Technical Publication SJ94-3

FLOOD MANAGEMENT STUDY
HOWELL CREEK BASIN
ORANGE AND SEMINOLE COUNTIES, FLORIDA

by

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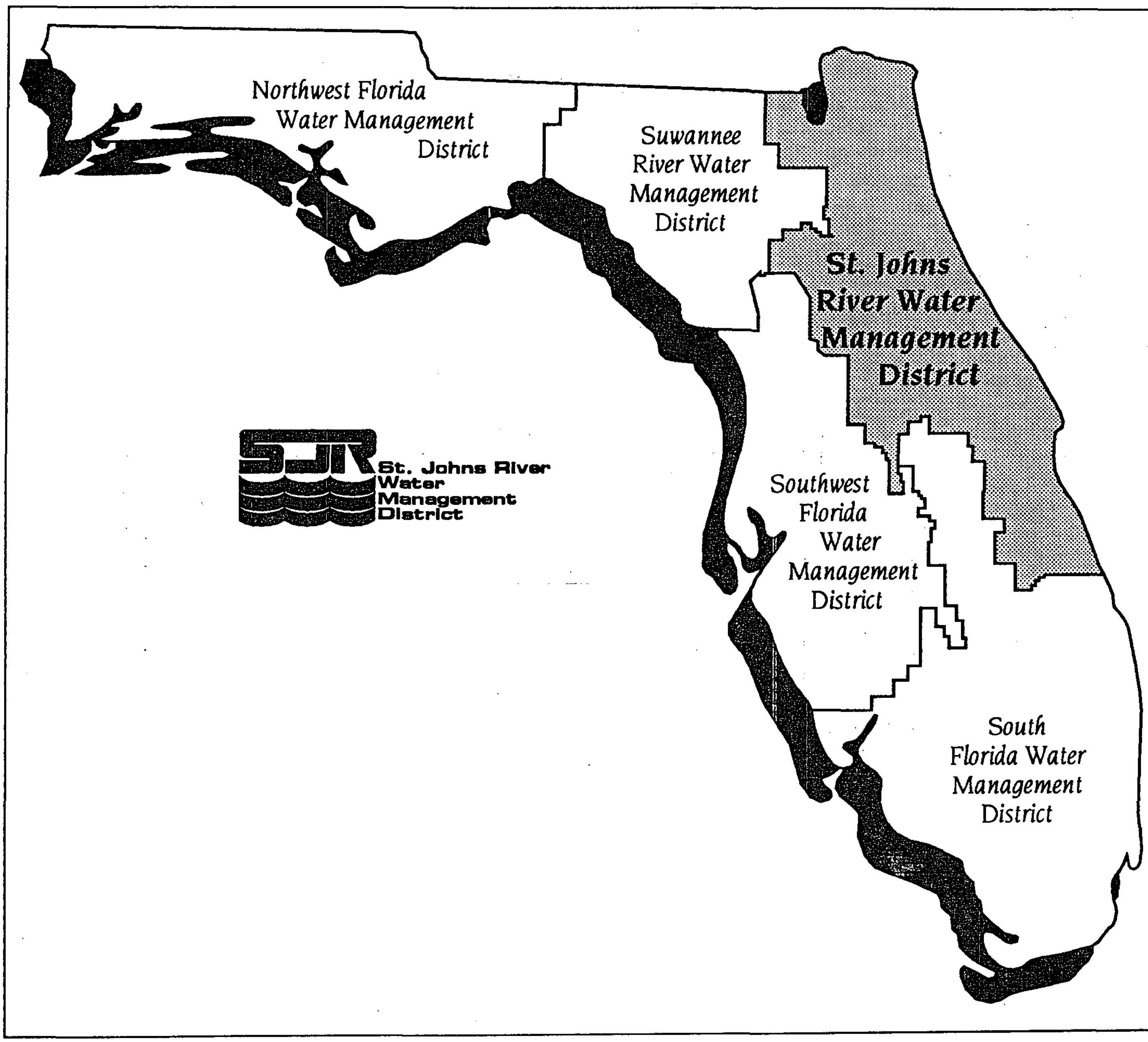

The **St. Johns River Water Management District** (SJRWMD) was created by the Florida Legislature in 1972 to be one of five water management districts in Florida. It includes all or part of 19 counties in northeast Florida. The mission of SJRWMD is to manage water resources to ensure their continued availability while maximizing environmental and economic benefits. It accomplishes its mission through regulation; applied research; assistance to federal, state, and local governments; operation and maintenance of water control works; and land acquisition and management.

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EXECUTIVE SUMMARY

The Howell Creek Basin is located in central Florida, in Orange and Seminole counties. The St. Johns River Water Management District (SJRWMD) conducted a two-phase study to evaluate the flooding problems of the basin and to formulate a comprehensive flood management plan to reduce flood and erosion damages. Water quality and environmental conditions in the basin also were assessed. In Phase I (the floodplain study), flood elevations and floodprone areas in the basin were determined through detailed hydrologic and hydraulic analyses. In Phase II (the flood management study), damages were analyzed, major problem areas in the basin were identified, and several flood protection alternatives were presented for each problem area. An analysis of water quality in the basin, environmental conditions, and wetland loss was also part of this study. The present report presents the results of the work completed under Phase II.

A study of building structures indicated that approximately 330 buildings lie in the 100-year floodplain, 65 of which might suffer actual flood damages. Other buildings are in areas that might experience street or yard flooding but no significant structural damages would occur. The structures that might sustain damages during a major storm event are scattered throughout the basin (Table A and Exhibit A).

Expected residential damages were calculated based on Federal Insurance Administration guidelines. In addition, other likely damages (e.g., overtopping of bridges and culverts, street flooding, and damages due to erosion) were considered in identifying problem areas. This report identifies problem areas I-VIII (Table A and Exhibit A) as areas in need of minor or major flood control measures to reduce damages. Each of the eight areas was considered separately in formulating and evaluating different flood protection alternatives.

Because the problem areas are scattered throughout the basin, providing flood relief to all areas by a single solution is not

Table A. Major problem areas and flood protection alternatives (see Exhibit A for locations of problem areas)

Problem Areas	Structure	Estimated Damages in Thousand Dollars†			Flood Protection Alternatives	Expected Annual Damages†		Benefit/ Cost Ratio
		10-Year	25-Year	100-Year		Without Improvements	With Recommended Alternatives	
Orange County								
I. Lake Ivanhoe and vicinity	Buildings	0	8	55	Floodproofing	$ 1,580	$ 0	*
	Streets	0	0.3	1	Lake regulation with improvements: IMP1[a] IMP1[b]	 $ 1,580 $ 5,280[c]	 $ 344 $ 3,320	 4.3 6.9
					*Local levee protection	$ 1,580	$ 0	Low
II. Rowena chain of lakes	Buildings	7	19	100	Floodproofing	$ 3,700	$ 0	@
					Lake regulation upstream: IMP2B[d] IMP2B[e]	 $ 3,700 $ 5,280[c]	 $ 2,410 $ 3,440	 4.5 6.4
					Regulation of Rowena chain of lakes with improvements: IMP3B[d] IMP3B[e]	 $ 3,700 $ 5,280[c]	 $ 830 $ 1,860	 1.5 1.8
III. Lake Killarney and vicinity	Buildings	4	15	49	Floodproofing	$ 2,070	$ 0	@
					Increase outflows (IMP4A)	$ 2,070	$ 956	No cost
					Lake regulation (IMP4C)	$ 2,070	$ 525	No cost

Table A—*Continued*

Problem Areas	Structure	Estimated Damages in Thousand Dollars†			Flood Protection Alternatives	Expected Annual Damages†		Benefit/ Cost Ratio
		10-Year	25-Year	100-Year		Without Improvements	With Recommended Alternatives	
IV. Park Lake and vicinity	Buildings	14	38	218	Local levee protection (IMP5)	$ 6,260	$ 2,760	1.15
					Floodproofing			@
					Channel and bridge improvements downstream (IMP6C)	$ 6,260	$ 310	0.24
V. Maitland chain of lakes	Buildings	44	98	259	Floodproofing	$15,000	$ 0	@
					Increase outflows (IMP7A)	$15,000	**	**
					Lake regulation: IMP8C IMP9	 $15,000 $15,000	 $ 2,870 $ 4,700	No cost
Seminole County								
VI. Lake Howell and vicinity	Buildings	1	3	21	*Floodproofing			
					**Lake regulation upstream			
VII. Bear Creek Basin	Buildings	0	0	0	**Channel improvements			
	Bridges	5	15	35	**Bridge improvements			
VIII. Howell Creek downstream of Lake Howell	Buildings	0	0	0	**Channel improvements			
	Bridges	2	10	25	**Bridge improvements			

See Table 23 (page 92) for a description of various improvements

†Calculated using 1988 or 1991 tax values

**Not evaluated

[c]Total annual damages at problem areas I and II

*No cost estimates are made

[a]Excluding benefits to problem area II

[d]Excluding benefits to problem area I

@See Table 26 (page 99)

[b]Including benefits to problem area II

[e]Including benefits to problem area I

possible. A number of flood protection alternatives were considered for each problem area (Table A). For most problem areas, residential flood damages could be significant only during extreme storm events, *extreme* meaning more severe than a 25-year event. Damages would be confined to a small number of waterfront homes on each lake. Flood damages would be significant primarily in Orange County.

Water quality and environmental assessments indicated that, in general, Howell Creek Basin has elevated levels of biological oxygen demand, nutrients, heavy metals, and chlorophyll *a*. The lakes and creeks are highly influenced by urban stormwater runoff, erosion, and agricultural inputs, which are probably the source of most pollutants. In addition, the basin has lost 35 percent of its wetlands (about 1,833 acres) since 1947 due to urban development. Water quality and flood control problems have occurred because of wetland loss. Flood control measures should be designed to improve the foregoing conditions wherever feasible.

An important finding of this study is that keeping the gates of Lake Maitland control structure permanently in a closed position (the existing condition) would increase flooding both upstream and downstream. With gates in the closed position, higher lake levels would prevail in the chain of lakes during the wet season, reducing the flood absorption capacity of the lakes. As a result, the lakes would both rise higher and pass on higher discharges downstream during storm events.

Regulation of lake levels by maintaining lower levels in the wet season can offer significant flood mitigation benefits. This flood protection alternative is recommended for problem areas I (Lake Ivanhoe and vicinity), II (Rowena chain of lakes), III (Lake Killarney and vicinity), and V (Maitland chain of lakes). However, any regulation schedule selected now should be considered as *interim* until the third and final study is completed by SJRWMD. This third study started in October 1993 and is developing a continuous hydrologic simulation model for the Howell Creek Basin. The model will simulate the hydrologic impacts of any variation in structure operation or overflow elevation for the Lake Maitland control structure under flood or drought conditions or other water management alternatives. The simulation will identify the related potential environmental effects for any scenario.

CONTENTS

*The 100-year floodplain maps (Appendix A) are not available for general distribution. They may be inspected at the Orange County and County of Seminole water management offices or the St. Johns River Water Management District library in Palatka or the field office in Orlando.

FIGURES

TABLES

INTRODUCTION

The Howell Creek Basin is located in central Florida, in Orange and Seminole counties, in the St. Johns River Water Management District (SJRWMD) (Figures 1 and 2). It is a subbasin of the Middle St. Johns River Basin. Most of the Howell Creek Basin is highly urbanized, and it experiences considerable flooding during major storm events. Both Orange and Seminole counties identified the basin as a critical area in need of surface water management. At the request of Orange and Seminole counties, SJRWMD commenced a water management study for this basin in 1982.

The objectives of the study were to complete a floodplain study (Phase I) and to develop a comprehensive water management plan for the basin (Phase II). The floodplain study was completed in August 1984 (Suphunvorranop and Clapp 1984). It consisted of detailed hydrologic and hydraulic analyses to determine flood elevations and floodprone areas throughout the basin. The report presented flood profiles for 10-, 25-, and 100-year (yr) 24-hour (hr) storm events, 25-yr 6-hr storm events, and floodplain maps (showing 10- and 100-yr boundaries) for the existing conditions of the basin. However, a report by Dyer, Riddle, Mills, and Precourt in October 1984 indicated that an urbanized area of about 5 square miles (mi^2) that was not considered in the August 1984 study discharges into the Howell Creek drainage system. Therefore, the August 1984 study was re-evaluated and revised.

The present report presents results of the work completed under Phase II. This work consisted of (1) a re-evaluation of the 1984 floodplain study, (2) a detailed flood management study evaluating the areas affected by the 100-yr storm event, and (3) an environmental assessment of the basin. Phase II includes water management alternatives to reduce flood damages. Major problem areas were identified, and flood damages for the affected areas were estimated. For areas where damages due to a 100-yr

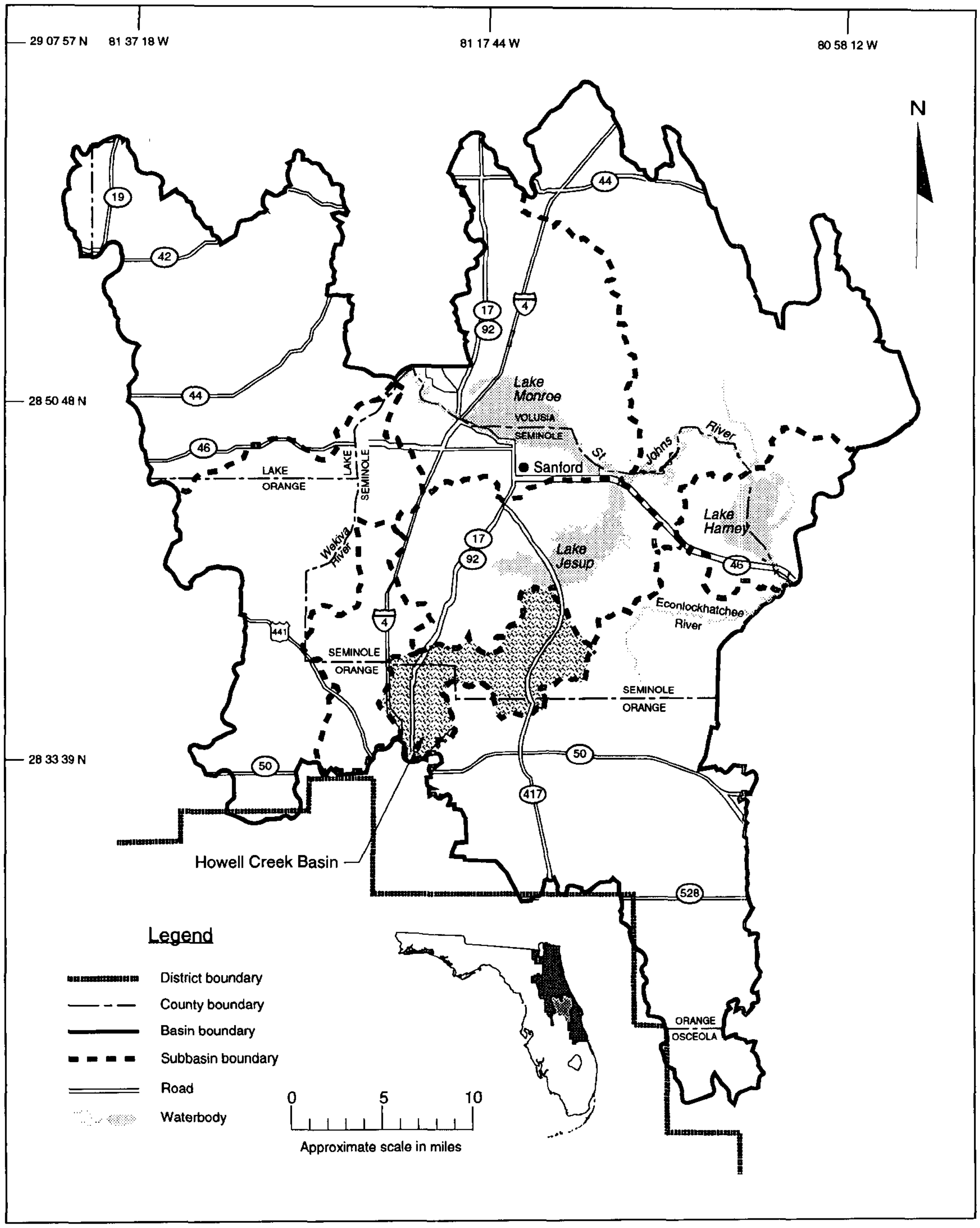


Figure 1. The Middle St. Johns River Basin. *The Howell Creek subbasin is shaded.*

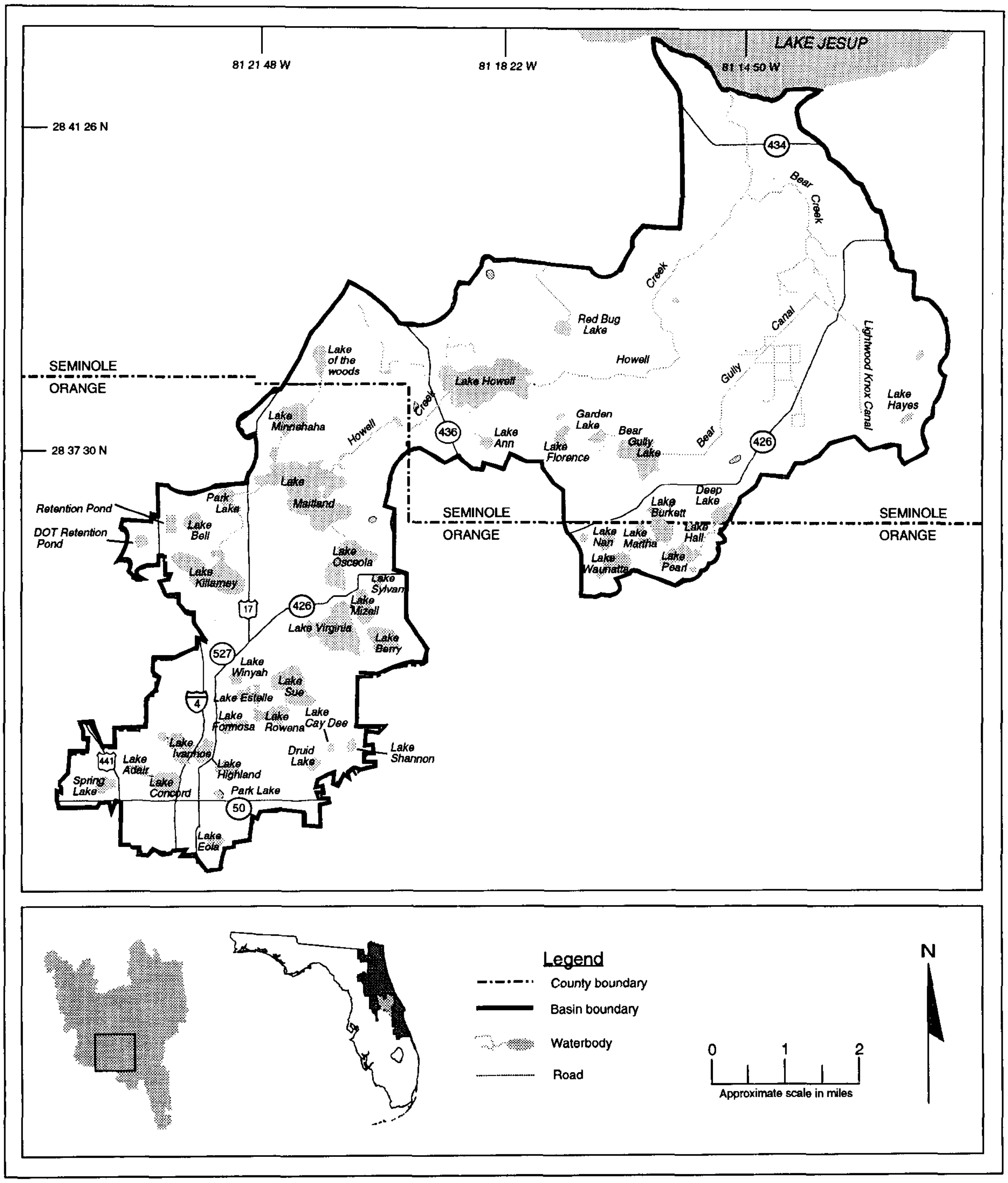


Figure 2. The Howell Creek Basin

flood would exceed $25,000, several flood protection alternatives were discussed, and some were evaluated. Approximate costs were estimated for the potential alternatives to determine benefit/cost ratios.

One of the original objectives of the Phase II study was to develop operating schedules for the existing water control structures at Lakes Killarney and Maitland (Orange County) to provide maximum flood control benefits. These schedules, however, were not developed for this report because the effects of lake regulation were not evaluated. The third and final Howell Creek Basin study, begun in October 1993, will develop a continuous hydrologic simulation model for the basin. The model will simulate the hydrologic impacts of any variation in structure operation or overflow elevation for the Lake Maitland control structure under flood or drought conditions or other water management alternatives. The simulation will identify the related potential environmental effects for any scenario. Upon completion of the final study, Orange County officials can choose an alternative and implement any associated lake regulation schedules.

The loss of wetlands in the Howell Creek Basin due to urbanization has resulted in the degradation of water quality, reduction of water storage capabilities, increased erosion and sedimentation, and general ecological deterioration. This report assesses water quality conditions in the basin, quantifies wetland loss, discusses the problems associated with wetland loss, discusses the ecological effects of flood control alternatives, and proposes ecosystem management recommendations for the Howell Creek Basin. Additional studies will be conducted to evaluate other environmental issues.

METHODS

This section describes the engineering and environmental methods used in various calculations and analyses performed in this study. Although these are common methods used by the profession, there are alternative approaches available in the literature.

ENGINEERING METHODS

The engineering methods used in this study include the following.

- Calculation of flood discharges at various locations in the basin for return periods; T (given return period) = 10 yr, 25 yr, and 100 yr
- Determination of flood elevations throughout the basin (computing flood profiles for streams and floodplain mapping)
- Assessment of flood damage and identification of major problem areas (direct damages to buildings, bridges, and culverts; areal flooding; erosion)
- Evaluation of alternative flood control measures
- Calculation of benefit/cost ratios

Flood Discharge Calculations

Accurate prediction of peak discharges is essential for the planning and design of stormwater management systems. The response of a basin to stormwater management systems is best evaluated by streamflow monitoring. Long-term data collected in this fashion constitute the basic information for estimating maximum flows for various return periods. Adequate monitoring networks have been operated in very few basins. In some instances, the historic data may become obsolete due to changing basin conditions, especially in urbanizing basins. For these reasons, peak discharges for a watershed are often calculated by rainfall-runoff models. This procedure is also useful in evaluating the effects of different alternative management practices under present and future basin conditions. Two types of rainfall-runoff models are available: single-storm event models and continuous hydrologic simulation models. Single-event models produce flood hydrographs for a design storm event (given return period, T). Notable among this category of models are the U.S. Army Corps of Engineers (USACE) HEC-1 program (1981) and the U.S. Soil Conservation Service (SCS) TR-20 program (1983).

Continuous simulation models generate long-term discharge data at a suitable time-step (daily, hourly, etc.). Annual peak discharges are evaluated from this data, and frequency analysis is performed to estimate T-yr peak discharges.

The HEC-1 model was selected for this study. This model simulates the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic components. The model has five major components.

- A land surface runoff component
- A river-routing component
- A reservoir component
- A diversion component
- A pump component

Available techniques for modeling some of these components are not unique. Several different, but equally meritorious methods exist in the literature. The HEC-1 program incorporates all well-known methods and provides the user with a choice of these methods. The Howell Creek Basin is divided into a number of subbasins (Figure 3). Peak discharges at selected locations along the stream courses and peak elevations for lakes are obtained by

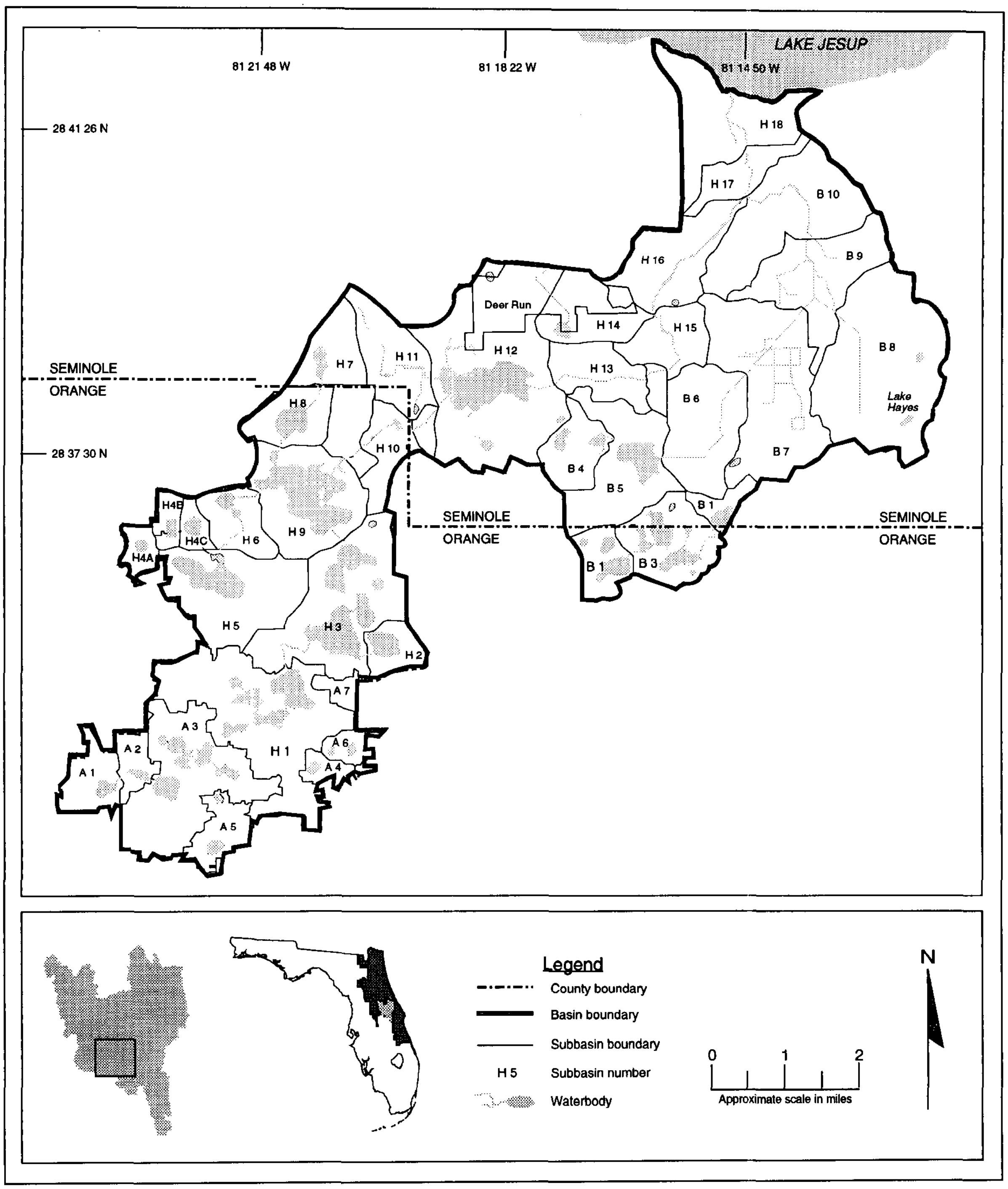


Figure 3. Subbasin delineation in the Howell Creek Basin

HEC-1. For this study, the February 1, 1985, personal computer version (IBM XT 512K) of HEC-1 was used.

For modeling the surface runoff component, SCS methods are selected (SCS 1972). Input data for the HEC-1 model include hypothetical storm distribution, 24-hr rainfall values, SCS runoff curve number (CN), watershed lag, basin area, Muskingum Routing parameters for channel routing, the initial stage elevations in lakes and other storage areas, and stage-storage-discharge relationships for use in storage routing.

Hypothetical Storm Distribution. A 24-hr storm distribution was developed for the Howell Creek Basin (Rao 1988a).

24-Hour Rainfall Values. The basin average (point) rainfall values for 24-hr 10-yr, 25-yr, and 100-yr storm events are determined as 6.9 inches (in.), 8.5 in., and 11.5 in., respectively, from the generalized rainfall charts produced for SJRWMD (Rao 1988b). These rainfall values are further adjusted for the basin size using the area-depth relationships given by Hershfield (1961). As the basin size increases, a storm cannot be as intense as it can be at a single point. For this reason, the point rainfall values are reduced when applied to larger basins. For a 50-mi^2 basin, the adjustment factor is 0.95 for a 24-hr storm rainfall. Thus, the 100-yr rainfall value for a 50-mi^2 contributing area within the Howell Creek Basin would be 10.9 in. Various calculations for this purpose are facilitated by using the *JD card* option in the HEC-1 program.

Runoff Curve Number. For estimating runoff from storm rainfall, SCS uses the runoff CN method (SCS 1972, ch. 4-10). Determination of CN depends upon soil and land cover conditions of the watershed. For adequately describing these conditions, SCS classifies soils into four hydrologic soil groups (A, B, C, and D), depending on the drainage properties of the soil. Group D has the highest runoff-producing potential, and group A has the lowest potential. Some soils have been assigned to two hydrologic soil groups. Soils that have a seasonally high water table but can be drained are assigned first to a soil group that indicates the drained condition of the soil and then to a soil group that indicates the undrained condition, for example, soil group A/D. The CN value of a given soil is determined from its hydrologic soil group and land use. Soil data for the study area are extracted from the U.S. Department of Agriculture-SCS soil surveys (USDA-SCS 1960, 1966). Land use is determined from the 1980–81 aerial photographs and the land use maps prepared by the Center for Wetlands, University of Florida (1973). Ten different groups of land use are identified for the study area (Table 1). The CN values for various hydrologic soil groups

Table 1. Runoff curve numbers for selected land use and soil complexes under antecedent moisture condition II

Description of Land Use	Hydrologic Soil Group				
	A	B	C	D	A/D*
Open land, recreation	39	61	74	80	80
Residential—low density (1/3-acre lots)	57	72	81	86	86
Residential—medium density (1/4-acre lots)	61	75	83	87	87
Residential—high density (1/8-acre lots)	77	85	90	92	92
Improved pasture	68	79	86	89	89
Citrus	55	73	82	86	86
Swamp	65	82	89	95	82
Marsh	78	90	94	98	90
Industrial	89	92	94	95	95
Lakes	98	98	98	98	98

*This soil changes its behavior from Group A to Group D with saturation. The values given under column A/D are used in this study for these kinds of soils.

associated with these land uses also are summarized in Table 1. An average antecedent moisture condition (II) was assumed for the basin in determining these values. This condition represents a 5-day antecedent rainfall of 0.5–1.1 in. during the dry season and 1.4–2.1 in. during the wet season. For each subbasin, a weighted CN is calculated based on soils and land use.

Watershed Lag Time. The time in hours between a brief heavy rain and the maximum runoff rate is called lag (L). The value of L for a given subbasin can be calculated based on travel time or time of concentration (T_c) by the relation $L = 0.6\ T_c$. However, in the present study, the SCS equation given below is used to calculate L.

$$L = \frac{\ell^{0.8}\ (S + 1)^{0.7}}{1{,}900\ Y^{0.5}} \qquad \textbf{(1)}$$

where:

L = lag time in hours
ℓ = hydraulic length of watershed in feet
$S = \frac{1{,}000}{CN'} - 10$ (where CN' is the retardance factor and is equivalent to the runoff curve number)
Y = average watershed land slope in percent

The HEC-1 program uses a peak rate factor of 484 for runoff calculations by the SCS methods. The peak rate factor, however, has been known to vary from 300 in flat swampy areas to 600 in steep terrain. For the Howell Creek Basin, it can be less than 484. The peak rate factor of 484 is retained for this study, but the value of L calculated by Equation 1 is increased if any of the following conditions exist.

- Ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts
- Reduction of land slope through grading
- The presence of pond and swamp areas in the basin

No adjustments are made in the lag time for subbasins with a high degree of urbanization. For subbasins with flat, swampy, or/and depression areas, a factor of 1.5 is used to adjust the estimated lag time. A factor of 2.0 is applied to the subbasins in which a detention pond is connected to or located near the channel (Suphunvorranop and Clapp 1984).

Basin Area. Subbasin areas are determined from the U.S. Geological Survey quadrangle maps.

Muskingum Routing Parameters. These values are estimated from the known data for similar drainage basins.

Initial Stage Elevations. Initial elevations for lakes and other storage areas are estimated based on long-term stage records, U.S. Geological Survey quadrangle maps, and photogrammetric maps.

Stage-Storage-Discharge Relationships. Development of these relationships for lakes, ponded areas, and various water control structures is described in the next section.

Flood Elevation Determinations

For a hypothetical storm event of given return period (T), the HEC-1 program computes streamflow hydrographs at desired locations in the river basin. For ponded areas through which streamflow routing is performed (e.g., ponds and reservoirs which intercept a stream), HEC-1 also computes a stage hydrograph. These hydrographs furnish peak discharges for streams and peak elevations for lakes connected by Howell Creek and its tributaries. Flood profiles for streams are developed using the peak discharges obtained from HEC-1. The USACE computer program HEC-2 (1990) is selected for this purpose. The program computes water surface profiles for steady, gradually varied flow in natural or man-made channels. The effects of various obstructions such as bridges, culverts, weirs, and other structures in the floodplain may be considered in computations. The program is designed also for application in floodplain management studies to assess the effects of channel improvements, levees, and structural modifications on water surface profiles. For this study, the February 1991 personal computer version (4.6.0) of HEC-2 was used.

Model Input Data. Input parameters used in the HEC-2 model include channel and overbank Manning's roughness coefficients, channel and structure (bridges and culverts) profiles, areas in orifice flow, and weir flow and other loss coefficients.

Orange and Seminole counties furnished field-surveyed channel cross sections and details of culverts and bridges. Locations of cross sections were selected according to the guidelines provided in the HEC-2 users manual.

For obtaining cross-sectional data of the floodplain, the contour information available on photogrammetric maps is used. The aerial photography was conducted in February 1981 for Orange County and in May 1980 for Seminole County. The aerial maps have a scale of 1 in. to 200 feet (ft) and show contour lines at 1-ft intervals for Orange County maps and 2-ft intervals for Seminole County maps.

The channel roughness coefficients are assessed based on field inspections and color photographs taken at various sites. Roughness coefficients for channels varied from 0.015 to 0.080. Overbank roughness has a range of 0.040 to 0.120.

Stage-Storage-Discharge Relationships. With few exceptions, stage-discharge relationships for various control structures are determined directly from the HEC-2 output. However, several iterations are made to reflect appropriate backwater effects at each stage. Stage-storage relationships are obtained from the HEC-2 output for those portions of the basin where the surveyed cross sections adequately described the available stage-area relationships. For lakes and other areas of ponding, the stage-area relationships are determined by planimetry.

Flood Damage Assessments and Identification of Major Problem Areas

Floods cause direct damage to buildings, bridges, and agricultural crops and litter streets and adjoining areas. The extent of damage depends on depth of flooding and, in some instances, on the duration of flooding, for example, of agricultural crops. Indirect damages occur through inconveniences caused by flooding, for example, traffic detours around flooded areas, interruptions in utility services, closure of public facilities or industrial plants, damage to the environment, etc. To identify general floodprone areas, 100-yr floodplain maps are prepared from the HEC-1 and HEC-2 results using 1980–81 aerial maps (Appendix A).

Damages to Buildings (Residential and Commercial) (Appendix B). All structures (buildings) in the 100-yr floodplain were assigned identification numbers, and Orange County, Seminole County, and the City of Orlando were requested to survey these structures to obtain additional information. The information collected consists of the value of the structure as appraised by the county for taxing purposes, the type of structure, first-floor and ground elevations, and other miscellaneous information, including a photograph of the structure (Figure 4). The original request for survey information was made in 1987, based on the results obtained in the 1984 study and the 1980–81 aerial maps. However, several new housing developments occurred in the basin (especially in Seminole County) or new houses were built after the 1980–81 aerial mapping. The Florida Department of Transportation (DOT) periodically conducts aerial photographic surveys, and the latest available DOT aerial maps at the time of the present study were those taken in 1986. The 1980–81 aerial maps are compared with the DOT maps to identify new houses. The present study also identified additional houses that are now in the 100-yr floodplain because of revisions in the flood elevations. The counties were later (1991) requested to provide survey information for the structures that were built in the 100-yr floodplain after the 1980-81 photogrammetric mapping. The information for most of the new/additional houses was received for Orange County, but not for Seminole County.

Structure Survey Field Form

Project Name: Howell Creek WMS
Project Number: 01-44-5140-1201-DIST-10012

Prepared by: JOE STOKES / CITY OF ORL. Date: 12 / 2/1991

Structure ID#: R-1 County: Orange

Section, Township, Range: 13 , 22 S, 29 E

Address:

Structure Category:
(X) Residential - Single Family
(__) Residential - Multi-Family
(__) Commercial
(__) Other ____________

Structure Type:
(__) Mobile Home
(__) Single Story Concrete Slab Floor
(__) Single Story Elevated Wood Floor
(X) Multi-Story

Survey Data: Ground Elevation Next to Structure 77.14 ft.
First Floor Elevation 77.50 ft.

Comments: Land Value: Structure Value:

Figure 4. Field survey information

Flood damages for single storm events for each structure are calculated from the 1974 depth-damage data developed by the Federal Insurance Administration (FIA) (Table 2). FIA developed these data based on flood insurance claims. Determining the value of the contents of each house by survey is not practical. Therefore, an assumption is made that the contents have a value of 35 percent of the structure, a method suggested by Johnson (1985).

The FIA data (Table 2), however, are general and may be used for preliminary estimates of damages. Site-specific data are essential for accurate estimates. Note that damages for houses with no basements begin when the flood level is 1 ft below the first-floor elevation, because of capillary action of water.

In the case of the Howell Creek Basin, a majority of the houses that are likely to be damaged by floods are located at the fringe of the 100-yr flood line of lakes, and the 100-yr flood depth has a range of 0.0 to 1.0 ft below first-floor elevation. Only one side of the house would come in contact with flood waters (because the houses are located on grounds that slope down toward the lakes), not the entire house. Also, the lakes may rise gradually, and thus the buildings would not experience the dynamic forces of water. In such cases, the damages calculated by the FIA methodology may be higher than the damages that can actually occur. Flood damages, however, are calculated using the FIA factors, and in these cases the results include a remark that the calculated damages might be overestimates.

The 10-, 25-, and 100-yr flood elevations at each house (structure) are evaluated from the results of the HEC-1 and HEC-2 programs. The damages are calculated based on the depth of flooding from an elevation 1 ft below the first floor, and the damage as a percentage of the value of the structure and contents (Table 2).

Table 2. Federal Insurance Administration (FIA) 1974 depth-damage data for single storm events

Depth Above and Below First Floor (feet)	Damage as a Percentage of Structure or Contents Value			
	One Story, No Basement		One Story With Basement	
	Structure	Contents	Structure	Contents
-8.0				0
-3.0			0	5
-2.0		0	4	7
-1.0	0	*	8	8
0.0 (first floor)	7	10	11	15
1.0	10	17	18	20
2.0	14	23	20	22
3.0	26	29	23	28
4.0	28	35	28	33
5.0	29	40	33	39
6.0	41	45	38	44
7.0	43	50	44	50
8.0	44	55	49	55
9.0	45	60	51	60
10.0	46		53	
11.0	47		55	
12.0	48		57	
13.0	49		59	
14.0	50		60	
15.0				
16.0				
17.0				
18.0				

*No value is given by FIA. A value of zero is assumed for this study.

Source: Flack 1978

Erosion Damages. Major storms produce high velocities of flow in Howell Creek and its tributaries. When these velocities exceed a certain limit (about 3 feet per second [fps]), the dynamic forces of flood waters cause channel erosion. If not adequately protected, erosion of the channel bed, banks, and bridge abutments can occur. In general, flow velocities exceeding 3 fps can develop at all bridges and culverts during 10-, 25-, and 100-yr storm events. In addition, channel reaches at several locations may carry flow of high velocities.

Bank erosion can pose a threat to nearby houses and to the safety of bridges. Foundations of houses can suffer subsidence, requiring grout treatment as a result of problems caused by bank erosion. No detailed survey has been conducted to estimate the potential damage (in dollars) due to erosion in various reaches of Howell Creek and its tributaries.

Potential Damage Areas. To identify problem areas with potential flood damages, residential damages for the 100-yr storm event are lumped together for various locations and marked on the basin map (Exhibit A). In addition to residential damages, damages resulting from the overtopping of bridges and culverts, damages from street flooding, and damages due to erosion (if quantified) are also considered in estimating total damages at each problem area.

Alternative Flood Control Measures

A single solution will not provide flood relief to all the affected areas in the Howell Creek Basin because the areas of potential flood damages are scattered throughout the basin. Each problem area is considered separately in formulating and evaluating different flood protection alternatives. Some of the areas with low damages (not exceeding $25,000 during a 100-yr storm event) are excluded from this analysis.

The following are the general kinds of flood control measures proposed in this study.

- Construction of levees and floodproofing
- Expansion of bridges and culverts
- Widening of channels
- Lowering of lake levels during wet periods to achieve additional flood storage capacity
- Creation of marsh storage areas
- Retention or detention of flood waters in upstream lakes

For a given problem area, each of the foregoing is considered either as a sole measure or in combination with other measures. All possible alternatives are considered for a given problem area to determine relative costs and benefits. Some alternatives, however, are presented conceptually without evaluation.

Benefit/Cost Calculations

Benefits are defined as the flood damages reduced by flood protection measures. Benefits (i.e., the preventable flood damages) and costs of the flood protection alternatives are expressed as annual figures for Orange County. Benefit/cost ratios were not calculated for flood protection areas in Seminole County. The ratio of annual benefits to the annual cost is a simple economic indicator (the benefit/cost ratio) used to select flood control alternatives. Annual cost is calculated by amortizing the present total cost of the flood protection measure over its expected life. The following methods are used in this study for calculating annual benefits.

Direct Flood Damages. Urban flood damages are primarily a function of flood peaks, that is, flood severity or flooding depth. In certain instances, damages also depend on flood duration, for example, agricultural and erosion damages. In this study, flood damages are estimated based on flood peaks.

For each flood peak, based on probability theory, a percent chance that the flood would occur in a given year can be assigned. In this study, three representative flood magnitudes are chosen: 1 percent (100 yr), 4 percent (25 yr), and 10 percent (10 yr) annual probability events. For each problem area, the total damages to buildings and damages to streets and bridges are estimated separately for each storm event chosen. Calculations of damages to buildings are explained in an earlier section. Cost of repair or replacement of damaged bridges constitutes the damages to bridges. Street damages are essentially debris clearance and street clearing following a storm event. These values are estimated based on 1991 dollar costs.

Annual Flood Damages. Flood damages for a community can be calculated for an infinite number of floods, covering all possible magnitudes, and a relationship can be drawn between flood damages and the annual percent flood probability (Figure 5). It is not practical to estimate flood damages for a large number of floods to derive a smooth relationship, as shown in Figure 5.

The 10-, 25-, and 100-yr (10 percent, 4 percent, and 1 percent probabilities, respectively) flood damages calculated for a given problem area provide three points on a damage-frequency curve (e.g., Figure 5). The remainder of the curve is sketched approximately, based on the trend of the curve already drawn. The area under the curve represents the expected annual damages (James and Lee 1971).

Flood Protection Alternatives—Total Cost. Each flood protection alternative in this study consists of a number of components (e.g., earthwork, sodding, structural components, labor). Present-day unit costs (i.e., at the time of this study, 1991) of various components are used to compute the total cost of a proposed flood control alternative (Appendix C).

