1.8	0.95	2.8
C	11/3/80	5.2	1.7	1.99	3.4
C	12/2/80	6.6	3.5	2.68	1.4
C	1/6/80	7.8	1.5	3.8	2.4
C	4/7/80	5.6	5.2	1.05	2.1
C	7/7/80	5.7	5.1	1.8	1.6
C	10/13/80	6.0	4.0	1.4	-
	Mean	5.3	3.1	1.9	1.4

Station C is Orange County Station Code LEH.

Appendix 11. Raw data used in Table 6, for Upper Econ Stations 1-4, 1980-1981. Orange County Pollution Control Data.

Station	Date	DO	BOD	TN	TP	
1	3/19/80	3.4	1.1	0.56	0.58	Station 1 is Orange County Station Code BEH.
1	6/3/80	1.6	3.9	1.54	0.05	
1	8/5/80	2.2	4.8	1.64	0.19	
1	4/7/81	1.2	7.05	0.89	0.15	
1	10/13/81	2.4	3.6	5.1	-	
1	1/5/82	4.2	2.1	2.22	0.045	
	Mean	2.5	3.8	2.0	0.02	
2	3/19/81	1.9	2.6	0.53	0.08	Station 2 is Orange County Station Code BEA.
2	6/3/81	0.6	6.5	1.5	0.05	
2	12/2/81	0.9	3.5	1.63	0.32	
2	4/7/81	1.8	7.2	2.01	0.23	
2	7/7/81	2.8	4.7	2.11	0.39	
2	10/13/81	-	2.55	3.1	-	
	Mean	1.6	4.5	1.8	0.2	
3	1/6/81	8.7	1.7	0.67	0.09	Station 3 is Orange County Station Code BEF.
3	4/7/81	4.7	4.4	1.21	0.17	
3	7/7/81	1.0	4.4	1.2	0.28	
3	10/13/81	-	4.4	1.46	-	
	Mean	4.8	3.7	1.1	0.2	
4	3/19/80	5.0	2.2	1.33	0.12	Station 4 is Orange County Station Code BEB.
4	6/3/80	4.5	1.1	1.18	0.13	
4	12/2/80	6.2	3.3	0.94	0.07	
	Mean	5.2	2.2	1.2	0.1	

Appendix 12. Total and fecal coliform bacteria per 100 ml in the Lower Econ. Orange County Pollution Control Data.

Date	Total Coliform	Fecal Coliform
1/3/79	350	>120
2/6/79	130	<100
3/6/79	>800	670
4/3/79	<100	<100
5/1/79	170	42
6/5/79	< 20	< 20
7/2/79	44	20
8/7/79	142	< 20
9/4/79	>160	>120
10/2/79	580	< 20
11/6/79	150	< 20
12/4/79	170	< 20
1/3/80	76	20
3/19/80	62	< 20
4/1/80	50	< 20
5/6/80	110	< 20
6/3/80	122	< 20
7/1/80	-	< 20
10/20/80	640*	42
11/3/80	1200	< 20
12/2/80	-	56
1/6/81	140	48
4/7/81	1500	20
7/7/81	1800	-
10/13/81	1000	<100

*Possible overgrowth of bacterial colonies

Appendix 13. Chlorophyll levels in the Lower Econ. Orange County Pollution Control Data.

	Chla A (ppb)	Chla B (ppb)	Chla C (ppb)
1/3/79	1.75	1.61	0.00
2/6/79	0.72	0.17	0.00
3/1/79	2.58	2.07	3.60
4/3/79	1.56	0.53	0.00
5/1/79	4.63	2.08	0.00
6/5/79	2.32	1.23	0.28
7/2/79	2.30	1.69	5.89
8/7/79	1.20	0.71	0.00
9/4/79	1.87	1.50	0.79
10/2/79	0.66	1.16	0.00
11/6/79	1.62	1.13	0.00
12/4/79	0.71	0.77	0.00
1/30/80	2.18	0.20	1.13
3/19/80	2.05	1.75	0.00
4/1/80	2.00	2.17	0.00
5/6/80	5.97	2.62	2.27
6/3/80	5.19	2.65	0.49
7/1/80	3.86	0.46	0.37
8/5/80	5.95	2.06	0.00
10/20/80	13.61	1.40	3.79
1/6/81	6.45	1.14	1.65
4/7/81	15.78	1.69	1.85
7/7/81	6.24	2.09	0.00
1/5/82	3.04	1.18	0.71
Mean	3.92	1.42	0.95