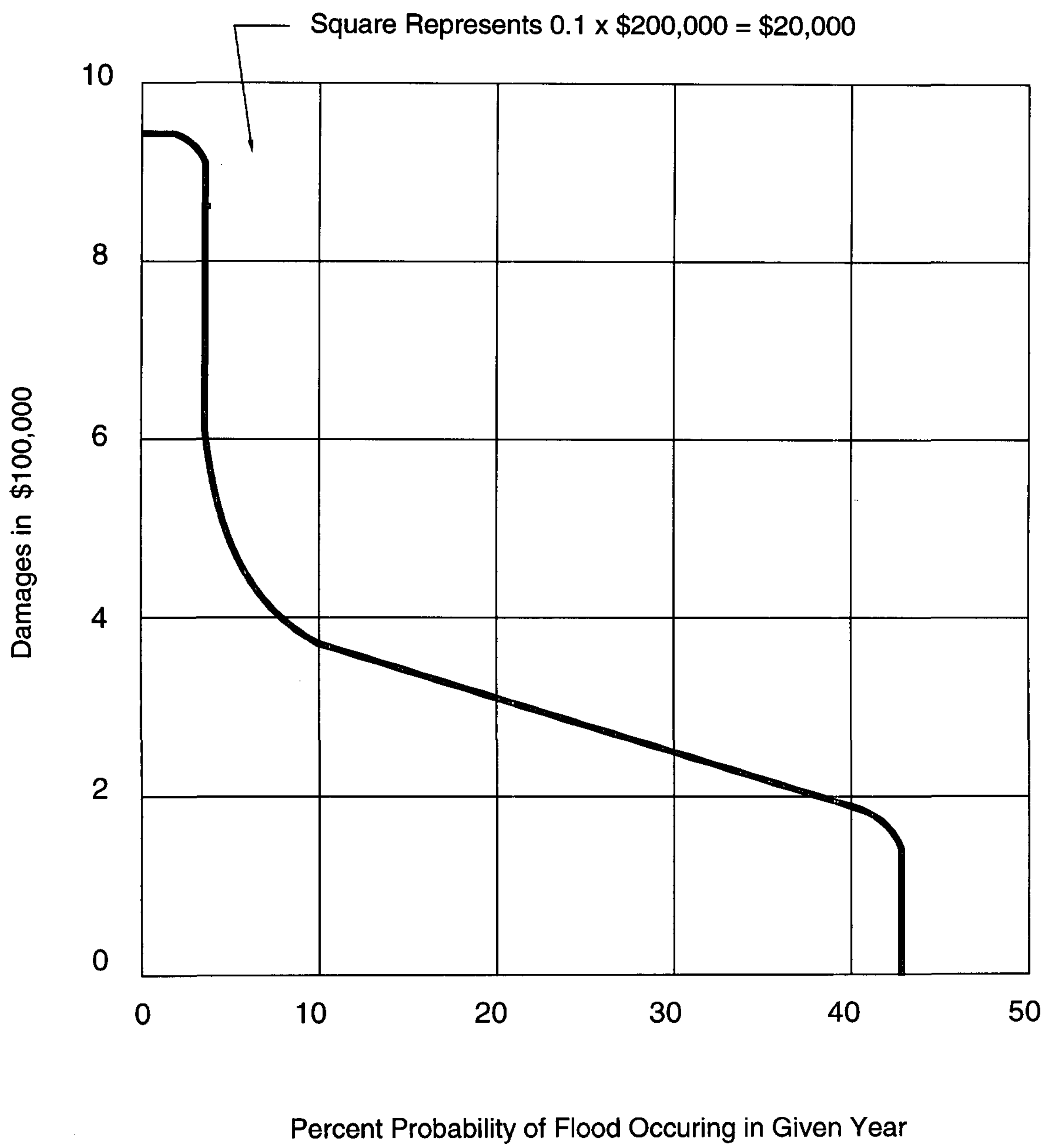


Figure 5. Typical damage-frequency curve

Flood Protection Alternatives—Annual Cost. The formula for converting the *present worth* into *annual values* over a period of time is as follows.

$$CRF = \frac{C}{P} = \frac{i\,(1 + i)^n}{(1 + i)^n - 1} \qquad (2)$$

where:

CRF = capital recovery factor: the number of dollars one can withdraw in equal amounts at the end of each of n years if one dollar is initially deposited at i percent annual interest rate

C = annual cost of the flood protection alternative

P = present worth, that is, total cost of the flood protection alternative as calculated at the time of the study

All annual costs (C) in this report are calculated using an annual discount rate (i) of 8 percent and a life expectancy (n) of 50 yr for the improvements.

Benefit/Cost Ratio. The annual benefits offered by a flood protection alternative are calculated as follows.

$$B = EAD_p - EAD_a \qquad (3)$$

where:

B = annual benefits

EAD_p = expected annual damages under present conditions, that is, without a flood control project

EAD_a = expected annual damages after the improvements, that is, with a flood control project

Indirect and Intangible Benefits. In projecting benefit/cost ratios for various flood protection alternatives in this study, only direct benefits (i.e., those accruing from a reduction in physical damage to items coming in contact with flood water) are considered. A flood control project offers several other benefits that are either indirect or intangible. In project decision making, all of these benefits should be carefully evaluated and considered. A detailed analysis of these benefits is beyond the scope of this study. Following are some of these benefits (James and Lee 1971).

- Fewer interruptions to transportation and communication (traffic detours around the flooded area and flood-induced interruptions in utility service)
- Reduction in wages lost by workers if industrial plants are closed by floods
- Enhancement of land values as a result of reduction in flood threat
- Less loss of life; improvements to health
- Improved aesthetics and the preservation of areas of natural beauty and scenic interest
- Benefits to the environment

By analyzing a number of USACE projects, Kates (USACE 1958) found the values of the indirect damage benefits (i.e., if the flood protection measures are completed) to be 15 percent of the direct flood damages for residential damage, 37 percent for commercial, 45 percent for industrial, 10 percent for agricultural, 10 percent for damage to utilities, 34 percent for public property, 25 percent for highways, and 23 percent for railroads.

The intangible effect most strongly emphasized in flood control planning is the sense of security that comes when floods no longer occur. Most agencies use rare-design floods because, according to the Senate Committee on National Water Resources (U.S. Senate 1960), "If the degree of protection originally provided is too low, a false sense of security is induced, unwarranted development is encouraged, and when the great flood comes, inevitably the stage will be set for a disaster."

In addition to direct and indirect damages, there is a cost associated with the uncertainty of when major floods will occur (James and Lee 1971). This cost is the amount individuals are willing to pay to avoid a flood loss pattern that is highly variable from year to year and occasionally reaches catastrophic proportions (Bhavnagri and Bugliarello 1965). Thus, the total average annual damages consist of the following: direct damages (as calculated in this study), indirect damages, and an uncertainty cost. The benefit/cost ratios in this study could be higher than the calculated ratios because of indirect and intangible benefits. The calculated benefit/cost ratios presented in this report may be increased by 30 percent to account for these benefits.

ENVIRONMENTAL METHODS

Environmental methods used in this study include the following.

- An assessment of water quality conditions in the basin
- Mapping of vegetation and quantification of wetland loss
- An evaluation of the ecologic effects of some proposed flood control alternatives

Assessment of Water Quality Conditions

Water quality conditions in the Howell Creek Basin are evaluated using Hand et al. (1990), *State Water Quality Standards* (Chapter 17-3, *Florida Administrative Code* [F.A.C.]), and Friedemann and Hand (1989).

Water quality samples were collected at many locations in the Howell Creek Basin. Fifteen stations were selected for this study because of their pertinence to the study and their extensive sampling records. The locations of these stations are marked on Exhibit A.

Water Quality Data. Data from the Orange County Environmental Protection Department (Appendix D) were used to assess water quality at stations 1–7 (Exhibit A) in the Howell Creek Basin. Data from the Seminole County Environmental Services (Appendix D) were used to assess water quality for stations 8–15 (Exhibit A) in Howell Creek Basin. Station numbers and names, locations, periods of record, number of samples taken, and sampling agencies are listed in Table 3. Many different water quality parameters were measured; however, only those significant to the study are discussed and, in most cases, only when values indicate potential water quality problems (Table 4).

Department of Environmental Protection Standards. The Department of Environmental Protection (DEP, formerly Departments of Environmental Regulation and Natural Resources) uses mathematical models to evaluate water quality: the Water Quality Index (WQI) to evaluate water quality in streams and the Trophic State Index (TSI) to evaluate water quality in lakes. The WQI calculates a value based on water clarity, dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD), total and fecal coliforms, nutrients, and biological diversity. Calculated values are compared to index values for other Florida streams. Streams receiving values between 0 and 44 are rated "good," those between 45 and 59 are rated "fair," and scores between 60 and 90 are termed "poor." The TSI, used for assessing lakes, is calculated based on nutrient concentrations (nitrogen and phosphorus), chlorophyll *a*, and Secchi depth. Lakes receiving values between 0 and 59 are rated "good," scores between 60 and 69 are "fair," and scores between 70 and 100 are "poor." The parameters used in this report to calculate the WQI and TSI ratings are listed in Table 5.

Table 3. Water quality stations: Howell Creek

County	Water Quality Station Number	Station Name	Location	Period of Record	Number of Samples	Sampling Agency*
Orange	1	HB21	Lake Killarney	09/19/83-10/23/89	22	Orange County
	2	HB32	Park Lake	03/28/89-12/11/89	8	Orange County
	3	HB24	Lake Maitland	02/19/80-10/18/88	38	Orange County
	4	HB26	Lake Minnehaha	02/19/80-10/18/88	29	Orange County
	5	HB39	Lake Virginia	02/19/80-10/18/88	39	Orange County
	6	HB20	Lake Ivanhoe	06/30/83-10/18/88	21	Orange County
Seminole	7	HB436	Howell Creek at State Road 436	08/16/83-03/03/86	14	Orange County
	8	LH2	Outlet of Lake Howell	08/01/83-03/03/86	11	Seminole County
	9	BG1	Bear Gully Creek at State Road 426	01/22/80-01/14/86	14	Seminole County
	10	BG3	Bear Gulley Creek at Tuskawillow Road	01/22/80-01/14/86	21	Seminole County
	11	BG4	Bear Gulley Creek at Red Bug Lake Road	01/27/80-01/14/86	22	Seminole County
	12	BG6	Bear Gulley Creek just upstream of confluence with Howell Creek	02/01/84-01/14/86	7	Seminole County
	13	HB5	Howell Creek at Tuskawillow Road	08/01/83-03/03/86	11	Seminole County
	14	HB7	Howell Creek at Dyson Road	08/01/83-03/03/86	11	Seminole County
	15	HB8	Howell Creek at State Road 419 (434)	08/01/83-03/03/86	11	Seminole County

*Orange County Environmental Protection Department or Seminole County Environmental Services

Table 4. Water quality parameters sampled in each county

Parameter	Orange County	Seminole County
Copper	X	
Lead	X	
Zinc	X	
Cadmium	X	
Nickel	X	
Turbidity	X	X
Secchi depth	X	
Dissolved oxygen	X	X
Biological oxygen demand	X	X
Chemical oxygen demand	X	
Chlorophyll *a*	X	
Total coliforms	X	
Fecal coliforms	X	
Total nitrogen	X	X
Total phosphorus	X	X

Table 5. Water quality parameters and method of assessment

Parameter	Assessment			
	Water Quality Index (rivers)	Trophic State Index (lakes)	State (Class III waters)	Typical Water Quality Values (lakes)
Copper			X	
Lead			X	
Zinc			X	
Cadmium			X	
Nickel			X	
Turbidity	X			X
Secchi depth		X		
Dissolved oxygen	X			X
Biological oxygen demand	X			X
Chemical oxygen demand	X			
Chlorophyll *a*	X			
Total coliforms	X			
Fecal coliforms	X			
Total nitrogen	X	X		
Total phosphorus	X	X		

State Standards. The state water quality standards (Chapter 17-3, *F.A.C.*) establish use attainability limits for many parameters; however, only heavy metals are evaluated by state standards in this report (Table 5). The Howell Creek Basin contains Class III water, so water quality data are compared to Class III numerical standards. State standards for heavy metals vary because they are based on the natural log of hardness. These state standards for heavy metals were calculated only from measurements made after 1985 (Appendix D), when new analytical instrumentation was installed by Orange County.

Typical Water Quality Values. Friedemann and Hand (1989) identified median values for water quality constituents for 1,000 lake stations and 2,700 stream stations in Florida. Median values for selected parameters at Howell Creek stations (Table 5) were then compared to percentile distributions of typical water quality values for the state. In this report, elevated levels are considered to be those exceeding the 50th percentile; depressed levels are those below the 50th percentile.

Mapping of Vegetation

Development in the basin has involved the filling and draining of many wetlands. To determine the extent of wetland loss, vegetation maps were prepared using 1947–48 and 1984–88 aerial photographs. Areas of vegetation types were compared using the SJRWMD geographical information system (GIS).

Wetlands were interpreted for 1947–48 using February 23, 1947, Agricultural Stabilization and Conservation Service black-and-white aerial positives (scale 1:20,000) for Orange County and November 25, 1948, positives for Seminole County. Wetlands were interpreted for 1984–88 using March 8, 1984, color, infrared aerial photographic transparencies (scale 1:24,000) for Seminole County and March 16, 1988, transparencies for Orange County. The acreages presented for 1947–48 are approximate because of the impossibility of ground verification.

A stereo zoom transfer scope was used to view 1947–48 photographs. A high-intensity light table with stereo-optics was used to view 1984–88 photographs. Vegetation types were delineated on high transmissivity mylar using india ink pens. Wetlands for 1947–48 were characterized as being herbaceous, shrub, forested, converted to agricultural land, or open water. Wetlands for 1984–88 were characterized according to the SJRWMD wetland diagnostic characteristics (Appendix E) and then grouped as forested, shrub, herbaceous, or open water. Wetland polygons were digitized and entered into the ARC/INFO GIS computer system. These wetland polygons were analytically adjusted for spatial distortions from aircraft movements using an in-house photorectification process. Acreages were calculated by GIS, and maps were plotted using an electrostatic plotter.

Flood Control Alternatives: Evaluation of Ecological Effects

The following are the general kinds of flood control measures proposed in this study.

- Construction of levees and floodproofing
- Widening of channels
- Lowering of lake levels during wet periods for achieving additional flood storage capacity

The first two measures involve construction activity; they disturb the soils and vegetation near the construction sites and alter the existing stream configuration. Depending on the specific situation, these disturbances can result in negative effects on the environment/ecology and water quality (Darnell 1976).

Levees. Levee building has direct effects on the aquatic community. Disturbing sediments often releases contaminants into the water. Deleterious compounds can be found in sediments, depending upon surrounding land uses. Industrial, agricultural, and urban activities can input heavy metals, pesticides, and other organic compounds. Organic matter is often present in sediments and will cause depressed oxygen levels if introduced to the water column.

Scraping the banks to remove fill also disrupts the benthic community. Removal of vegetation near streambanks destroys wildlife habitat and promotes erosion and downstream sedimentation.

Bank construction removes the tree canopy at the water's edge so the channel is no longer shaded. Canfield and Hoyer (1988) reported that more sunlight reaching the Little Wekiva River could cause aquatic plant problems. Nutrients in the water would support a significant aquatic plant population, but lack of light generally prevents plant growth.

Widening Channels. Widened channels are often lined with construction materials to prevent erosion. This lining suffocates the benthic community and leaches substances into the water. Channel widening also changes water flow dynamics. A wider channel conveys more water but may dry out during periods of little rain. The benthic community requires a minimum flow of water to be sustained.

The construction managers and contractors are required to follow certain *best management practices* to minimize the effects of construction activities on the environment. A detailed discussion of these practices is beyond the scope of this report. Following are two important remedial measures.

- Native plants should be used for bank stabilization. This will prevent the spread of exotics and preserve native habitat.

- Spoil banks and levees should not isolate adjacent wetlands. Levees will alter the wetlands by eliminating the flow of water, the transport of organic matter, and the migration of animals. Canfield and Hoyer (1988) reported that increasing the residence time of nutritive river water could cause algal populations to increase drastically. Algal populations generally do not form in fast-moving water but may proliferate in slow flow or stagnant pools.

Lowering Lake Levels. Lowering water levels in lakes during wet periods could increase bottom exposure of the lake with time, producing minor ecological benefits. Exposure of at least the wetland margin of lakes is necessary for healthy wetlands, as it rejuvenates lake shores and allows oxidation of organic sediments. The degree of ecological benefit depends on the amount and duration of fluctuation and lake bottom exposure.

Other effects, if any, are discussed with the specific flood control solutions proposed.

THE REVISED FLOODPLAIN STUDY

A floodplain study for the Howell Creek Basin was completed by SJRWMD in 1984 (Suphunvorranop and Clapp 1984). This study, however, inadvertently omitted about 5 mi^2 of highly urbanized area that is a part of the Howell Creek drainage system. Therefore, the results of the 1984 study are considered inadequate for developing a flood management plan for the basin. The study was revised by including the omitted area. Revisions were made in the HEC-2 input data based on additional field observations. Also, some improved modeling techniques were used. This chapter presents (1) a summary of the revised basin input data, (2) a summary of revised flood discharges, elevations, and velocities, and (3) an explanation of the revised flood profiles and maps of flood hazard areas.

REVISED BASIN INPUT DATA

The Howell Creek Basin (Exhibit A) is located in Orange and Seminole counties in central Florida. The area of the basin is about 52 mi^2, and the upper portion of the basin lies in the City of Orlando in Orange County (Exhibit A, Sheet 1). The headwaters of Howell Creek originate in Lake Maitland, which receives inflows from a number of surrounding lakes that are interconnected by channels or underground pipes. The creek then flows northeasterly through Lake Howell and continues on to meet Bear Creek near State Road (S.R.) 434; the confluence is approximately 2 miles upstream of Lake Jesup (Exhibit A, Sheet 2). The headwaters of Bear Creek are located in Bear Gully Lake, which receives inflows from other lakes. Construction activities in the Bear Creek Basin appear to have altered the hydrology/hydraulics of the area somewhat since the 1984 study. No attempt has been made to incorporate these changes into this study because it would involve extensive field survey. The hydraulic connections that exist among the lakes in Orange County are schematically shown in Figure 6.

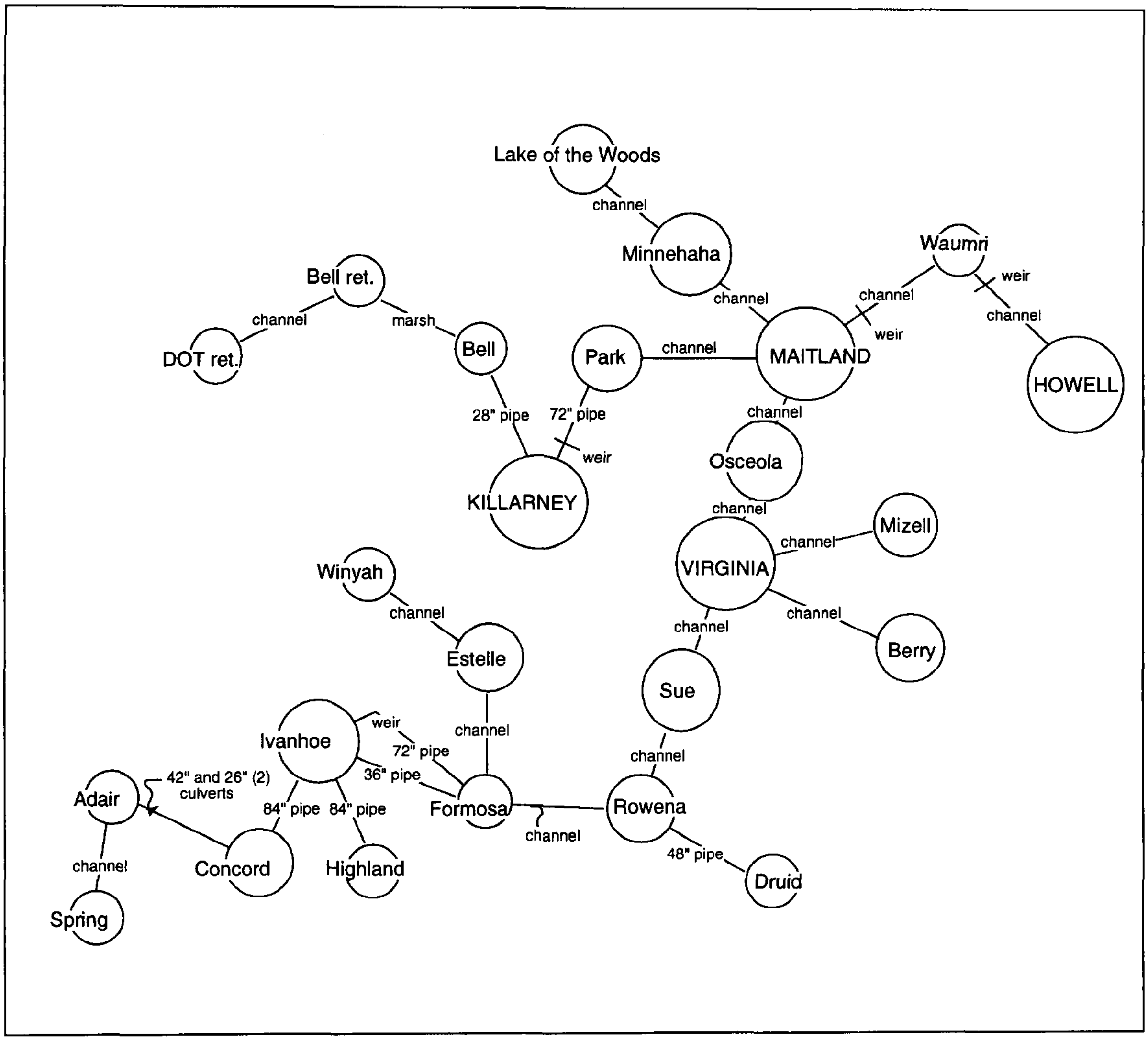


Figure 6. Schematic of the hydraulic connections among the lakes above Lake Howell

The Howell Creek Basin is divided into 39 subbasins for modeling (Figure 3). Subbasins H4A, A-1 through A-7, and a portion of H-1 (Figure 7) were not included in the 1984 study. Subbasins A-5, A-6, and A-7 have insignificant runoff contribution and, therefore, are not included in the hydrologic modeling.

Table 6 summarizes subbasin areas, weighted runoff curve numbers (CN), and subbasin lag times (L). Table 7 gives the initial lake and ponded area elevations assumed in this study. Data presented in Tables 6 and 7 are used in HEC-1 modeling (see "Methods" section).

The 1984 study attempted to determine the elevation differences within the following lake chains in Orange County: (1) Lakes Maitland-Minnehaha, (2) Lakes Osceola-Virginia-Mizell, and (3) Lakes Sue-Rowena-Formosa-Estelle-Winyah. The observed elevations since July 1984, however, indicated that the elevation differences within each chain of lakes were insignificant. For example, the following elevations were observed on April 3, 1987, following a major storm event.

Lake Minnehaha	66.91 ft NGVD*
Lake Maitland	66.96 ft NGVD
Lakes Osceola/Virginia	67.26 ft NGVD
Lake Berry	70.45 ft NGVD
Lake Sue	72.82 ft NGVD
Lake Formosa	72.88 ft NGVD
Lake Estelle	72.87 ft NGVD
Park Lake	70.25 ft NGVD
Lake Killarney	84.20 ft NGVD
Lake Bell	89.33 ft NGVD

*feet, National Geodetic Vertical Datum

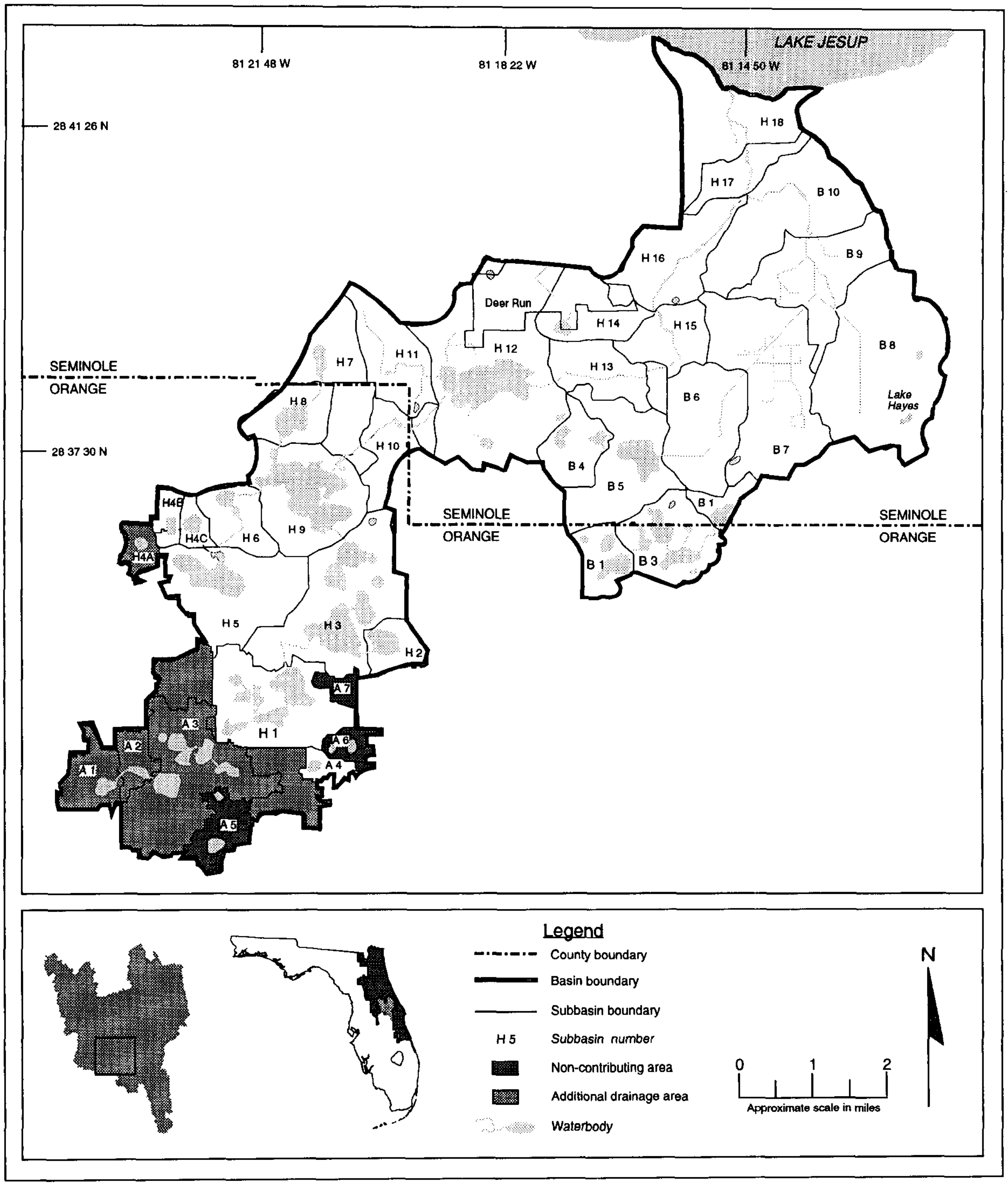


Figure 7. Subbasins not included in the 1984 study (Suphunvorranop and Clapp 1984)

Table 6. Summary of subbasin areas, runoff curve numbers (CN), and lag times. *Subbasins are identified in Figure 3.*

Subbasin	Area (mi^2)	Weighted CN	Lag Time (hours)
A-1	0.70	62.9	1.4
A-2	0.39	74.7	1.6
A-3	0.57	74.7	1.6
A-4	0.24	79.0	0.58
A-5	0.68	NC	NC
A-6	0.31	NC	NC
A-7	0.20	NC	NC
H-1	3.80	87.6	1.8
H-2	0.53	76.0	1.0
H-3	2.88	83.5	2.1
H-4A	0.37	60.0	1.2
H-4B	0.21	77.0	1.5
H-4C	0.22	77.0	1.2
H-5	2.40	88.0	2.3
H-6	0.77	81.0	2.0
H-7	0.87	84.0	2.0
H-8	0.77	74.0	1.5
H-9	2.07	86.0	1.5
H-10A	0.59	78.0	1.5
H-10B	0.79	78.0	2.0
H-10C	0.20	78.0	0.5
H-11	1.27	80.0	6.0
H-12	3.94	82.0	3.8
H-13	1.16	70.0	3.3
H-14	0.90	75.0	1.9
H-15	0.62	61.0	2.7
H-16	1.69	75.0	6.0

Table 6—*Continued*

Subbasin	Area (mi^2)	Weighted CN	Lag Time (hours)
H-17	0.71	76.0	1.8
H-18	2.01	75.0	2.8
B-1	0.33	65.0	2.0
B-2	0.66	73.0	2.5
B-3	1.60	70.0	4.0
B-4	0.83	72.0	2.8
B-5	1.86	73.0	3.9
B-6	1.82	73.0	4.3
B-7	3.12	77.0	3.5
B-8	3.88	74.0	4.1
B-9	1.95	74.0	3.4
B-10	2.42	73.0	3.1

Note: mi^2 = square miles
CN = curve number
NC = non-contributing subbasins

Table 7. Initial lake stages assumed in the HEC-1 model. *Elevations in parentheses in the initial stage column are the initial stages used in the 1984 study.*

Location (subbasin)	Initial Stage (ft NGVD)
Spring Lake (A-1)	88.1
Lake Adair (A-2)	78.0
Chain of lakes: Ivanhoe, Highland, Concord (A-3)	78.0
Druid Lake (A-4)	99.0
Chain of lakes: Sue, Rowena, Formosa, Winyah, Estelle (H-1)	71.7
Lake Berry (H-2)	69.6
Chain of lakes: Osceola, Virginia, Mizell (H-3)	66.3 (66.2)
Department of Transportation retention pond (H-4A)	91.5
Lake Bell retention pond (H-4B)	90.8
Lake Bell (H-4C)	88.0 (89.0)
Lake Killarney (H-5)	82.9
Park Lake (H-6)	69.4 (70.0)
Lake of the Woods (H-7)	75.8
Lake Minnehaha (H-8)	66.3 (66.2)
Lake Maitland (H-9)	66.3
Lake Waumpi (H-10B)	60.2
Lake Howell (H-12)	53.6
Deep Lake (B-1)	56.0
Lake Waunatta (B-2)	62.5
Chain of lakes: Burkett, Martha, Pearl (B-3)	53.0
Garden Lake (B-4)	53.0
Bear Gulley Lake (B-5)	49.0

Note: ft NGVD = feet, National Geodetic Vertical Datum

For the HEC-1 modeling in this study, each of the following lake chains is treated as a single storage system.

- Lakes Minnehaha and Maitland
- Lakes Osceola, Mizell, and Virginia
- Lakes Sue, Rowena, Formosa, Estelle, and Winyah
- Lakes Ivanhoe, Highland, and Concord

Two major lakes in Orange County have control structures—Killarney and Maitland. The Lake Killarney structure has downward-operating weir gates which can control the weir crest elevation to be between 82.00 and 84.00 ft NGVD. During flood events, the maximum level that the lake would reach depends on the lake level at the onset of the storm. The purpose of the Lake Killarney structure is to control flooding in Park Lake.

The present Lake Maitland structure, built in 1979, is fitted with two upward-operating 28-ft-wide roller gates with a sill elevation of 62.50 ft NGVD. Prior to 1979, it was a fixed-board crested weir, which was adjusted by adding or deleting boards. This structure controls the water levels of Lakes Maitland, Minnehaha, Osceola, Mizell, and Virginia, which together form a more-or-less level pool during normal periods. The gates of the structure, however, were welded shut soon after its construction because of the concerns of Seminole County government and residents about potential downstream flooding. The structure now operates as fixed weir at a crest elevation of 66.15 ft NGVD, which is the height at the top of the gates.

REVISED FLOOD DISCHARGES, ELEVATIONS, AND VELOCITIES

Flood Discharges

Simulation of Storm Events. Flood discharges for 10-yr, 25-yr, and 100-yr return periods were calculated by the HEC-1 program by simulating single storm events of the same recurrence intervals (see "Methods" section). Peak discharges for the 100-yr return period ranged from 440 to 6,070 cubic feet per second (cfs) on the mainstem of Howell Creek and from 62 to 3,640 cfs on the tributaries (Table 8). Figure 8 gives locations of some of the stations presented in Table 8.

Comparison with Other Studies. USACE Jacksonville District performed hydrologic and hydraulic analyses for the Howell Creek Basin to complete Flood Insurance Study reports for various communities in Orange and Seminole counties (FEMA 1978, 1979, 1981, 1989a, 1989b). Flood discharges presented in these reports are compared with discharges from the present study (SJRWMD) in Table 9. The differences in the two discharge estimates may be attributed primarily to the basin conditions at the time of the studies and the methods used.

Flood Elevations

Computation of Peak Elevations/Flood Profiles. Peak elevations for all lakes and storage areas are calculated by the HEC-1 program. For the mainstem of Howell Creek and other tributaries, flood profiles are computed by the HEC-2 program using peak discharges generated by the HEC-1 program.

Table 8 includes the 10-yr, 25-yr, and 100-yr flood elevations for key locations in the basin, including the major lakes. Flood profiles are presented in Appendix F.

Comparison with Other Studies. Table 10 presents a comparison of flood elevations computed in this study (SJRWMD) with those of USACE. The USACE values were published in the Federal Emergency Management Agency (FEMA) references given under the comparison of discharges section above.

Both 10-yr and 100-yr flood elevations computed by SJRWMD are higher than the FEMA projections for most locations. Urban development in the basin since the completion of the USACE studies and the detailed modeling procedures used in this study have generally resulted in upward revisions of flood elevations for the basin. The few exceptions in which the SJRWMD estimates are lower (e.g., at S.R. 434) may be the result of drainage improvements in the basin.

Table 8. Summary of flood discharges, elevations, and velocities

Station	Location	Discharge (cfs)			Elevation (ft NGVD)			Velocity (fps)		
		10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
Howell Creek										
0 + 00	Mouth of Howell Creek	2800	3930	6070	8.10	8.70	9.80	0.52	0.61	0.76
47 + 55	Channel*	2880	3930	6070	8.19	8.81	9.93	1.95	2.19	2.52
58 + 20	S.R. 419/434 (HS-1)	2660	3650	5700	9.35	12.17	12.45	8.30	5.33	7.48
65 + 45	Channel*	2660	3650	5700	11.94	12.51	13.04	4.77	5.85	8.24
78 + 30	Seaboard Railroad (HS-2)	2660	3650	5700	12.93	13.82	15.19	3.01	3.29	3.90
92 + 75	Channel*	2660	3650	5700	13.51	14.40	15.83	2.97	3.51	4.48
94 + 25	Northern Way (HS-3)	2660	3650	5700	13.48	14.44	16.55	8.38	9.45	10.67
100 + 60	Confluence with Bear Creek	2620	3580	5620	15.41	16.74	19.21	4.33	4.95	5.86
106 + 60	Channel*	1140	1540	2330	15.80	17.19	19.75	2.69	2.86	2.97
110 + 00	Extension of Winter Springs Blvd.	1140	1540	2330	16.60	18.06	20.38	1.44	1.56	1.80
122 + 50	Channel*	1140	1540	2330	17.87	18.96	20.93	3.87	3.59	3.15
123 + 10	Golf cart bridge (HS-5)	1140	1540	2330	18.27	19.03	20.92	3.42	3.98	4.07
134 + 45	Golf cart bridge (HS-6)	1140	1540	2330	19.79	20.79	22.16	3.84	4.38	5.25
145 + 15	Channel*	1140	1540	2330	21.14	22.17	23.62	5.00	5.32	6.00
145 + 65	Golf cart bridge (HS-7)	1140	1540	2330	21.52	23.03	23.88	6.11	6.64	8.94
147 + 25	Golf cart bridge (HS-8)	1140	1540	2330	22.46	23.96	25.50	1.76	1.79	2.17
165 + 60	Channel*	991	1340	2030	23.74	24.94	26.49	2.49	2.62	3.05
166 + 25	Golf cart bridge (HS-9)	991	1340	2030	23.78	24.97	26.70	2.47	2.44	2.59
172 + 19	Northern Way (HS-10)	991	1340	2030	24.63	25.62	27.18	4.28	4.87	5.88
198 + 60	Channel*	991	1340	2030	28.15	28.91	30.17	3.27	3.39	3.43
207 + 00	Dyson Drive (HS-13)	847	1140	1730	29.20	29.98	31.20	3.73	4.34	5.41
225 + 00	Channel*	677	914	1380	29.94	30.73	32.01	3.59	4.11	4.87
253 + 60	Channel*	677	914	1380	33.28	34.11	35.06	4.10	4.01	3.28
268 + 59	Red Bug Lake Road (HS-15)	677	914	1380	35.04	35.63	36.69	9.59	10.72	12.50
281 + 04	Wooden bridge (HS-15A)	677	914	1380	38.07	38.99	41.00	5.75	6.36	6.62
288 + 99	Tuskawillow Road (HS-16)	539	710	1160	38.78	39.99	41.98	7.50	6.51	6.54
308 + 40	Dam (HS-16B)	539	710	1160	43.53	44.30	46.11	3.17	3.33	3.48
313 + 90	Channel*	539	710	1160	43.95	44.69	46.46	1.94	1.94	1.87
332 + 65	Dodd Road (HS-17)	539	710	1160	45.14	45.82	48.02	12.32	11.72	8.46
337 + 0	Channel*	539	710	1160	48.24	48.68	49.68	1.35	1.31	1.28
363 + 40	Channel*	539	710	1160	50.62	51.12	52.09	3.10	3.21	3.45
377 + 50	Weir at Jericho Drive (HS-19)	502	664	1090	56.30	56.85	57.78	0.97	1.16	1.59

Table 8—*Continued*

Station	Location	Discharge (cfs)			Elevation (ft NGVD)			Velocity (fps)		
		10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
429 + 00	Lake Howell	502	664	1090	56.36	56.92	58.03	0.02	0.02	0.03
480 + 98	S.R. 436 (HS-24)	278	400	681	56.38	56.95	58.07	0.32	0.42	0.60
493 + 40	Lake Howell Lane (HS-25)	278	400	681	56.45	57.04	58.15	2.20	2.67	3.43
497 + 97	Lake Howell Road (HS-27)	278	400	681	59.78	60.28	61.03	4.17	5.22	7.43
499 + 59	Channel*	278	400	681	61.75	62.23	63.00	0.74	0.96	1.40
516 + 00	Mouth of Lake Waumpi	278	400	681	62.95	63.54	64.53	0.28	0.36	0.51
537 + 00	Channel*	278	400	681	63.01	63.59	64.58	1.24	1.36	1.38
557 + 65	Temple Trail	285	404	686	63.56	64.14	65.03	3.13	3.75	5.08
573 + 25	Channel*	289	408	695	64.63	65.32	66.48	1.85	2.05	2.49
574 + 91	Lake Maitland Weir	289	408	695	67.10	67.33	67.84	5.48	6.17	7.38
605 + 10	Lake Maitland	197	260	440	67.79	68.23	69.09	0.01	0.01	0.02
659 + 60	Channel*	214	289	455	67.95	68.39	69.20	2.25	2.68	3.44
660 + 40	Palmer Avenue	214	289	455	67.97	68.41	69.21	2.07	2.58	3.55
680 + 70	Lake Osceola	214	289	455	68.09	68.57	69.49	0.07	0.09	0.12
707 + 70	Osceola Avenue	214	289	455	68.09	68.57	69.49	1.52	1.86	2.49
732 + 50	Lake Virginia	214	289	455	68.09	68.57	69.49	0.00	0.01	0.01
755 + 47	Stirling Avenue	258	337	572	68.69	68.90	71.14	4.02	4.82	2.94
767 + 00	Channel*	258	337	572	69.37	69.92	71.18	2.10	2.40	3.12
776 + 42	Pennsylvania Avenue	258	337	572	70.21	70.76	72.05	2.66	3.13	4.33
779 + 30	Footbridge	258	337	572	70.68	71.37	73.06	3.76	4.11	4.51
786 + 00	Channel*	258	337	572	70.93	71.65	73.33	2.31	2.45	2.76
788 + 65	Footbridge	258	337	572	71.01	71.72	73.38	3.21	3.32	3.56
791 + 75	Footbridge	258	337	572	71.21	71.93	73.61	2.82	2.43	2.01
796 + 85	Footbridge	258	337	572	73.02	73.68	75.24	1.91	1.87	1.81
800 + 26	Lake Shore Drive	258	337	572	74.28	74.80	75.72	2.79	3.12	4.20
805 + 00	Lake Sue				74.72	75.30	76.19			
832 + 46	Lakeside Drive				74.72	75.30	76.19			
836 + 50	Lake Rowena				74.72	75.30	76.19			
863 + 90	Mills Street				74.72	75.30	76.19			
884 + 00	Lake Formosa				74.72	75.30	76.19			
	Lake Ivanhoe				79.24	79.88	81.10			

Table 8—*Continued*

Station	Location	Discharge (cfs)			Elevation (ft NGVD)			Velocity (fps)		
		10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
	Lake Highland				79.24	79.88	81.10			
	Lake Concord				79.24	79.88	81.10			
	Lake Adair				79.67	80.38	81.97			
	Spring Lake				89.86	90.59	91.92			
	Druid Lake				100.44	100.93	101.87			
Howell Creek Tributary 1										
0 + 00	Lake Howell	334	442	647	56.36	56.92	58.03	0.01	0.01	0.01
15 + 01	Channel*	334	442	647	56.35	56.90	58.00	1.29	1.54	1.90
16 + 10	Building over creek (HS-23D)	334	442	647	56.35	56.91	58.01	1.15	1.39	1.74
19 + 95	Road to apartments	334	442	647	56.40	56.97	58.08	2.86	3.23	3.59
21 + 70	S.R. 436 (HS-23F)	334	442	647	57.47	57.87	58.48	8.18	8.59	9.41
30 + 41	New Bridge (HS-23G)	334	442	647	59.26	59.84	60.76	3.32	3.77	4.55
50 + 40	Near treatment plant	334	442	647	81.37	81.83	82.55	7.93	8.37	9.06
Howell Creek Tributary 2										
0 + 00	Lake Maitland				67.79	68.23	69.09			
47 + 90	Horatio Avenue South				67.79	68.23	69.09			
51 + 40	Horatio Avenue				67.79	68.23	69.09			
71 + 60	Lake Minnehaha				67.79	68.23	69.09			
88 + 30	Dommerich Drive	152	205	269	69.21	69.72	69.92	3.85	4.30	5.93
103 + 00	Channel*	152	205	269	74.27	74.49	74.70	1.55	1.48	1.49
107 + 21	Derbyshire Road	152	205	269	76.88	77.77	78.94	1.83	2.09	2.28
128 + 20	Lake of the Woods	152	205	269	77.84	78.37	79.29	0.01	0.01	0.01
Howell Creek Tributary 3										
0 + 00	Lake Maitland				67.79	68.23	69.09			
23 + 45	Channel*	110	159	278	68.95	69.12	69.35	1.78	1.99	2.60
34 + 40	U.S. 17/92	110	159	278	70.85	71.42	72.61	6.70	7.57	9.12
40 + 40	Seaboard Coastline Railroad	110	159	278	72.07	72.90	74.76	1.86	2.10	2.46
53 + 00	Park Lake	110	159	278	72.19	73.04	74.89	0.01	0.01	0.02
100 + 15	Channel*	52	99	197	74.41	75.46	85.79	3.60	4.76	2.38
100 + 85	Lee Road, S.R. 438	52	99	197	85.21	85.79	86.73	0.16	0.26	0.40

Table 8—*Continued*

Station	Location	Discharge (cfs)			Elevation (ft NGVD)			Velocity (fps)		
		10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
124 + 25	Lake Killarney				85.21	85.79	86.73			
126 + 00	Lake Bell				89.92	90.67	92.01			
	Retention pond				91.65	91.82	92.16			
	Department of Transportation retention pond				93.63	94.21	95.23			
Howell Creek Tributary 4										
0 + 00	Lake Virginia				68.09	68.57	69.49			
21 + 10	Lake Mizell				68.09	68.57	69.49			
Howell Creek Tributary 5										
0 + 00	Lake Virginia				68.09	68.57	68.49			
38 + 70	Agricultural Road	11	18	62	69.97	70.77	71.45	3.55	4.14	1.86
68 + 00	Lake Berry	11	18	62	70.85	71.21	71.69	0.00	0.00	0.00
Howell Creek Tributary 6										
0 + 00	Lake Rowena				74.72	75.30	76.19			
23 + 05	Lake Estelle at U.S. 17/92				74.72	75.30	76.19			
44 + 00	Lake Winyah				74.72	75.30	76.19			
Bear Creek										
0 + 00	Confluence with Howell Creek	1580	2260	3640	15.80	17.19	19.75	3.94	4.37	4.61
3 + 55	Extension of Winter Springs Blvd.	1580	2260	3640	18.21	18.65	19.96	1.57	2.12	2.92
15 + 66	Extension of Winter Springs Blvd.	1580	2260	3640	19.21	19.92	20.94	2.73	2.61	2.49
26 + 00	Channel*	1580	2260	3640	19.62	20.39	21.50	3.67	4.31	5.33
71 + 20	Northern Way (BS-2A)	1580	2260	3640	20.27	21.20	22.58	1.34	1.67	2.25
55 + 40	Channel*	1580	2260	3640	20.71	21.69	23.16	2.09	2.34	2.79
71 + 20	X-section at power line	1580	2260	3640	21.45	22.40	13.83	3.91	3.67	3.43
110 + 80	X-section north of runway	1320	1910	3070	26.93	27.45	28.02	3.54	4.48	6.09
154 + 80	Dirt road (BS-3)	508	686	1030	30.55	31.94	34.14	3.09	3.39	1.08
172 + 80	Dirt road (BS-4)	508	686	1030	30.82	32.22	34.19	1.29	0.87	0.60
192 + 05	Red Bug Lake Road	508	686	1030	30.94	32.24	34.20	4.56	5.07	4.15
220 + 85	Michler Road (BS-7)	425	582	888	40.47	40.77	41.01	2.82	3.63	5.16
239 + 69	Extension of Dike Road (BS-8)	425	582	888	40.58	40.94	41.33	1.04	1.09	1.29
254 + 30	Channel*	425	582	888	40.59	40.95	41.34	0.83	1.00	1.34
260 + 40	Bruce Lane	240	342	571	41.03	41.84	42.83	2.04	2.49	2.48

Table 8—*Continued*

Station	Location	Discharge (cfs)			Elevation (ft NGVD)			Velocity (fps)		
		10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
280 + 18	Michael Drive (BS-10)	178	261	466	45.15	46.33	47.12	3.40	3.66	4.51
290 + 20	Channel *	178	261	466	46.98	47.50	48.31	2.84	2.26	2.07
324 + 81	BS-11	54	101	255	51.56	52.04	52.60	6.59	7.42	9.72
327 + 61	Tuskawillow Road (BS-12)	54	101	255	52.01	52.55	53.26	0.60	1.01	0.69
351 + 60	Bear Gully Lake	54	101	255	52.02	52.58	53.28	0.01	0.02	0.04
362 + 21	Goldenrod Drive	53	65	94	53.41	53.54	55.02	5.50	6.49	1.27
365 + 05	Bear Gully Road	53	65	94	54.22	54.80	55.21	2.62	1.87	2.17
379 + 19	Seaboard Railroad (BS-14)	53	65	94	54.17	54.60	54.87	6.61	6.93	9.21
381 + 19	S.R. 426	53	65	94	55.23	55.93	57.10	0.58	0.37	0.28
400 + 00	Lake Burkett	53	65	94	55.25	55.95	57.11	0.00	0.00	0.01
430 + 20	Lake Pearl	53	65	94	55.25	55.95	57.11	0.01	0.01	0.01
480 + 80	Deep Lake	17	35	80	57.17	57.33	57.66	0.00	0.00	0.00
Bear Creek Tributary 1										
0 + 00	Bear Gulley Lake	79	124	262	52.02	52.58	53.28	0.00	0.00	0.01
40 + 25	Channel*	79	124	262	51.99	52.57	53.28	2.42	1.31	1.42
41 + 24	Dodd Road (BS-16)	79	124	262	53.60	55.02	55.32	4.38	1.22	2.06
44 + 47	Dirt road (BS-17)	79	124	262	55.73	56.23	56.85	3.05	3.34	4.48
51 + 00	Garden Lake	79	124	262	55.89	56.40	57.14	0.01	0.01	0.02
Bear Creek Tributary 2										
0 + 00	Lake Burkett	66	99	198	55.25	55.95	57.11	0.01	0.01	0.02
9 + 00	Lake Martha	66	99	198	55.25	55.95	57.11	0.16	0.21	0.35
31 + 50	Channel*	66	99	198	54.99	55.78	57.04	4.93	3.92	3.07
39 + 09	Hall Road	66	99	198	62.54	63.20	63.35	2.83	3.37	9.34
59 + 10	Lake Waunatta	66	99	198	63.78	64.18	64.64	0.00	0.01	0.01

Note: cfs = cubic feet per second
ft NGVD = feet, National Geodetic Vertical Datum
fps = feet per second
Yr = year
BS = hydraulic structure in the Bear Creek Basin
HS = hydraulic structure (bridge, culvert, or weir)
S.R. = state road

*Refers to a typical channel section between two structures (e.g., bridges); these locations are included mainly to indicate flow velocities in the channel. The station numbers also refer to the channel cross sections used in the HEC-2 program.

At all named streets and elevations refer to the upstream side of a bridge or culvert.

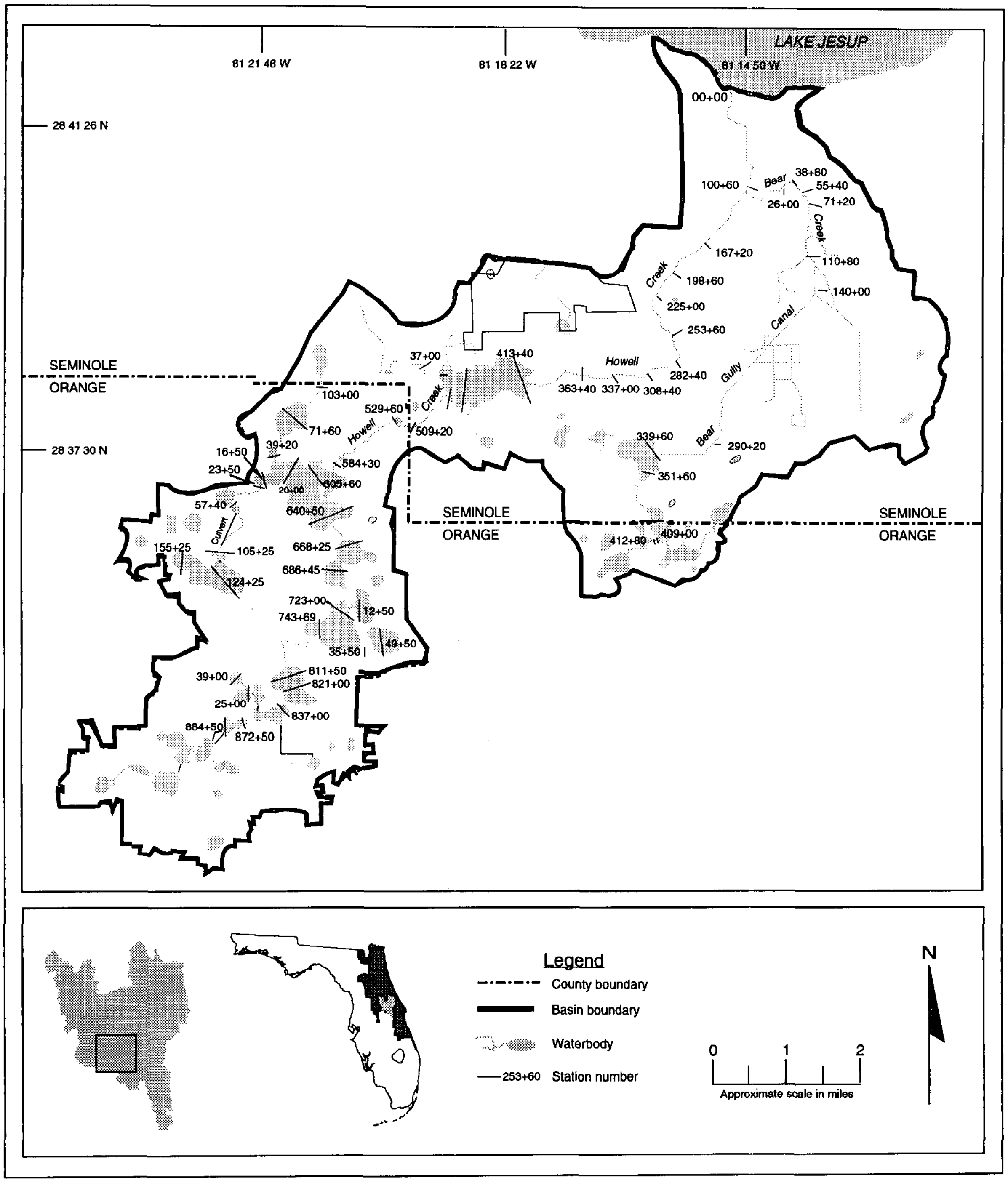


Figure 8. River stationing in the Howell Creek Basin

Table 9. Comparison of peak discharges as estimated by the U.S. Army Corps of Engineers* (USACE) and the St. Johns River Water Management (SJRWMD) (present study)

Location	Peak Discharges (cfs)			
	10-Year		100-Year	
	SJRWMD	USACE	SJRWMD	USACE
Howell Creek				
At Lake Maitland weir	289	440	695	880
At State Road 436	274	440	681	880
At mouth of Lake Howell	502	500	1,090	1,800
At State Roads 419/434	2,660	2,030	5,700	6,240
At mouth of Howell Creek	2,880	2,080	6,070	6,420
Bear Creek				
At confluence with Howell Creek	1,580	1,430	3,640	4,800

Note: cfs = cubic feet per second

*FEMA 1978, 1979, 1981, 1989a, 1989b

Table 10. Comparison of flood elevations as estimated by the U.S. Army Corps of Engineers* (USACE) and the St. Johns River Water Management District (SJRWMD) (present study)

Location	Flood Elevation (ft NGVD)			
	10-Year		100-Year	
	SJRWMD	USACE	SJRWMD	USACE
Howell Creek				
At Lake Jesup	8.1	8.1	9.8	9.8
At State Roads 419/434	11.82	13.9	12.87	15.3
At confluence with Bear Creek	15.41	15.1	19.21	18.4
At Tuskawillow Road	39.76	39.2	42.64	43.5
At Lake Howell	56.36	55.2	58.03	56.6
At State Road 436	56.38	57.0	58.07	58.4
At Lake Waumpi	62.95	61.6	64.53	63.5
At Lake Maitland	67.79	67.6	69.09	68.3
At Lake Osceola	68.09	67.7	69.49	68.3
At Lake Virginia	68.09	67.7	69.49	68.3
At Lake Mizell	68.09	67.7	67.79	68.3
At Lake Minnehaha	67.79	67.7	69.09	68.3
At Lake Berry	70.85	70.7	71.69	71.7
At Lake Sue	74.72	73.7	76.19	74.8
At Lake Rowena	74.72	73.7	76.19	74.8
At Park Lake	72.19	71.9	74.89	72.7
At Lake Killarney	85.21	84.2	86.73	85.4
At Lake Bell	89.92	90.08	92.01	92.4
Bear Creek				
At Bear Gulley Lake	52.02	51.2	53.28	53.3
At Garden Lake	55.89	55.2	57.14	55.7
At Lake Burkett	55.25	54.7	57.11	56.0
At Lake Waunatta	63.78	62.8	64.64	63.8

Note: ft NGVD = feet, National Geodetic Vertical Datum

*FEMA 1978, 1979, 1981, 1989a, 1989b

Structural Hazards. Several culverts and bridges in the study area are likely to be overtopped during major storm events. Erosion near the structures and other damages can occur. Table 11 summarizes depths of overtopping of the various affected structures. Eight structures may be overtopped during a 10-yr storm event, 14 during a 25-yr event, and 26 during a 100-yr event.

Flood Velocities

Velocity of flow near bridges and culverts and at several locations in the channel was computed by the HEC-2 program. The 10-yr, 25-yr, and 100-yr velocities are summarized in Table 8 for important locations in the basin. High velocities are expected near bridges and culverts because of channel constrictions at these structures. These structures are designed normally to be safe against such velocities. Channel reaches subject to high velocities, however, need to be investigated for safety against erosion.

Flood Hazard Areas

Floodplain maps have been prepared for the 100-yr return period from the results obtained in this study. The 1980–81 aerial maps (scale, 1 in. = 200 ft) were used for locating the limits of the 100-yr floodplain (Appendix A). These maps indicate that flood hazard areas are scattered throughout the basin. Exhibit A shows the approximate locations of these areas. About 330 structures, primarily single-family houses and some multifamily and commercial units, are located within the 100-yr floodplain. The extent of damage that may occur to these structures would depend upon the depth of flooding and the type of structure.

Major Differences Between the 1984 Study and the Present Study

The 1984 floodplain study has been used in the Management and Storage of Surface Waters (MSSW) permitting activities by the

Table 11. List of culverts and bridges that may be overtopped

Location (subbasin)	Road Elevation (ft NGVD)	Depth of Overtopping		
		10-Year	25-Year	100-Year
Howell Creek				
S.R. 419/434 (HS-1)	11.8		0.35	0.64
Golf cart bridge (HS-5)	17.8	0.48	1.24	3.14
Golf cart bridge (HS-6)	19.9		0.89	2.27
Service road (HS-7)	23.2			0.68
Golf cart bridge (HS-8)	23.0		0.96	2.50
Golf cart bridge (HS-9)	26.6			0.10
Wooden bridge (HS-15A)	40.5			0.50
Stirling Avenue	70.7			0.57
Howell Creek Tributary 5				
Agricultural road	71.3			0.15
Bear Creek				
Extension of Winter Springs Blvd. (BS-1)	16.8	0.06	1.48	2.67
Extension of Winter Springs Blvd. (BS-2)	16.6	2.47	3.30	4.27
Dirt road (BS-3)	31.7		0.23	2.44
Dirt road (BS-4)	28.1	2.72	4.12	6.08
Red Bug Lake Road (BS-5)	33.8			0.40
Michler Road (BS-7)	40.1	0.37	0.67	0.91
Extension of Dike Road (BS-8)	40.0	0.75	1.00	1.33
Bruce Lane (BS-9)	42.0			0.83
Michael Drive (BS-10)	46.7			0.42
East of Tuskawillow Road (BS-11)	51.3	0.26	0.74	1.30
Tuskawillow Gabriella Road (BS-12)	52.7			0.56
Goldenrod Drive (BS-15A)	54.0			1.02
Bear Gulley Road (BS-15)	54.7		0.10	0.51
S.R. 426 (BS-13)	56.9			0.20
Bear Creek Tributary 1				
Dodd Road (BS-16)	54.8		0.22	0.52
Dirt road (BS-17)	55.6	0.13	0.63	1.25
Bear Creek Tributary 2				
Hall Road	63.3			0.05

Note: ft NGVD = feet, National Geodetic Vertical Datum
S.R. = state road
BS = hydraulic structure in the Bear Creek Basin
HS = hydraulic structure (bridge, culvert, or weir)

SJRWMD Department of Resource Management. Other agencies also have used it as a reference for flood discharges and elevations. To illustrate the differences between the 1984 study and the present study, the peak discharges and peak elevations from the two studies are compared in Tables 12 and 13, respectively. The reasons for various discrepancies between the two studies are as follows.

Rowena Chain of Lakes

Most of the contributing drainage area that was not included in the 1984 study is located upstream of these lakes (Figure 7). As calculated in the present study, drainage contribution from the omitted area significantly increased the inflows into the Rowena lakes (Table 12). Because the inflows are higher, the outflows from the lakes also are higher. Flood elevations are higher by about 1.2 ft (Table 13).

Lakes Maitland and Minnehaha

In the 1984 study, the elevation differences between Lakes Maitland and Minnehaha were calculated as 0.5, 0.6, and 1.0 ft for the 10-, 25-, and 100-yr events, respectively. The observed stage data for the two lakes, however, indicated no such major elevation differences between the two lakes. The elevation differences between the two lakes were insignificant during both wet and dry periods. Therefore, the two lakes together are treated as a single storage system in the present study. The stage-storage-discharge relationship for the Lake Maitland control structure was revised. The HEC-2 data for the structure were revised based on additional field data. Peak discharges calculated in the present study are higher as a result of both higher inflows and the revised stage-storage-discharge data. Discrepancies in elevations calculated by the two studies are minor for Lakes Maitland, Osceola, and Virginia.

Table 12. Comparison of peak discharges from the 1984 study and the present study

Location	Peak Discharge (cfs)					
	1984 Study			Present Study		
	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
Howell Creek						
Discharge into the Rowena chain of lakes	1,680	2,140	3,100	2,980	3,700	5,120
Outflow from the Rowena chain of lakes	70	105	185	258	337	572
At Lake Maitland weir	220	335	615	289	408	695
At State Road 436	550	740	1,160	278	400	681
Discharge into Lake Howell from the mainstem and tributaries	2,390	3,120	4,690	2,094	2,732	3,965
Outflow from Lake Howell	510	715	1,310	502	664	1,090
At Dyson Drive	910	1,270	2,300	847	1,140	1,730
At confluence with Bear Creek	1,230	1,680	2,900	1,140	1,540	2,330
At State Roads 419/434	2,910	3,970	6,600	2,660	3,650	5,700
At mouth of Howell Creek	3,060	4,180	6,930	2,880	3,930	6,070
Howell Creek Tributary 2						
Outflow from Lake of the Woods	156	208	278	152	205	269
Howell Creek Tributary 3						
At U.S. 17/92	125	187	348	110	159	278
Outflow from Lake Killarney	65	123	285	52	99	197
Bear Creek						
At Red Bug Lake Road	490	670	1,050	508	686	1,030
At Bear Gully Lake	55	90	270	54	101	255
At Lake Burkett	50	65	100	53	65	94
Bear Creek Tributary 1						
At Garden Lake	75	120	270	79	124	262

Note: cfs = cubic feet per second
Yr = year

Table 13. Comparison of flood elevations from the 1984 study and the present study

Location	Flood Elevation (ft NGVD)					
	1984 Study			Present Study		
	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
Howell Creek						
Mouth of Howell Creek	8.1	8.7	9.8	8.1	8.7	9.8
State Roads 434/419 (HS-1)	11.6	13.3	14.9	9.35	12.17	12.45
Confluence with Bear Creek	15.6	16.9	19.5	15.41	16.74	19.21
Northern Way	25.0	26.2	28.5	24.63	25.62	27.18
Red Bug Lake Road	34.9	35.3	36.3	35.04	35.63	36.69
Dodd Road	47.7	48.1	49.3	45.14	45.82	48.02
Lake Howell	56.4	57.1	58.4	56.36	56.92	58.03
State Road 436 (HS-24)	56.5	57.2	58.5	56.38	56.95	58.07
Mouth of Lake Waumpi	62.0	62.7	64.2	62.95	63.54	64.53
Lake Maitland weir	67.4	67.8	68.6	67.10	67.33	67.84
Lake Maitland	67.7	68.3	69.1	67.79	68.23	69.09
Lake Osceola	67.9	68.5	69.4	68.09	68.57	69.49
Lake Virginia	67.9	68.5	69.4	68.09	68.57	69.49
Lake Sue	73.3	73.7	74.5	74.72	75.30	76.19
Lake Rowena	73.5	73.9	74.9	74.72	75.30	76.19
Lake Formosa	73.5	73.9	74.9	74.72	75.30	76.19
Howell Creek Tributary 2						
Lake Minnehaha	68.2	68.9	70.1	67.79	68.23	69.09
Lake of the Woods	77.9	78.4	79.5	77.84	78.37	79.29
Howell Creek Tributary 3						
Park Lake	72.4	73.4	76.0	72.19	73.04	74.89
Lake Killarney	84.9	85.4	86.3	85.21	85.79	86.73
Lake Bell	90.3	90.7	91.4	89.92	90.67	92.01
Howell Creek Tributary 4						
Lake Mizell	67.9	68.5	69.4	68.09	68.57	69.49
Howell Creek Tributary 5						
Lake Berry	70.8	71.4	71.9	70.85	71.21	71.69
Howell Creek Tributary 6						
Lake Winyah	73.6	74.1	75.1	74.72	75.30	76.19

Table 13—*Continued*

Location	Flood Elevation (ft NGVD)					
	1984 Study			Present Study		
	10-Yr	25-Yr	100-Yr	10-Yr	25-Yr	100-Yr
Bear Creek						
Northern Way	20.2	21.2	22.7	20.27	21.20	22.58
Red Bug Lake Road	30.9	32.5	33.9	30.94	32.44	34.20
Michler Road	42.7	43.1	43.5	40.47	40.77	41.01
Michael Road	46.0	46.9	47.6	45.15	46.33	47.12
Bear Gully Lake	51.9	52.5	53.3	52.02	52.58	53.28
Lake Burkett	54.8	55.4	57.1	55.25	55.95	57.11
Deep Lake	57.1	57.3	57.7	57.17	57.33	57.66
Bear Creek Tributary 1						
Garden Lake	55.8	56.4	57.2	55.89	56.40	57.14
Bear Creek Tributary 2						
Lake Martha	54.8	55.4	57.1	55.25	55.95	57.11
Hall Road	62.9	63.5	64.2	62.54	63.20	63.35
Lake Waunatta	63.8	64.2	64.7	63.70	64.11	64.66

Note: ft NGVD = feet, National Geodetic Vertical Datum
Yr = year
HS = hydraulic structure (bridge, culvert, or weir)

Howell Creek Tributary 3

This tributary connects Lake Bell, Lake Killarney, and Park Lake to Lake Maitland (Exhibit A). The discharges calculated in the present study at U.S. 17/92 and from Lake Killarney are less than the 1984 study values because of a revision of stage-discharge relationships. Field inspection indicated that the outlet culvert of Lake Bell is different from the culvert modeled in the 1984 study. The current culvert would maintain the lake at about 1 ft below the elevation maintained by the previous culvert and would allow lower outflows. Correcting the simulation using the current culvert resulted in slightly lower elevations for Lake Bell for the 10- and 25-yr events and higher elevation for the 100-yr event.

The Lake Killarney stage-discharge relationship is revised using the *special culvert* routine now available in the HEC-2 program. The revised relationship shows that Lake Killarney outflow at a given stage would be less than that calculated by the 1984 study for elevations above 84.00 ft NGVD. As a result, the flood elevations calculated by the present study are higher for Lake Killarney and lower for Park Lake, which receives discharges from Lake Killarney. The 1984 study discharges at U.S. 17/92 were higher because of higher stages and higher outflows calculated for Park Lake.

State Road 436 and Lake Howell

Howell Creek passes through a forested wetland and Lake Waumpi between Lakes Maitland and Howell (see Exhibit A). These areas provide temporary storage to flood waters. As a result, the peak discharges passing through the area would be attenuated. A storage routing procedure is to be used to consider these effects in HEC-1 modeling. The 1984 study did not consider this feature and modeled Howell Creek as a simple natural channel in this reach. The forested wetland is treated as two separate storage areas in the present study (Table 8) because Temple Trail separates the wetland into two parts. The outlets for these two areas are (1) the culvert under Temple Trail and (2) the mouth of Lake Waumpi. The attenuation provided by these storage areas considerably reduces peak discharges at S.R. 436 and somewhat reduces inflows to Lake Howell (Table 12). As a result, outflows from Lake Howell also are lower compared to the 1984 study and remain low for the entire downstream reach of the creek. Anticipated flood elevations (Table 13), however, indicate only minor variations in elevations.

State Roads 419/434

Bridge data in the HEC-2 program were thoroughly revised based on recent survey data and field inspection. This revision and the revised discharge values considerably reduced the peak elevations from the 1984 study.

Other Areas

Minor discrepancies in discharges and/or stages are noticed between the two studies. These discrepancies may be attributed to the use of slightly different rainfall values and rainfall distributions in the two studies.

FLOOD AND ENVIRONMENTAL ASSESSMENTS OF THE BASIN

FLOOD ASSESSMENT

The 100-yr floodplain maps showed that flood waters may reach or surround about 330 buildings, 185 in Orange County and 145 in Seminole County (primarily single-family houses and some multifamily and commercial units), during major storm events in the Howell Creek Basin (Exhibit A). These include the buildings identified in the 1986 DOT aerial maps in addition to those identified on the original 1980–81 photogrammetric maps. Orange and Seminole counties and the City of Orlando furnished field survey information, such as the value of the building, first-floor and ground elevations, etc. The survey indicated that a majority of the surveyed houses in the 100-yr floodplain have their first-floor elevations over 1 ft above the 100-yr flood elevation (Table 14). The survey information, however, is not available for 34 buildings in Orange County and 120 in Seminole County. Most of the residents in the floodplain will experience areal/street flooding rather than structural/property damages. For all buildings located within the 100-yr floodplain, the following items are summarized in Appendix B: first-floor elevation; 10-, 25-, and 100-yr flood elevations; depth of flooding; structure value; flood damages; and house street address.

The locations of basin areas with the potential for flood damage are shown in Exhibit A (basin map). Eight specific areas are found to be in need of minor or major flood control measures to alleviate flood damages (Table 15). Five of these areas are located in Orange County and three in Seminole County. The damage estimates shown in Table 15 may be considered somewhat overestimates for the reasons given in the "Methods" section. The following is a brief description of the expected flooding problems; refer to Exhibit A for specific locations of flooded areas.

Table 14. Number of buildings that may sustain damages during a 100-year flood event (see Exhibit A for locations of flood areas)

Location	Buildings in 100-Year Floodplain*	Buildings that Might Sustain Damages®	Buildings With 100-Year Flood Depth		Maximum 100-Year Flood Depth (feet)
			-1 to 0 feet	Greater than 0 feet	
Orange County					
Lake Ivanhoe and vicinity	12 (0)	8	7	1	0.85
Lakes Sue, Rowena, Formosa, Estelle, and Winyah	57 (0)	12	10	2	1.1
Lake Killarney	58 (28)	9	6	3	0.94
Park Lake	12 (0)	11	2	9	3.85
Lakes Minnehaha, Maitland, Virginia, Osceola, and Mizell	38 (5)	20	12	8	1.09
Lake Waumpi and vicinity	7 (0)	0			
Other isolated structures	1 (1)	0			
Total	185 (34)	60	37	23	
Seminole County					
Lake Howell and vicinity	50 (34)	5	2	3	1.01
Bear Creek Basin	95 (86)				
Total	145 (120)	5	2	3	

*Primarily single-family houses; some multifamily and commercial units. These buildings are located on the aerial maps. Numbers shown in parentheses indicate number of structures for which survey information was not available.

®These buildings could sustain flooding damage when flood waters are within 1.0 foot below the finished first-floor elevation or higher.

Table 15. Major problem areas and projected annual damages (see Exhibit A for locations of problem areas)

Problem Areas	Structure	Estimated Damages in Thousand Dollars*			Projected Annual Damages@
		10-Year	25-Year	100-Year	
Orange County					
I. Lake Ivanhoe and vicinity	Buildings	0	8	55	$1,575
II. Rowena chain of lakes	Buildings	7	19	100	$3,700
III. Lake Killarney	Buildings	4	15	49	$2,070†
IV. Park Lake	Buildings	14	38	218	$6,260
V. Maitland chain of lakes	Buildings	44	98	259	$15,000†
Seminole County					
VI. Lake Howell and vicinity	Buildings	1	3	21	†
VII. Bear Creek Basin	Buildings Bridges	5	15	35	†
VIII. Howell Creek downstream of Lake Howell	Buildings Bridges	0 2	0 10	0 25	

*Calculated using 1988 or 1991 tax values
@Annual damages computed based on an approximate damage-frequency curve (see Figure 5)
†Survey information not available for some structures (see Table 14)

Problem Area I: Lake Ivanhoe and Vicinity

The 10-, 25-, and 100-yr flood elevations for this part of Orange County are estimated as 79.24, 79.88, and 81.10 ft NGVD, respectively. Marginal street flooding might occur on the eastern shore of Lake Ivanhoe during a 100-yr storm event. One single-family house, one storage building, and ten commercial units are located at the fringe of the 100-yr floodplain.

All commercial buildings are located on Orange Avenue (S.R. 527) across the lake; Orange Avenue intervenes between the lake and the buildings. Because the buildings are located across a paved area, the flood damages may not go as high as those estimated by the FIA factors (Table 2). Table 15, however, presents damage estimates as calculated by the FIA factors. Survey information indicates that one commercial building (Structure I-5, Appendix B) valued at $124,400 would be flooded by a depth of 0.85 ft during the 100-yr event. Depth of the 100-yr flood at five other commercial buildings varied from 0.99 to 0.23 ft below first-floor elevation.

Problem Area II: Rowena Chain of Lakes

The Rowena chain of lakes includes Lakes Formosa, Rowena, Winyah, Estelle, and Sue, all of which are in Orange County.

Extensive shoreline flooding and some street flooding would occur during a 100-yr storm event (flood elevation equals 76.20 ft NGVD). Fifty-seven lakefront homes are located within or at the fringe of the 100-yr floodplain. Some flooding might also occur during the 10- and 25-yr storm events (flood elevations 74.72 and 75.30 ft NGVD, respectively). Survey information indicated that two houses might suffer damages during the 10- and 25-yr storm events and 12 during a 100-yr event (Appendix B). For 10 of the 12 houses, however, the 100-yr flood depth ranged from 0.92 to 0.17 ft below first-floor elevation. For this reason, the flood damages given in Table 15 for this area may be regarded as overestimates.

Problem Area III: Lake Killarney

Extensive shoreline flooding and some residential flooding might occur during 10-, 25-, and 100-yr storm events in this part of Orange County. Fifty-eight houses are located within or at the fringe of the 100-yr floodplain. Nine houses might be damaged. Six of the nine houses have a 100-yr flooding depth in the range of 0.94 to 0.47 ft below first-floor elevation. Survey information, however, is not available for 28 houses. For this reason, the damage estimates given in Table 15 are approximate.

Problem Area IV: Park Lake

Seven units of a multifamily two-story apartment complex located on the eastern shore of Park Lake (Orange County) might be flooded during a 100-yr event. The depth of flooding at various buildings would range from 0.1 to 1.3 ft. Damages for this event at this complex are estimated at $154,000. In addition, four single-family houses might sustain damages.

Problem Area V: Maitland Chain of Lakes

The Maitland chain of lakes includes Lakes Minnehaha, Maitland, Osceola, Virginia, and Mizell, all of which are located in Orange County.

Extensive shoreline flooding and some street flooding would occur during the 25- and 100-yr storm events. Thirty-eight lakefront homes are located within or at the fringe of the 100-yr floodplain. Substantial flooding also would occur during a 10-yr event.

Major flood damages are expected to occur during the 10-, 25-, and 100-yr storm events (Table 15). These are somewhat overestimated because 12 of the 20 damageable houses are located at the fringe of the 100-yr floodplain with the 100-yr flood depths ranging from 0.01 to 0.96 ft below first-floor elevation. Eight houses might be damaged, with the 100-yr damages exceeding $15,000 each (Appendix B).

Problem Area VI: Lake Howell and Vicinity

Flood damages occur during all three major storm events considered (10-, 25-, and 100-yr) for this part of Seminole County. A comparison of the 1980–81 aerial photogrammetric maps with the 1986 Florida DOT aerial maps indicated that extensive urban development occurred throughout Seminole County during this period. About 50 buildings are located in the 100-yr floodplain of Lake Howell, of which 34 are new structures. No survey information is available for the new structures. Five of the 16 structures for which survey information is available would suffer only minor flood damages because they are generally inexpensive houses (Appendix B).

Problem Area VII: Bear Creek Basin

The nine houses located in the 100-yr floodplain of this part of Seminole County (1980–81 aerial maps) would not suffer flood damages. The 1986 DOT aerial maps, however, indicated that 86 additional houses have been built in the 100-yr floodplain in this basin during 1980–86. No survey information is available for the new structures. Seventeen bridges/culverts would be overtopped during major floods (Table 11). Approximate bridge damages are summarized in Table 15.

Problem Area VIII: Howell Creek Downstream of Lake Howell

This problem area extends from downstream of Lake Howell to S.R. 419/434 (Seminole County).

No significant urban development is identified within the 100-yr floodplain. However, seven bridges and culverts, including the bridge at S.R. 419/434, would be overtopped during a 100-yr storm event (see Table 11, excluding Stirling Avenue); four golf cart bridges (included in the preceding total) might be washed away. Damage estimates shown in Table 15 are very approximate.

ENVIRONMENTAL ASSESSMENT

Wetland Loss in the Howell Creek Basin

In general, wetlands have several important hydrologic and biological functions. Some of the more important ones are as follows.

- Water storage. Wetlands store large volumes of stormwater runoff, delaying its movement into stream channels (Darnell 1976). As a result, flood amplitudes are reduced. If the storage capacity provided by wetlands is diminished, more water will enter streams at a faster pace and at higher velocities. Flood amplitudes will, therefore, increase. In Howell Creek Basin, flood problems are evident, many of them probably a direct result of reduced water storage capacity through wetland loss.

- Pollutant removal. Wetlands remove pollutants from stormwater runoff by entrapping sediments, nutrients, and metals (Bastian and Benforado 1988). The retention of these materials within the wetland maintains water quality of the adjacent waterbody. In some areas of Howell Creek Basin, these pollutants are now entering lakes and streams directly, due to the loss of wetlands and their filtering capacities.

- Erosion control. Wetland vegetation controls erosion (Allen 1978). The dense mats of vegetation along streambanks slow water flow and reduce its erosive force. High water velocities cut away streambanks, but erosion also degrades water quality by introducing suspended solids. Water quality in some areas of Howell and Bear creeks was degraded because of erosion.

  Some general effects of suspended solids on the aquatic community include the following.

  > Suspended solids are a significant source of pollutants such as nutrients, oxygen-demanding substances, and metals.

  > The presence of suspended solids reduces light penetration. Photosynthesis is decreased, stunting or killing submerged native vegetation. Decaying vegetation depletes oxygen, with severe conditions eliminating sensitive species.

> Suspended solids absorb additional heat from sunlight. As temperatures increase, chemical changes occur in the water column. Oxygen solubility is decreased and nutrient release is increased. Species sensitive to changing environments may become physiologically stressed. Higher water temperatures may eliminate some aquatic organisms from the community only to have them replaced by less desirable species (Darnell 1976).

> Suspended solids eventually settle to the bottom (sedimentation). General effects of sedimentation include burying and killing the benthic community, reduction of food supply for higher trophic levels, a loss of habitat diversity, and the elimination of spawning areas.

> Sedimentation probably affects Howell Creek and Bear Gully Creek to some degree. Field observations indicated that large amounts of sediment are flowing into Lake Jesup, creating a delta at the mouth of Howell Creek. This large-scale movement of sediment could have adverse effects on an already stressed lake.

- Critical habitat provision. Wetland areas provide critical native plant and wildlife habitat, serving as refugia for fish, waterfowl, and endangered species, as well as nursery and spawning habitat for aquatic biota. Many acres of wetlands have been developed in the Howell Creek Basin, entailing the loss of all biological functions. Many of the remaining wetlands have been fragmented, resulting in the loss of some biological functions.

A comparison of the wetland vegetation maps for 1947-48 and 1984-88 indicated that the total wetland loss for the basin was approximately 1,833 acres, or 35 percent (Table 16, Plates 1 and 2). This total includes 650 acres of wetlands that were converted to agriculture before 1947. The largest wetland loss in the basin was herbaceous wetland (690 acres), followed by forested wetland (465 acres) and shrub wetland (28 acres). Since the period 1984–88, there has been intensive development within the

Table 16. Wetland acreage comparisons for the Howell Creek Basin

Cover Type	Acres		Acres Lost or Gained
	1947-48	1984-88	
Wetlands			
Herbaceous	1,041	351	-690
Forested	3,212	2,747	-465
Shrub	278	250	-28
Wetlands altered to agriculture	650	0	-650
Wetlands total	5,181	3,348	-1,833
Open water	3,781	3,715	-66
Uplands	27,979	29,878	+1,899
Basin total	36,941	36,941	0

basin. As a result, the acres of wetlands lost to urbanization since 1984-1988 are much higher.

Areas of significant wetland loss from 1947-48 to 1984-88 are listed below.

- North bank of Lake Killarney
- East bank of Park Lake
- South of Lake Minnehaha
- Howell Creek from Lake Maitland to Lake Jesup
- South of Lake Howell to Lake Ann
- Bear Gully Creek and Canal
- East of Bear Gully Canal

Water Quality Assessment

The waters of Howell Creek Basin are influenced by urban stormwater runoff, agricultural discharges, and erosion. These processes introduce varying amounts of nutrients, heavy metals, BOD, COD, turbidity, and sediments to the water (Darnell 1976; Thornton and Payne 1988; Weibel 1969; Whipple et al. 1976). Each input can have adverse effects on water quality. Nutrients, generally nitrogen and phosphorus, stimulate the growth of algae, rooted vegetation, and floating plants. Shading by these plants and the eventual decomposition cause low oxygen levels in the water. Nutrient enrichment can be measured by monitoring nutrient concentration; however, the effects are readily observed through increased amounts of chlorophyll *a*, reduced Secchi disc depths, and depressed oxygen levels.

Heavy metals such as lead, zinc, cadmium, copper, and nickel may slowly accumulate in sediment and plant and animal tissues. Such accumulations may eventually harm organisms through loss of habitat or poisoning, cause the concentration of the toxin to be increased in higher trophic levels (biological magnification), or make the tissue unfit for human consumption.

BOD and COD are substances that deplete oxygen. The more BOD and COD that are introduced into the water, the less oxygen will be available for aquatic organisms. The potential for harm to aquatic systems can be determined by measuring BOD and COD and monitoring DO levels.

Erosion causes turbidity and sediment problems, as well as the possible introduction of toxic substances. Sedimentation kills benthic organisms through burial and suffocation, resulting in decreased plant and animal diversity. Habitats also are destroyed as bottom areas are filled with sand. Turbidity measurements give some indication of the amounts of eroded materials in the water, but often elevated levels are only present during periods of high flow.

For a general discussion of water quality, the Howell Creek Basin was divided into three parts: lakes, Howell Creek, and Bear Creek. The lakes consist of Orange County lakes in the western portion of the basin; Howell Creek begins just downstream of Lake Maitland and extends to Lake Jesup; and Bear Creek begins just downstream of Lake Burkett and extends to its confluence with Howell Creek.

Lakes (stations 1-6). The water quality of lakes in the Howell Creek Basin was generally rated "good" using TSI. Many lakes had a TSI of "good," but were very close to being rated "fair" (Figure 9A). A small decline in water quality could cause a drop in status. Nutrient concentrations were low (Figures 10A and 11A). However, chlorophyll *a* (Figure 12) was "fair" at many sites and Secchi disc values (Figure 13) were "good" at most sites.

The lakes are influenced by urban stormwater runoff, which probably caused the observed elevated levels of heavy metals. Copper, lead, and cadmium concentrations consistently exceeded state standards at all lakes (Table 17). BOD levels (Figure 14A)

Table 17. Number of times heavy metal samples exceeded state standards/number of samples collected. *Stations 1-6 are lake stations in Howell Creek Basin; station 7 is in Howell Creek.*

Station	Copper	Lead	Zinc	Cadmium	Nickel
1	5/7	3/3	1/7	7/7	1/7
2	2/2	1/2	1/2	1/2	0/2
3	6/9	5/6	0/9	8/8	0/9
4	8/9	5/6	2/9	8/8	0/9
5	7/10	6/7	1/10	9/9	0/10
6	7/8	3/4	2/8	8/8	4/8
7	2/4	1/1	0/4	4/4	0/4

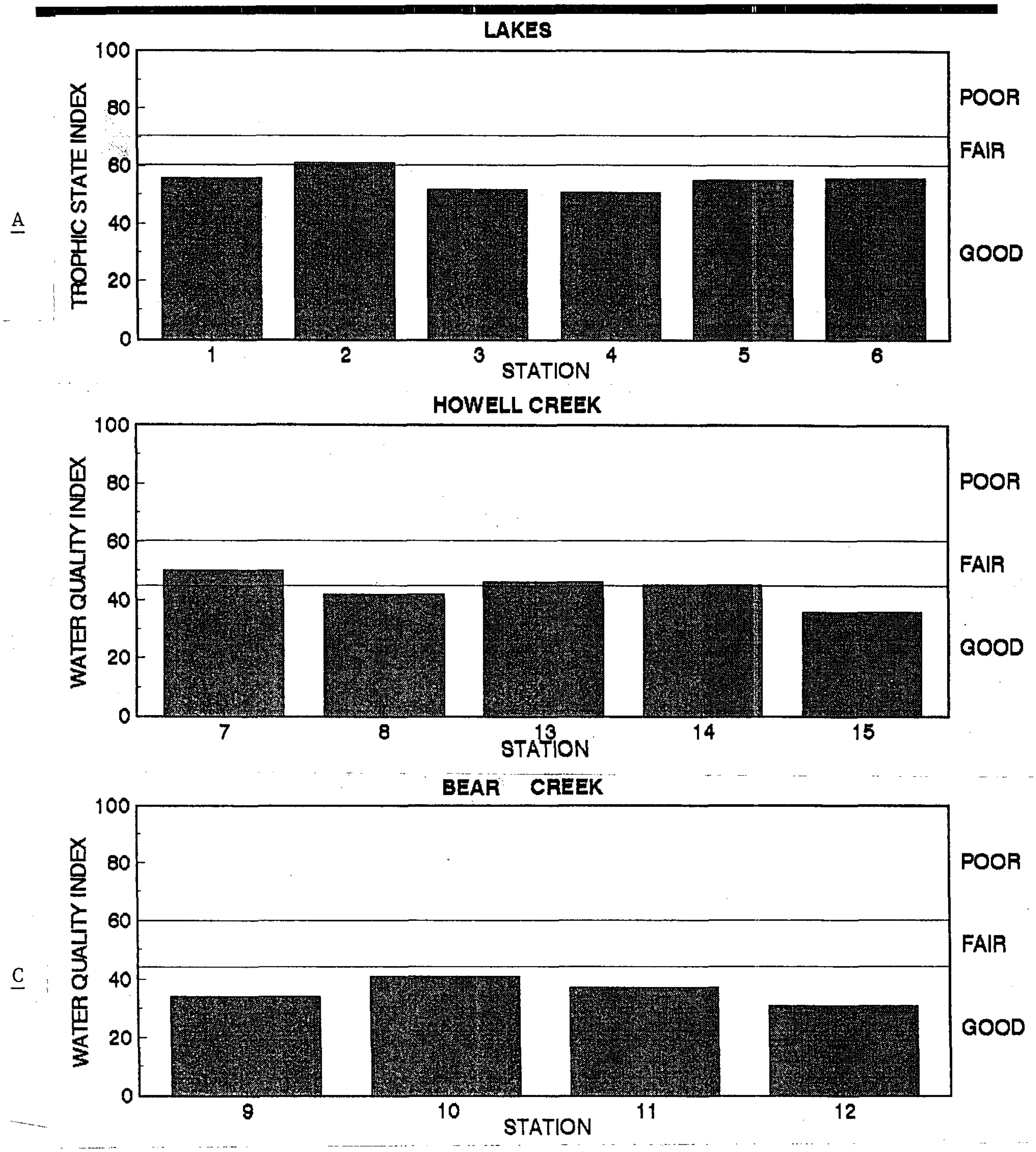


Figure 9. Trophic state and water quality indexes for *(A)* lakes, *(B)* Howell Creek, and *(C)* Bear Creek

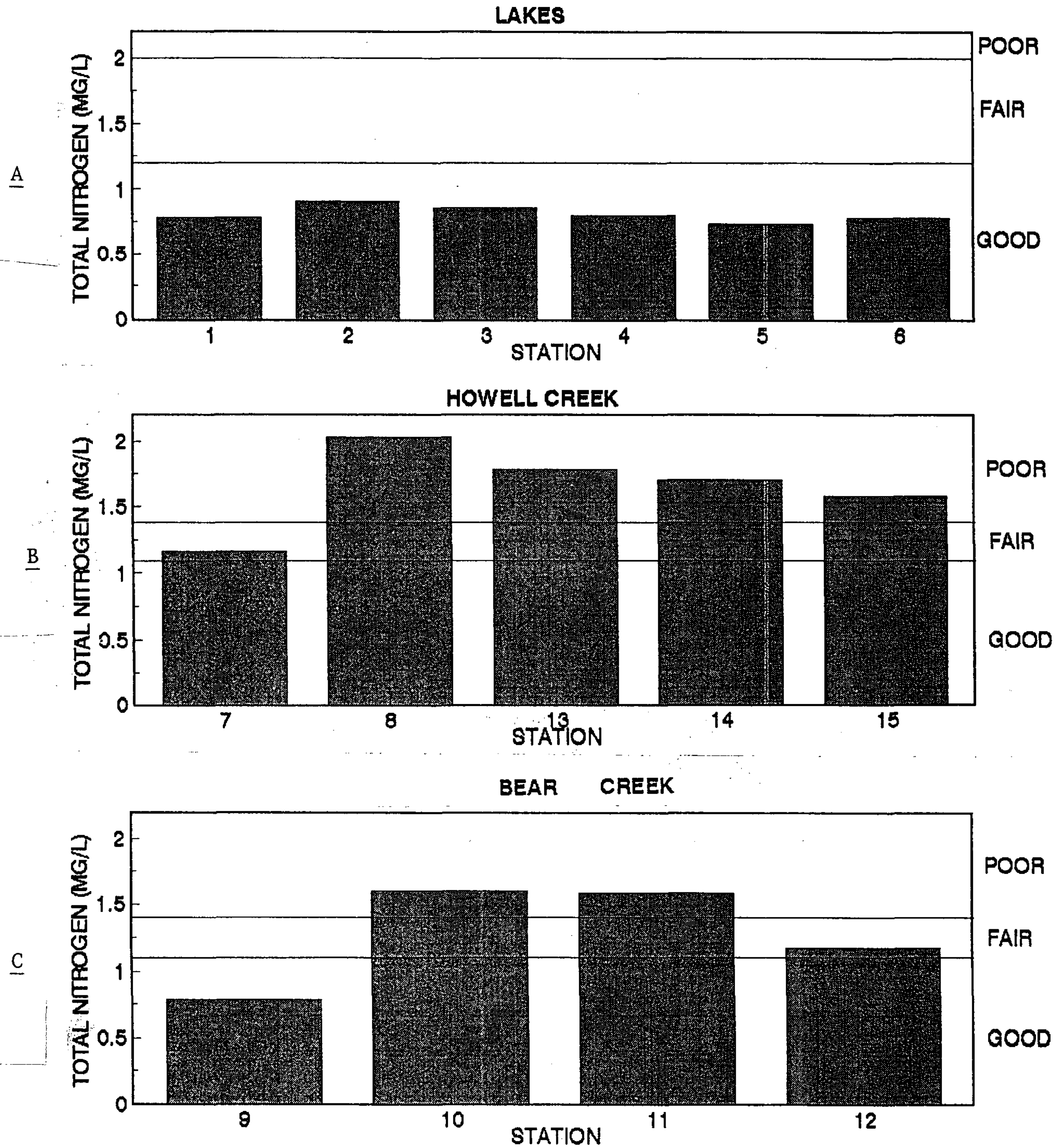


Figure 10. Total nitrogen levels (in milligrams per liter [MG/L]) for *(A)* lakes, *(B)* Howell Creek, and *(C)* Bear Creek

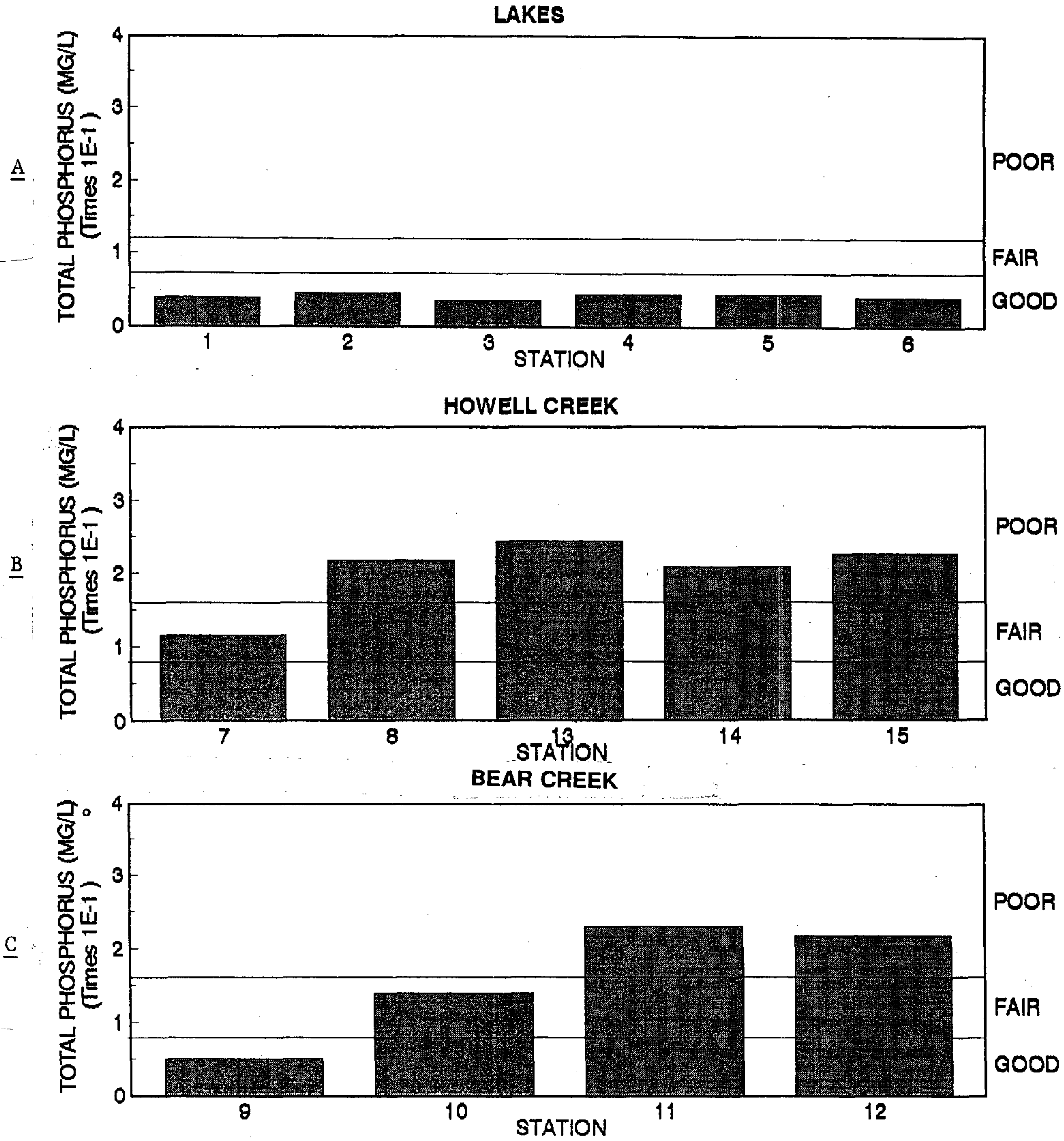


Figure 11. Total phosphorous levels (in tenths of milligrams per liter [0.1 MG/L]) for *(A)* lakes, *(B)* Howell Creek, and *(C)* Bear Creek

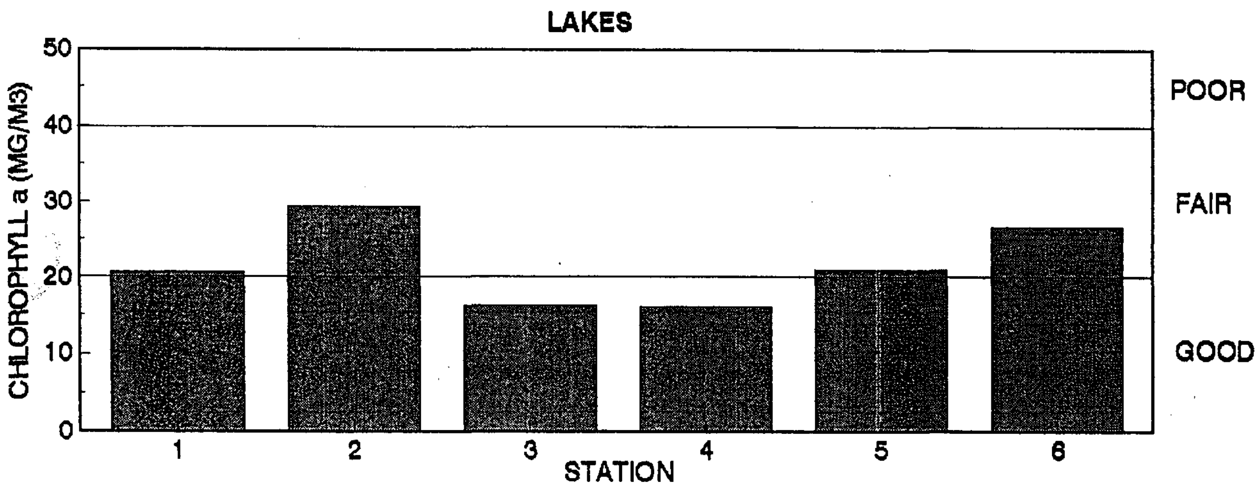


Figure 12. Chlorophyll *a* for lakes (in milligrams per cubic meter [MG/M3])

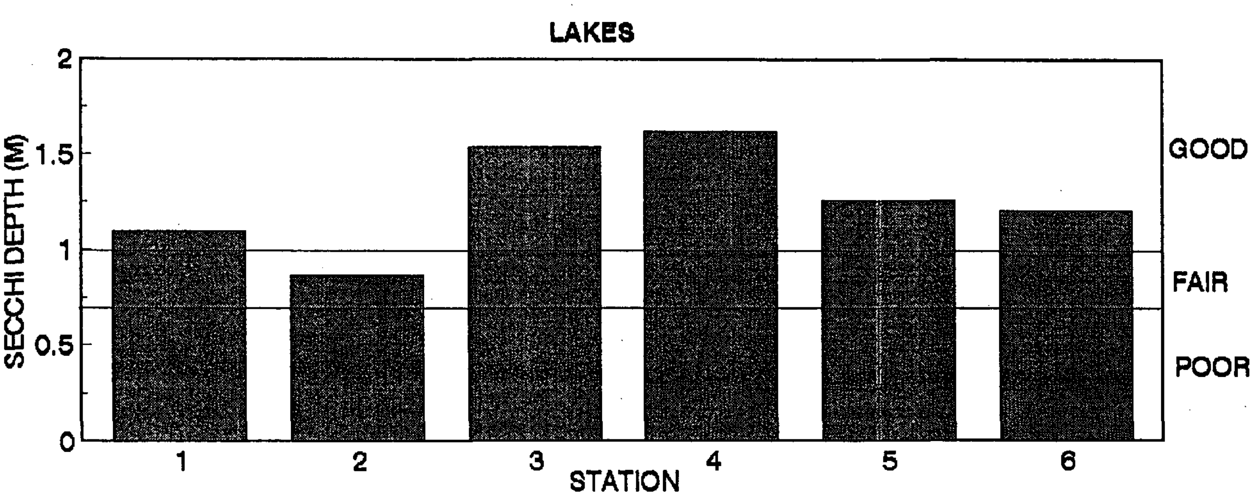


Figure 13. Secchi depth for lakes (in meters [M])

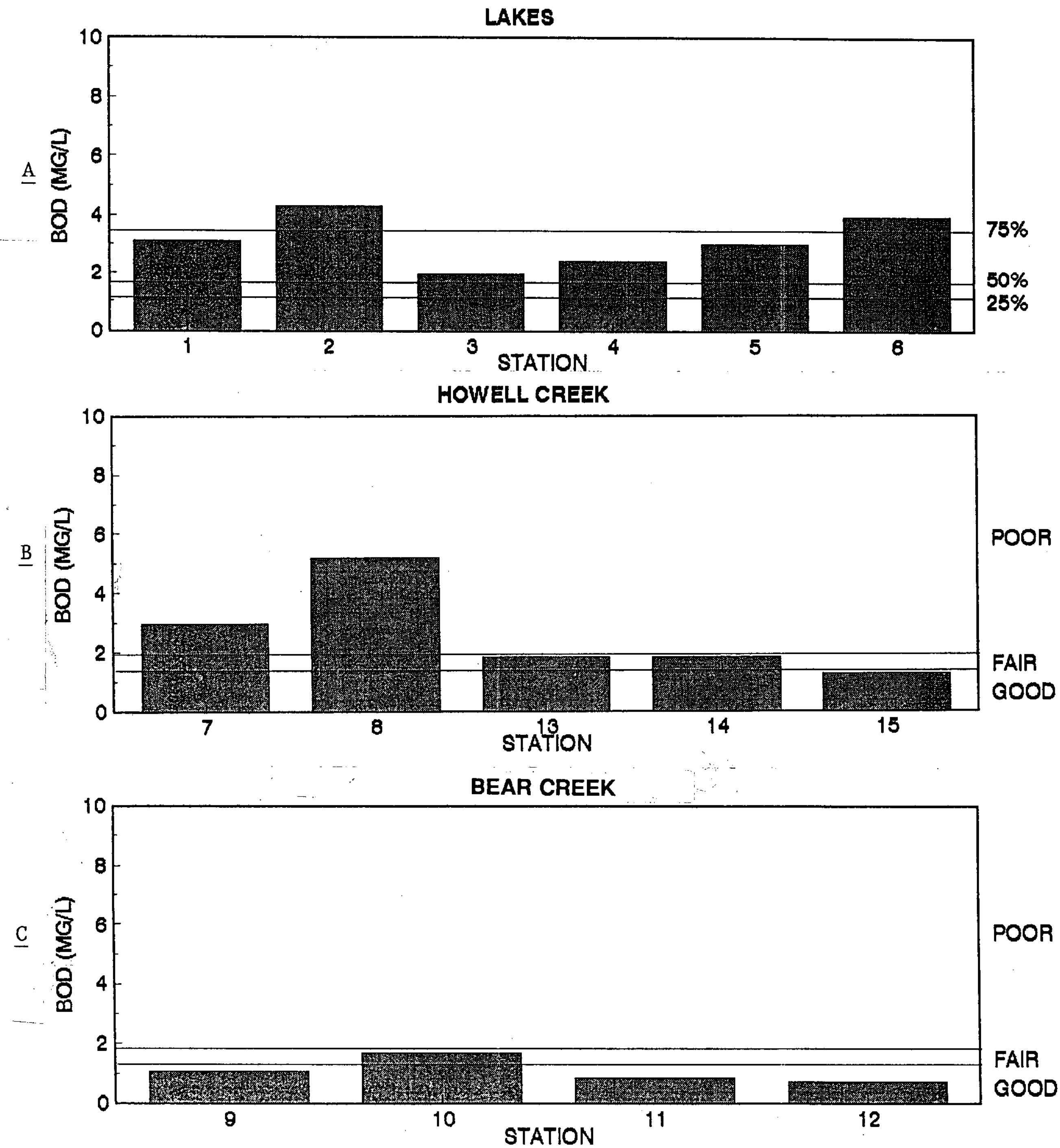


Figure 14. **Biological oxygen demand (BOD) (in milligrams per liter [MG/L]) for *(A)* lakes, *(B)* Howell Creek, and *(C)* Bear Creek**

were elevated at all lakes, probably also due to urban stormwater runoff.

Howell Creek (stations 7, 8, 13-15). Two sewage treatment plants (STP) were discharging into Howell Creek prior to 1983. The Winter Park STP, located upstream of station 7, stopped discharging in July 1983. The City of Maitland STP, discharging into the northwest portion of Lake Howell, stopped in March 1983. Statistical analyses (Anova and Duncans Multiple Range Tests) indicated total nitrogen, total phosphorus, conductivity, and BOD levels were higher for Howell Creek during the discharge period. Post-discharge data for Howell Creek were used for the water quality assessment that follows.

Water quality in Howell Creek was generally rated "fair" (Figure 9B) using WQI. It is influenced by urban stormwater runoff, agricultural discharges, and erosion. As a result, elevated levels of nutrients (Figures 10B and 11B) and BOD (Figure 14B) were evident throughout the creek. Localized areas had depressed DO concentrations (Figure 15B) or elevated COD (Figure 16A). Turbidity levels were generally low (Figure 17B); however, field inspections conducted April 3, 1991, indicated that the water became quite turbid during periods of high flow.

Heavy metals were measured only at station 7. Concentrations of cadmium and occasionally copper and lead (Table 17) exceeded state water quality standards. Because some heavy metal levels exceeded standards at station 7 and in other parts of the basin, elevated levels of heavy metals may be present in Howell Creek.

Bear Creek Basin (stations 9–12). Water quality in Bear Gully Creek is generally rated "good" (Figure 9C) using WQI; however, it is influenced by urban stormwater runoff, agricultural discharges, and erosion. As a result, elevated levels of nutrients were evident throughout the creek (Figures 10C and 11C). Localized areas had low DO concentrations (Figure 15C) and elevated BOD and COD concentrations (Figures 14C and 16B). Turbidity levels were low overall (Figure 17C); however, field

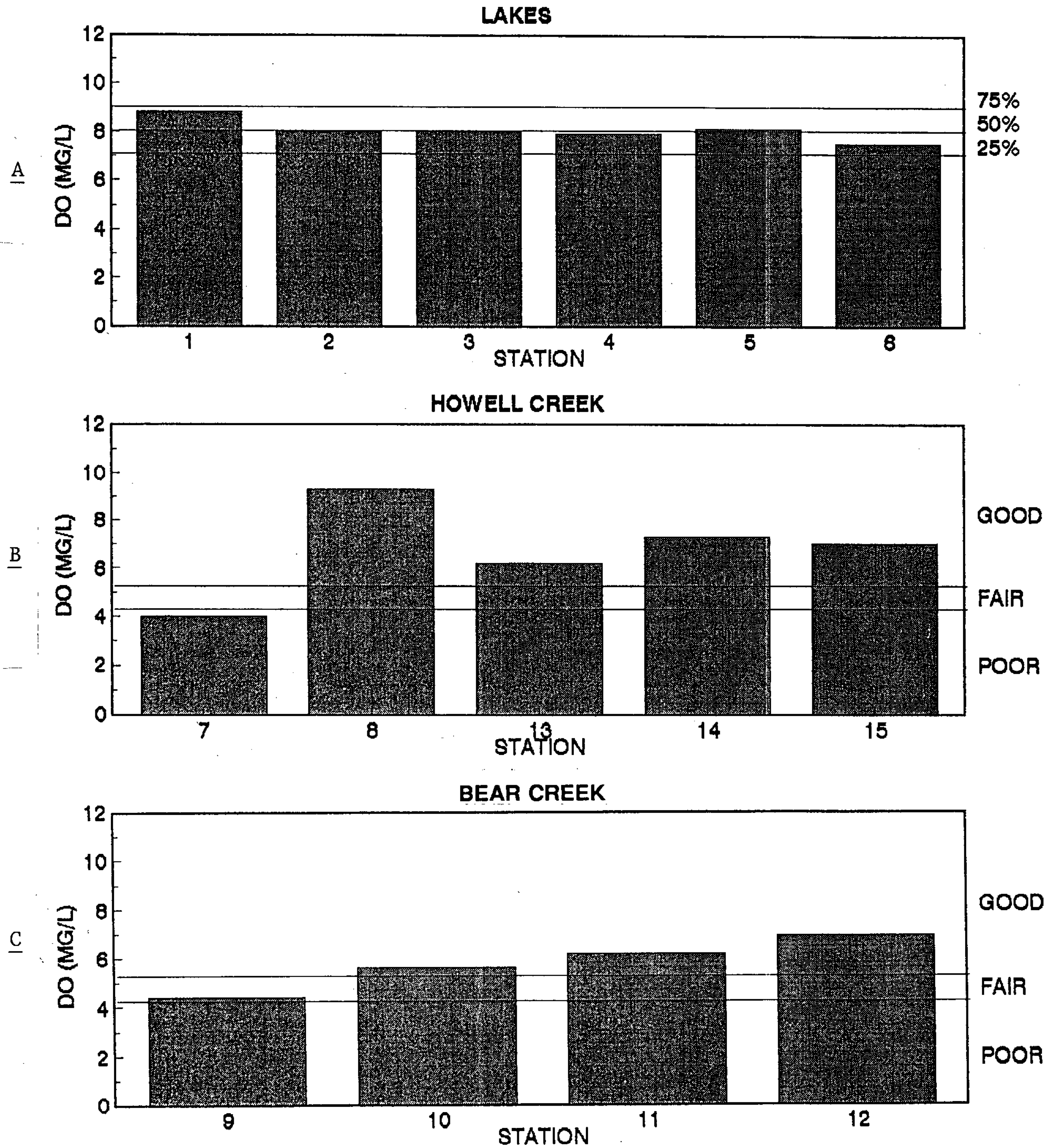
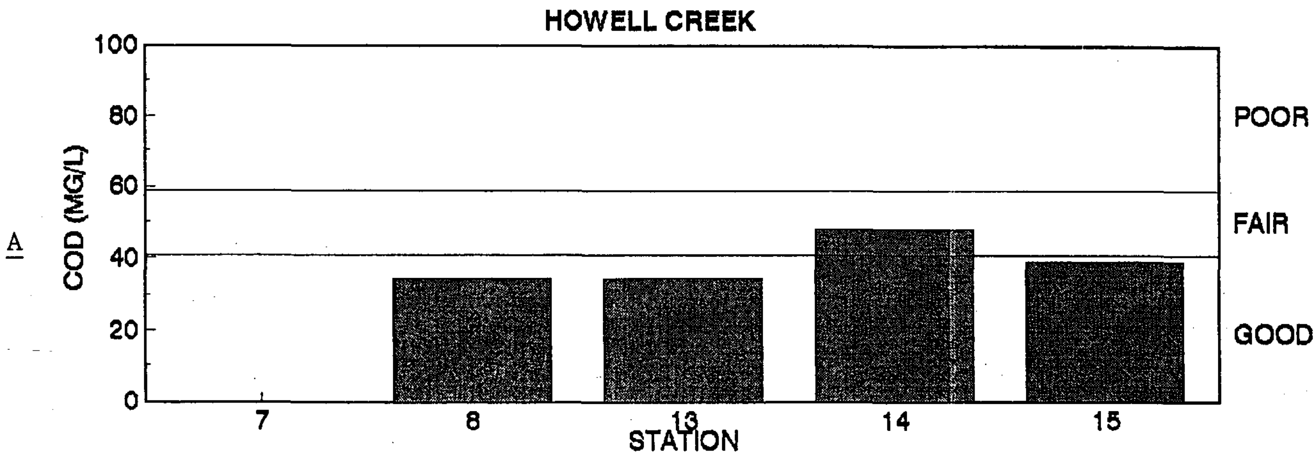


Figure 15. Dissolved oxygen (DO) (in milligrams per liter [MG/L]) for *(A)* lakes, *(B)* Howell Creek, and *(C)* Bear Creek



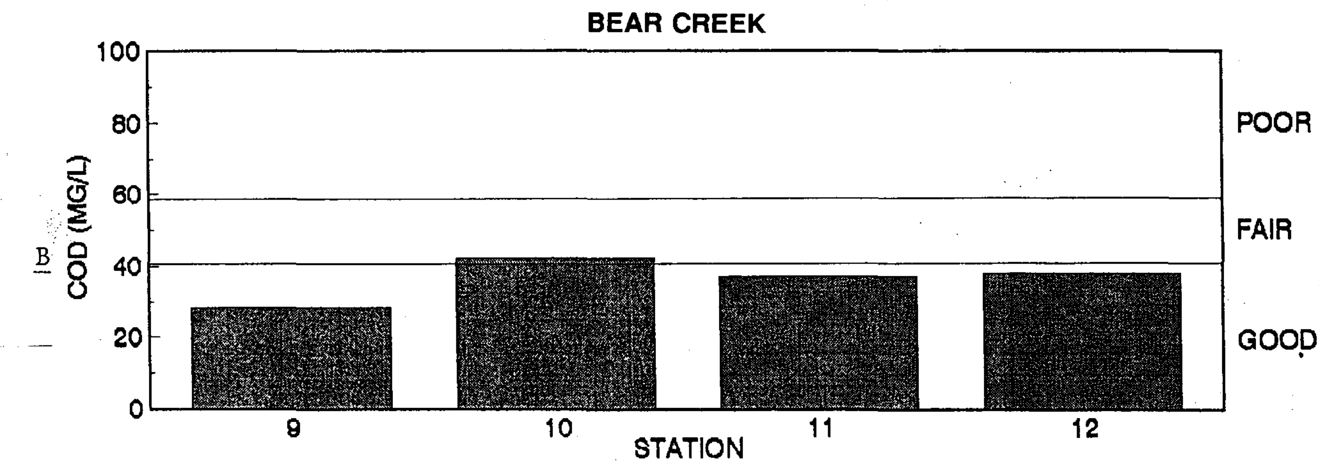


Figure 16. **Chemical oxygen demand (COD) (in milligrams per liter [MG/L]) for *(A)* Howell Creek and *(B)* Bear Creek**

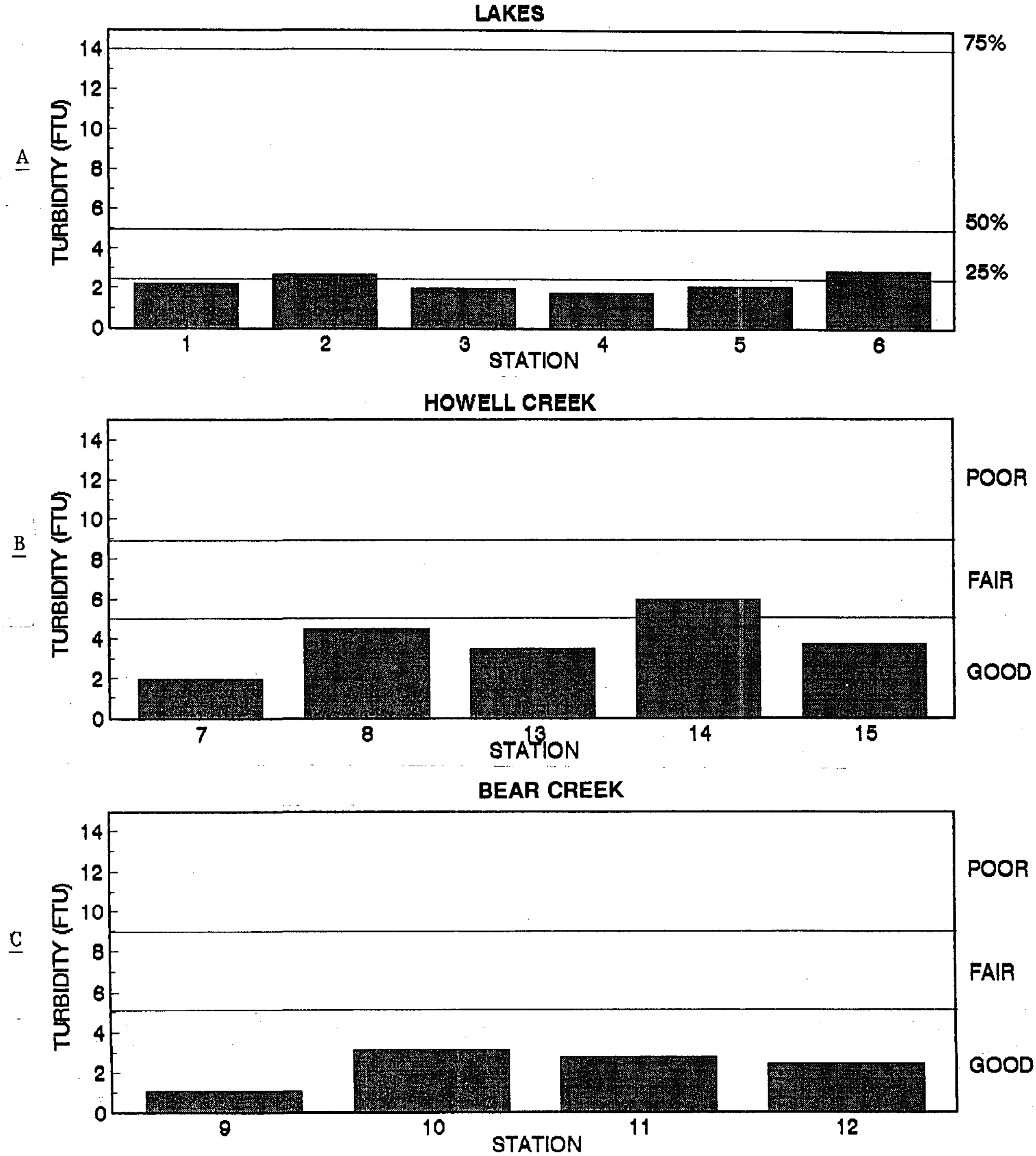


Figure 17. Turbidity levels (in formazene turbidity units [FTU]) for *(A)* lakes, *(B)* Howell Creek, and *(C)* Bear Creek

inspections conducted April 3, 1991, indicated that water became quite turbid during periods of high flow.

Heavy metals were not measured in Bear Gully Creek. However, because concentrations of copper, lead, and cadmium consistently exceeded state water quality standards in other parts of the basin, elevated levels may be present here.

Water Quality Analyses by Problem Area

Following is the water quality analysis for each of the eight problem areas (see Table 3 for station locations). Water quality is discussed in terms of TSI (Secchi depth, chlorophyll *a*, total nitrogen, and total phosphorus), heavy metals, and WQI.

Problem Area I: Lake Ivanhoe. Secchi disc and nutrient readings for Lake Ivanhoe (station 6) were "good" (Figures 10A, 11A, and 13). Chlorophyll *a* concentrations were "fair," indicating increased algal populations (Figure 12).

Levels of copper, lead, and cadmium consistently exceeded state water quality standards; levels of nickel generally exceeded these standards; and levels of zinc occasionally exceeded these standards (Table 17). Elevated levels of BOD and depressed levels of DO were present (Figures 14A and 15A). These conditions may have been due to the urban stormwater runoff entering the lake.

<u>Trophic State Index</u>. Water quality at station 6 was rated "good" by the TSI, with an average annual value of 56 (Figure 9A). The separate components of the TSI were rated as follows (Table 18).

- The average Secchi depth of 1.21 meters (m) was rated "good" (Figure 13).
- The average chlorophyll *a* concentration of 26.70 milligrams per cubic meter (mg/m^3) was rated "fair" (Figure 12).

Table 18. Trophic State Index component ratings for lake stations in the Howell Creek Basin

Station	Secchi Depth (m)	Chlorophyll *a* (mg/m^3)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
1	1.10, Good-Fair	20.65, Fair	0.780, Good	0.039, Good
2	0.87, Fair	29.26, Fair	0.913, Good	0.044, Good
3	1.54, Good	16.21, Good	0.863, Good	0.034, Good
4	1.62, Good	16.11, Good	0.803, Good	0.043, Good
5	1.26, Good	21.09, Fair	0.738, Good	0.043, Good
6	1.21, Good	26.70, Fair	0.787, Good	0.039, Good

Note: m = meter
mg/m^3 = milligrams per cubic meter
mg/L = milligrams per liter

- The average total nitrogen concentration of 0.787 milligrams per liter (mg/L) was rated "good" (Figure 10A).
- The average total phosphorus concentration of 0.039 mg/L was rated "good" (Figure 11A).

State Standards for Class III Water—Heavy Metals. Levels of copper, lead, and cadmium consistently exceeded state water quality standards; levels of nickel generally exceeded these standards; and levels of zinc occasionally exceeded these standards (Table 17). Only measurements determined by more accurate instrumentation installed in 1986 were used in the computation.

Typical Water Quality Values. Elevated levels are those exceeding the 50th percentile for Florida lakes; depressed levels are those below the 50th percentile. Elevated levels of BOD (3.96 mg/L) were present (Table 19), corresponding to the 79th percentile. Depressed levels of DO (7.5 mg/L) were present

Table 19. Typical water quality values for lake stations in the Howell Creek Basin

Station	Biological Oxygen Demand		Turbidity		Dissolved Oxygen	
	Median Value (mg/L)	Percentile	Median Value (ftu)	Percentile	Median Value (mg/L)	Percentile
1	3.10	72	2.20	23	8.8	71
2	4.30	81	2.70	29	8.0	50
3	1.95	58	2.00	20	8.0	50
4	2.40	64	1.75	16	7.9	47
5	3.00	71	2.10	21	8.1	53
6	3.96	79	2.94	32	7.5	33
8*	5.16	86	4.48	44	9.3	81

Note: mg/L = milligrams per liter
ftu = formazene turbidity unit
*Downstream of Lake Howell in which there were no sampling stations

(Figure 15A), corresponding to the 33rd percentile.

Problem Area II: Rowena Chain of Lakes. Problem area II consists of Lakes Sue, Winyah, Estelle, Rowena, and Formosa. The only available water quality data were taken from an unpublished SJRWMD study (Table 20). Water quality at Lakes Sue and Rowena was rated "good" and "fair," respectively, by the TSI, with annual average values of 51 and 62. Only two samples were taken, however. Reduced Secchi depths and elevated chlorophyll *a* and total nitrogen concentrations indicate that Lake Rowena probably has elevated algal populations.

The remaining lakes in the chain may have water quality problems similar to those of Lake Rowena. All of the lakes are thought to have elevated levels of some heavy metals and BOD because these lakes are influenced by urban stormwater runoff.

Table 20. Water quality values in problem area II: Rowena chain of lakes

Lake	Date	Secchi Disc (m)	Chlorophyll *a* (µg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Trophic State Index
Sue	05/01/90	1.38	11.63	0.7	0.012	
	09/10/90	0.80	18.72	1.375	0.032	51, good
Rowena	05/01/90	0.68	42.81	1.258	0.032	
	09/10/90	0.85	33.70	1.085	0.052	62, fair

Note: µg/L = micrograms per liter
m = meter
mg/L = milligrams per liter

Problem Area III: Lake Killarney. Secchi disc readings for Lake Killarney (station 1) were "good-fair," indicating the presence of light-obscuring materials in the water, yet turbidity values were not elevated (Figure 17A). Because Lake Killarney had elevated chlorophyll *a* concentrations, the presence of algal layers below the depth of surface turbidity sampling may explain the low Secchi disc readings (Figures 12 and 13, Table 18). Nutrient levels were "good" (Figures 9A and 10A, Table 18)

Levels of lead and cadmium consistently exceeded state water quality standards; levels of copper generally exceeded these standards (Table 17). Elevated levels of BOD were present (Figure 14A). These conditions may have been due to the urban stormwater runoff entering the lake.

Trophic State Index. Water quality at station 1 was rated "good" by the TSI, with an average annual value of 56 (Figure 9A). The separate components of the TSI were rated as follows (Table 18).

- The average Secchi depth of 1.10 m was rated "good-fair" (Figure 13).

- The average chlorophyll *a* concentration of 20.65 mg/m^3 was rated "fair" (Figure 12).

- The average total nitrogen concentration of 0.780 mg/L was rated "good" (Figure 10A).

- The average total phosphorus concentration of 0.039 mg/L was rated "good" (Figure 11A).

State Standards for Class III Water—Heavy Metals. Levels of lead and cadmium consistently exceeded state water quality standards; levels of copper generally exceeded these standards; and levels of zinc and nickel occasionally exceeded these standards (Table 17).

Typical Water Quality Values. Elevated levels of BOD (3.10 mg/L) were present, corresponding to the 72nd percentile (Table 19).

Problem Area IV: Park Lake. In general, Park Lake (station 2) had slightly elevated levels of chlorophyll *a* (Figure 12). Secchi disc readings were "fair" (Figure 13), indicating the presence of some light-absorbing materials in the water, yet surface turbidity values were not elevated (Figure 17A). Layers of algae populations below the depth at which turbidity samples were taken may explain the low Secchi disc readings. Nutrient levels were rated "good" (Figures 10A and 11A).

Levels of copper, lead, zinc, and cadmium generally exceeded state water quality standards, although only two samples were taken (Table 17). Elevated levels of BOD were also present (Figure 14A). These conditions were probably a result of urban stormwater runoff entering the lake.

Trophic State Index. Water quality in station 2 (Figure 9A) was rated "fair" by the TSI, with an average annual value of 61. The separate components of the TSI are rated as follows (Table 18).

- The average Secchi depth of 0.87 m was rated "fair" (Figure 13).
- The average chlorophyll *a* concentration of 29.26 mg/m^3 was rated "fair" (Figure 12).
- The average total nitrogen concentration of 0.913 mg/L was rated "good" (Figure 10A).
- The average total phosphorus concentration of 0.044 mg/L was rated "good" (Figure 11A).

<u>State Standards for Class III Water—Heavy Metals</u>. Levels of copper, lead, zinc, and cadmium generally exceeded state water quality standards (Table 17); however, only two samples were taken.

<u>Typical Water Quality Values</u>. Elevated levels of BOD (4.30 mg/L) were present, corresponding to the 81st percentile (Table 19).

Problem Area V: Maitland Chain of Lakes. Problem area V consists of Lakes Minnehaha, Maitland, Osceola, Virginia, and Mizell. Water quality was assessed using TSI at Lake Maitland (station 3), Lake Minnehaha (station 4), and Lake Virginia (station 5). Conditions in these three lakes were considered representative of the entire chain, because all lakes were urban, in the same area, connected, and influenced by stormwater runoff.

Water quality was generally rated "good." Levels of copper, lead, and cadmium consistently exceeded state water quality standards (Table 17), and BOD levels were elevated (Figure 14A), again indicating input by urban stormwater runoff.

<u>Trophic State Index</u>. Water quality at stations 3, 4, and 5 was rated "good" by TSI, with average annual values of 52, 51, and 55, respectively (Figure 9A). The separate components of the TSI were rated "good" except for the chlorophyll *a* average at

station 5, which was rated "fair" (Figures 10A, 11A, 12A, and 13A, Table 18).

State Standards for Class III Water—Heavy Metals. The levels of copper, lead, and cadmium consistently exceeded state water quality standards (Table 17).

Typical Water Quality Values. Elevated levels of BOD were present at stations 3 (1.95 mg/L), 4 (2.40 mg/L), and 5 (3.00 mg/L), corresponding to the 58th, 64th, and 71st percentiles, respectively (Table 19).

Problem Area VI: Lake Howell and Vicinity. There were no sampling locations on Lake Howell, making it difficult to assess the lake's water quality. The nearest water quality stations were in Howell Creek, immediately upstream (station 7) and downstream (station 8) of Lake Howell (Exhibit A).

Because these stations are riverine, water quality would be assessed using criteria for rivers (WQI). Water quality was rated "good-fair" with river criteria (Figure 9B); however, levels of BOD, nutrients, and fecal coliforms were elevated and DO at station 7 was depressed (Figures 10B, 11B, 14B, and 15B).

Equating the two stream sites with the lake itself would be misleading. However, water quality at station 8 (stream site immediately downstream of Lake Howell) should be similar to conditions in Lake Howell. Based on data from station 8 and using lake criteria, Lake Howell water quality could be rated "poor."

Heavy metals were measured only at station 7 (Table 17). There, copper, lead, and cadmium concentrations exceeded state water quality standards. Elevated levels of heavy metals could be present in Lake Howell.

Based on both stream and lake criteria, levels of BOD were elevated at stations 7 and 8. Upstream erosion and urban stormwater runoff may be the source of high BOD and fecal coliforms at station 7, while organic loads from Lake Howell were probably the source at station 8. Lake Howell was expected to have elevated BOD because of elevated BOD levels present at upstream and downstream sites; upstream levels of fecal coliforms indicate possible elevated fecal coliforms in Lake Howell.

Nutrient inputs by the Winter Park STP (1.5 miles upstream) and the City of Maitland STP (into the northwest portion of the lake) probably had lasting effects on the water quality of Lake Howell. Although the plants stopped discharging in 1983, nutrient cycling from sediment to the water probably continues. Therefore, water quality may improve slowly, even though discharge has stopped.

Water Quality Index. Water quality at stations 7 and 8 was rated "fair" and "good," respectively, by the WQI, with average annual values of 50 and 42 (Figure 9B). DO, BOD, and fecal coliform counts at station 7, all components of the WQI, were rated "poor" (Figures 14B and 15B, Table 21), while total nitrogen and total phosphorus were rated "fair" (Figures 10B and 11B, Table 21). At station 8, BOD, total nitrogen, and total phosphorus were rated "poor" (Figures 10B, 11B, and 14B, Table 21).

Trophic State Index. Lake Howell would be rated "poor," with a TSI of 70, if assessed by lake criteria at station 8 instead of stream criteria (WQI). Individual components of the TSI would be rated "poor" (chlorophyll *a*, Secchi depth, and total phosphorus) or "fair" (total nitrogen).

State Standards for Class III Water—Heavy Metals. The concentration of lead at station 7 exceeded the state water quality standard, although only one sample was taken (Table 17). The concentration of cadmium and copper at station 7 exceeded the state standard. These conditions may exist in Lake Howell.

Typical Water Quality Values. BOD was "poor" at stations 7 and 8 based on the WQI (Table 19 and Figure 14B), but was not assessed using the TSI. Assuming water quality data at station 8 to be representative of Lake Howell, BOD (5.16 mg/L) was

Table 21. Average water quality values and water quality index component ratings for stream stations in the Howell Creek Basin

Station	Parameters							
	Dissolved Oxygen (ppm)	Biological Oxygen Demand (mg/L)	Chemical Oxygen Demand (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Turbidity (ftu)	Total Coliforms (#/100 mL)	Fecal Coliforms (#/100 mL)
7	4.0, Poor	2.96, Poor	----	1.159, Fair	0.115, Fair	1.96, Good	492	200
8	9.3, Good	5.16, Poor	34.44, Good	2.303, Poor	0.218, Poor	4.48, Good	----	----
9	4.4, Poor	1.07, Good	28.29, Good	0.782, Good	0.051, Good	1.05, Good	----	----
10	5.6, Fair	1.69, Fair	42.18, Good-Fair	1.602, Poor	0.139, Fair	3.15, Good	----	----
11	6.2, Good	0.85, Good	37.09, Good	1.587, Poor	0.230, Poor	2.80, Good	----	----
12	6.9, Good	0.70, Good	37.37, Good	1.167, Fair	0.217, Poor	2.41, Good	----	----
13	6.2, Good	1.82, Fair-Poor	34.23, Good	1.785, Poor	0.243, Poor	3.50, Good	----	----
14	7.3, Good	1.84, Fair-Poor	48.13, Fair	1.706, Poor	0.209, Poor	5.95, Fair	----	----
15	7.0, Good	1.29, Good	39.09, Good	1.579, Poor	0.227, Poor	3.75, Good	----	----

Note: ppm = parts per million
mg/L = milligrams per liter
ftu = formazene turbidity unit
#/100 mL = number per one hundred milliliters

elevated and corresponded to the 86th percentile. No measurements of COD were made at station 7; station 8 had good COD (Figure 16A).

Problem Area VII: Bear Creek Basin. Water quality sites for Bear Creek were located at the intersection of Bear Creek and S.R. 426 (station 9), at Tuskawillow Road (station 10), at Red Bud

Lake Road (station 11), and immediately upstream of the confluence of Bear Creek and Howell Creek (station 12).

Water quality was rated "good" using WQI (Figure 9C), although nutrient levels were generally elevated (Figures 10C and 11C). Localized areas of depressed DO levels and elevated BOD existed (Figures 14C and 15C). Turbidity was rated "good" for the entire reach (Figure 17C); however, field inspections conducted April 3, 1991, indicated that the water became quite turbid during periods of high flow.

Bear Creek was influenced by urban stormwater runoff, agricultural inputs, and erosion, which contributed to nutrient, DO, and BOD problems. Heavy metals were not measured in Bear Creek Basin. However, because concentrations of copper, lead, and cadmium consistently exceeded state water quality standards in other parts of the basin, elevated levels may be present here.

Water Quality Index. Water quality at stations 9-12 was rated "good" by the WQI, with average values of 34, 41, 37, and 31, respectively. DO levels at stations 9 and 10 were low, BOD and COD levels at station 10 were low, and levels of nutrients at stations 10-12 were elevated (Table 21).

Problem Area VIII: Howell Creek Downstream of Lake Howell. Water quality sites were located at the intersection of Howell Creek and Tuskawillow Road (station 13), at Dyson Road (station 14), and at S.R. 434 (station 15).

Water quality was generally rated "fair," but nutrient and BOD levels were elevated (Figures 10B, 11B, and 14B). Localized areas of elevated COD and turbidity levels existed (Figures 16A and 17B). Turbidity was generally rated "good"; however, field inspections (April 3, 1991) indicated the water became quite turbid during periods of high flow.

Howell Creek was influenced by urban stormwater runoff and erosion, which probably account for nutrient, BOD, and turbidity problems. Heavy metals were not measured; however, elevated levels may be present because of contamination upstream.

Water Quality Index. Water quality at stations 13-15 was rated "fair," "fair," and "good" by the WQI, with average values of 46, 45, and 36, respectively (Figure 9B). Individual components of the WQI (Table 21) were elevated at one or more locations. BOD was elevated at stations 13 and 14; COD was high at station 14. Nutrients were elevated at stations 13-15 and turbidity at station 14.

FLOOD MANAGEMENT ALTERNATIVES

ORANGE COUNTY FLOOD PROTECTION

Lakes comprise a major portion of the Howell Creek system in Orange County (Exhibit A, Sheet 1). In general, flood damages could occur to lakefront properties at all major lakes. Flood protection measures for these areas consist primarily of lake regulation, local levee protection, floodproofing, and channel and bridge/culvert improvements (Table 22). Because the distance separating any two consecutive lakes is not large, the improvements proposed for an upstream lake might affect somewhat the stages in a downstream lake. The upstream improvements, however, are not conjunctively considered in evaluating downstream proposals, as that would require evaluating too many combinations of alternatives. After selection of a flood protection measure is made, the combined effect of all selected measures can be evaluated.

Two methods of floodproofing the houses are considered for cost estimates in this study: (1) an earthen ring levee and (2) a flood wall (a free-standing wall). Where there is enough space available between the house and the lake, an earthen ring levee can be built inexpensively and blended into the landscape. If the location is crowded, however, construction of a flood wall would be required. Other methods also may be available, for which a special contractor should be consulted.

Even though lake regulation is an effective flood mitigation alternative, any regulation schedule selected now should be considered as *interim*, because the effects of the proposed regulation schemes are not evaluated in this study. Sample regulation schemes are evaluated to illustrate the benefits offered. Final regulation schedules will be developed through a future study. Details of the proposed flood protection measures for the five problem areas in Orange County follow.

Table 22. Major problem areas and relevant flood protection alternatives (see Exhibit A for locations of problem areas)

Problem Areas	Structure	Estimated Damages in Thousand Dollars@			Flood Protection Alternatives
		10-Year	25-Year	100-Year	
Orange County					
I. Lake Ivanhoe and vicinity	Buildings	0	8	55	Lake regulation
					*Floodproofing
	Streets	0	0.3	1	Local levee protection
II. Rowena chain of lakes	Buildings	7	19	100	Lake regulation upstream
					Outlet and down-stream channel improvements
					Floodproofing
III. Lake Killarney and vicinity	Buildings	4	15	49	Lake regulation
					Floodproofing
IV. Park Lake and vicinity	Buildings	14	38	218	Channel and bridge improvements downstream
					Floodproofing
					Local levee protection
V. Maitland chain of lakes	Buildings	44	98	259	Lake regulation
					Floodproofing
Seminole County**					
VI. Lake Howell and vicinity	Buildings	1	3	21	Lake regulation upstream
					*Floodproofing

Table 22—*Continued*

Problem Areas	Structure	Estimated Damages in Thousand Dollars@			Flood Protection Alternatives
		10-Year	25-Year	100-Year	
VII. Bear Creek Basin	Buildings	0	0	0	*Channel improvements
	Bridges	5	15	35	*Bridge improvements
VIII. Howell Creek downstream of Lake Howell	Buildings	0	0	0	*Channel improvements
	Bridges	2	10	25	*Bridge improvements

@Calculated using 1988 or 1991 tax values
*Not evaluated
**Estimates based on houses built before 1981

Problem Area I: Lake Ivanhoe and Vicinity

Flood damages in this area can be significant only for extreme storm events, that is, more severe than a 25-yr event (Table 22). The damage values shown in Table 22 for this area may be overestimates for the reasons explained in the "Methods" section. Damages would be confined primarily to a single commercial building, Structure I-5, which has a sunken first floor (first-floor elevation is 80.25 ft NGVD [Appendix B], while the ground level is in the vicinity is 80.89 ft NGVD).

Floodproofing. Damages to this building can be prevented by floodproofing or minimized by emergency flood protection measures, such as sandbagging. Other general measures are lake regulation and local levee protection.

Lake Regulation. Outflow from Lake Ivanhoe occurs over a fixed weir, with crest elevation at 77.90 ft NGVD. This maintains water elevations at about 78.00 ft NGVD in Lakes Ivanhoe, Highland, Concord, and Adair (Exhibit A) during the wet season. For this reason, to calculate flood elevations, an initial elevation of 78.00 ft NGVD is assumed in the HEC-1 modeling. Observed stage data, however, showed that the lake levels are predominantly below 78.00 ft NGVD because of evaporation loss. The lowest elevation observed was 76.26 ft NGVD (May 1961). Maintaining the lakes at a lower level during wet periods would reduce peak stages in the lakes.

Maintaining Lake Ivanhoe chain of lakes about 1 ft below the weir crest, that is, 76.90 ft NGVD (IMP1, Table 23), would reduce the 100-yr flood elevation from 81.10 to 80.46 ft NGVD for this area (IMP1, Table 24). This would reduce the 100-yr flood damages from an estimated $55,000 to an estimated $17,000.

Local Levee Protection. A 3-ft-high levee built along the eastern shore of Lake Ivanhoe can prevent flooding of streets and buildings but may affect the aesthetic value of the lake.

Problem Area II: Rowena Chain of Lakes

Flood damages in this area also can be significant only for extreme storm events, that is, more severe than a 25-yr event (Table 22). Also, the damage values shown in Table 22 for this area may be overestimates for the reasons explained in the "Methods" section. The damages would be confined primarily to five expensive houses (S-4, S-8, S-18, S-21, and E-12) with total estimated damages of $78,300 for a 100-yr storm event (Appendix B).

Floodproofing. Floodproofing these five houses would greatly reduce damages for this area. Other general measures are lake regulation upstream and regulation of the Rowena chain of lakes.

Lake Regulation Upstream. Flooding of the Rowena chain of lakes would be caused partially by the high discharges received from Lake Ivanhoe. Flood relief can be obtained by regulating stages and discharges in Lake Ivanhoe. IMP1, which proposes to maintain Lake Ivanhoe at low levels, gives marginal relief to Lake

Table 23. Flood management alternatives evaluated by HEC-1 and HEC-2 modeling for Orange County

Alternative	Description
IMP1	Modify average lake elevation of Lake Ivanhoe from 78.00 ft NGVD to 76.90 ft NGVD
IMP2A	IMP1 + raise Lake Ivanhoe outlet weir crest from 77.90 ft NGVD to 78.40 ft NGVD
IMP2B	IMP1 + raise Lake Ivanhoe outlet weir crest from 77.90 ft NGVD to 78.90 ft NGVD
IMP3A	Construct an outlet weir on Lake Sue and provide downstream improvements (expand culvert and dredge channel)
IMP3B	IMP2B + IMP3A
IMP4A	Increase outflows from Lake Killarney by lowering weir crest from 84.00 ft NGVD to 82.00 ft NGVD
IMP4B	Maintain Lake Killarney at 82.20 ft NGVD. No change in outlet weir (crest elevation = 84.00 ft NGVD)
IMP4C	Maintain Lake Killarney at 82.20 ft NGVD. Lower outlet weir crest to 82.00 ft NGVD
IMP5	Levee protection to the apartment complex on the east shore of Park Lake
IMP6A	Improve U.S. 17/92 bridge downstream of Park Lake (add two 4- x 8-ft box culverts at an invert elevation of 67.00 ft NGVD to the existing 6- x 8-ft box with an invert at 68.00 ft NGVD)
IMP6B	IMP6A + improve channel between Park Lake and Lake Maitland (dredge channel about 1 ft, to an elevation of 67.50 ft NGVD between Park Lake and U.S. 17/92; grade the remaining channel from 67.00 ft NGVD at U.S. 17/92 to about 66.00 ft NGVD near Lake Maitland)
IMP6C	IMP6B + improve railroad bridge downstream of Park Lake (replace existing four 48-in.-diameter culverts at the invert elevation of 68.10 ft NGVD by two 8- x 8-ft box culverts at an invert elevation of 67.50 ft NGVD)
IMP7A	Increase outflow from the Lake Maitland structure as per rating curve B (Figure 18)
IMP7B	Increase outflow from the Lake Maitland structure as per rating curve C (Figure 18)
IMP8A	Maintain Lake Maitland at 65.00 ft NGVD during the wet season by operating the outlet structure. Keep gates closed during storm events (rating curve A, Figure 18)

Table 23—*Continued*

Alternative	Description
IMP8B	Maintain Lake Maitland at 65.00 ft NGVD during the wet season. Operate the Lake Maitland outlet structure as per rating curve D (Figure 18) during storm events
IMP8C	Maintain Lake Maitland at 65.00 ft NGVD during the wet season. Operate the Lake Maitland outlet structure as per rating curve E (Figure 18) during storm events
IMP9	Maintain Lake Maitland at 65.50 ft NGVD during the wet season. Operate the Lake Maitland outlet structure as per rating curve E (Figure 18) during storm events

Note: IMP = Improvement
ft NGVD = feet, National Geodetic Vertical Datum

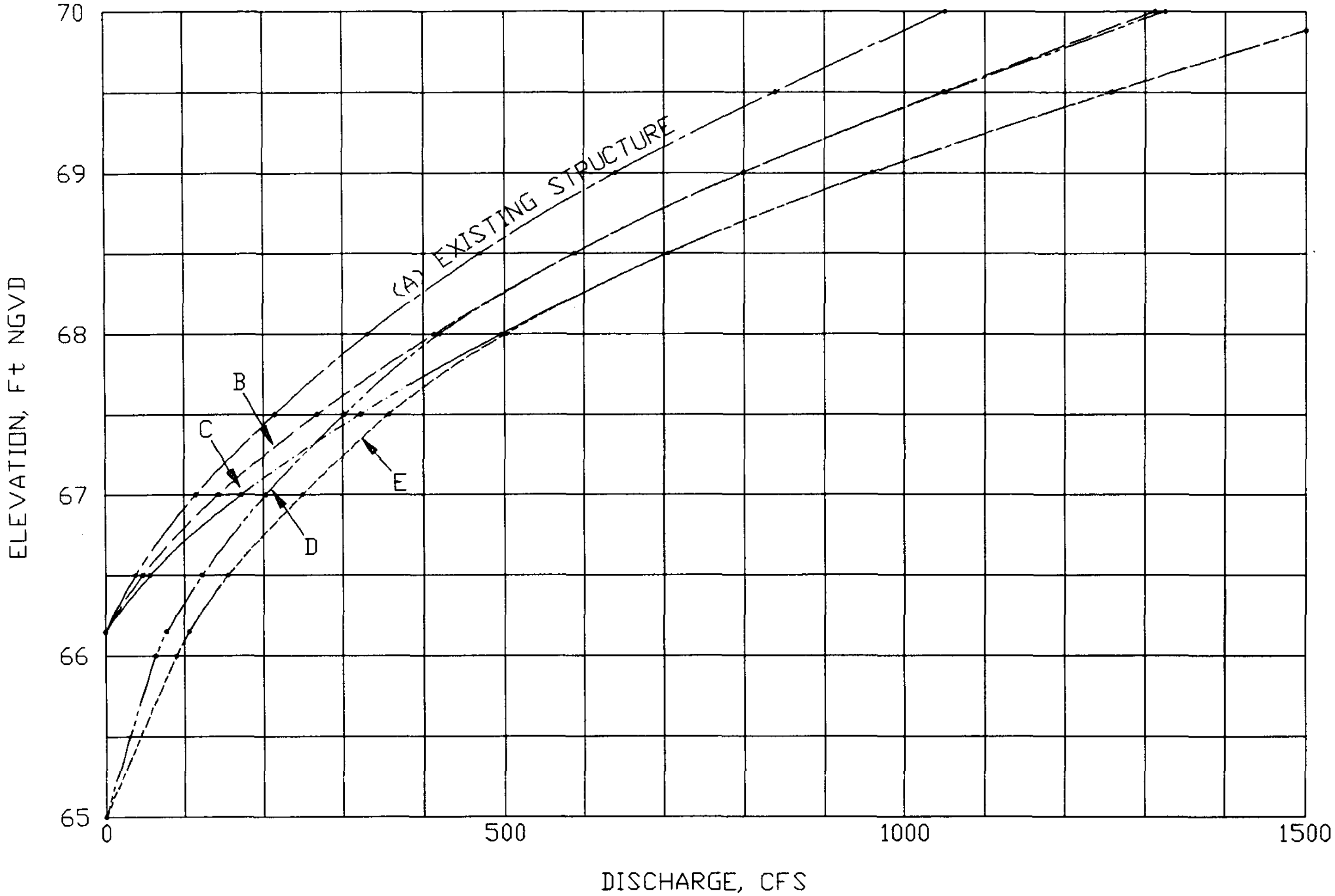


Figure 18. Proposed discharge rating curves for the Lake Maitland control structure

Table 24. Summary of flood elevations for various proposed management alternatives for Orange County

Alternative	Flood Event	Lakes							
		Adair	Ivanhoe	Rowena	Virginia	Killarney	Park	Maitland	Howell
No change, existing conditions	10-year	79.67	79.24	74.72	68.09	85.21	72.19	67.79	56.36
	25-year	80.38	79.88	75.30	68.57	85.79	73.04	68.23	56.92
	100-year	81.97	81.10	76.19	69.49	86.73	74.89	69.09	58.03
IMP1	10-year	79.37	78.73	74.46	67.98	*	*	67.77	*
	25-year	80.04	79.22	75.21	68.50	*	*	68.23	*
	100-year	81.66	80.46	76.13	69.45	*	*	69.08	*
IMP2A	10-year	NE	NE	NE	NE	NE	NE	NE	NE
	25-year	NE	NE	NE	NE	NE	NE	NE	NE
	100-year	NE	NE	NE	NE	NE	NE	NE	NE
IMP2B	10-year	79.37	79.16	74.19	67.90	*	*	67.76	*
	25-year	80.04	79.78	74.88	68.36	*	*	68.21	*
	100-year	81.66	80.80	75.99	69.35	*	*	69.06	*
IMP3A	10-year	*	*	74.21	68.14	*	*	67.80	*
	25-year	*	*	74.80	68.64	*	*	68.26	*
	100-year	*	*	75.80	69.51	*	*	69.07	*
IMP3B	10-year	79.37	79.16	73.71	67.90	*	*	67.77	*
	25-year	80.04	79.78	74.37	68.40	*	*	68.23	*
	100-year	81.66	80.80	75.56	69.38	*	*	69.06	*
IMP4A	10-year	*	*	*	68.13	84.62	73.74	67.99	56.37
	25-year	*	*	*	68.61	85.18	74.64	68.43	56.91
	100-year	*	*	*	69.51	86.40	75.63	69.15	58.02
IMP4B	10-year	*	*	*	68.07	84.69	72.09	67.76	56.36
	25-year	*	*	*	68.56	85.33	72.82	68.20	56.91
	100-year	*	*	*	69.49	86.35	74.49	69.03	58.02
IMP4C	10-year	*	*	*	68.13	84.24	73.20	67.93	*
	25-year	*	*	*	68.61	84.80	74.19	68.38	*
	100-year	*	*	*	69.51	85.98	75.32	69.14	*
IMP5	10-year	*	*	*	*	*	*	*	*
	25-year	*	*	*	*	*	*	*	*
	100-year	*	*	*	*	*	*	*	*
IMP6A	10-year	*	*	*	68.09	*	71.98	67.80	*
	25-year	*	*	*	68.59	*	72.68	68.25	*
	100-year	*	*	*	69.55	*	74.09	69.10	*
IMP6B	10-year	*	*	*	68.09	*	71.76	67.81	*
	25-year	*	*	*	68.59	*	72.40	68.26	*
	100-year	*	*	*	69.55	*	73.79	69.11	*
IMP6C	10-year	*	*	*	68.09	*	71.58	67.82	*
	25-year	*	*	*	68.59	*	72.19	68.27	*
	100-year	*	*	*	69.55	*	73.42	69.12	*
IMP7A	10-year	*	*	*	68.02	*	*	67.68	56.39
	25-year	*	*	*	68.50	*	*	68.10	56.95
	100-year	*	*	*	69.44	*	*	68.87	58.08

Table 24—*Continued*

Alternative	Flood Event	Lakes							
		Adair	Ivanhoe	Rowena	Virginia	Killarney	Park	Maitland	Howell
IMP7B	10-year	*	*	*	67.97	*	*	67.61	56.41
	25-year	*	*	*	68.42	*	*	68.01	56.99
	100-year	*	*	*	69.36	*	*	68.72	58.13
IMP8A	10-year	*	*	*	67.35	*	72.17	67.02	56.23
	25-year	*	*	*	67.92	*	73.03	67.54	56.79
	100-year	*	*	*	68.97	*	74.88	68.48	57.89
IMP8B	10-year	*	*	*	67.22	*	72.17	66.82	56.26
	25-year	*	*	*	67.80	*	73.03	67.34	56.82
	100-year	*	*	*	68.88	*	74.88	68.27	57.92
IMP8C	10-year	*	*	*	67.18	*	73.17	66.71	56.28
	25-year	*	*	*	67.75	*	74.03	67.22	56.84
	100-year	*	*	*	68.82	*	74.88	68.11	57.94
IMP9	10-year	*	*	*	67.41	*	73.17	67.10	56.37
	25-year	*	*	*	67.95	*	74.03	67.59	56.91
	100-year	*	*	*	68.90	*	74.88	68.32	58.02

*Same as existing conditions
NE = not evaluated

Rowena. The peak discharge from Lake Ivanhoe is reduced from 250 cfs to 245 cfs for the 100-yr storm event.

By detaining floodwaters temporarily in the Ivanhoe chain of lakes, flood relief can be obtained to the Rowena chain of lakes. Two schemes are modeled for this purpose: Raise Lake Ivanhoe weir crest elevation from 77.90 ft to 78.40 ft NGVD (IMP2A) or to 78.90 ft NGVD (IMP2B). The 100-yr elevations resulting from these schemes are summarized in Table 25.

IMP2B reduces 100-yr flood stages in Lakes Ivanhoe and Rowena by 0.3 ft and 0.2 ft, respectively. This flood relief is not adequate to alleviate flood damages completely in the two problem areas.

Regulation of the Rowena Chain of Lakes. No control structure exists at present for the Rowena chain of lakes. A 4- x 6-ft box culvert located downstream of Lake Sue restricts flow somewhat during flood stages. The conveyance capacity of the lake outlet

Table 25. Results of floodwater detention in Lake Ivanhoe and its effects on Lake Rowena

Alternative	Lake Ivanhoe				Lake Rowena
	Weir Crest Elevation (ft NGVD)	Initial Elevation (ft NGVD)	100-Year Elevation (ft NGVD)	100-Year Outflow (cfs)	100-Year Elevation (ft NGVD)
No change, existing conditions	77.90	78.00	81.10	250	76.19
IMP1	77.90	76.90	80.46	245	76.13
IMP2A	78.40	76.90	80.69	230	76.04
IMP2B	78.90	76.90	80.80	217	75.99

Note: ft NGVD = feet, National Geodetic Vertical Datum
cfs = cubic feet per second
IMP = improvement

can be improved by expanding the culvert and dredging the outlet channel. This would reduce the flood stages but may also cause lower stages than the existing low stages due to continued drainage of the lakes. To maintain desirable low stages, a control structure (weir) is also necessary in addition to the above-mentioned improvements. The following improvements (IMP3A) are proposed to accomplish lake regulation.

- Construct a 24-ft weir at the outlet of Lake Sue, with crest elevation at 70.50 ft NGVD, and flash boards.
- Expand the downstream culvert by adding a 4- x 4-ft box culvert.
- Dredge Lake Sue outlet channel bottom to an elevation of 70.00 ft NGVD from the existing approximate elevation of 70.80 ft NGVD.

Based on observed stage data, an initial lake elevation of 71.70 ft NGVD was assumed for the existing conditions in HEC-1 modeling. The lowest elevation recorded was 70.61 ft NGVD in May 1977. In addition to the improvements described above, the lakes should be maintained at 71.00 ft NGVD during the wet period.

IMP3A reduces flood stages in the lakes by about 0.5 ft during 10- and 25-yr events and by 0.4 ft during the 100-yr event. Flood stage reduction by IMP3B (a combination of IMP2B and IMP3A, Table 23) would be about 0.9 ft for the 10- and 25-yr events and 0.7 ft for the 100-yr event (Table 24). With IMP3B, only one house (E-12) would be flooded (by 0.46 ft) during the 100-yr event (Appendix B).

Cost Estimates and Benefit/Cost Ratios for Floodproofing. Damages to individual houses are considered significant if the 100-yr damages to the building exceed $5,000 or 5 percent of the structure value, whichever is greater (a 100-yr damage of $5,000 equals about $125 per annum). Cost of floodproofing such houses is estimated, and benefit/cost ratios are evaluated in Table 26. In general, when flood depths are in the range of 1.0 to 0.0 ft below first-floor elevation, annual flood damages do not appear significant, and floodproofing would not offer economic benefits. A flood wall is invariably cost-prohibitive.

For structures S-4, S-8, S-13, and S-18, floodproofing is not economical (Table 26). Floodproofing is recommended for S-21. For structure E-12, flood protection by other methods should be explored.

Problem Area III: Lake Killarney and Vicinity

Flood damages for this area can be significant only during extreme storm events, that is, more severe than a 25-yr event (Table 22). There are three houses with potentially high damages (structures 17, 23, and 34; see Appendix B) with the 100-yr flood depth in the range of 0.02 to 0.94 ft. There are six other houses where the 100-yr flood depth would be in the range of 0.94 to

Table 26. Economics of floodproofing in the Howell Creek Basin, Orange County (see Appendix B). *The higher the benefit/cost ratio the greater the return on the investment.*

Building Identification	Building Value ($)*	100-Year Flood Depth (feet)**	100-Year Damage ($)	Method	Total Cost ($)*	Annual Cost ($)	Annual Benefits ($)*	Benefit/ Cost Ratio
Lake Ivanhoe (Problem Area I)								
I-5	124,400	0.85	18,800	Emergency sandbagging	--	--	820	NA
Rowena Chain of Lakes (Problem Area II)								
S-4	341,300	-0.42	20,800	Ring levee	4,660	381	220	0.58
S-8	222,680	-0.43	13,400	Flood wall	16,500	1,350	134	0.10
S-13	94,780	-0.31	6,900	Ring levee	2,200	180	70	0.39
S-18	143,750	-0.17	12,500	Flood wall	17,000	1,390	125	0.09
S-21	102,780	0.50	13,600	Ring levee	1,800	147	340	2.31
E-12	109,000	1.10	18,050	Flood wall	21,300	1,740	873	0.50
Lake Killarney (Problem Area III)								
23	63,160	0.94	9,870	Flood wall	37,600	3,070	424	0.14
17	91,590	0.02	9,720	Flood wall	67,470	5,500	134	0.02
34	109,430	0.63	15,250	Flood wall	41,500	3,390	368	0.11
Park Lake (Problem Area IV)								
36–38 (three houses)	210,000 (approx.)	1.59 to 3.85	57,000 (approx.)	Ring levee	8,400	687	2,600	3.80
39	57,540	0.09	6,300	Ring levee	4,200	343	160	0.47
40-46 (apt. complex)	1,675,000	-0.51 to 1.29	154,000	Ring levee and flood wall	197,000	16,100	3,500	0.22
				Earthen levee (if feasible)	37,500	3,040	3,500	1.15
Maitland Chain of Lakes (Problem Area V)								
71	137,400	0.39	17,300	Ring levee and flood wall	16,100	1,320	756	0.57
72	223,000	0.09	24,500	Ring levee	5,300	433	910	2.10
63	290,400	1.09	47,900	Ring levee	4,700	384	4,690	12.2
62	237,500	-0.01	24,700	Ring levee	5,600	458	860	1.88
61	270,400	-0.01	28,100	Ring levee	4,800	392	940	2.40
4	149,900	1.05	24,400	No room for flood-proofing	NA	NA	2,660	NA

Table 26—*Continued*

Building Identification	Building Value ($)*	100-Year Flood Depth (feet)**	100-Year Damage ($)	Method	Total Cost ($)*	Annual Cost ($)	Annual Benefits ($)*	Benefit/Cost Ratio
1	52,100	0.98	8,250	Flood wall	78,700	6,430	424	0.07
54	118,600	-0.11	11,100	Flood wall	78,700	6,430	144	0.02
53	219,400	0.59	30,100	Flood wall	78,700	6,430	2,250	0.35
49	55,600	0.42	7,100	Flood wall	49,600	4,050	335	0.08

*Building value and annual benefits are based on 1988 or 1991 tax values, while total costs are based on 1991 dollars
**A negative number indicates the depth of the flooding in feet below first-floor elevation
Note: $ = dollar
-- = variable
NA = not applicable

0.47 ft below first-floor elevation. Minor damages might occur to these houses.

Floodproofing. A flood wall would be necessary to protect the three houses from potentially major damages. This would be cost-prohibitive (Table 26). Other methods should be explored. Increasing outflows during the storm event and lake regulation are considered as other flood protection alternatives.

Increasing Outflows During the Storm Event. The crest elevation of Lake Killarney outlet weir can be adjusted between 82.00 and 84.00 ft NGVD. Orange County operates this structure to reduce flood stages in Park Lake downstream. To obtain conservative estimates of flood elevations, this study assumed that the weir crest would be maintained at 84.00 ft NGVD during storm events. An initial lake elevation of 82.9 ft NGVD was assumed based on observed data in HEC-1 modeling for existing conditions.

This alternative (IMP4A, Table 23) proposes to increase flood discharges out of Lake Killarney by lowering the weir crest to 82.00 ft NGVD at the onset of a storm. A discharge rating curve is developed for this condition by the HEC-2 program. With this measure, the 10- and 25-yr flood stages in Lake Killarney would be reduced by about 0.6 ft and the 100-yr stage by 0.3 ft (Table 24). This would reduce flood damages only partially. Flood stages in Park Lake, however, would increase by about 1.6 ft for the 10- and 25-yr events and by 0.7 ft for the 100-yr event. Stages would also increase marginally in Lake Maitland.

Lake Regulation. Two alternative regulation schemes are evaluated (IMP4B and IMP4C, Table 23). IMP4B reduces the 100-yr flood elevation by about 0.4 ft and IMP4C by 0.75 ft (Table 24). These two schemes reduce the 100-yr flood damages from $48,700 to about $30,000 and $20,000, respectively (Appendix B). In general, lake regulation would greatly reduce flood threat to the area. Expected annual damages with IMP4C are calculated as $525. This alternative, however, would increase flood stages in Park Lake (Table 24).

Problem Area IV: Park Lake and Vicinity

Significant damages at this area would occur only during extreme storm events, that is, more severe than a 25-yr event (Table 22). Three flood protection alternatives are identified for this area: local levee protection, floodproofing, and bridge and channel improvements.

Local Levee Protection. Major flood damages at the Park Lake area would occur primarily on the eastern shore of the lake, to a two-story apartment complex. Damages to the apartment complex can be prevented by building an 8-ft-high levee around the development (IMP5, Table 23). The length of the levee would be about 2,000 ft. With a 5-ft top width and 2:1 side slopes, the cost of the levee is estimated as $37,500 (annual cost = $3,040). This would give a benefit/cost ratio of 1.15 (Table 26, Appendix C). However, the area appears to be crowded, requiring a combination of flood wall and the earthen levee. This would give a benefit/cost ratio of 0.22.

Floodproofing. The costs and benefit/cost ratio for floodproofing the four single-family houses are presented in Table 26.

Bridge and Channel Improvements Downstream. The length of the channel connecting Park Lake to Lake Maitland is about 2,400 ft. A railroad bridge and a road bridge (U.S. 17/92) are located on this channel at about 300 ft and 900 ft, respectively, from Park Lake. In general, the area is congested; there is no scope for channel widening, and bridge improvements would be expensive. Nevertheless, the improvements are considered progressively (IMP6A, IMP6B, IMP6C, Table 23), and the effects on flood elevations are evaluated (Table 24). No upstream improvements (Lake Killarney) are considered with this alternative. Table 27 summarizes the benefits offered by the proposed improvements—bridge improvements (IMP6A, IMP6B, and IMP6C) would not be cost-effective. Protection by a levee (with a benefit/cost ratio of 1.15 or less) does not appear to be an economic benefit either.

Table 27. Flood damage analysis for the Park Lake area (problem area IV)

Alternative	Damages*		Cost of Improvements*		Benefit/ Cost Ratio
	100-year	Annual	Total	Annual	
No change, existing conditions	$217,800	$6,260	NA	NA	NA
IMP6A	$ 80,200	$2,080	$ 97,200	$ 7,950	0.27
IMP6B	$ 50,300	$1,300	$101,000	$ 8,280	0.36
IMP6C	$ 18,000	$ 310	$206,000	$16,800	0.24

*Calculated using 1988 or 1991 tax values
Note: NA = not applicable
IMP = improvement

Problem Area V: Maitland Chain of Lakes

Major flood damages are confined to ten houses (seven on Lake Maitland and one each on Lakes Minnehaha, Mizell, and Virginia), with the 100-yr flood depths ranging from 0.11 ft below first-floor elevation to 1.05 ft above first-floor elevation (Appendix B). The estimated 100-yr damages for these ten houses totals about $223,000. For ten other houses, the 100-yr flood depth is in the range of 0.51 to 0.96 ft below first-floor elevation; therefore, the residual damages may not be significant. Floodproofing, increasing discharges from Lake Maitland during storm events, and lake regulation are considered as possible flood management alternatives.

Floodproofing. By floodproofing the ten expensive houses, damages in this area can be greatly reduced. This method, however, will not be cost-effective for six of these houses (Table 26).

Increasing Discharges from Lake Maitland During Storm Events. The Lake Maitland control structure is equipped with two vertical roller gates. However, the gates have never been operated since the construction of the structure in 1979 because a regulation/operation schedule for the lake has not been developed. The structure has been functioning as a fixed-crest weir, with a crest elevation of 66.15 ft NGVD. A discharge rating curve (curve A, Figure 18) for this condition was developed using the HEC-2 program. Appropriate tailwater conditions were assumed. Flood stages for the existing conditions were determined using rating curve A and assuming an initial lake elevation of 66.30 ft NGVD.

By operating the gates, greater flows from Lake Maitland can be released during storm events than would occur if the structure functioned as a fixed weir. This will reduce flood stages in the Maitland chain of lakes. Several operation scenarios are possible. However, no major deviation from the weir condition is proposed in the present study. Two rating curves with discharges 25 percent and 50 percent greater than the weir flows are developed (curves B and C, Figure 18). To operate the gates (i.e., to adjust the gate opening) to achieve these discharges, a hydraulic rating curve for the structure is necessary. No rating curves exist for the structure; however, such curves will be developed as part of the final study being conducted by

SJRWMD. The hydraulic rating curves relate discharges and gate openings for various headwater/tailwater conditions.

An evaluation of the storm events with the Lake Maitland structure operation as per the two proposed rating curves (B and C) indicates that the flood stage reduction in the lakes would not be substantial (IMP7A and IMP7B, Tables 23 and 24). The 10-, 25-, and 100-yr flood stages in Lakes Maitland and Minnehaha would be reduced by 0.11, 0.13, and 0.22 ft, respectively, with rating curve B (Figure 18) and by 0.18, 0.22, and 0.37 ft, respectively, with rating curve C. No major reduction in flood damages would occur. Flood stages in Lake Howell would increase slightly, up to a tenth of a foot. Greater flood reduction benefits may be obtained by regulating the lakes so that lower lake levels will prevail during the rainy season.

Lake Regulation. Four alternative regulation schemes are considered (IMP8A, IMP8B, IMP8C, and IMP9; Table 23). These regulation schemes would maintain the chain of lakes at 65.00 ft NGVD (IMP8A, IMP8B, IMP8C) and 65.50 ft NGVD (IMP9) during the wet season by operating the Lake Maitland control structure. This would create storage capacity within the lake system to absorb a portion of storm discharge. This chain of lakes recorded a low elevation of about 64.00 ft NGVD during the 1981 drought. Thus, the proposed regulation elevations are considerably higher than the 1981 low elevations. When the lakes rise above the regulated elevations during a storm event, discharges would be made through the structure as per the rating curves proposed (Figure 18).

With IMP8A, the gates of the Lake Maitland structure would be kept closed during the storm event. This simulates the existing conditions and evaluates the effect of storage capacity created by maintaining lower lake levels. During the storm event, the lakes would fill up to the level of the top of the gates (66.15 ft NGVD), then discharge would take place as weir flow over the gates. Curve A in Figure 18 is the rating curve for the weir flow conditions.

With IMP8B and IMP8C, discharges through the structure would be as per rating curves D and E (Figure 18), respectively, when the lake stage exceeds 65.00 ft NGVD. Rating curves D and E are developed assuming the structure discharge as 125 percent and 150 percent of the weir flow, respectively, for elevations above 68.00 ft NGVD. A smooth transition curve is drawn for the segment between 65.00 ft and 68.00 ft NGVD (Figure 18).

IMP9 would operate under rating curve E, except that the gates would be opened when water the level exceeds 65.50 ft NGVD.

Once an option (scheme) is selected, gate openings that would achieve the required discharges at various elevations could be determined from the hydraulic rating curves. The 100-yr flood stages in the Maitland chain of lakes would be reduced by 0.61 ft, 0.82 ft, 0.98 ft, and 0.77 ft under the four options, IMP8A, IMP8B, IMP8C, and IMP9, respectively (Table 24). Table 28 summarizes the other benefits resulting from these options.

Table 28. Maitland chain of lakes: discharges and flood damages

Alternative	Discharge (cfs)			Expected Annual Damages*
	10-Year	25-Year	100-Year	
No change, existing conditions	289	408	695	$15,000
IMP8A	147	257	482	$ 4,920
IMP8B	191	293	526	$ 3,700
IMP8C	216	323	565	$ 2,870
IMP9	277	390	647	$ 4,700

Note: cfs = cubic feet per second
*Calculated using 1988 or 1991 tax values

Lower flood discharges would occur from the Lake Maitland control structure under all regulation alternatives proposed. Flood damages would be greatly reduced. Flood stages would be slightly reduced in Lake Howell under the three options of IMP8 but would remain about the same as existing conditions under IMP9.

The foregoing results also indicate that keeping the gates of the Lake Maitland structure permanently in a closed position would increase flooding both upstream and downstream. With gates in the closed position, higher lake levels would prevail in the chain of lakes during wet season, reducing flood storage capacity of the lakes. As a result, the lakes would both rise higher and pass on higher discharges downstream during storm events. The desirable wet season lake levels, however, need to be determined also from the consideration of recreation, ecology, and water quality requirements. With the lake regulation proposed under IMP8B, IMP8C, or IMP9, the 100-yr flood depth would exceed 0.00 ft (range 0.11 to 0.98 ft) only for three houses; for seven (IMP8C) or eight (IMP9) other houses the depth would be 1.0 to 0.00 ft below first-floor elevation (Appendix B).

SEMINOLE COUNTY FLOOD PROTECTION

Residential damages to the houses built before 1981 in Seminole County are not excessive (Table 22). The 1986 DOT aerial maps, however, indicated that 120 new houses were built within the 100-yr floodplain (34 near Lake Howell and 86 in the Bear Creek Basin). Flood damages for the new houses are not calculated due to lack of survey information.

Problem Area VI: Lake Howell and Vicinity

There are two flood protection alternatives available for this area, lake regulation upstream and floodproofing.

Lake Regulation Upstream. Flood discharges into Lake Howell can be reduced by regulating lake levels and outflows of the Maitland chain of lakes upstream. The regulation schemes proposed under IMP8A, IMP8B, and IMP8C offer moderate reduction in flood stages (Table 24) and flood discharges in Lake Howell. Flood damages would be further reduced.

Floodproofing. If flood damages calculated for new houses are found to be significant (after obtaining survey information), floodproofing the affected buildings is recommended.

Problem Area VII: Bear Creek Basin

No residential damages would occur to the houses built before 1981. Further evaluations should be performed based on calculated damages to the buildings constructed after 1981.

Several culverts and minor bridges would suffer damages due to erosion and/or overtopping during a flood. No detailed evaluations were performed regarding possible damages and protection alternatives. Channel and bridge improvements are the remedial measures to reduce damages.

Problem Area VIII: Howell Creek Downstream of Lake Howell

No residential development occurred within the 100-yr floodplain according to DOT maps (i.e., up to 1986). Several culverts and minor bridges would suffer damages due to erosion and/or overtopping during a flood. No detailed evaluations are performed regarding possible damages and protection alternatives. Channel and bridge improvements are proposed to reduce damages.

EROSION CONTROL MEASURES

High velocities of flow develop near bridges and culverts due to channel constriction. Velocities produced by the 10-, 25-, and 100-yr storm runoff at various locations on Howell Creek and its tributaries are listed on Table 8. Bridges should be designed to address scour and erosion problems near piers and abutments and to make appropriate provisions for safety, for example, using riprap or concrete or masonry wing walls. Orange and Seminole counties should perform periodic inspections of bridges and culverts and carry out repairs if any of the protection devices are damaged.

Channel reaches can be eroded if the conveyance capacity is inadequate. If no action is taken, bank and/or bed erosion will continue until the channel section expands to sufficient dimensions so that the flow velocity is reduced to non-scouring velocity. Such erosion is undesirable in urbanized areas because there may not be sufficient margin on either side of the river channel section to allow uncontrolled channel erosion. Houses may be close to the river banks.

To increase conveyance capacity, the existing natural channel should be replaced by a designed channel in the reaches of Howell Creek where erosion problems are indicated. To arrive at the final design section, however, it will be necessary to determine the non-scouring and non-silting velocities for various problem reaches based on bed material and other channel properties. The channel section is then dimensioned based on these velocities and design discharges. No detailed evaluation of erosion problems was performed as a part of this study. Additional field and channel survey would be necessary for this purpose. The counties should undertake this analysis as a special study based on observed erosion.

PERMIT REQUIREMENTS

MSSW and Wetland Resource Management (WRM) permits would be required prior to construction of flood protection alternatives. Demonstration should be required that no degradation of water quality below the standards set forth in Chapters 17-3 and 17-4, *F.A.C.*, would occur as a result of the project would be required. The proposed alternatives are all potentially permittable provided various permit requirements are met, as described in the SJRWMD MSSW Applicant's Handbook (SJRWMD 1991). Orange and Seminole counties would be required to perform additional calculations and provide additional measures to meet some of the MSSW criteria. The MSSW and WRM permits are described below.

Management and Storage of Surface Waters (MSSW) Permit

A permit from SJRWMD would likely be required under Chapter 40C-4, *F.A.C.*, for construction and operation of flood control alternatives. To obtain a permit, the applicant must provide reasonable assurance that the proposed activity will not harm the water resources or be inconsistent with the objectives of SJRWMD (see SJRWMD 1991, section 9.0). Projects must not result in a net loss of the floodplain storage within the 100-yr floodplain of the Howell Creek Basin.

Wetland Resource Management (WRM) Permit

Permits are required from both the federal government (i.e., USACE) and the state (i.e., DEP) for dredging, filling, or other activities to be conducted within the waters of the state. Joint application can be made to both DEP and USACE for a permit; permits from both agencies must be issued. Under the existing operating agreement with DEP and SJRWMD, WRM permits will be processed and issued by SJRWMD for most projects that also require an MSSW permit.

The data on water quantity impacts from each alternative provided by this report will be suitable to use in the permit application process to address MSSW water quantity criteria. The proposed alternatives are all potentially permittable. Some alternatives, however, may have potential adverse impact on water quality or wetlands. This must be evaluated in detail prior to determining if the detailed investigations demonstrate that the plan meets the MSSW review criteria concerning wetlands and water quality impacts, including the issues related to ecological effects discussed in the "Methods" section of this report.

SJRWMD permitting rules and Chapter 120, *Florida Statutes*, provide interested parties (such as affected property owners, governmental agencies, and environmental action groups) with the opportunity to comment and request an administrative hearing on any proposed agency action on a permit application. The final outcome of a permit application for any particular proposed flood control alternative cannot be determined until the SJRWMD Governing Board makes a decision based on a technical review and recommendation prepared by the SJRWMD staff as well as on comments from all interested parties. County governments should seek to work closely with interested parties to develop specific proposals which are mutually beneficial.

SUMMARY AND RECOMMENDATIONS

The Howell Creek Basin is located in central Florida, in Orange and Seminole counties, in SJRWMD. Most of the basin is highly urbanized, and street flooding, damages to residential and commercial buildings, losses of bridges and culverts, and channel and bank erosion can occur within the basin during major storm events. SJRWMD conducted a two-phase study to evaluate the flooding problems of the basin and to formulate a comprehensive flood management plan to reduce flood and erosion damages. Water quality and environmental conditions in the basin also were assessed.

In Phase I (the floodplain study), flood elevations and floodprone areas in the basin were determined through detailed hydrologic and hydraulic analyses. The floodplain study indicated that about 330 buildings, 185 in Orange County and 145 in Seminole County (primarily single-family houses, with some multifamily and commercial units), are located in the 100-yr floodplain. The study also identified 26 bridges and culverts that might be overtopped during a 100-yr storm event.

In Phase II (the present study—the flood management study), damages were analyzed, major problem areas in the basin were identified, and several flood protection alternatives were presented for each problem area. An analysis of water quality in the basin, environmental conditions, and wetland loss were also part of this study. A study of building structures during Phase II indicated that, of the approximately 330 buildings in the 100-yr floodplain, only about 65 buildings might suffer actual flood damage. Residents of other buildings would experience street or yard flooding but no significant structural damages because the first-floor elevations of the houses were more than 1 ft above the 100-yr flood elevation. Survey information, however, was not available for 154 of the 330 aforementioned buildings. Most of these buildings are located in the new housing developments that occurred in Seminole County after the 1981 aerial survey for this project. These buildings were very likely constructed with house pads above 100-yr flood elevations. The structures that might sustain damages during a major storm event are scattered throughout the basin (Table 29 and Exhibit A).

One of the original objectives of Phase II was to develop operating schedules for the existing water control structures at Lakes Killarney and Maitland (Orange County) to provide maximum flood control benefits. These schedules, however, were not developed for this report because the effects of lake regulation cannot be assessed without a continuous hydrologic simulation model. A future study (requested by Orange County officials) that uses a continuous hydrologic simulation model will develop lake regulation schedules to provide flood control and will consider aesthetics, navigation, and recreation of the Maitland chain of lakes and downstream waterbodies.

Expected residential damages were calculated based on FIA guidelines. In addition, other likely damages (e.g., overtopping of bridges and culverts, street flooding, and damages due to erosion) were considered in identifying problem areas. Because these problem areas are scattered throughout the basin, providing flood relief to all areas by a single solution is not possible. This report identifies problem areas I-VIII (Table 29 and Exhibit A) as areas in need of minor or major flood control measures to reduce damages. Each of the eight areas was considered separately in formulating and evaluating different flood protection alternatives. Areas with low damages (not exceeding $25,000 during a 100-yr storm event) were excluded from the study. Orange and Seminole counties may want to re-evaluate the low-damage areas based on actual flood experience.

A number of flood protection alternatives were considered for each problem area with significant damages (Table 29). Residential flood damages would be significant primarily in Orange County. Damages to residential developments constructed prior to 1981 in Seminole County would be minimal. New developments, however, occurred throughout the basin in Seminole County, and about 120 additional houses were located

Table 29. Major problem areas and flood protection alternatives (see Exhibit A for locations of problem areas and Table 23 for description of improvements [IMP])

Problem Areas	Structure	Estimated Damages in Thousand Dollars†			Flood Protection Alternatives	Expected Annual Damages†		Benefit/ Cost Ratio
		10-Year	25-Year	100-Year		Without Improvements	With Recommended Alternatives	
Orange County								
I. Lake Ivanhoe and vicinity	Buildings	0	8	55	Floodproofing	$ 1,580	$ 0	*
	Streets	0	0.3	1	Lake regulation with improvements:			
					IMP1[a]	$ 1,580	$ 344	4.3
					IMP1[b]	$ 5,280[c]	$ 3,320	6.9
					*Local levee protection	$ 1,580	$ 0	Low
II. Rowena chain of lakes	Buildings	7	19	100	Floodproofing	$ 3,700	$ 0	@
					Lake regulation upstream:			
					IMP2B[d]	$ 3,700	$ 2,410	4.5
					IMP2B[e]	$ 5,280[c]	$ 3,440	6.4
					Regulation of Rowena chain of lakes with improvements:			
					IMP3B[d]	$ 3,700	$ 830	1.5
					IMP3B[e]	$ 5,280[c]	$ 1,860	1.8
III. Lake Killarney and vicinity	Buildings	4	15	49	Floodproofing	$ 2,070	$ 0	@
					Increase outflows (IMP4A)	$ 2,070	$ 956	No cost
					Lake regulation (IMP4C)	$ 2,070	$ 525	No cost

Table 29—*Continued*

Problem Areas	Structure	Estimated Damages in Thousand Dollars†			Flood Protection Alternatives	Expected Annual Damages†		Benefit/ Cost Ratio
		10-Year	25-Year	100-Year		Without Improvements	With Recommended Alternatives	
IV. Park Lake and vicinity	Buildings	14	38	218	Local levee protection (IMP5)	$ 6,260	$ 2,760	1.15
					Floodproofing			@
					Channel and bridge improvements downstream (IMP6C)	$ 6,260	$ 310	0.24
V. Maitland chain of lakes	Buildings	44	98	259	Floodproofing	$15,000	$ 0	@
					Increase outflows (IMP7A)	$15,000	**	**
					Lake regulation: IMP8C IMP9	 $15,000 $15,000	 $ 2,870 $ 4,700	No cost
Seminole County								
VI. Lake Howell and vicinity	Buildings	1	3	21	*Floodproofing			
					**Lake regulation upstream			
VII. Bear Creek Basin	Buildings	0	0	0	**Channel improvements			
	Bridges	5	15	35	**Bridge improvements			
VIII. Howell Creek downstream of Lake Howell	Buildings	0	0	0	**Channel improvements			
	Bridges	2	10	25	**Bridge improvements			

†Calculated using 1988 or 1991 tax values
**Not evaluated
[c]Total annual damages at problem areas I and II
*No cost estimates were made
[a]Excluding benefits to problem area II
[d]Excluding benefits to problem area I
@See Table 26
[b]Including benefits to problem area II
[e]Including benefits to problem area I

within the 100-yr floodplain based on 1986 DOT aerial maps. If these houses were not built at least 1 ft above the 100-yr flood elevation, damages could occur. This damage analysis was not completed because no survey information was available for the new structures.

Water quality and environmental assessments indicated that, in general, Howell Creek Basin suffers from elevated levels of BOD, nutrients, heavy metals, and chlorophyll *a*. The lakes and creeks are highly influenced by urban stormwater runoff, erosion, and agricultural inputs, which are probably the source of most pollutants. In addition, the basin has lost 35 percent of its wetlands (about 1,833 acres) since 1947 due to urban development. Water quality and flood control problems have occurred because of wetland loss. Flood control measures should be designed to improve the foregoing conditions wherever feasible.

Regulation of lake levels by maintaining lower levels in the wet season can offer significant flood mitigation benefits. However, any regulation schedule selected now should be considered as *interim* until the third and final study is completed by SJRWMD. This third study started in October 1993 and is developing a continuous hydrologic simulation model for the Howell Creek Basin. The model will simulate the hydrologic impacts of any variation in structure operation or overflow elevation for the Lake Maitland control structure under flood or drought conditions or other water management alternatives. The simulation will identify the related potential environmental benefits for any scenario. Upon completion of the final study, Orange County officials can choose an alternative and implement any associated lake regulation schedules.

Various analyses of the present study (i.e., Phase II) indicated that for most problem areas, residential flood damages could be significant only during extreme storm events, *extreme* meaning more severe than a 25-yr event (Table 29). Damages would be confined to a small number of lakefront homes on each lake. For this reason, general lowering of lake levels (which would greatly curtail recreational benefits and might lead to environmental problems) may not be necessary for flood mitigation. Floodproofing or a similar protection measure should be considered first as a major flood protection alternative.

An important finding of this study is that keeping the gates of Lake Maitland control structure permanently in a closed position (the existing condition) would increase flooding both upstream and downstream. With gates in the closed position, higher lake levels would prevail in the chain of lakes during the wet season, reducing the flood absorption capacity of the lakes. As a result, the lakes would both rise higher and pass on higher discharges downstream during storm events.

Recommended Flood Protection Alternatives: Orange County

The following recommendations reflect input from a public workshop, written comments, and further discussions with Orange County officials (Appendix G).

The present study focused on reducing flood damages in the Howell Creek Basin. One flood protection alternative for Orange County includes a recommendation for the lowering of water levels for many lakes. A general lowering of lake levels, however, could create water quality problems. Many of these lakes are connected by shallow canals. With lower water levels, droughts would drop lake levels below the shallow canals with greater frequency. Downstream flow would stop; however, the lakes would continue to receive urban stormwater inputs. These inputs contain high amounts of nutrients, BOD, and heavy metals. With no lake outflows and continuous evaporation, concentrations of these deleterious compounds could increase.

Table 30 summarizes various flood protection alternatives considered for the Orange County problem areas. The following recommendations are made based on this study.

Table 30. Orange County flood protection alternatives

Flood Protection Alternative	Problem Areas for which the Alternative is Considered	Benefits/Advantages	Limitations/ Disadvantages
Lake regulation	Lake Ivanhoe and vicinity Rowena chain of lakes Lake Killarney Maitland chain of lakes	Can offer least expense if no capital improvements are needed Can offer protection to the entire affected area	May not provide full flood protection May cause environmental problems May decrease the recreational benefits
Increased outflows from lakes during flood events	Lake Killarney Maitland chain of lakes	Can offer least expense if no capital improvements are needed Can offer protection to the entire affected area	May not provide full flood protection May cause downstream flooding
Floodproofing	Lake Ivanhoe and vicinity Rowena chain of lakes Lake Killarney Park Lake Maitland chain of lakes	Gives full protection to the affected property Can protect individual properties without general measures Can base degree of protection on severity of flood threat	May affect aesthetic value of the properties Need to perform cost estimates separately for each property and determine benefit/cost ratio May be too expensive compared to other measures
Local levee protection	Lake Ivanhoe and vicinity Park Lake	Can protect a group of buildings or the entire affected area	May affect aesthetic value of the area
Channel and bridge improvements	Park Lake	Can offer protection to the entire affected area	May not provide full protection May be expensive May cause downstream flooding May cause environmental problems

Lake Ivanhoe and Vicinity (Problem Area I)

Flood damages for this area can be significant only during extreme storm events, that is, more severe than a 25-yr event. One commercial building on Orange Avenue would be flooded by water 0.85 ft deep. There are five other commercial buildings that might suffer minor damages because of the wetness caused by the proximity of the flood waters. Lake regulation with lower water levels in the wet season can significantly reduce flood damages. The existing control structure, however, needs modification to provide lake regulation. One of the following measures is recommended.

- Build a levee if aesthetically acceptable.
- Floodproof buildings that might suffer the greatest damages and that have favorable benefit/cost ratios.
- Adopt a lake regulation schedule that would minimize flood levels after assessing the environmental effects of various regulation schedules. Construct the necessary improvements.

Rowena Chain of Lakes (Problem Area II)

Flood damages for this area can be significant only during extreme storm events. Damages would be confined primarily to five expensive houses, with total estimated damages of $78,300 for a 100-yr storm event. Only two of these houses, however, would suffer damages due to flood waters actually entering the house; others might suffer damages due to the proximity of the flood waters.

Lake regulation with lower water levels during the wet season can offer major flood protection benefits, but no control structure exists at present. One or a combination of the following measures is recommended.

- Floodproof the houses that might suffer the greatest damages and that have favorable benefit/cost ratios.

- Adopt a lake regulation schedule that would minimize flood levels after assessing the environmental effects of various regulation schedules. Construct the necessary improvements.

Lake Killarney (Problem Area III)

Flood damages for this area can be significant only during extreme storm events, that is, more severe than a 25-yr event. Three houses would suffer damages due to flood waters entering the houses. There are six other houses that might be damaged due to the proximity of the flood waters. Lake regulation with lower water levels during the wet season can offer major flood protection benefits; but a regulation schedule evaluated in this study showed that flood stages in Park Lake downstream would increase by this measure. Therefore, this alternative should be selected only if the Park Lake area is protected by a levee, as recommended in the next section. One or a combination of the following measures is recommended.

- Floodproof the houses that might suffer greater damages and that have favorable benefit/cost ratios.

- Adopt a lake regulation schedule that would minimize flood levels after assessing the environmental effects of various regulation schedules. Adopt this measure only if flood protection to the Park Lake area is provided by a levee.

Park Lake (Problem Area IV)

Severe damages would occur during extreme flood events (return period greater than 25 yr), primarily to an apartment complex located on the east shore of Park Lake. Channel and bridge improvements downstream would provide only partial relief to flooding problems. Moreover, these improvements would be cost-prohibitive.

If sufficient land were available between the apartment complex and Park Lake, a new earthen levee could provide flood protection. A 2,000-ft long earthen levee would cost about

$37,000, giving a marginally positive benefit/cost ratio of 1.15. Problem area IV is congested, however, necessitating construction of a flood wall to provide the benefits. A flood wall would not be cost effective. Minor damages also might occur to four single family houses, which can be protected by floodproofing.

The present study indicates that structural methods of flood protection (floodproofing, bridge and channel improvements, or flood wall and/or levee construction) for the Park Lake and Lake Killarney areas would not be economically cost-effective. Some benefits, however meager, might accrue by conventional lake regulation and real-time operation of the Lake Killarney structure. Real-time operation, however, calls for judgment or carefully formulated guidelines to balance the damages/benefits for both areas. Developing a real-time operating schedule of the Lake Killarney structure is recommended.

Maitland Chain of Lakes (Problem Area V)

Lake regulation with lower lake levels during the wet season can reduce greatly flood damages in this area and also provide some flood relief downstream.

Lakes Maitland, Osceola, Virginia, and Mizell recorded elevations in the range of 64.11 to 64.15 ft NGVD during the drought of 1981. Based on this event, the present study evaluated the benefits of maintaining the lakes at two alternative low elevations during the wet period: 65.50 ft NGVD (IMP9) and 65.00 ft NGVD (IMP8C). The annual damages would be reduced from $15,000 to $4,700 using IMP9 and to $2,870 using IMP8C. Residual damages would occur to ten houses under IMP9 and nine houses under IMP8C. Downstream flood stages would be practically unaffected under both alternatives. Because both alternatives offer significant benefits, IMP9 is tentatively recommended pending the development of an optimal regulation schedule. Under IMP9, lakes would be maintained 0.5 ft higher than under IMP8C. IMP9 is more desirable from recreational aspects than IMP8C.

The following are the recommended actions.

- Maintain the lakes at 65.50 ft NGVD during the wet period. If the lake levels exceed this elevation, operate the Lake Maitland control structure to release flows according to a rating curve developed in this report (Figure 18, curve E).

- Floodproof the houses that might suffer residual damages, based on a benefit/cost analysis.

- Inspect levees, bridges, and other control structures periodically. Provide and maintain erosion protection measures.

RECOMMENDED FLOOD PROTECTION ALTERNATIVES: SEMINOLE COUNTY

Lake Howell and Vicinity (Problem Area VI)

Flood damages would not be significant to developments that occurred before 1981. If damages calculated for new houses are found to be significant, flood protection by levees or floodproofing is recommended.

Bear Creek Basin and Howell Creek Downstream of Lake Howell (Problem Areas VII and VIII)

The present study did not include an evaluation of erosion potential beyond the limited review of stream velocities associated with the HEC-2 modeling. Several culverts and minor bridges would suffer damages due to erosion and/or overtopping during a flood. The county should perform detailed evaluations for selected structures (based on their importance) regarding possible damages and protection alternatives.

Substantial land-use and hydraulic changes have occurred in the basin since the 1984 study. Many of the changes were due to development-related pressures and associated infrastructure construction.

Major impacts are directly and indirectly related to the construction of the Seminole County Expressway (S.R. 417). Construction included the physical relocation of the confluence of Bear Gully Canal and Lightwood Knox Canal. Part of Lightwood Knox Canal was modified to a fabriform lined channel with new hydraulic structures between S.R. 426 and the realigned, newly divided Red Bug Lake Road.

Responding to these canal changes and to impacts further upstream, Seminole County funded a drainage inventory and engineering study (Dyer, Riddle, Mills, and Precourt 1994). This study was submitted to SJRWMD in support of a MSSW conceptual permit application. The study provides both a more current and a more detailed hydraulic and hydrologic simulation of the Bear Creek Basin. The study is based on Suphunvorranop and Clapp (1984) and new data (including surveys) collected for the Dyer, Riddle, Mills, and Precourt study.

The following are the recommended actions.

- Perform special studies based on actual flood experience for areas where minor damages are indicated.
- Inspect bridges periodically. Provide and maintain erosion protection measures. For stream reaches where erosion is observed or erosion potential is indicated, determine non-scouring and non-silting velocities.
- Provide a design channel to convey 100-yr or greater flood discharge.

ENVIRONMENTAL RECOMMENDATIONS

The following recommendations should be implemented to monitor potential water quality/environmental problems as indicated in this report.

Water Quality Monitoring of Lake Howell and Feasibility of Restoration

The water quality of Lake Howell is poor, possibly due to past discharges of sewage disposal effluent. Water quality should continue to be monitored and the need for restoration assessed.

Water Quality Monitoring of Howell Creek and Bear Creek

Nutrient sampling should be continued, and sampling for heavy metals and coliforms should be added because no data exist for Seminole County. An expanded water quality assessment is needed immediately upstream of Lake Jesup to determine pollutant loads entering the lake.

Water Quality Monitoring of Lakes

Nutrients, BOD, heavy metals, and coliform samples should be taken in untested lakes and the water quality assessed. Sampling for coliforms in lakes should be initiated or continued when sampling has occurred, to evaluate the potential health risks from urban stormwater runoff and possible septic tank leachates.

Fish Tissue Analysis

Levels of copper, lead, and cadmium consistently exceeded state standards in the creek and lakes in Orange County, indicating the possibility of bioaccumulation of heavy metals in fish throughout the Howell Creek Basin. Fish tissue samples should be collected at and below sites with elevated levels of heavy metals to evaluate potential health risk to the public from fish consumption.

Pesticide Monitoring

Bear Creek, and to some extent Howell Creek, is influenced by agricultural runoff. The possibility of contamination of the water by pesticides exists. Screening of water and sediments for pesticides in the basin should be initiated to evaluate possible health and ecological risks.

Wetlands Construction

Wetlands should be restored or constructed along Howell Creek and Bear Creek to improve water storage, water quality, and wildlife habitat and to prevent low-quality water and sediments from flowing into Lake Jesup.

Pretreatment of Stormwater

Constructing retention ponds where possible would minimize urban stormwater pollution loads entering waters of the Howell Creek Basin.

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APPENDIX A—100-YEAR FLOODPLAIN MAPS

Part I: Orange County
Part II: Seminole County

The 100-yr floodplain maps are not available for general distribution. They may be inspected at the Orange County and County of Seminole water management offices, the SJRWMD library in Palatka, or the SJRWMD field office in Orlando.

APPENDIX B—RESIDENTIAL DAMAGES

For Lake Ivanhoe and the Rowena chain of lakes, building data were collected from December 1991 through February 1992. For all other lakes in the Howell Creek Basin, building data on file as of April 1988 were used.

Lake Ivanhoe (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
IVANHOE	I-1		82.09	79.24	-2.85	79.88	-2.21	81.10	-0.99	$131,566.00	$0	$0	$138
IVANHOE	I-2		81.42	79.24	-2.18	79.88	-1.54	81.10	-0.32	$7,372.00	$0	$0	$526
IVANHOE	I-3		81.42	79.24	-2.18	79.88	-1.54	81.10	-0.32	NO VALUE DETERM	$0	$0	$0
IVANHOE	I-4		81.33	79.24	-2.09	79.88	-1.45	81.10	-0.23	$82,570.00	$0	$0	$6,676
IVANHOE	I-5		80.25	79.24	-1.01	79.88	-0.37	81.10	0.85	$124,446.00	$0	$8,232	$18,832
IVANHOE	I-6		81.37	79.24	-2.13	79.88	-1.49	81.10	-0.27	$119,032.00	$0	$0	$9,124
IVANHOE	I-7		81.50	79.24	-2.26	79.88	-1.62	81.10	-0.40	$64,210.00	$0	$0	$4,045
IVANHOE	I-8		81.59	79.24	-2.35	79.88	-1.71	81.10	-0.49	$198,238.00	$0	$0	$10,616
IVANHOE	I-9		82.86	79.24	-3.62	79.88	-2.98	81.10	-1.76	NO VALUE DETERM	$0	$0	$0
IVANHOE	I-10		81.94	79.24	-2.70	79.88	-2.06	81.10	-0.84	$293,025.00	$0	$0	$4,923
IVANHOE	I-11		82.91	79.24	-3.67	79.88	-3.03	81.10	-1.81	NO VALUE DETERM	$0	$0	$0
IVANHOE	I-12		82.00	79.24	-2.76	79.88	-2.12	81.10	-0.90	NO VALUE DETERM	$0	$0	$0
											$0	$8,232	$54,880

Lake Ivanhoe (IMP1)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
IVANHOE	I-1		82.09	78.73	-3.36	79.22	-2.87	80.46	-1.63	$131,566.00	$0	$0	$0
IVANHOE	I-2		81.42	78.73	-2.69	79.22	-2.20	80.46	-0.96	$7,372.00	$0	$0	$31
IVANHOE	I-3		81.42	78.73	-2.69	79.22	-2.20	80.46	-0.96		$0	$0	$0
IVANHOE	I-4		81.33	78.73	-2.60	79.22	-2.11	80.46	-0.87	$82,570.00	$0	$0	$1,127
IVANHOE	I-5		80.25	78.73	-1.52	79.22	-1.03	80.46	0.21	$124,446.00	$0	$0	$14,491
IVANHOE	I-6		81.37	78.73	-2.64	79.22	-2.15	80.46	-0.91	$119,032.00	$0	$0	$1,125
IVANHOE	I-7		81.50	78.73	-2.77	79.22	-2.28	80.46	-1.04	$64,210.00	$0	$0	$0
IVANHOE	I-8		81.59	78.73	-2.86	79.22	-2.37	80.46	-1.13	$198,238.00	$0	$0	$0
IVANHOE	I-9		82.86	78.73	-4.13	79.22	-3.64	80.46	-2.40		$0	$0	$0
IVANHOE	I-10		81.94	78.73	-3.21	79.22	-2.72	80.46	-1.48	$293,025.00	$0	$0	$0
IVANHOE	I-11		82.91	78.73	-4.18	79.22	-3.69	80.46	-2.45		$0	$0.	$0
IVANHOE	I-12		82.00	78.73	-3.27	79.22	-2.78	80.46	-1.54		$0	$0	$0
Improvement 1											$0	$0	$16,774

Lake Ivanhoe (IMP2)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
IVANHOE	I-1		82.09	79.16	-2.93	79.78	-2.31	80.80	-1.29	$131,566.00	$0	$0	$0
IVANHOE	I-2		81.42	79.16	-2.26	79.78	-1.64	80.80	-0.62	$7,372.00	$0	$0	$294
IVANHOE	I-3		81.42	79.16	-2.26	79.78	-1.64	80.80	-0.62		$0	$0	$0
IVANHOE	I-4		81.33	79.16	-2.17	79.78	-1.55	80.80	-0.53	$82,570.00	$0	$0	$4,075
IVANHOE	I-5		80.25	79.16	-1.09	79.78	-0.47	80.80	0.55	$124,446.00	$0	$6,925	$16,797
IVANHOE	I-6		81.37	79.16	-2.21	79.78	-1.59	80.80	-0.57	$119,032.00	$0	$0	$5,374
IVANHOE	I-7		81.50	79.16	-2.34	79.78	-1.72	80.80	-0.70	$64,210.00	$0	$0	$2,023
IVANHOE	I-8		81.59	79.16	-2.43	79.78	-1.81	80.80	-0.79	$198,238.00	$0	$0	$4,371
IVANHOE	I-9		82.86	79.16	-3.70	79.78	-3.08	80.80	-2.06		$0	$0	$0
IVANHOE	I-10		81.94	79.16	-2.78	79.78	-2.16	80.80	-1.14	$293,025.00	$0	$0	$0
IVANHOE	I-11		82.91	79.16	-3.75	79.78	-3.13	80.80	-2.11		$0	$0	$0
IVANHOE	I-12		82.00	79.16	-2.84	79.78	-2.22	80.80	-1.20		$0	$0	$0
Improvement 2											$0	$6,925	$32,934

Rowena Chain of Lakes (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
LAKE SUE	S-1		78.25	74.72	-3.53	75.30	-2.95	76.20	-2.05	250623.00	$0	$0	$0
LAKE SUE	S-2		77.03	74.72	-2.31	75.30	-1.73	76.20	-0.83	163233.00	$0	$0	$2,914
LAKE SUE	S-3			74.72		75.30		76.20		NO VALUE DETERM			
LAKE SUE	S-4		76.62	74.72	-1.90	75.30	-1.32	76.20	-0.42	341313.00	$0	$0	$20,786
LAKE SUE	S-5		79.66	74.72	-4.94	75.30	-4.36	76.20	-3.46	57250.00	$0	$0	$0
LAKE SUE	S-6		78.80	74.72	-4.08	75.30	-3.50	76.20	-2.60	27813.00	$0	$0	$0
LAKE SUE	S-7		76.96	74.72	-2.24	75.30	-1.66	76.20	-0.76	130489.00	$0	$0	$3,288
LAKE SUE	S-8		76.63	74.72	-1.91	75.30	-1.33	76.20	-0.43	223682.00	$0	$0	$13,387
LAKE SUE	S-9		77.57	74.72	-2.85	75.30	-2.27	76.20	-1.37	145904.00	$0	$0	$0
LAKE SUE	S-10		78.68	74.72	-3.96	75.30	-3.38	76.20	-2.48	81376.00	$0	$0	$0
LAKE SUE	S-11		77.37	74.72	-2.65	75.30	-2.07	76.20	-1.17	155502.00	$0	$0	$0
LAKE SUE	S-12		77.71	74.72	-2.99	75.30	-2.41	76.20	-1.51	111373.00	$0	$0	$0
LAKE SUE	S-13		76.51	74.72	-1.79	75.30	-1.21	76.20	-0.31	94781.00	$0	$0	$6,867
LAKE SUE	S-14		77.48	74.72	-2.76	75.30	-2.18	76.20	-1.28	83335.00	$0	$0	$0
LAKE SUE	S-15		76.75	74.72	-2.03	75.30	-1.45	76.20	-0.55	65876.00	$0	$0	$3,113
LAKE SUE	S-16		78.97	74.72	-4.25	75.30	-3.67	76.20	-2.77	130225.00	$0	$0	$0
LAKE SUE	S-17		77.03	74.72	-2.31	75.30	-1.73	76.20	-0.83	109530.00	$0	$0	$1,955
LAKE SUE	S-18		76.37	74.72	-1.65	75.30	-1.07	76.20	-0.17	143752.00	$0	$0	$12,528
LAKE SUE	S-19		79.68	74.72	-4.96	75.30	-4.38	76.20	-3.48	121097.00	$0	$0	$0
LAKE SUE	S-20			74.72		75.30		76.20		118626.00			
LAKE SUE	S-21		75.70	74.72	-0.98	75.30	-0.40	76.20	0.50	102780.00	$216	$6,475	$13,593
LAKE ROWENA	R-1		77.50	74.72	-2.78	75.30	-2.20	76.20	-1.30	204539.00	$0	$0	$0
LAKE ROWENA	R-2		78.63	74.72	-3.91	75.30	-3.33	76.20	-2.43	124614.00	$0	$0	$0
LAKE ROWENA	R-3		77.21	74.72	-2.49	75.30	-1.91	76.20	-1.01	109238.00	$0	$0	$0
LAKE ROWENA	R-4		77.45	74.72	-2.73	75.30	-2.15	76.20	-1.25	124597.00	$0	$0	$0
LAKE ROWENA	R-5		77.90	74.72	-3.18	75.30	-2.60	76.20	-1.70	76117.00	$0	$0	$0
LAKE ROWENA	R-6		78.45	74.72	-3.73	75.30	-3.15	76.20	-2.25	50677.00	$0	$0	$0
LAKE ROWENA	R-7		77.72	74.72	-3.00	75.30	-2.42	76.20	-1.52	104093.00	$0	$0	$0
LAKE ROWENA	R-8			74.72		75.30		76.20		NO VALUE DETERM			
LAKE ROWENA	R-9		77.40	74.72	-2.68	75.30	-2.10	76.20	-1.20	129758.00	$0	$0	$0
LAKE ROWENA	R-10		77.66	74.72	-2.94	75.30	-2.36	76.20	-1.46	70909.00	$0	$0	$0
LAKE ROWENA	R-11		78.81	74.72	-4.09	75.30	-3.51	76.20	-2.61	47530.00	$0	$0	$0
LAKE ROWENA	R-12		78.39	74.72	-3.67	75.30	-3.09	76.20	-2.19	111960.00	$0	$0	$0
LAKE ROWENA	R-13		78.38	74.72	-3.66	75.30	-3.08	76.20	-2.18	96770.00	$0	$0	$0
LAKE ROWENA	R-14		77.37	74.72	-2.65	75.30	-2.07	76.20	-1.17	55564.00	$0	$0	$0
LAKE ROWENA	R-15		78.15	74.72	-3.43	75.30	-2.85	76.20	-1.95	97591.00	$0	$0	$0
LAKE ROWENA	R-16		78.48	74.72	-3.76	75.30	-3.18	76.20	-2.28	58111.00	$0	$0	$0
LK ESTELLE	E-1		80.31	74.72	-5.59	75.30	-5.01	76.20	-4.11	57399.00	$0	$0	$0
LK ESTELLE	E-2		78.80	74.72	-4.08	75.30	-3.50	76.20	-2.60	56722.00	$0	$0	$0
LK ESTELLE	E-3		77.94	74.72	-3.22	75.30	-2.64	76.20	-1.74	58060.00	$0	$0	$0
LK ESTELLE	E-4		79.50	74.72	-4.78	75.30	-4.20	76.20	-3.30	62413.00	$0	$0	$0
LK ESTELLE	E-5		77.21	74.72	-2.49	75.30	-1.91	76.20	-1.01	75923.00	$0	$0	$0
LK ESTELLE	E-6		77.92	74.72	-3.20	75.30	-2.62	76.20	-1.72	45571.00	$0	$0	$0
LK ESTELLE	E-7		77.54	74.72	-2.82	75.30	-2.24	76.20	-1.34	83133.00	$0	$0	$0
LK ESTELLE	E-8		77.12	74.72	-2.40	75.30	-1.82	76.20	-0.92	117102.00	$0	$0	$984
LK ESTELLE	E-9		77.61	74.72	-2.89	75.30	-2.31	76.20	-1.41	102686.00	$0	$0	$0
LK ESTELLE	E-10		77.62	74.72	-2.90	75.30	-2.32	76.20	-1.42	99418.00	$0	$0	$0
LK ESTELLE	E-11		77.30	74.72	-2.58	75.30	-2.00	76.20	-1.10	111470.00	$0	$0	$0
LK ESTELLE	E-12		75.10	74.72	-0.38	75.30	0.20	76.20	1.10	108995.00	$7,096	$12,633	$18,050
LK ESTELLE	E-13		76.98	74.72	-2.26	75.30	-1.68	76.20	-0.78	95065.00	$0	$0	$2,196
LK ESTELLE	E-14		77.51	74.72	-2.79	75.30	-2.21	76.20	-1.31	145574.00	$0	$0	$0
LK ESTELLE	E-15		78.32	74.72	-3.60	75.30	-3.02	76.20	-2.12	84811.00	$0	$0	$0
LAKE WINYAH	W-1		78.17	74.72	-3.45	75.30	-2.87	76.20	-1.97	83685.00	$0	$0	$0
LAKE WINYAH	W-2		80.37	74.72	-5.65	75.30	-5.07	76.20	-4.17	120878.00	$0	$0	$0
											$7,312	$19,108	$99,661

Rowena Chain of Lakes (IMP1)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
LAKE SUE	S-1		78.25	74.46	-3.79	75.21	-3.04	76.13	-2.12	250623.00	$0	$0	$0
LAKE SUE	S-2		77.03	74.46	-2.57	75.21	-1.82	76.13	-0.90	163233.00	$0	$0	$1,714
LAKE SUE	S-3			74.46		75.21		76.13		NO VALUE DETERM			
LAKE SUE	S-4		76.62	74.46	-2.16	75.21	-1.41	76.13	-0.49	341313.00	$0	$0	$18,277
LAKE SUE	S-5		79.66	74.46	-5.20	75.21	-4.45	76.13	-3.53	57250.00	$0	$0	$0
LAKE SUE	S-6		78.80	74.46	-4.34	75.21	-3.59	76.13	-2.67	27813.00	$0	$0	$0
LAKE SUE	S-7		76.96	74.46	-2.50	75.21	-1.75	76.13	-0.83	130489.00	$0	$0	$2,329
LAKE SUE	S-8		76.63	74.46	-2.17	75.21	-1.42	76.13	-0.50	223682.00	$0	$0	$11,743
LAKE SUE	S-9		77.57	74.46	-3.11	75.21	-2.36	76.13	-1.44	145904.00	$0	$0	$0
LAKE SUE	S-10		78.68	74.46	-4.22	75.21	-3.47	76.13	-2.55	81376.00	$0	$0	$0
LAKE SUE	S-11		77.37	74.46	-2.91	75.21	-2.16	76.13	-1.24	155502.00	$0	$0	$0
LAKE SUE	S-12		77.71	74.46	-3.25	75.21	-2.50	76.13	-1.58	111373.00	$0	$0	$0
LAKE SUE	S-13		76.51	74.46	-2.05	75.21	-1.30	76.13	-0.38	94781.00	$0	$0	$6,170
LAKE SUE	S-14		77.48	74.46	-3.02	75.21	-2.27	76.13	-1.35	83335.00	$0	$0	$0
LAKE SUE	S-15		76.75	74.46	-2.29	75.21	-1.54	76.13	-0.62	65876.00	$0	$0	$2,628
LAKE SUE	S-16		78.97	74.46	-4.51	75.21	-3.76	76.13	-2.84	130225.00	$0	$0	$0
LAKE SUE	S-17		77.03	74.46	-2.57	75.21	-1.82	76.13	-0.90	109530.00	$0	$0	$1,150
LAKE SUE	S-18		76.37	74.46	-1.91	75.21	-1.16	76.13	-0.24	143752.00	$0	$0	$11,471
LAKE SUE	S-19		79.68	74.46	-5.22	75.21	-4.47	76.13	-3.55	121097.00	$0	$0	$0
LAKE SUE	S-20			74.46		75.21		76.13		118626.00			
LAKE SUE	S-21		75.70	74.46	-1.24	75.21	-0.49	76.13	0.43	102780.00	$0	$5,504	$13,201
LAKE ROWENA	R-1		77.50	74.46	-3.04	75.21	-2.29	76.13	-1.37	204539.00	$0	$0	$0
LAKE ROWENA	R-2		78.63	74.46	-4.17	75.21	-3.42	76.13	-2.50	124614.00	$0	$0	$0
LAKE ROWENA	R-3		77.21	74.46	-2.75	75.21	-2.00	76.13	-1.08	109238.00	$0	$0	$0
LAKE ROWENA	R-4		77.45	74.46	-2.99	75.21	-2.24	76.13	-1.32	124597.00	$0	$0	$0
LAKE ROWENA	R-5		77.90	74.46	-3.44	75.21	-2.69	76.13	-1.77	76117.00	$0	$0	$0
LAKE ROWENA	R-6		78.45	74.46	-3.99	75.21	-3.24	76.13	-2.32	50677.00	$0	$0	$0
LAKE ROWENA	R-7		77.72	74.46	-3.26	75.21	-2.51	76.13	-1.59	104093.00	$0	$0	$0
LAKE ROWENA	R-8			74.46		75.21		76.13		NO VALUE DETERM			
LAKE ROWENA	R-9		77.40	74.46	-2.94	75.21	-2.19	76.13	-1.27	129758.00	$0	$0	$0
LAKE ROWENA	R-10		77.66	74.46	-3.20	75.21	-2.45	76.13	-1.53	70909.00	$0	$0	$0
LAKE ROWENA	R-11		78.81	74.46	-4.35	75.21	-3.60	76.13	-2.68	47530.00	$0	$0	$0
LAKE ROWENA	R-12		78.39	74.46	-3.93	75.21	-3.18	76.13	-2.26	111960.00	$0	$0	$0
LAKE ROWENA	R-13		78.38	74.46	-3.92	75.21	-3.17	76.13	-2.25	96770.00	$0	$0	$0
LAKE ROWENA	R-14		77.37	74.46	-2.91	75.21	-2.16	76.13	-1.24	55564.00	$0	$0	$0
LAKE ROWENA	R-15		78.15	74.46	-3.69	75.21	-2.94	76.13	-2.02	97591.00	$0	$0	$0
LAKE ROWENA	R-16		78.48	74.46	-4.02	75.21	-3.27	76.13	-2.35	58111.00	$0	$0	$0
LK ESTELLE	E-1		80.31	74.46	-5.85	75.21	-5.10	76.13	-4.18	57399.00	$0	$0	$0
LK ESTELLE	E-2		78.80	74.46	-4.34	75.21	-3.59	76.13	-2.67	56722.00	$0	$0	$0
LK ESTELLE	E-3		77.94	74.46	-3.48	75.21	-2.73	76.13	-1.81	58060.00	$0	$0	$0
LK ESTELLE	E-4		79.50	74.46	-5.04	75.21	-4.29	76.13	-3.37	62413.00	$0	$0	$0
LK ESTELLE	E-5		77.21	74.46	-2.75	75.21	-2.00	76.13	-1.08	75923.00	$0	$0	$0
LK ESTELLE	E-6		77.92	74.46	-3.46	75.21	-2.71	76.13	-1.79	45571.00	$0	$0	$0
LK ESTELLE	E-7		77.54	74.46	-3.08	75.21	-2.33	76.13	-1.41	83133.00	$0	$0	$0
LK ESTELLE	E-8		77.12	74.46	-2.66	75.21	-1.91	76.13	-0.99	117102.00	$0	$0	$123
LK ESTELLE	E-9		77.61	74.46	-3.15	75.21	-2.40	76.13	-1.48	102686.00	$0	$0	$0
LK ESTELLE	E-10		77.62	74.46	-3.16	75.21	-2.41	76.13	-1.49	99418.00	$0	$0	$0
LK ESTELLE	E-11		77.30	74.46	-2.84	75.21	-2.09	76.13	-1.17	111470.00	$0	$0	$0
LK ESTELLE	E-12		75.10	74.46	-0.64	75.21	0.11	76.13	1.03	108995.00	$4,120	$12,098	$17,584
LK ESTELLE	E-13		76.98	74.46	-2.52	75.21	-1.77	76.13	-0.85	95065.00	$0	$0	$1,497
LK ESTELLE	E-14		77.51	74.46	-3.05	75.21	-2.30	76.13	-1.38	145574.00	$0	$0	$0
LK ESTELLE	E-15		78.32	74.46	-3.86	75.21	-3.11	76.13	-2.19	84811.00	$0	$0	$0
LAKE WINYAH	W-1		78.17	74.46	-3.71	75.21	-2.96	76.13	-2.04	83685.00	$0	$0	$0
LAKE WINYAH	W-2		80.37	74.46	-5.91	75.21	-5.16	76.13	-4.24	120878.00	$0	$0	$0
Improvement 1											$4,120	$17,602	$87,887

Rowena Chain of Lakes (IMP2)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
LAKE SUE	S-1		78.25	74.19	-4.06	74.88	-3.37	75.99	-2.26	250623.00	$0	$0	$0
LAKE SUE	S-2		77.03	74.19	-2.84	74.88	-2.15	75.99	-1.04	163233.00	$0	$0	$0
LAKE SUE	S-3			74.19		74.88		75.99		NO VALUE DETERM			
LAKE SUE	S-4		76.62	74.19	-2.43	74.88	-1.74	75.99	-0.63	341313.00	$0	$0	$13,260
LAKE SUE	S-5		79.66	74.19	-5.47	74.88	-4.78	75.99	-3.67	57250.00	$0	$0	$0
LAKE SUE	S-6		78.80	74.19	-4.61	74.88	-3.92	75.99	-2.81	27813.00	$0	$0	$0
LAKE SUE	S-7		76.96	74.19	-2.77	74.88	-2.08	75.99	-0.97	130489.00	$0	$0	$411
LAKE SUE	S-8		76.63	74.19	-2.44	74.88	-1.75	75.99	-0.64	223682.00	$0	$0	$8,455
LAKE SUE	S-9		77.57	74.19	-3.38	74.88	-2.69	75.99	-1.58	145904.00	$0	$0	$0
LAKE SUE	S-10		78.68	74.19	-4.49	74.88	-3.80	75.99	-2.69	81376.00	$0	$0	$0
LAKE SUE	S-11		77.37	74.19	-3.18	74.88	-2.49	75.99	-1.38	155502.00	$0	$0	$0
LAKE SUE	S-12		77.71	74.19	-3.52	74.88	-2.83	75.99	-1.72	111373.00	$0	$0	$0
LAKE SUE	S-13		76.51	74.19	-2.32	74.88	-1.63	75.99	-0.52	94781.00	$0	$0	$4,777
LAKE SUE	S-14		77.48	74.19	-3.29	74.88	-2.60	75.99	-1.49	83335.00	$0	$0	$0
LAKE SUE	S-15		76.75	74.19	-2.56	74.88	-1.87	75.99	-0.76	65876.00	$0	$0	$1,660
LAKE SUE	S-16		78.97	74.19	-4.78	74.88	-4.09	75.99	-2.98	130225.00	$0	$0	$0
LAKE SUE	S-17		77.03	74.19	-2.84	74.88	-2.15	75.99	-1.04	109530.00	$0	$0	$0
LAKE SUE	S-18		76.37	74.19	-2.18	74.88	-1.49	75.99	-0.38	143752.00	$0	$0	$9,358
LAKE SUE	S-19		79.68	74.19	-5.49	74.88	-4.80	75.99	-3.69	121097.00	$0	$0	$0
LAKE SUE	S-20			74.19		74.88		75.99		118626.00			
LAKE SUE	S-21		75.70	74.19	-1.51	74.88	-0.82	75.99	0.29	102780.00	$0	$1,943	$12,416
LAKE ROWENA	R-1		77.50	74.19	-3.31	74.88	-2.62	75.99	-1.51	204539.00	$0	$0	$0
LAKE ROWENA	R-2		78.63	74.19	-4.44	74.88	-3.75	75.99	-2.64	124614.00	$0	$0	$0
LAKE ROWENA	R-3		77.21	74.19	-3.02	74.88	-2.33	75.99	-1.22	109238.00	$0	$0	$0
LAKE ROWENA	R-4		77.45	74.19	-3.26	74.88	-2.57	75.99	-1.46	124597.00	$0	$0	$0
LAKE ROWENA	R-5		77.90	74.19	-3.71	74.88	-3.02	75.99	-1.91	76117.00	$0	$0	$0
LAKE ROWENA	R-6		78.45	74.19	-4.26	74.88	-3.57	75.99	-2.46	50677.00	$0	$0	$0
LAKE ROWENA	R-7		77.72	74.19	-3.53	74.88	-2.84	75.99	-1.73	104093.00	$0	$0	$0
LAKE ROWENA	R-8			74.19		74.88		75.99		NO VALUE DETERM			
LAKE ROWENA	R-9		77.40	74.19	-3.21	74.88	-2.52	75.99	-1.41	129758.00	$0	$0	$0
LAKE ROWENA	R-10		77.66	74.19	-3.47	74.88	-2.78	75.99	-1.67	70909.00	$0	$0	$0
LAKE ROWENA	R-11		78.81	74.19	-4.62	74.88	-3.93	75.99	-2.82	47530.00	$0	$0	$0
LAKE ROWENA	R-12		78.39	74.19	-4.20	74.88	-3.51	75.99	-2.40	111960.00	$0	$0	$0
LAKE ROWENA	R-13		78.38	74.19	-4.19	74.88	-3.50	75.99	-2.39	96770.00	$0	$0	$0
LAKE ROWENA	R-14		77.37	74.19	-3.18	74.88	-2.49	75.99	-1.38	55564.00	$0	$0	$0
LAKE ROWENA	R-15		78.15	74.19	-3.96	74.88	-3.27	75.99	-2.16	97591.00	$0	$0	$0
LAKE ROWENA	R-16		78.48	74.19	-4.29	74.88	-3.60	75.99	-2.49	58111.00	$0	$0	$0
LK ESTELLE	E-1		80.31	74.19	-6.12	74.88	-5.43	75.99	-4.32	57399.00	$0	$0	$0
LK ESTELLE	E-2		78.80	74.19	-4.61	74.88	-3.92	75.99	-2.81	56722.00	$0	$0	$0
LK ESTELLE	E-3		77.94	74.19	-3.75	74.88	-3.06	75.99	-1.95	58060.00	$0	$0	$0
LK ESTELLE	E-4		79.50	74.19	-5.31	74.88	-4.62	75.99	-3.51	62413.00	$0	$0	$0
LK ESTELLE	E-5		77.21	74.19	-3.02	74.88	-2.33	75.99	-1.22	75923.00	$0	$0	$0
LK ESTELLE	E-6		77.92	74.19	-3.73	74.88	-3.04	75.99	-1.93	45571.00	$0	$0	$0
LK ESTELLE	E-7		77.54	74.19	-3.35	74.88	-2.66	75.99	-1.55	83133.00	$0	$0	$0
LK ESTELLE	E-8		77.12	74.19	-2.93	74.88	-2.24	75.99	-1.13	117102.00	$0	$0	$0
LK ESTELLE	E-9		77.61	74.19	-3.42	74.88	-2.73	75.99	-1.62	102686.00	$0	$0	$0
LK ESTELLE	E-10		77.62	74.19	-3.43	74.88	-2.74	75.99	-1.63	99418.00	$0	$0	$0
LK ESTELLE	E-11		77.30	74.19	-3.11	74.88	-2.42	75.99	-1.31	111470.00	$0	$0	$0
LK ESTELLE	E-12		75.10	74.19	-0.91	74.88	-0.22	75.99	0.89	108995.00	$1,030	$8,927	$16,731
LK ESTELLE	E-13		76.98	74.19	-2.79	74.88	-2.10	75.99	-0.99	95065.00	$0	$0	$100
LK ESTELLE	E-14		77.51	74.19	-3.32	74.88	-2.63	75.99	-1.52	145574.00	$0	$0	$0
LK ESTELLE	E-15		78.32	74.19	-4.13	74.88	-3.44	75.99	-2.33	84811.00	$0	$0	$0
LAKE WINYAH	W-1		78.17	74.19	-3.98	74.88	-3.29	75.99	-2.18	83685.00	$0	$0	$0
LAKE WINYAH	W-2		80.37	74.19	-6.18	74.88	-5.49	75.99	-4.38	120878.00	$0	$0	$0
Improvement 2											$1,030	$10,870	$67,168

Rowena Chain of Lakes (IMP3B)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
LAKE SUE	S-1		78.25	73.71	-4.54	74.37	-3.88	75.56	-2.69	250623.00	$0	$0	$0
LAKE SUE	S-2		77.03	73.71	-3.32	74.37	-2.66	75.56	-1.47	163233.00	$0	$0	$0
LAKE SUE	S-3			73.71		74.37		75.56		NO VALUE DETERM			
LAKE SUE	S-4		76.62	73.71	-2.91	74.37	-2.25	75.56	-1.06	341313.00	$0	$0	$0
LAKE SUE	S-5		79.66	73.71	-5.95	74.37	-5.29	75.56	-4.10	57250.00	$0	$0	$0
LAKE SUE	S-6		78.80	73.71	-5.09	74.37	-4.43	75.56	-3.24	27813.00	$0	$0	$0
LAKE SUE	S-7		76.96	73.71	-3.25	74.37	-2.59	75.56	-1.40	130489.00	$0	$0	$0
LAKE SUE	S-8		76.63	73.71	-2.92	74.37	-2.26	75.56	-1.07	223682.00	$0	$0	$0
LAKE SUE	S-9		77.57	73.71	-3.86	74.37	-3.20	75.56	-2.01	145904.00	$0	$0	$0
LAKE SUE	S-10		78.68	73.71	-4.97	74.37	-4.31	75.56	-3.12	81376.00	$0	$0	$0
LAKE SUE	S-11		77.37	73.71	-3.66	74.37	-3.00	75.56	-1.81	155502.00	$0	$0	$0
LAKE SUE	S-12		77.71	73.71	-4.00	74.37	-3.34	75.56	-2.15	111373.00	$0	$0	$0
LAKE SUE	S-13		76.51	73.71	-2.80	74.37	-2.14	75.56	-0.95	94781.00	$0	$0	$498
LAKE SUE	S-14		77.48	73.71	-3.77	74.37	-3.11	75.56	-1.92	83335.00	$0	$0	$0
LAKE SUE	S-15		76.75	73.71	-3.04	74.37	-2.38	75.56	-1.19	65876.00	$0	$0	$0
LAKE SUE	S-16		78.97	73.71	-5.26	74.37	-4.60	75.56	-3.41	130225.00	$0	$0	$0
LAKE SUE	S-17		77.03	73.71	-3.32	74.37	-2.66	75.56	-1.47	109530.00	$0	$0	$0
LAKE SUE	S-18		76.37	73.71	-2.66	74.37	-2.00	75.56	-0.81	143752.00	$0	$0	$2,868
LAKE SUE	S-19		79.68	73.71	-5.97	74.37	-5.31	75.56	-4.12	121097.00	$0	$0	$0
LAKE SUE	S-20			73.71		74.37		75.56		118626.00			
LAKE SUE	S-21		75.70	73.71	-1.99	74.37	-1.33	75.56	-0.14	102780.00	$0	$0	$9,281
LAKE ROWENA	R-1		77.50	73.71	-3.79	74.37	-3.13	75.56	-1.94	204539.00	$0	$0	$0
LAKE ROWENA	R-2		78.63	73.71	-4.92	74.37	-4.26	75.56	-3.07	124614.00	$0	$0	$0
LAKE ROWENA	R-3		77.21	73.71	-3.50	74.37	-2.84	75.56	-1.65	109238.00	$0	$0	$0
LAKE ROWENA	R-4		77.45	73.71	-3.74	74.37	-3.08	75.56	-1.89	124597.00	$0	$0	$0
LAKE ROWENA	R-5		77.90	73.71	-4.19	74.37	-3.53	75.56	-2.34	76117.00	$0	$0	$0
LAKE ROWENA	R-6		78.45	73.71	-4.74	74.37	-4.08	75.56	-2.89	50677.00	$0	$0	$0
LAKE ROWENA	R-7		77.72	73.71	-4.01	74.37	-3.35	75.56	-2.16	104093.00	$0	$0	$0
LAKE ROWENA	R-8			73.71		74.37		75.56		NO VALUE DETERM			
LAKE ROWENA	R-9		77.40	73.71	-3.69	74.37	-3.03	75.56	-1.84	129758.00	$0	$0	$0
LAKE ROWENA	R-10		77.66	73.71	-3.95	74.37	-3.29	75.56	-2.10	70909.00	$0	$0	$0
LAKE ROWENA	R-11		78.81	73.71	-5.10	74.37	-4.44	75.56	-3.25	47530.00	$0	$0	$0
LAKE ROWENA	R-12		78.39	73.71	-4.68	74.37	-4.02	75.56	-2.83	111960.00	$0	$0	$0
LAKE ROWENA	R-13		78.38	73.71	-4.67	74.37	-4.01	75.56	-2.82	96770.00	$0	$0	$0
LAKE ROWENA	R-14		77.37	73.71	-3.66	74.37	-3.00	75.56	-1.81	55564.00	$0	$0	$0
LAKE ROWENA	R-15		78.15	73.71	-4.44	74.37	-3.78	75.56	-2.59	97591.00	$0	$0	$0
LAKE ROWENA	R-16		78.48	73.71	-4.77	74.37	-4.11	75.56	-2.92	58111.00	$0	$0	$0
LK ESTELLE	E-1		80.31	73.71	-6.60	74.37	-5.94	75.56	-4.75	57399.00	$0	$0	$0
LK ESTELLE	E-2		78.80	73.71	-5.09	74.37	-4.43	75.56	-3.24	56722.00	$0	$0	$0
LK ESTELLE	E-3		77.94	73.71	-4.23	74.37	-3.57	75.56	-2.38	58060.00	$0	$0	$0
LK ESTELLE	E-4		79.50	73.71	-5.79	74.37	-5.13	75.56	-3.94	62413.00	$0	$0	$0
LK ESTELLE	E-5		77.21	73.71	-3.50	74.37	-2.84	75.56	-1.65	75923.00	$0	$0	$0
LK ESTELLE	E-6		77.92	73.71	-4.21	74.37	-3.55	75.56	-2.36	45571.00	$0	$0	$0
LK ESTELLE	E-7		77.54	73.71	-3.83	74.37	-3.17	75.56	-1.98	83133.00	$0	$0	$0
LK ESTELLE	E-8		77.12	73.71	-3.41	74.37	-2.75	75.56	-1.56	117102.00	$0	$0	$0
LK ESTELLE	E-9		77.61	73.71	-3.90	74.37	-3.24	75.56	-2.05	102686.00	$0	$0	$0
LK ESTELLE	E-10		77.62	73.71	-3.91	74.37	-3.25	75.56	-2.06	99418.00	$0	$0	$0
LK ESTELLE	E-11		77.30	73.71	-3.59	74.37	-2.93	75.56	-1.74	111470.00	$0	$0	$0
LK ESTELLE	E-12		75.10	73.71	-1.39	74.37	-0.73	75.56	0.46	108995.00	$0	$3,090	$14,177
LK ESTELLE	E-13		76.98	73.71	-3.27	74.37	-2.61	75.56	-1.42	95065.00	$0	$0	$0
LK ESTELLE	E-14		77.51	73.71	-3.80	74.37	-3.14	75.56	-1.95	145574.00	$0	$0	$0
LK ESTELLE	E-15		78.32	73.71	-4.61	74.37	-3.95	75.56	-2.76	84811.00	$0	$0	$0
LAKE WINYAH	W-1		78.17	73.71	-4.46	74.37	-3.80	75.56	-2.61	83685.00	$0	$0	$0
LAKE WINYAH	W-2		80.37	73.71	-6.66	74.37	-6.00	75.56	-4.81	120878.00	$0	$0	$0
Improvement 3B											$0	$3,090	$26,824

Lake Killarney (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
KILLARNEY	22	101 + 20	88.30	85.21	-3.09	85.79	-2.51	86.73	-1.57		$0	$0	$0
KILLARNEY	23	101 + 85	85.79	85.21	-0.58	85.79	0.00	86.73	0.94	$63,162.00	$2,785	$6,632	$9,868
KILLARNEY	21	102 + 35	88.04	85.21	-2.83	85.79	-2.25	86.73	-1.31		$0	$0	$0
KILLARNEY	20	102 + 95	88.25	85.21	-3.04	85.79	-2.46	86.73	-1.52		$0	$0	$0
KILLARNEY	19	103 + 40	88.42	85.21	-3.21	85.79	-2.63	86.73	-1.69		$0	$0	$0
KILLARNEY	18	109 + 25	89.47	85.21	-4.26	85.79	-3.68	86.73	-2.74	$92,633.00	$0	$0	$0
KILLARNEY	24	111 + 20	88.85	85.21	-3.64	85.79	-3.06	86.73	-2.12	$42,797.00	$0	$0	$0
KILLARNEY	25	112 + 70	88.80	85.21	-3.59	85.79	-3.01	86.73	-2.07	$86,188.00	$0	$0	$0
KILLARNEY	26	115 + 10	87.80	85.21	-2.59	85.79	-2.01	86.73	-1.07	$74,342.00	$0	$0	$0
KILLARNEY	27	116 + 20	90.03	85.21	-4.82	85.79	-4.24	86.73	-3.30	$71,240.00	$0	$0	$0
KILLARNEY	28	116 + 85	91.30	85.21	-6.09	85.79	-5.51	86.73	-4.57	$100,082.00	$0	$0	$0
KILLARNEY	29	117 + 15	90.60	85.21	-5.39	85.79	-4.81	86.73	-3.87	$70,983.00	$0	$0	$0
KILLARNEY	32	117 + 55	87.50	85.21	-2.29	85.79	-1.71	86.73	-0.77		$0	$0	$0
KILLARNEY	30	117 + 80	89.40	85.21	-4.19	85.79	-3.61	86.73	-2.67	$76,362.00	$0	$0	$0
KILLARNEY	31	118 + 45	87.42	85.21	-2.21	85.79	-1.63	86.73	-0.69		$0	$0	$0
KILLARNEY	33	119 + 40	87.80	85.21	-2.59	85.79	-2.01	86.73	-1.07		$0	$0	$0
KILLARNEY	16	125 + 5	87.20	85.21	-1.99	85.79	-1.41	86.73	-0.47	$83,462.00	$0	$0	$4,645
KILLARNEY	14	126 + 70	87.39	85.21	-2.18	85.79	-1.60	86.73	-0.66	$62,226.00	$0	$0	$2,221
KILLARNEY	15	126 + 80	87.80	85.21	-2.59	85.79	-2.01	86.73	-1.07	$68,478.00	$0	$0	$0
KILLARNEY	13	127 + 0	87.60	85.21	-2.39	85.79	-1.81	86.73	-0.87	$58,202.00	$0	$0	$794
KILLARNEY	12	127 + 55	87.20	85.21	-1.99	85.79	-1.41	86.73	-0.47	$65,900.00	$0	$0	$3,667
KILLARNEY	11	127 + 80	87.67	85.21	-2.46	85.79	-1.88	86.73	-0.94	$63,105.00	$0	$0	$398
KILLARNEY	10	128 + 5	87.82	85.21	-2.61	85.79	-2.03	86.73	-1.09	$86,470.00	$0	$0	$0
KILLARNEY	9	128 + 20	87.39	85.21	-2.18	85.79	-1.60	86.73	-0.66	$59,582.00	$0	$0	$2,127
KILLARNEY	8	128 + 65	87.84	85.21	-2.63	85.79	-2.05	86.73	-1.11	$95,302.00	$0	$0	$0
KILLARNEY	17	130 + 0	86.71	85.21	-1.50	85.79	-0.92	86.73	0.02	$91,588.00	$0	$769	$9,717
KILLARNEY	34	130 + 0	86.10	85.21	-0.89	85.79	-0.31	86.73	0.63	$109,428.00	$1,264	$7,928	$15,247
											$4,049	$15,329	$48,684

Lake Killarney (IMP4A)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
KILLARNEY	22	101 + 20	88.30	84.62	-3.68	85.18	-3.12	86.40	-1.90		$0	$0	$0
KILLARNEY	23	101 + 85	85.79	84.62	-1.17	85.18	-0.61	86.40	0.61	$63,162.00	$0	$2,586	$8,732
KILLARNEY	21	102 + 35	88.04	84.62	-3.42	85.18	-2.86	86.40	-1.64		$0	$0	$0
KILLARNEY	20	102 + 95	88.25	84.62	-3.63	85.18	-3.07	86.40	-1.85		$0	$0	$0
KILLARNEY	19	103 + 40	88.42	84.62	-3.80	85.18	-3.24	86.40	-2.02		$0	$0	$0
KILLARNEY	18	109 + 25	89.47	84.62	-4.85	85.18	-4.29	86.40	-3.07	$92,633.00	$0	$0	$0
KILLARNEY	24	111 + 20	88.85	84.62	-4.23	85.18	-3.67	86.40	-2.45	$42,797.00	$0	$0	$0
KILLARNEY	25	112 + 70	88.80	84.62	-4.18	85.18	-3.62	86.40	-2.40	$86,188.00	$0	$0	$0
KILLARNEY	26	115 + 10	87.80	84.62	-3.18	85.18	-2.62	86.40	-1.40	$74,342.00	$0	$0	$0
KILLARNEY	27	116 + 20	90.03	84.62	-5.41	85.18	-4.85	86.40	-3.63	$71,240.00	$0	$0	$0
KILLARNEY	28	116 + 85	91.30	84.62	-6.68	85.18	-6.12	86.40	-4.90	$100,082.00	$0	$0	$0
KILLARNEY	29	117 + 15	90.60	84.62	-5.98	85.18	-5.42	86.40	-4.20	$70,983.00	$0	$0	$0
KILLARNEY	32	117 + 55	87.50	84.62	-2.88	85.18	-2.32	86.40	-1.10		$0	$0	$0
KILLARNEY	30	117 + 80	89.40	84.62	-4.78	85.18	-4.22	86.40	-3.00	$76,362.00	$0	$0	$0
KILLARNEY	31	118 + 45	87.42	84.62	-2.80	85.18	-2.24	86.40	-1.02		$0	$0	$0
KILLARNEY	33	119 + 40	87.80	84.62	-3.18	85.18	-2.62	86.40	-1.40		$0	$0	$0
KILLARNEY	16	125 + 5	87.20	84.62	-2.58	85.18	-2.02	86.40	-0.80	$83,462.00	$0	$0	$1,753
KILLARNEY	14	126 + 70	87.39	84.62	-2.77	85.18	-2.21	86.40	-0.99	$62,226.00	$0	$0	$65
KILLARNEY	15	126 + 80	87.80	84.62	-3.18	85.18	-2.62	86.40	-1.40	$68,478.00	$0	$0	$0
KILLARNEY	13	127 + 0	87.60	84.62	-2.98	85.18	-2.42	86.40	-1.20	$58,202.00	$0	$0	$0
KILLARNEY	12	127 + 55	87.20	84.62	-2.58	85.18	-2.02	86.40	-0.80	$65,900.00	$0	$0	$1,384
KILLARNEY	11	127 + 80	87.67	84.62	-3.05	85.18	-2.49	86.40	-1.27	$63,105.00	$0	$0	$0
KILLARNEY	10	128 + 5	87.82	84.62	-3.20	85.18	-2.64	86.40	-1.42	$86,470.00	$0	$0	$0
KILLARNEY	9	128 + 20	87.39	84.62	-2.77	85.18	-2.21	86.40	-0.99	$59,582.00	$0	$0	$63
KILLARNEY	8	128 + 65	87.84	84.62	-3.22	85.18	-2.66	86.40	-1.44	$95,302.00	$0	$0	$0
KILLARNEY	17	130 + 0	86.71	84.62	-2.09	85.18	-1.53	86.40	-0.31	$91,588.00	$0	$0	$6,636
KILLARNEY	34	130 + 0	86.10	84.62	-1.48	85.18	-0.92	86.40	0.30	$109,428.00	$0	$919	$13,279
Improvement 4A											$0	$3,505	$31,912

Lake Killarney (IMP4B)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
KILLARNEY	22	101 + 20	88.30	84.69	-3.61	85.33	-2.97	86.35	-1.95		$0	$0	$0
KILLARNEY	23	101 + 85	85.79	84.69	-1.10	85.33	-0.46	86.35	0.56	$63,162.00	$0	$3,581	$8,560
KILLARNEY	21	102 + 35	88.04	84.69	-3.35	85.33	-2.71	86.35	-1.69		$0	$0	$0
KILLARNEY	20	102 + 95	88.25	84.69	-3.56	85.33	-2.92	86.35	-1.90		$0	$0	$0
KILLARNEY	19	103 + 40	88.42	84.69	-3.73	85.33	-3.09	86.35	-2.07		$0	$0	$0
KILLARNEY	18	109 + 25	89.47	84.69	-4.78	85.33	-4.14	86.35	-3.12	$92,633.00	$0	$0	$0
KILLARNEY	24	111 + 20	88.85	84.69	-4.16	85.33	-3.52	86.35	-2.50	$42,797.00	$0	$0	$0
KILLARNEY	25	112 + 70	88.80	84.69	-4.11	85.33	-3.47	86.35	-2.45	$86,188.00	$0	$0	$0
KILLARNEY	26	115 + 10	87.80	84.69	-3.11	85.33	-2.47	86.35	-1.45	$74,342.00	$0	$0	$0
KILLARNEY	27	116 + 20	90.03	84.69	-5.34	85.33	-4.70	86.35	-3.68	$71,240.00	$0	$0	$0
KILLARNEY	28	116 + 85	91.30	84.69	-6.61	85.33	-5.97	86.35	-4.95	$100,082.00	$0	$0	$0
KILLARNEY	29	117 + 15	90.60	84.69	-5.91	85.33	-5.27	86.35	-4.25	$70,983.00	$0	$0	$0
KILLARNEY	32	117 + 55	87.50	84.69	-2.81	85.33	-2.17	86.35	-1.15		$0	$0	$0
KILLARNEY	30	117 + 80	89.40	84.69	-4.71	85.33	-4.07	86.35	-3.05	$76,362.00	$0	$0	$0
KILLARNEY	31	118 + 45	87.42	84.69	-2.73	85.33	-2.09	86.35	-1.07		$0	$0	$0
KILLARNEY	33	119 + 40	87.80	84.69	-3.11	85.33	-2.47	86.35	-1.45		$0	$0	$0
KILLARNEY	16	125 + 5	87.20	84.69	-2.51	85.33	-1.87	86.35	-0.85	$83,462.00	$0	$0	$1,315
KILLARNEY	14	126 + 70	87.39	84.69	-2.70	85.33	-2.06	86.35	-1.04	$62,226.00	$0	$0	$0
KILLARNEY	15	126 + 80	87.80	84.69	-3.11	85.33	-2.47	86.35	-1.45	$68,478.00	$0	$0	$0
KILLARNEY	13	127 + 0	87.60	84.69	-2.91	85.33	-2.27	86.35	-1.25	$58,202.00	$0	$0	$0
KILLARNEY	12	127 + 55	87.20	84.69	-2.51	85.33	-1.87	86.35	-0.85	$65,900.00	$0	$0	$1,038
KILLARNEY	11	127 + 80	87.67	84.69	-2.98	85.33	-2.34	86.35	-1.32	$63,105.00	$0	$0	$0
KILLARNEY	10	128 + 5	87.82	84.69	-3.13	85.33	-2.49	86.35	-1.47	$86,470.00	$0	$0	$0
KILLARNEY	9	128 + 20	87.39	84.69	-2.70	85.33	-2.06	86.35	-1.04	$59,582.00	$0	$0	$0
KILLARNEY	8	128 + 65	87.84	84.69	-3.15	85.33	-2.51	86.35	-1.49	$95,302.00	$0	$0	$0
KILLARNEY	17	130 + 0	86.71	84.69	-2.02	85.33	-1.38	86.35	-0.36	$91,588.00	$0	$0	$6,155
KILLARNEY	34	130 + 0	86.10	84.69	-1.41	85.33	-0.77	86.35	0.25	$109,428.00	$0	$2,643	$12,981
Improvement 4B											$0	$6,224	$30,049

Lake Killarney (IMP4C)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
KILLARNEY	22	101 + 20	88.30	84.24	-4.06	84.80	-3.50	85.98	-2.32		$0	$0	$0
KILLARNEY	23	101 + 85	85.79	84.24	-1.55	84.80	-0.99	85.98	0.19	$63,162.00	$0	$66	$7,286
KILLARNEY	21	102 + 35	88.04	84.24	-3.80	84.80	-3.24	85.98	-2.06		$0	$0	$0
KILLARNEY	20	102 + 95	88.25	84.24	-4.01	84.80	-3.45	85.98	-2.27		$0	$0	$0
KILLARNEY	19	103 + 40	88.42	84.24	-4.18	84.80	-3.62	85.98	-2.44		$0	$0	$0
KILLARNEY	18	109 + 25	89.47	84.24	-5.23	84.80	-4.67	85.98	-3.49	$92,633.00	$0	$0	$0
KILLARNEY	24	111 + 20	88.85	84.24	-4.61	84.80	-4.05	85.98	-2.87	$42,797.00	$0	$0	$0
KILLARNEY	25	112 + 70	88.80	84.24	-4.56	84.80	-4.00	85.98	-2.82	$86,188.00	$0	$0	$0
KILLARNEY	26	115 + 10	87.80	84.24	-3.56	84.80	-3.00	85.98	-1.82	$74,342.00	$0	$0	$0
KILLARNEY	27	116 + 20	90.03	84.24	-5.79	84.80	-5.23	85.98	-4.05	$71,240.00	$0	$0	$0
KILLARNEY	28	116 + 85	91.30	84.24	-7.06	84.80	-6.50	85.98	-5.32	$100,082.00	$0	$0	$0
KILLARNEY	29	117 + 15	90.60	84.24	-6.36	84.80	-5.80	85.98	-4.62	$70,983.00	$0	$0	$0
KILLARNEY	32	117 + 55	87.50	84.24	-3.26	84.80	-2.70	85.98	-1.52		$0	$0	$0
KILLARNEY	30	117 + 80	89.40	84.24	-5.16	84.80	-4.60	85.98	-3.42	$76,362.00	$0	$0	$0
KILLARNEY	31	118 + 45	87.42	84.24	-3.18	84.80	-2.62	85.98	-1.44		$0	$0	$0
KILLARNEY	33	119 + 40	87.80	84.24	-3.56	84.80	-3.00	85.98	-1.82		$0	$0	$0
KILLARNEY	16	125 + 5	87.20	84.24	-2.96	84.80	-2.40	85.98	-1.22	$83,462.00	$0	$0	$0
KILLARNEY	14	126 + 70	87.39	84.24	-3.15	84.80	-2.59	85.98	-1.41	$62,226.00	$0	$0	$0
KILLARNEY	15	126 + 80	87.80	84.24	-3.56	84.80	-3.00	85.98	-1.82	$68,478.00	$0	$0	$0
KILLARNEY	13	127 + 0	87.60	84.24	-3.36	84.80	-2.80	85.98	-1.62	$58,202.00	$0	$0	$0
KILLARNEY	12	127 + 55	87.20	84.24	-2.96	84.80	-2.40	85.98	-1.22	$65,900.00	$0	$0	$0
KILLARNEY	11	127 + 80	87.67	84.24	-3.43	84.80	-2.87	85.98	-1.69	$63,105.00	$0	$0	$0
KILLARNEY	10	128 + 5	87.82	84.24	-3.58	84.80	-3.02	85.98	-1.84	$86,470.00	$0	$0	$0
KILLARNEY	9	128 + 20	87.39	84.24	-3.15	84.80	-2.59	85.98	-1.41	$59,582.00	$0	$0	$0
KILLARNEY	8	128 + 65	87.84	84.24	-3.60	84.80	-3.04	85.98	-1.86	$95,302.00	$0	$0	$0
KILLARNEY	17	130 + 0	86.71	84.24	-2.47	84.80	-1.91	85.98	-0.73	$91,588.00	$0	$0	$2,597
KILLARNEY	34	130 + 0	86.10	84.24	-1.86	84.80	-1.30	85.98	-0.12	$109,428.00	$0	$0	$10,111
Improvement 4C											$0	$66	$19,994

Park Lake (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
PARK LAKE	35	47 + 75	76.58	72.19	-4.39	73.04	-3.54	74.89	-1.69	$70,735.00	$0	$0	$0
PARK LAKE	36	49 + 0	71.04	72.19	1.15	73.04	2.00	74.89	3.85	$70,735.00 *	$11,929	$15,597	$28,036
PARK LAKE	37	49 + 50	72.90	72.19	-0.71	73.04	0.14	74.89	1.99	$70,735.00 *	$2,154	$7,967	$15,554
PARK LAKE	38	49 + 75	73.30	72.19	-1.11	73.04	-0.26	74.89	1.59	$70,735.00 *	$0	$5,496	$13,828
PARK LAKE	46	49 + 95	74.40	72.19	-2.21	73.04	-1.36	74.89	0.49	$239,303.14	$0	$0	$25,893
PARK LAKE	44	52 + 35	74.45	72.19	-2.26	73.04	-1.41	74.89	0.44	$239,303.14	$0	$0	$25,388
PARK LAKE	45	52 + 35	73.60	72.19	-1.41	73.04	-0.56	74.89	1.29	$239,303.14	$0	$9,213	$34,554
PARK LAKE	42	55 + 35	74.40	72.19	-2.21	73.04	-1.36	74.89	0.49	$239,303.14	$0	$0	$25,893
PARK LAKE	43	55 + 35	74.60	72.19	-2.41	73.04	-1.56	74.89	0.29	$239,303.14	$0	$0	$23,871
PARK LAKE	41	56 + 45	75.50	72.19	-3.31	73.04	-2.46	74.89	-0.61	$239,303.14	$0	$0	$8,166
PARK LAKE	39	56 + 75	74.80	72.19	-2.61	73.04	-1.76	74.89	0.09	$57,541.00	$0	$0	$6,324
PARK LAKE	40	59 + 15	75.40	72.19	-3.21	73.04	-2.36	74.89	-0.51	$239,303.14	$0	$0	$10,260
* Estimated Structure Value											$14,083	$38,273	$217,767

Park Lake (IMP6A)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	DURING FLOOD EVENT 10 YR	25 YR	100 YR
PARK LAKE	35	47 + 75	76.58	71.98	-4.60	72.68	-3.90	74.09	-2.49	$70,735.00	$0	$0	$0
PARK LAKE	36	49 + 0	71.04	71.98	0.94	72.68	1.64	74.09	3.05		$0	$0	$0
PARK LAKE	37	49 + 50	72.90	71.98	-0.92	72.68	-0.22	74.09	1.19		$0	$0	$0
PARK LAKE	38	49 + 75	73.30	71.98	-1.32	72.68	-0.62	74.09	0.79		$0	$0	$0
PARK LAKE	46	49 + 95	74.40	71.98	-2.42	72.68	-1.72	74.09	-0.31	$239,303.14	$0	$0	$14,448
PARK LAKE	44	52 + 35	74.45	71.98	-2.47	72.68	-1.77	74.09	-0.36	$239,303.14	$0	$0	$13,401
PARK LAKE	45	52 + 35	73.60	71.98	-1.62	72.68	-0.92	74.09	0.49	$239,303.14	$0	$1,675	$25,893
PARK LAKE	42	55 + 35	74.40	71.98	-2.42	72.68	-1.72	74.09	-0.31	$239,303.14	$0	$0	$14,448
PARK LAKE	43	55 + 35	74.60	71.98	-2.62	72.68	-1.92	74.09	-0.51	$239,303.14	$0	$0	$10,260
PARK LAKE	41	56 + 45	75.50	71.98	-3.52	72.68	-2.82	74.09	-1.41	$239,303.14	$0	$0	$0
PARK LAKE	39	56 + 75	74.80	71.98	-2.82	72.68	-2.12	74.09	-0.71	$57,541.00	$0	$0	$1,752
PARK LAKE	40	59 + 15	75.40	71.98	-3.42	72.68	-2.72	74.09	-1.31	$239,303.14	$0	$0	$0
Improvement 6A											$0	$1,675	$80,202

Park Lake (IMP6B)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
PARK LAKE	35	47 + 75	76.58	71.76	-4.82	72.40	-4.18	73.79	-2.79	$70,735.00	$0	$0	$0
PARK LAKE	36	49 + 0	71.04	71.76	0.72	72.40	1.36	73.79	2.75		$0	$0	$0
PARK LAKE	37	49 + 50	72.90	71.76	-1.14	72.40	-0.50	73.79	0.89		$0	$0	$0
PARK LAKE	38	49 + 75	73.30	71.76	-1.54	72.40	-0.90	73.79	0.49		$0	$0	$0
PARK LAKE	46	49 + 95	74.40	71.76	-2.64	72.40	-2.00	73.79	-0.61	$239,303.14	$0	$0	$8,166
PARK LAKE	44	52 + 35	74.45	71.76	-2.69	72.40	-2.05	73.79	-0.66	$239,303.14	$0	$0	$7,119
PARK LAKE	45	52 + 35	73.60	71.76	-1.84	72.40	-1.20	73.79	0.19	$239,303.14	$0	$0	$22,860
PARK LAKE	42	55 + 35	74.40	71.76	-2.64	72.40	-2.00	73.79	-0.61	$239,303.14	$0	$0	$8,166
PARK LAKE	43	55 + 35	74.60	71.76	-2.84	72.40	-2.20	73.79	-0.81	$239,303.14	$0	$0	$3,978
PARK LAKE	41	56 + 45	75.50	71.76	-3.74	72.40	-3.10	73.79	-1.71	$239,303.14	$0	$0	$0
PARK LAKE	39	56 + 75	74.80	71.76	-3.04	72.40	-2.40	73.79	-1.01	$57,541.00	$0	$0	$0
PARK LAKE	40	59 + 15	75.40	71.76	-3.64	72.40	-3.00	73.79	-1.61	$239,303.14	$0	$0	$0
Improvement 6B											$0	$0	$50,289

Park Lake (IMP6C)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
PARK LAKE	35	47 + 75	76.58	71.58	-5.00	72.19	-4.39	73.42	-3.16	$70,735.00	$0	$0	$0
PARK LAKE	36	49 + 0	71.04	71.58	0.54	72.19	1.15	73.42	2.38		$0	$0	$0
PARK LAKE	37	49 + 50	72.90	71.58	-1.32	72.19	-0.71	73.42	0.52		$0	$0	$0
PARK LAKE	38	49 + 75	73.30	71.58	-1.72	72.19	-1.11	73.42	0.12		$0	$0	$0
PARK LAKE	46	49 + 95	74.40	71.58	-2.82	72.19	-2.21	73.42	-0.98	$239,303.14	$0	$0	$419
PARK LAKE	44	52 + 35	74.45	71.58	-2.87	72.19	-2.26	73.42	-1.03	$239,303.14	$0	$0	$0
PARK LAKE	45	52 + 35	73.60	71.58	-2.02	72.19	-1.41	73.42	-0.18	$239,303.14	$0	$0	$17,170
PARK LAKE	42	55 + 35	74.40	71.58	-2.82	72.19	-2.21	73.42	-0.98	$239,303.14	$0	$0	$419
PARK LAKE	43	55 + 35	74.60	71.58	-3.02	72.19	-2.41	73.42	-1.18	$239,303.14	$0	$0	$0
PARK LAKE	41	56 + 45	75.50	71.58	-3.92	72.19	-3.31	73.42	-2.08	$239,303.14	$0	$0	$0
PARK LAKE	39	56 + 75	74.80	71.58	-3.22	72.19	-2.61	73.42	-1.38	$57,541.00	$0	$0	$0
PARK LAKE	40	59 + 15	75.40	71.58	-3.82	72.19	-3.21	73.42	-1.98	$239,303.14	$0	$0	$0
Improvement 6C											$0	$0	$18,008

Maitland Chain of Lakes (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
MAIN STEM	80	552 + 80	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$93,103.00	$0	$0	$0
MAIN STEM	79	552 + 95	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$80,963.00	$0	$0	$0
MAIN STEM	76	558 + 35	68.20	63.74	-4.46	64.41	-3.79	65.57	-2.63	$113,973.00	$0	$0	$0
MAIN STEM	75	558 + 70	69.20	63.77	-5.43	64.44	-4.76	65.59	-3.61	$90,130.00	$0	$0	$0
MAIN STEM	78	560 + 85	67.90	63.89	-4.01	64.52	-3.38	65.72	-2.18	$80,167.00	$0	$0	$0
MAIN STEM	77	561 + 30	68.70	63.92	-4.78	64.60	-4.10	65.75	-2.95	$94,428.00	$0	$0	$0
MAIN STEM	65	581 + 35	69.90	67.79	-2.11	68.23	-1.67	69.09	-0.81	$56,511.00	$0	$0	$1,127
MAIN STEM	66	581 + 55	70.05	67.79	-2.26	68.23	-1.82	69.09	-0.96	$83,676.00	$0	$0	$351
MAIN STEM	67	583 + 90	69.70	67.79	-1.91	68.23	-1.47	69.09	-0.61	$227,713.00	$0	$0	$9,325
MAIN STEM	69	584 + 40	70.02	67.79	-2.23	68.23	-1.79	69.09	-0.93	$148,028.00	$0	$0	$1,088
MAIN STEM	70	597 + 70	70.49	67.79	-2.70	68.23	-2.26	69.09	-1.40	$215,498.00	$0	$0	$0
MAIN STEM	71	602 + 30	68.70	67.79	-0.91	68.23	-0.47	69.09	0.39	$137,386.00	$1,298	$7,646	$17,346
MAIN STEM	72	605 + 40	69.00	67.79	-1.21	68.23	-0.77	69.09	0.09	$223,043.00	$0	$5,386	$24,514
MAIN STEM	64	617 + 30	69.90	67.79	-2.11	68.23	-1.67	69.09	-0.81	$776,009.00	$0	$0	$15,481
MAIN STEM	63	617 + 55	68.00	67.79	-0.21	68.23	0.23	69.09	1.09	$290,448.00	$24,093	$34,138	$47,921
MAIN STEM	62	619 + 20	69.10	67.79	-1.31	68.23	-0.87	69.09	-0.01	$237,537.00	$0	$3,242	$24,692
MAIN STEM	61	628 + 0	69.10	67.79	-1.31	68.23	-0.87	69.09	-0.01	$270,384.00	$0	$3,691	$28,106
MAIN STEM	73	636 + 15	70.30	67.79	-2.51	68.23	-2.07	69.09	-1.21	$103,619.00	$0	$0	$0
MAIN STEM	5	670 + 9	70.26	68.09	-2.17	68.57	-1.69	69.49	-0.77	$172,340.00	$0	$0	$4,162
MAIN STEM	6	680 + 10	70.91	68.09	-2.82	68.57	-2.34	69.49	-1.42	$270,197.00	$0	$0	$0
MAIN STEM	7	681 + 20	71.71	68.09	-3.62	68.57	-3.14	69.49	-2.22	$426,209.00	$0	$0	$0
MAIN STEM	3	712 + 95	70.37	68.09	-2.28	68.57	-1.80	69.49	-0.88	$80,707.00	$0	$0	$1,017
MAIN STEM	4	712 + 95	68.44	68.09	-0.35	68.57	0.13	69.49	1.05	$149,922.00	$10,232	$16,804	$24,370
MAIN STEM	1	756 + 57	70.36	69.40	-0.96	70.75	0.39	71.34	0.98	$52,074.00	$219	$6,575	$8,249
MAIN STEM	2	759 + 42	76.27	69.45	-6.82	70.77	-5.50	71.38	-4.89	$58,500.00	$0	$0	$0
TRIBUTARY 2	60	9 + 75	72.87	67.79	-5.08	68.23	-4.64	69.09	-3.78	$270,384.00	$0	$0	$0
TRIBUTARY 2	52	10 + 25	71.12	67.79	-3.33	68.23	-2.89	69.09	-2.03	$68,663.00	$0	$0	$0
TRIBUTARY 2	59	10 + 25	70.40	67.79	-2.61	68.23	-2.17	69.09	-1.31	$304,156.00	$0	$0	$0
TRIBUTARY 2	58	12 + 25	71.10	67.79	-3.31	68.23	-2.87	69.09	-2.01	$173,526.00	$0	$0	$0
TRIBUTARY 2	56	13 + 50	71.20	67.79	-3.41	68.23	-2.97	69.09	-2.11	$206,288.00	$0	$0	$0
TRIBUTARY 2	55	14 + 15	69.60	67.79	-1.81	68.23	-1.37	69.09	-0.51	$61,441.00	$0	$0	$3,161
TRIBUTARY 2	57	14 + 35	69.80	67.79	-2.01	68.23	-1.57	69.09	-0.71		$0	$0	$0
TRIBUTARY 2	54	17 + 30	69.20	67.79	-1.41	68.23	-0.97	69.09	-0.11	$118,620.00	$0	$374	$11,085
TRIBUTARY 2	53	17 + 80	68.50	67.79	-0.71	68.23	-0.27	69.09	0.59	$219,366.00	$6,680	$16,814	$30,087
TRIBUTARY 2	50	54 + 65	70.69	67.79	-2.90	68.23	-2.46	69.09	-1.60	$56,835.00	$0	$0	$0
TRIBUTARY 2	49	56 + 60	68.67	67.79	-0.88	68.23	-0.44	69.09	0.42	$55,639.00	$701	$3,272	$7,116
TRIBUTARY 2	51	57 + 40	71.47	67.79	-3.68	68.23	-3.24	69.09	-2.38	$90,110.00	$0	$0	$0
TRIBUTARY 2	48	57 + 80	68.47	67.79	-0.68	68.23	-0.24	69.09	0.62		$0	$0	$0
TRIBUTARY 2	47	60 + 95	71.90	67.79	-4.11	68.23	-3.67	69.09	-2.81	$67,049.00	$0	$0	$0
											$43,223	$97,942	$259,198

Maitland Chain of Lakes (IMP8A)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
MAIN STEM	80	552 + 80	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$93,103.00	$0	$0	$0
MAIN STEM	79	552 + 95	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$80,963.00	$0	$0	$0
MAIN STEM	76	558 + 35	68.20	63.74	-4.46	64.41	-3.79	65.57	-2.63	$113,973.00	$0	$0	$0
MAIN STEM	75	558 + 70	69.20	63.77	-5.43	64.44	-4.76	65.59	-3.61	$90,130.00	$0	$0	$0
MAIN STEM	78	560 + 85	67.90	63.89	-4.01	64.52	-3.38	65.72	-2.18	$80,167.00	$0	$0	$0
MAIN STEM	77	561 + 30	68.70	63.92	-4.78	64.60	-4.10	65.75	-2.95	$94,428.00	$0	$0	$0
MAIN STEM	65	581 + 35	69.90	67.02	-2.88	67.54	-2.36	68.48	-1.42	$56,511.00	$0	$0	$0
MAIN STEM	66	581 + 55	70.05	67.02	-3.03	67.54	-2.51	68.48	-1.57	$83,676.00	$0	$0	$0
MAIN STEM	67	583 + 90	69.70	67.02	-2.68	67.54	-2.16	68.48	-1.22	$227,713.00	$0	$0	$0
MAIN STEM	69	584 + 40	70.02	67.02	-3.00	67.54	-2.48	68.48	-1.54	$148,028.00	$0	$0	$0
MAIN STEM	70	597 + 70	70.49	67.02	-3.47	67.54	-2.95	68.48	-2.01	$215,498.00	$0	$0	$0
MAIN STEM	71	602 + 30	68.70	67.02	-1.68	67.54	-1.16	68.48	-0.22	$137,386.00	$0	$0	$11,252
MAIN STEM	72	605 + 40	69.00	67.02	-1.98	67.54	-1.46	68.48	-0.52	$223,043.00	$0	$0	$11,241
MAIN STEM	64	617 + 30	69.90	67.02	-2.88	67.54	-2.36	68.48	-1.42	$776,009.00	$0	$0	$0
MAIN STEM	63	617 + 55	68.00	67.02	-0.98	67.54	-0.46	68.48	0.48	$290,448.00	$610	$16,468	$38,095
MAIN STEM	62	619 + 20	69.10	67.02	-2.08	67.54	-1.56	68.48	-0.62	$237,537.00	$0	$0	$9,478
MAIN STEM	61	628 + 0	69.10	67.02	-2.08	67.54	-1.56	68.48	-0.62	$270,384.00	$0	$0	$10,788
MAIN STEM	73	636 + 15	70.30	67.02	-3.28	67.54	-2.76	68.48	-1.82	$103,619.00	$0	$0	$0
MAIN STEM	5	670 + 9	70.26	67.35	-2.91	67.92	-2.34	68.97	-1.29	$172,340.00	$0	$0	$0
MAIN STEM	6	680 + 10	70.91	67.35	-3.56	67.92	-2.99	68.97	-1.94	$270,197.00	$0	$0	$0
MAIN STEM	7	681 + 20	71.71	67.35	-4.36	67.92	-3.79	68.97	-2.74	$426,209.00	$0	$0	$0
MAIN STEM	3	712 + 95	70.37	67.35	-3.02	67.92	-2.45	68.97	-1.40	$80,707.00	$0	$0	$0
MAIN STEM	4	712 + 95	68.44	67.35	-1.09	67.92	-0.52	68.97	0.53	$149,922.00	$0	$7,556	$20,072
MAIN STEM	1	756 + 57	70.36	69.28	-1.08	69.83	-0.53	71.15	0.79	$52,074.00	$0	$2,570	$7,710
MAIN STEM	2	759 + 42	76.27	69.40	-6.87	69.96	-6.31	71.25	-5.02	$58,500.00	$0	$0	$0
TRIBUTARY 2	60	9 + 75	72.87	67.02	-5.85	67.54	-5.33	68.48	-4.39	$270,384.00	$0	$0	$0
TRIBUTARY 2	52	10 + 25	71.12	67.02	-4.10	67.54	-3.58	68.48	-2.64	$68,663.00	$0	$0	$0
TRIBUTARY 2	59	10 + 25	70.40	67.02	-3.38	67.54	-2.86	68.48	-1.92	$304,156.00	$0	$0	$0
TRIBUTARY 2	58	12 + 25	71.10	67.02	-4.08	67.54	-3.56	68.48	-2.62	$173,526.00	$0	$0	$0
TRIBUTARY 2	56	13 + 50	71.20	67.02	-4.18	67.54	-3.66	68.48	-2.72	$206,288.00	$0	$0	$0
TRIBUTARY 2	55	14 + 15	69.60	67.02	-2.58	67.54	-2.06	68.48	-1.12	$61,441.00	$0	$0	$0
TRIBUTARY 2	57	14 + 35	69.80	67.02	-2.78	67.54	-2.26	68.48	-1.32		$0	$0	$0
TRIBUTARY 2	54	17 + 30	69.20	67.02	-2.18	67.54	-1.66	68.48	-0.72	$118,620.00	$0	$0	$3,487
TRIBUTARY 2	53	17 + 80	68.50	67.02	-1.48	67.54	-0.96	68.48	-0.02	$219,366.00	$0	$921	$22,573
TRIBUTARY 2	50	54 + 65	70.69	67.02	-3.67	67.54	-3.15	68.48	-2.21	$56,835.00	$0	$0	$0
TRIBUTARY 2	49	56 + 60	68.67	67.02	-1.65	67.54	-1.13	68.48	-0.19	$55,639.00	$0	$0	$4,732
TRIBUTARY 2	51	57 + 40	71.47	67.02	-4.45	67.54	-3.93	68.48	-2.99	$90,110.00	$0	$0	$0
TRIBUTARY 2	48	57 + 80	68.47	67.02	-1.45	67.54	-0.93	68.48	0.01		$0	$0	$0
TRIBUTARY 2	47	60 + 95	71.90	67.02	-4.88	67.54	-4.36	68.48	-3.42	$67,049.00	$0	$0	$0
Improvement 8A											$610	$27,515	$139,428

Maitland Chain of Lakes (IMP8C)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
MAIN STEM	80	552 + 80	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$93,103.00	$0	$0	$0
MAIN STEM	79	552 + 95	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$80,963.00	$0	$0	$0
MAIN STEM	76	558 + 35	68.20	63.74	-4.46	64.41	-3.79	65.57	-2.63	$113,973.00	$0	$0	$0
MAIN STEM	75	558 + 70	69.20	63.77	-5.43	64.44	-4.76	65.59	-3.61	$90,130.00	$0	$0	$0
MAIN STEM	78	560 + 85	67.90	63.89	-4.01	64.52	-3.38	65.72	-2.18	$80,167.00	$0	$0	$0
MAIN STEM	77	561 + 30	68.70	63.92	-4.78	64.60	-4.10	65.75	-2.95	$94,428.00	$0	$0	$0
MAIN STEM	65	581 + 35	69.90	66.71	-3.19	67.22	-2.68	68.11	-1.79	$56,511.00	$0	$0	$0
MAIN STEM	66	581 + 55	70.05	66.71	-3.34	67.22	-2.83	68.11	-1.94	$83,676.00	$0	$0	$0
MAIN STEM	67	583 + 90	69.70	66.71	-2.99	67.22	-2.48	68.11	-1.59	$227,713.00	$0	$0	$0
MAIN STEM	69	584 + 40	70.02	66.71	-3.31	67.22	-2.80	68.11	-1.91	$148,028.00	$0	$0	$0
MAIN STEM	70	597 + 70	70.49	66.71	-3.78	67.22	-3.27	68.11	-2.38	$215,498.00	$0	$0	$0
MAIN STEM	71	602 + 30	68.70	66.71	-1.99	67.22	-1.48	68.11	-0.59	$137,386.00	$0	$0	$5,914
MAIN STEM	72	605 + 40	69.00	66.71	-2.29	67.22	-1.78	68.11	-0.89	$223,043.00	$0	$0	$2,576
MAIN STEM	64	617 + 30	69.90	66.71	-3.19	67.22	-2.68	68.11	-1.79	$776,009.00	$0	$0	$0
MAIN STEM	63	617 + 55	68.00	66.71	-1.29	67.22	-0.78	68.11	0.11	$290,448.00	$0	$6,709	$32,238
MAIN STEM	62	619 + 20	69.10	66.71	-2.39	67.22	-1.88	68.11	-0.99	$237,537.00	$0	$0	$249
MAIN STEM	61	628 + 0	69.10	66.71	-2.39	67.22	-1.88	68.11	-0.99	$270,384.00	$0	$0	$284
MAIN STEM	73	636 + 15	70.30	66.71	-3.59	67.22	-3.08	68.11	-2.19	$103,619.00	$0	$0	$0
MAIN STEM	5	670 + 9	70.26	67.18	-3.08	67.75	-2.51	68.82	-1.44	$172,340.00	$0	$0	$0
MAIN STEM	6	680 + 10	70.91	67.18	-3.73	67.75	-3.16	68.82	-2.09	$270,197.00	$0	$0	$0
MAIN STEM	7	681 + 20	71.71	67.18	-4.53	67.75	-3.96	68.82	-2.89	$426,209.00	$0	$0	$0
MAIN STEM	3	712 + 95	70.37	67.18	-3.19	67.75	-2.62	68.82	-1.55	$80,707.00	$0	$0	$0
MAIN STEM	4	712 + 95	68.44	67.18	-1.26	67.75	-0.69	68.82	0.38	$149,922.00	$0	$4,880	$18,847
MAIN STEM	1	756 + 57	70.36	69.29	-1.07	69.84	-0.52	71.15	0.79	$52,074.00	$0	$2,625	$7,710
MAIN STEM	2	759 + 42	76.27	69.40	-6.87	69.96	-6.31	71.25	-5.02	$58,500.00	$0	$0	$0
TRIBUTARY 2	60	9 + 75	72.87	66.71	-6.16	67.22	-5.65	68.11	-4.76	$270,384.00	$0	$0	$0
TRIBUTARY 2	52	10 + 25	71.12	66.71	-4.41	67.22	-3.90	68.11	-3.01	$68,663.00	$0	$0	$0
TRIBUTARY 2	59	10 + 25	70.40	66.71	-3.69	67.22	-3.18	68.11	-2.29	$304,156.00	$0	$0	$0
TRIBUTARY 2	58	12 + 25	71.10	66.71	-4.39	67.22	-3.88	68.11	-2.99	$173,526.00	$0	$0	$0
TRIBUTARY 2	56	13 + 50	71.20	66.71	-4.49	67.22	-3.98	68.11	-3.09	$206,288.00	$0	$0	$0
TRIBUTARY 2	55	14 + 15	69.60	66.71	-2.89	67.22	-2.38	68.11	-1.49	$61,441.00	$0	$0	$0
TRIBUTARY 2	57	14 + 35	69.80	66.71	-3.09	67.22	-2.58	68.11	-1.69		$0	$0	$0
TRIBUTARY 2	54	17 + 30	69.20	66.71	-2.49	67.22	-1.98	68.11	-1.09	$118,620.00	$0	$0	$0
TRIBUTARY 2	53	17 + 80	68.50	66.71	-1.79	67.22	-1.28	68.11	-0.39	$219,366.00	$0	$0	$14,050
TRIBUTARY 2	50	54 + 65	70.69	66.71	-3.98	67.22	-3.47	68.11	-2.58	$56,835.00	$0	$0	$0
TRIBUTARY 2	49	56 + 60	68.67	66.71	-1.96	67.22	-1.45	68.11	-0.56	$55,639.00	$0	$0	$2,571
TRIBUTARY 2	51	57 + 40	71.47	66.71	-4.76	67.22	-4.25	68.11	-3.36	$90,110.00	$0	$0	$0
TRIBUTARY 2	48	57 + 80	68.47	66.71	-1.76	67.22	-1.25	68.11	-0.36		$0	$0	$0
TRIBUTARY 2	47	60 + 95	71.90	66.71	-5.19	67.22	-4.68	68.11	-3.79	$67,049.00	$0	$0	$0
Improvement 8C											$0	$14,214	$84,439

Maitland Chain of Lakes (IMP9)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
MAIN STEM	80	552 + 80	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$93,103.00	$0	$0	$0
MAIN STEM	79	552 + 95	67.50	63.52	-3.98	64.11	-3.39	65.04	-2.46	$80,963.00	$0	$0	$0
MAIN STEM	76	558 + 35	68.20	63.74	-4.46	64.41	-3.79	65.57	-2.63	$113,973.00	$0	$0	$0
MAIN STEM	75	558 + 70	69.20	63.77	-5.43	64.44	-4.76	65.59	-3.61	$90,130.00	$0	$0	$0
MAIN STEM	78	560 + 85	67.90	63.89	-4.01	64.52	-3.38	65.72	-2.18	$80,167.00	$0	$0	$0
MAIN STEM	77	561 + 30	68.70	63.92	-4.78	64.60	-4.10	65.75	-2.95	$94,428.00	$0	$0	$0
MAIN STEM	65	581 + 35	69.90	67.10	-2.80	67.59	-2.31	68.32	-1.58	$56,511.00	$0	$0	$0
MAIN STEM	66	581 + 55	70.05	67.10	-2.95	67.59	-2.46	68.32	-1.73	$83,676.00	$0	$0	$0
MAIN STEM	67	583 + 90	69.70	67.10	-2.60	67.59	-2.11	68.32	-1.38	$227,713.00	$0	$0	$0
MAIN STEM	69	584 + 40	70.02	67.10	-2.92	67.59	-2.43	68.32	-1.70	$148,028.00	$0	$0	$0
MAIN STEM	70	597 + 70	70.49	67.10	-3.39	67.59	-2.90	68.32	-2.17	$215,498.00	$0	$0	$0
MAIN STEM	71	602 + 30	68.70	67.10	-1.60	67.59	-1.11	68.32	-0.38	$137,386.00	$0	$0	$8,944
MAIN STEM	72	605 + 40	69.00	67.10	-1.90	67.59	-1.41	68.32	-0.68	$223,043.00	$0	$0	$7,494
MAIN STEM	64	617 + 30	69.90	67.10	-2.80	67.59	-2.31	68.32	-1.58	$776,009.00	$0	$0	$0
MAIN STEM	63	617 + 55	68.00	67.10	-0.90	67.59	-0.41	68.32	0.32	$290,448.00	$3,050	$17,993	$35,562
MAIN STEM	62	619 + 20	69.10	67.10	-2.00	67.59	-1.51	68.32	-0.78	$237,537.00	$0	$0	$5,487
MAIN STEM	61	628 + 0	69.10	67.10	-2.00	67.59	-1.51	68.32	-0.78	$270,384.00	$0	$0	$6,246
MAIN STEM	73	636 + 15	70.30	67.10	-3.20	67.59	-2.71	68.32	-1.98	$103,619.00	$0	$0	$0
MAIN STEM	5	670 + 9	70.26	67.41	-2.85	67.95	-2.31	68.90	-1.36	$172,340.00	$0	$0	$0
MAIN STEM	6	680 + 10	70.91	67.41	-3.50	67.95	-2.96	68.90	-2.01	$270,197.00	$0	$0	$0
MAIN STEM	7	681 + 20	71.71	67.41	-4.30	67.95	-3.76	68.90	-2.81	$426,209.00	$0	$0	$0
MAIN STEM	3	712 + 95	70.37	67.41	-2.96	67.95	-2.42	68.90	-1.47	$80,707.00	$0	$0	$0
MAIN STEM	4	712 + 95	68.44	67.41	-1.03	67.95	-0.49	68.90	0.46	$149,922.00	$0	$8,028	$19,500
MAIN STEM	1	756 + 57	70.36	69.40	-0.96	70.75	0.39	71.34	0.98	$52,074.00	$219	$6,575	$8,249
MAIN STEM	2	759 + 42	76.27	69.45	-6.82	70.77	-5.50	71.38	-4.89	$58,500.00	$0	$0	$0
TRIBUTARY 2	60	9 + 75	72.87	67.10	-5.77	67.59	-5.28	68.32	-4.55	$270,384.00	$0	$0	$0
TRIBUTARY 2	52	10 + 25	71.12	67.10	-4.02	67.59	-3.53	68.32	-2.80	$68,663.00	$0	$0	$0
TRIBUTARY 2	59	10 + 25	70.40	67.10	-3.30	67.59	-2.81	68.32	-2.08	$304,156.00	$0	$0	$0
TRIBUTARY 2	58	12 + 25	71.10	67.10	-4.00	67.59	-3.51	68.32	-2.78	$173,526.00	$0	$0	$0
TRIBUTARY 2	56	13 + 50	71.20	67.10	-4.10	67.59	-3.61	68.32	-2.88	$206,288.00	$0	$0	$0
TRIBUTARY 2	55	14 + 15	69.60	67.10	-2.50	67.59	-2.01	68.32	-1.28	$61,441.00	$0	$0	$0
TRIBUTARY 2	57	14 + 35	69.80	67.10	-2.70	67.59	-2.21	68.32	-1.48		$0	$0	$0
TRIBUTARY 2	54	17 + 30	69.20	67.10	-2.10	67.59	-1.61	68.32	-0.88	$118,620.00	$0	$0	$1,495
TRIBUTARY 2	53	17 + 80	68.50	67.10	-1.40	67.59	-0.91	68.32	-0.18	$219,366.00	$0	$2,073	$18,887
TRIBUTARY 2	50	54 + 65	70.69	67.10	-3.59	67.59	-3.10	68.32	-2.37	$56,835.00	$0	$0	$0
TRIBUTARY 2	49	56 + 60	68.67	67.10	-1.57	67.59	-1.08	68.32	-0.35	$55,639.00	$0	$0	$3,797
TRIBUTARY 2	51	57 + 40	71.47	67.10	-4.37	67.59	-3.88	68.32	-3.15	$90,110.00	$0	$0	$0
TRIBUTARY 2	48	57 + 80	68.47	67.10	-1.37	67.59	-0.88	68.32	-0.15		$0	$0	$0
TRIBUTARY 2	47	60 + 95	71.90	67.10	-4.80	67.59	-4.31	68.32	-3.58	$67,049.00	$0	$0	$0
Improvement 9											$3,269	$34,669	$115,661

Lake Howell (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
MAIN STEM	97	145 + 50	25.25	21.08	-4.17	22.00	-3.25	23.22	-2.03	$373,860.00	$0	$0	$0
MAIN STEM	96	437 + 60	59.69	56.36	-3.33	56.92	-2.77	58.03	-1.66	$175,140.00	$0	$0	$0
MAIN STEM	95-A	440 + 50	61.25	56.36	-4.89	56.92	-4.33	58.03	-3.22	$18,980.00	$0	$0	$0
MAIN STEM	95	441 + 60	58.72	56.36	-2.36	56.92	-1.80	58.03	-0.69	$152,510.00	$0	$0	$4,964
MAIN STEM	94	442 + 0		56.36		56.92		58.03		NO VALUE DETERM			
MAIN STEM	82	444 + 25	59.08	56.36	-2.72	56.92	-2.16	58.03	-1.05	$50,000.00	$0	$0	$0
MAIN STEM	84	444 + 25	59.24	56.36	-2.88	56.92	-2.32	58.03	-1.21	$53,220.00	$0	$0	$0
MAIN STEM	81	445 + 70	59.21	56.36	-2.85	56.92	-2.29	58.03	-1.18	$67,000.00	$0	$0	$0
MAIN STEM	83	445 + 70	59.14	56.36	-2.78	56.92	-2.22	58.03	-1.11	$53,220.00	$0	$0	$0
MAIN STEM	93	445 + 25	61.97	56.36	-5.61	56.92	-5.05	58.03	-3.94	$46,290.00	$0	$0	$0
MAIN STEM	92-A	448 + 80	58.08	56.36	-1.72	56.92	-1.16	58.03	-0.05	$36,600.00	$0	$0	$3,651
MAIN STEM	92	452 + 5	60.30	56.36	-3.94	56.92	-3.38	58.03	-2.27	NO VALUE DETERM			
MAIN STEM	91	453 + 5	58.25	56.36	-1.89	56.92	-1.33	58.03	-0.22	NO VALUE DETERM			
MAIN STEM	90 *	453 + 60	61.54	56.36	-5.18	56.92	-4.62	58.03	-3.51	$45,570.00	$471	$582	$788
MAIN STEM	89-A	456 + 10	57.02	56.36	-0.66	56.92	-0.10	58.03	1.01	$9,130.00	$326	$863	$1,462
MAIN STEM	89	459 + 75	57.80	56.36	-1.44	56.92	-0.88	58.03	0.23	$97,230.00			
MAIN STEM	88	460 + 65	59.20	56.36	-2.84	56.92	-2.28	58.03	-1.17	NO VALUE DETERM			
MAIN STEM	87	460 + 65	57.71	56.36	-1.35	56.92	-0.79	58.03	0.32	$50,080.00	$0	$1,104	$6,132
MAIN STEM	86	461 + 95	60.04	56.36	-3.68	56.92	-3.12	58.03	-2.01	$53,010.00	$0	$0	$0
* With Basement											$797	$2,549	$16,997

Bear Creek (existing conditions)

TRIBUTARY	STRUCTURE ID NUMBER	STATION	FIRST-FLOOR ELEVATION	FLOOD ELEVATION 10 YR	DELTA	25 YR	DELTA	100 YR	DELTA	STRUCTURE VALUE	EXPECTED DAMAGE DURING FLOOD EVENT 10 YR	25 YR	100 YR
BEAR CREEK	110	240 + 25	44.97	40.80	-4.17	41.03	-3.94	41.37	-3.60	$101,240.00	$0	$0	$0
BEAR CREEK	107	240 + 40	43.56	40.80	-2.76	41.03	-2.53	41.37	-2.19	$66,370.00	$0	$0	$0
BEAR CREEK	108	241 + 10	42.13	40.81	-1.32	41.05	-1.08	41.39	-0.74	NO VALUE DETERM			
BEAR CREEK	106	241 + 20	42.20	40.81	-1.39	41.05	-1.15	41.39	-0.81	NO VALUE DETERM			
BEAR CREEK	109	241 + 65	43.25	40.81	-2.44	41.05	-2.20	41.39	-1.86	NO VALUE DETERM			
BEAR CREEK	105	242 + 70	44.27	40.81	-3.46	41.05	-3.22	41.39	-2.88	$131,740.00	$0	$0	$0
BEAR CREEK	104	245 + 30								NOT YET CONSTRU			
BEAR CREEK	100	248 + 5	45.61	40.81	-4.80	41.05	-4.56	41.39	-4.22	$48,310.00	$0	$0	$0
BEAR CREEK	100-A	248 + 90	45.86	40.81	-5.05	41.05	-4.81	41.39	-4.47	$99,620.00	$0	$0	$0
BEAR CREEK	102	250 + 55	42.54	40.81	-1.73	41.05	-1.49	41.39	-1.15	NO VALUE DETERM			
BEAR CREEK	103	254 + 20	44.30	40.81	-3.49	41.05	-3.25	41.39	-2.91	$107,130.00	$0	$0	$0
BEAR TRIB 1	98-A	47 + 99	59.01	55.85	-3.16	56.34	-2.67	57.04	-1.97	NO VALUE DETERM			
BEAR TRIB 1	99	48 + 25	58.33	55.86	-2.47	56.35	-1.98	57.05	-1.28	$53,740.00	$0	$0	$0
BEAR TRIB 1	98	48 + 50	60.05	55.87	-4.18	56.36	-3.69	57.06	-2.99	$79,780.00	$0	$0	$0
											$0	$0	$0

Street Addresses of the Buildings Located in the 100-Year Floodplain

Structure ID	Address	Structure ID	Address
I-1	29 Ivanhoe Blvd., Orlando	I-2	1414 N. Orange Ave., Orlando
I-3	1303 N. Orange Ave., Orlando	I-4	1249 N. Orange Ave., Orlando
I-5	1235 N. Orange Ave., Orlando	I-6	1231 N. Orange Ave., Orlando
I-7	1224 N. Orange Ave., Orlando	I-8	1213 N. Orange Ave., Orlando
I-9	1211 N. Orange Ave., Orlando	I-10	1203 N. Orange Ave., Orlando
I-11	1199 N. Orange Ave., Orlando	I-12	1155 N. Orange Ave., Orlando
E-1	2906 Westchester Ave. Orlando	E-2	2900 Westchester Ave., Orlando
E-3	1100 Dorchester St., Orlando	E-4	1106 Dorchester St., Orlando
E-5	1112 Dorchester St., Orlando	E-6	1114 Dorchester St., Orlando
E-7	1122 Dorchester St., Orlando	E-8	1132 Dorchester St., Orlando
E-9	2810 Middlesex Rd., Orlando	E-10	2710 Middlesex Rd., Orlando
E-11	2700 Middlesex Rd., Orlando	E-12	2620 Middlesex Rd., Orlando
E-13	2610 Middlesex Rd., Orlando	E-14	2602 Middlesex Rd., Orlando
E-15	1301 Lakeshore Dr., Orlando	R-1	1395 Dolive Dr., Orlando
R-2	1410 Lakeshore Dr., Orlando	R-3	1416 Lakeshore Dr., Orlando
R-4	1500 Lakeshore Dr., Orlando	R-5	1516 Lakeshore Dr., Orlando
R-6	1524 Lakeshore Dr., Orlando	R-7	1532 Lakeshore Dr., Orlando
R-8	No structure located	R-9	1616 Lakeshore Dr., Orlando
R-10	1720 Lakeshore Dr., Orlando	R-11	1800 Lakeshore Dr., Orlando
R-12	1900 Lakeshore Dr., Orlando	R-13	1908 Lakeshore Dr., Orlando
R-14	1918 Lakeshore Dr., Orlando	R-15	1920 Lakeshore Dr., Orlando
R-16	1720 Lakeshore Dr., Orlando	W-1	818 Wilkinson St., Orlando
W-2	830 Wilkinson St., Orlando	S-1	3327 Lakeshore Dr., Orlando
S-2	1750 Barcelona Way, Orlando	S-3	245 Salvador Sq., Orlando
S-5	2115 Lakeside Ave., Orlando	S-6	1955 Lakeside Dr., Orlando
S-7	1935 Lakeside Dr., Orlando	S-8	1925 Lakeside Dr., Orlando
S-9	1919 Lakeside Dr., Orlando	S-10	1915 Lakeside Dr., Orlando
S-11	1911 Lakeside Dr., Orlando	S-12	1907 Lakeside Dr., Orlando
S-13	2403 Lake Shore Dr., Orlando	S-14	2411 Lake Shore Dr., Orlando
S-15	2501 Lake Shore Dr., Orlando	S-16	2627 Rose Isle Circle, Orlando
S-17	2643 Lake Shore Dr., Orlando	S-18	2655 Lake Shore Dr., Orlando
S-19	2659 Lake Shore Dr., Orlando	S-20	2667 Lake Shore Dr., Orlando
S-21	2675 Lake Shore Dr., Orlando	1	250 Sterling Ave., Winter Park
2	1481 Glencor Rd., Winter Park	3	900 Audubon Lane, Winter Park

Structure ID	Address	Structure ID	Address
4	999 Genius Dr., Winter Park	5	935 Green Tree Dr., Winter Park
6	401 Lakewood Dr., Winter Park	7	400 Lakewood Dr., Winter Park
8	1795 Killarney Dr., Winter Park	9	1791 Killarney Dr., Winter Park
10	1785 Killarney Dr., Winter Park	11	1781 Killarney Dr., Winter Park
12	1777 Killarney Dr., Winter Park	13	1771 Killarney Dr., Winter Park
14	336 Blue Heron Dr., Winter Park	15	338 Blue Heron Dr., Winter Park
16	405 Kilshore Lane, Winter Park	17	211 Rippling Lane, Winter Park
18	1800 Boitnott Lane, Winter Park	19	1800 Lee Road, Winter Park
20	1800 Lee Road, Winter Park	21	1800 Lee Road, Winter Park
22	1708-1720 Lee Road, Winter Park	23	638 Country Club Dr., Winter Park
24	571 Lakefront Blvd., Winter Park	25	565 Lakefront Blvd., Winter Park
26	531 Lakefront Blvd., Winter Park	27	515 Lakefront Blvd., Winter Park
28	505 Lakefront Blvd., Winter Park	29	465 Lakefront Blvd., Winter Park
30	455 Lakefront Blvd., Winter Park	31	1500 Gay Road, Winter Park
32	1500 Gay Road, Winter Park	33	1500 Gay Road, Winter Park
34	2403 Buston Rd., Winter Park	35	500 Lake Ave., Maitland
36	660 Lake Ave., Maitland	37	680 Lake Ave., Maitland
38	700 Lake Ave., Maitland	39	175 Gem Lake Dr., Maitland
40	Twin Lake Apartments, Maitland	41	Twin Lake Apts. Club House
42	Twin Lake Apartments, Maitland	43	Twin Lake Apartments, Maitland
44	Twin Lake Apartments, Maitland	45	Twin Lake Apartments, Maitland
46	Twin Lake Apartments, Maitland	47	440 Minnehaha Rd., Maitland
48	608 Minnehaha Rd., Maitland	49	606 Minnehaha Rd., Maitland
50	Minnehaha Park Boy Scout Lodge, Maitland	51	180 Minnehaha Lane, Maitland
52	129 White Cap Circle, Maitland	53	2040 Summerland Ave., Winter Park
54	2020 Summerland Ave., Winter Park	55	1860 Summerland Ave., Winter Park
56	1800 Summerland Ave., Winter Park	57	1800 Summerland Ave., Winter Park
58	621 Gains Way, Winter Park	59	600 Gains Way, Winter Park
60	1760 Gains Way, Winter Park	61	#3 Isle of Sicily, Winter Park
62	#11 Isle of Sicily, Winter Park	63	#9 Isle of Sicily, Winter Park
64	#10 Isle of Sicily, Winter Park	65	2190 Venetian Way, Winter Park
66	112 Poinciana Lane, Winter Park	67	2110 Venetian Way, Winter Park
68	Structure Removed	69	1827 Venetian Way, Winter Park
70	1600 Venetian Way, Winter Park	71	1300 Venetian Way, Winter Park
71	1300 Venetian Way, Winter Park	72	1250 Venetian Way, Winter Park
73	680 Via Lugano, Winter Park	74	No Structure in this Area

Structure ID	Address	Structure ID	Address
75	2001 Cove Trail, Maitland	76	2009 Cove Trail, Maitland
77	2908 Cove Trail, Maitland	78	2900 Cove Trail, Maitland
79	2955 Temple Dr., Maitland	80	3011 Temple Trail, Maitland
81	193 Lago Vista Blvd., Casselberry	82	170 Lago Vista Blvd., Casselberry
83	203 Lago Vista Blvd., Casselberry	84	184 Lago Vista Blvd., Casselberry
85	No Structure in this Area	86	2580 Lake Howell Ln., Winter Park
87	2584 Lake Howell Ln., Winter Park	88	Abandoned House
89	2622 Lake Howell Ln., Winter Park	89A	2644 Lake Howell Ln., Winter Park
90	2652 Lake Howell Ln., Winter Park	91	2654 Lake Howell Ln., Winter Park
92	2652 Lake Howell Ln., Winter Park	92A	2714 Lake Howell Ln., Winter Park
93	2732 Lake Howell Ln., Winter Park	94	2740 Lake Howell Ln., Winter Park
95	2740 Lake Howell Ln., Winter Park	95A	2744 Lake Howell Ln., Winter Park
96	2752 Lake Howell Ln., Winter Park	97	2611 Technology Dr., Orlando
98	Rt. 1, Box 49, Dodd Rd., Winter Park	98A	1560 Dodd Road, Winter Park
99	P.O. Box 1026, Orlando	100	1535 Brooks Lane, Oviedo
100A	1501 Brooks Lane, Oviedo	102	1432 Brooks Lane, Oviedo
103	4995 Double R Lane, Oviedo	104	5010 Double R Lane, Casselberry
105	5100 Double R Lane, Casselberry	106	5100 Double R Lane, Casselberry
107	5175 Double R Lane, Oviedo	108	5200 Double R Lane, Oviedo
109	5175 Double R Lane, Oviedo	110	5200 Double R Lane, Oviedo

Appendix C—Cost Estimates of Various Flood Protection Alternatives

GENERAL

The formula for converting present worth into annual values over a period of time is as follows.

$$CRF = \frac{C}{P} = \frac{i\,(1 + i)^n}{(1 + i)^n - 1}$$

With i = 8% interest and n = 50 years, the capital recovery factor (CRF) is calculated as: CRF = 0.081743.

If p = the present cost of flood protection alternative, that is, the improvements, the annual cost of improvements (C) is given by $C = P \times 0.081743$.

COST OF IMP3

Cost of the improvements are estimated as lump sums

Expansion of Lake Sue outlet culvert	$ 3,000
Dredging	900
Modify Lake Ivanhoe weir and provide control	6,100
Total	$ 10,000

COST OF IMP5

Earth work (5,530 cubic yards [yd^3] @ $3.50/$yd^3$)	$ 19,360
Seeding (lump sum)	2,000
Contingencies	2,140
Total	$ 23,500

COST OF IMP6A, IMP6B, AND IMP6C

Add two 4- x 8-ft box culverts to U.S. 17/92 bridge	$ 97,200
Channel dredging between Park Lake and Lake Maitland	4,100
Replace four 48-in.-diameter pipes with two 8- x 8-ft-boxes	104,500
Total	$205,800

APPENDIX D—WATER QUALITY DATA

STATION: HB20 LOCATION: Lake Ivanhoe SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEP M	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB20	06/30/83	745		0.5			7.9	77.00	0.011	0.022	
HB20	01/28/85	825	13.0	0.5	9.8						
HB20	02/25/85	835	18.0	0.5	9.4						
HB20	03/04/85	800	20.5	0.5	9.0						
HB20	04/22/85	845	24.0	0.5	7.4						
HB20	06/10/85	825	30.0	0.5	4.8						
HB20	08/19/85	925	29.0	0.5	4.0						
HB20	09/23/85	900	27.0	0.5	8.2						
HB20	10/07/85	905	26.0	0.5	5.4						
HB20	11/25/85	820	23.0	0.5	7.4						
HB20	12/16/85	850	16.0	0.5	7.2						
HB20	02/04/86	740	15.0	0.5	8.4	4.30	7.5	7.10	0.018		0.030
HB20	04/02/86	800	21.0	0.5		4.80	8.3	88.20	0.008		0.040
HB20	07/01/86	750	28.5	0.5	6.7	5.50	8.6	54.60	0.014		0.045
HB20	10/07/86	920	29.0	0.5	5.9	3.10	7.6	37.50	0.005		0.036
HB20	02/03/87	750	15.0	0.5	8.0		7.8	73.80	0.012		0.042
HB20	03/31/87	815	19.0	0.5	7.7	2.70	7.8	73.90			
HB20	06/30/87	900	27.0	0.5	8.7		8.9	69.90	0.020	0.020	0.020
HB20	01/26/88	1000	14.0	0.5	10.4	1.60	7.7	83.20	0.020		0.032
HB20	07/25/88	1040	29.3	0.5	5.9	4.50	6.9	38.90	0.023	0.020	0.051
HB20	10/18/88	1036	23.6	0.5		5.20	8.0	62.10	0.014	0.003	0.052
	AVG.		22.4	0.5	7.5	3.96	7.9	60.56	0.015	0.016	0.039

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB20	06/30/83	0.040		0.040			1.680		220.0				
HB20	01/28/85												
HB20	02/25/85												
HB20	03/04/85												
HB20	04/22/85												
HB20	06/10/85												
HB20	08/19/85												
HB20	09/23/85												
HB20	10/07/85												
HB20	11/25/85												
HB20	12/16/85												
HB20	02/04/86	0.040		0.040	0.090	0.510	0.600	0.600	215.0		116.0	2.40	0.60
HB20	04/02/86	0.040		0.040	0.070	0.740	0.810	0.810	190.0		106.0	2.50	1.10
HB20	07/01/86	0.040		0.040	0.050	1.250	1.250	1.250	190.0		123.0	4.30	0.70
HB20	10/07/86	0.040		0.040	0.070	0.680	0.750	0.750	175.0		150.0	3.00	
HB20	02/03/87	0.070		0.070	0.090	0.540	0.700	0.630	235.0			1.60	2.20
HB20	03/31/87	0.068	0.010	0.058	0.040	0.506	0.564	0.506	220.0		121.0	2.00	0.80
HB20	06/30/87	0.048	0.010	0.038					220.0		111.0	3.60	1.00
HB20	01/26/88	0.026		0.026	0.040	0.429	0.455	0.429	330.0		133.0	2.10	2.40
HB20	07/25/88	0.031	0.010	0.021	0.040	0.583	0.604	0.583	180.0		122.0	3.30	0.90
HB20	10/18/88	0.062	0.010	0.052	0.040	0.363	0.455	0.403	245.0		138.0	4.60	
	AVG.	0.046	0.010	0.042	0.059	0.622	0.787	0.662	220.0		124.4	2.94	1.21

STATION: HB20—*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB20	06/30/83												
HB20	01/28/85	10.00	40.00	4.20	2.70	50.0	40.0	10.0	5.0	5.0	40.0	1.0	50.0
HB20	02/25/85	7.50	34.00	4.20	2.70	310.0	20.0	10.0	40.0	5.0	40.0	10.0	50.0
HB20	03/04/85	7.50	31.00	4.40	2.40	50.0	20.0	10.0	20.0	5.0	40.0	10.0	50.0
HB20	04/22/85	8.10	35.00	4.20	2.30	50.0	20.0	10.0	5.0	5.0	40.0	10.0	50.0
HB20	06/10/85	8.00	24.00	3.80	2.50	20.0	10.0	10.0	10.0	10.0	20.0	20.0	20.0
HB20	08/19/85					5.0	5.0		15.0	10.0	59.0	60.0	
HB20	09/23/85					8.0	8.0		33.0	10.0	124.0	89.0	
HB20	10/07/85					36.0	4.0		6.0	10.0	26.0	88.0	
HB20	11/25/85			5.15	4.76	10.0	11.0		10.0	6.0	5.0	10.0	27.0
HB20	12/16/85			3.22	4.46	50.0	1.0		27.0	1.0	7.0	12.0	7.0
HB20	02/04/86	9.70	24.16	3.12	6.88	18.0	8.0		18.0	23.0	32.0	2.0	6.0
HB20	04/02/86					110.0	48.0		8.0	3.0	97.0	9.0	7.0
HB20	07/01/86	8.72	20.66	3.60	2.38	110.0	42.0		8.0	3.0	97.0	9.0	7.0
HB20	10/07/86	7.40	17.60	3.49		27.0	5.0		7.0	1.0	120.0	14.0	16.0
HB20	02/03/87	7.50	28.56	3.19	2.14	17.0							
HB20	03/31/87												
HB20	06/30/87	5.79	17.93	5.76	2.10	28.0	24.0	83.0	34.0	1.0	1.0	5.0	17.0
HB20	01/26/88	5.52	25.41	3.80	1.87	19.0	19.0	1.0	11.0	2.0	21.0	7.0	36.0
HB20	07/25/88	7.96	14.21	3.96	1.73	70.0	21.0	10.0	341.0	11.0	78.0	17.0	7.0
HB20	10/18/88	6.81	27.42	3.84	1.61	3.0	17.0	30.0	1.0	10.0	25.0	20.0	8.0
	AVG.	7.73	26.15	4.00	2.90	52.2	17.9	19.3	33.3	6.7	48.4	21.8	23.9

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB20	06/30/83		20	25.07	2.71	26.72	8.60	0.00
HB20	01/28/85		14					
HB20	02/25/85		10					
HB20	03/04/85		12					
HB20	04/22/85		10					
HB20	06/10/85		10					
HB20	08/19/85		17					
HB20	09/23/85		26					
HB20	10/07/85							
HB20	11/25/85	40	20					
HB20	12/16/85		44					
HB20	02/04/86	20	20	10.20	5.30	13.40	0.80	4.70
HB20	04/02/86		20	14.30	1.70	15.50	0.20	1.80
HB20	07/01/86	20	20	11.40	21.40	23.00	13.20	9.30
HB20	10/07/86	20	20	32.70	1.90	34.30	0.60	1.10
HB20	02/03/87	20		11.00	3.20	13.10	0.30	0.70
HB20	03/31/87	160	122	15.90	3.70	18.20	1.10	2.60
HB20	06/30/87	54		40.10	4.10	43.00	1.80	4.90
HB20	01/26/88	94	66	12.80	4.00	15.20	1.70	1.50
HB20	07/25/88	264	220	28.70	3.30	30.80	3.30	9.90
HB20	10/18/88	102	18	56.10	6.70	60.50	6.00	0.00
	AVG.	72	38	23.48	5.27	26.70	3.42	3.32

STATION: HB21 LOCATION: Lake Killarney SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEP M	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB21	09/19/83	10:50	29.0	0.5	5.4		8.1	83.0	0.034		0.011
HB21	12/06/83	08:45	23.0	0.5	9.8	3.10	7.8	84.0	0.020		0.035
HB21	01/24/84	08:05	15.0	0.5	9.4	3.40	7.9	74.0	0.011		0.046
HB21	04/25/84	09:20	24.0	0.5	8.1	2.60			0.018		0.056
HB21	07/24/84	10:00	28.0	0.5	6.5	2.50	7.8	66.0	0.016		0.046
HB21	10/24/84	08:50	25.5	0.5	5.8	2.20	7.7	88.0	0.033		0.071
HB21	01/30/85	09:40	13.0	0.5	10.8	3.30	7.9	71.9	0.023		0.036
HB21	05/07/85	08:00	24.0	0.5	7.2	4.00	7.9	77.2	0.012		0.036
HB21	09/24/85	09:35	27.5	0.5	10.0	4.90	8.4	59.0	0.025		0.036
HB21	11/19/85	08:05	23.0	0.5	8.1	2.90	7.8	58.8	0.008		0.035
HB21	02/04/86	08:45	16.0	0.5	9.0	3.40	7.4	64.0	0.009		0.065
HB21	04/02/86	08:40	21.5	0.5		3.10	8.1	78.4	0.008		0.042
HB21	07/01/86	08:25	24.0	0.5	7.9	4.00	8.3	56.7	0.025		0.042
HB21	10/07/86	07:40	29.0	0.5	6.0	3.10	7.2	38.9	0.007		0.040
HB21	02/03/87	08:20	14.5	0.5	9.4		7.8	59.0	0.017		0.040
HB21	03/31/87	09:00	17.0	0.5	7.5	2.30	7.7	55.0			
HB21	06/30/87	10:00	28.0	0.5	8.2		8.1	60.0	0.020	0.020	0.020
HB21	10/05/87	11:00	25.0	0.5		4.20	7.9	62.0	0.029	0.020	0.037
HB21	03/28/89	09:20	23.9	0.5	7.8	3.00	7.0	60.0	0.009	0.001	0.043
HB21	04/25/89	09:05	24.9	0.5	9.5	3.20	8.6	69.0	0.004	0.001	0.033
HB21	07/31/89	08:16	29.1	0.5	7.2	2.90	7.5	57.0	0.006	0.001	0.026
HB21	10/23/89	09:05	22.5	0.5	8.8	4.30	7.5	72.0	0.014	0.001	0.024
	AVG.		23.1	0.5	8.1	3.28	7.8	66.4	0.017	0.007	0.039

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB21	09/19/83	0.040		0.040	0.070	0.470	0.540	0.540	200		137	1.80	0.80
HB21	12/06/83	0.040		0.040	0.050	0.760	0.850	0.810	230		124	1.90	1.00
HB21	01/24/84	0.040		0.040	0.050	0.940	1.030	0.990	260		146	3.00	1.20
HB21	04/25/84	0.040		0.040	0.130	0.290	0.460	0.420	250		135	2.00	1.00
HB21	07/24/84	0.040		0.040	0.160	0.680	0.840	0.840	220		159	1.50	1.40
HB21	10/24/84	0.040		0.040	0.060	0.300	0.360	0.360	200		140	2.20	1.00
HB21	01/30/85	0.040		0.040	0.050	0.520	0.520	0.520	215		153	2.00	1.00
HB21	05/07/85	0.040		0.040	0.050	0.870	0.870	0.870	205		127	2.30	1.20
HB21	09/24/85	0.040		0.040	0.140	0.850	0.990	0.990	180		139	2.50	0.70
HB21	11/19/85	0.040		0.040	0.210	0.900	1.110	1.110	190		124	2.30	0.70
HB21	02/04/86	0.160		0.160	0.110	0.610	0.880	0.720	200		107	2.10	1.20
HB21	04/02/86	0.040		0.040	0.110	0.550	0.660	0.660	200		102	2.00	1.40
HB21	07/01/86	0.040		0.040	0.420	0.660	1.080	1.080	185		116	2.70	0.90
HB21	10/07/86	0.040		0.040	0.050	0.540	0.540	0.540	170		144	2.40	
HB21	02/03/87	0.040		0.040	0.140	0.550	0.690	0.690	210			3.00	1.10
HB21	03/31/87	0.061	0.010	0.051	0.040	0.678	0.729	0.678	195		114	2.60	0.90
HB21	06/30/87	0.030	0.010	0.020					225		112	1.20	1.50
HB21	10/05/87	0.034	0.010	0.024	0.040	0.800	0.824	0.800	190		130	2.30	0.90
HB21	03/28/89	0.020	0.010	0.010	0.025	0.713	0.738	0.738	781		131	1.90	1.50
HB21	04/25/89	0.020	0.010	0.010	0.547		0.368	0.368	225		126	1.60	1.50
HB21	07/31/89	0.032	0.010	0.022	0.032	1.134	1.188	1.166	295		133	2.20	1.20
HB21	10/23/89	0.020	0.010	0.010	0.022	1.093	1.115	1.115	195		144	3.30	1.00
	AVG.	0.043	0.010	0.039	0.119	0.695	0.780	0.762	237		131	2.22	1.10

STATION: HB21—*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB21	09/19/83	11.00	28.00	4.30	2.40	50	20		5	5	40	10	50
HB21	12/06/83	10.00	35.00	4.20	2.20	50	20		5	5	40	10	50
HB21	01/24/84	9.00	25.00	4.20	2.20	50	20		5	5	40	10	50
HB21	04/25/84	9.62	34.20	4.60	2.49	50	20		5	5	40	10	50
HB21	07/24/84		35.00	4.70		50	20		5	10	40	10	50
HB21	10/24/84	10.10	39.50	4.10	1.30	50	20		5	5	40	10	50
HB21	01/30/85	9.70	32.00	4.80	2.30	50	20		5	5	40	10	50
HB21	05/07/85	12.20	26.00	6.20	1.40	50	20		5	5	40	10	50
HB21	09/24/85												
HB21	11/19/85	20.00			4.50	57	16		49	6	2	16	
HB21	02/04/86	12.02	20.80	3.81	4.20	22	31		29	24	50	8	6
HB21	04/02/86	6.40	24.56	3.18	4.06	89	52		4	17	25	2	48
HB21	07/01/86	9.32	17.62	4.29	2.29	56	7		1	1	76	8	7
HB21	10/07/86	3.86	17.06	4.10		21	1		9	1	73	11	14
HB21	02/03/87	8.68	22.08	3.67	1.74	22							
HB21	03/31/87												
HB21	06/30/87	7.62	19.72	4.86	2.15	30	23	54	25	1	1	6	11
HB21	10/05/87	8.26	20.01	4.12	2.04	10	21	87	60	19	1	7	42
HB21	03/28/89	8.18	21.68	4.13	1.99	50	32	5	69	5	46	7	5
HB21	04/25/89												
HB21	07/31/89												
HB21	10/23/89												
	AVG.	9.75	26.14	4.33	2.48	45	21	49	18	7	37	9	36

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB21	09/19/83	160	20	18.50	12.50	25.40	8.70	0.00
HB21	12/06/83	20	20	16.90	0.00	16.70	3.40	0.00
HB21	01/24/84	160	20	22.30	2.10	23.30	5.60	0.00
HB21	04/25/84	20	13.30	0.00	8.20	1.10	0.00	
HB21	07/24/84	86	22	20.10	3.90	22.10	4.60	0.00
HB21	10/24/84	20	20	24.60	6.40	28.50	3.00	0.00
HB21	01/30/85	20	20	15.90	6.00	19.50	1.40	5.50
HB21	05/07/85	20	20	13.00	0.00	13.20	0.50	2.30
HB21	09/24/85	22	20	38.80	0.00	35.00	0.00	2.50
HB21	11/19/85	26	20	11.20	1.60	12.20	1.50	2.50
HB21	02/04/86		30	15.70	6.60	19.80	1.10	5.60
HB21	04/02/86	20	20	11.70	2.50	13.30	1.40	4.00
HB21	07/01/86	68	20	21.00	4.80	24.20	0.30	1.50
HB21	10/07/86	36	20	20.70	3.60	23.10	0.90	3.30
HB21	02/03/87	20		18.20	7.70	23.00	1.80	2.70
HB21	03/31/87	160	148	12.90	2.40	14.50	0.70	1.10
HB21	06/30/87	8		14.20	3.30	16.50	0.00	4.40
HB21	10/05/87	116	22	39.70	2.20	41.50	1.30	14.10
HB21	03/28/89	2	6	9.20	2.40	10.60	1.60	6.00
HB21	04/25/89	14	2	8.80	1.60	9.70	1.80	0.00
HB21	07/31/89		6	31.70	2.80	33.40	4.20	11.70
HB21	10/23/89							
	AVG.	52.5	25.1	18.97	3.45	20.65	2.14	3.20

STATION: HB24 LOCATION: Lake Maitland SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEP M	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB24	02/19/80	840	12.0	0.5	7.7	1.30	7.6	73.00	0.030		0.030
HB24	05/20/80	840		0.5	7.8	1.30	7.8	6.90	0.040		0.020
HB24	08/19/80	845	30.0	0.5	7.8	1.90	8.1	69.00	0.050		0.040
HB24	11/17/80	845	22.5	0.5	7.3	2.00	7.2	65.00	0.000		0.040
HB24	03/10/81	900	18.5	0.5	8.9	0.30	7.8	63.00	0.020		0.020
HB24	06/02/81	940	27.5	0.5	8.8	2.90	7.8	64.00	0.020		0.040
HB24	09/15/81	948	29.0	0.5	5.4	1.20	7.1	55.00	0.050		0.050
HB24	12/14/81	930	15.0	0.5	8.6	1.60	7.4	54.00	0.021		0.064
HB24	02/16/82	920	20.0	0.5	8.3	2.10	7.3	52.00			
HB24	05/18/82	850	27.0	0.5	7.8	1.20	8.1	48.00	0.034		0.040
HB24	08/17/82	900	30.0	0.5	7.2	2.70	6.6	44.00	0.008		0.032
HB24	11/16/82	845	19.0	0.5	7.9	2.50	6.6	44.00	0.008		0.039
HB24	03/20/84	934	20.0	0.5	9.1	1.00	7.8	52.80	0.015		0.023
HB24	06/27/84	955	30.0	0.5	6.9	1.50	7.8	66.00	0.013		0.024
HB24	09/26/84	915	27.0	0.5	7.4	3.00	8.0	62.00	0.010		0.040
HB24	12/05/84	900	20.5	0.5	9.2	2.80	7.9	60.00	0.033		0.043
HB24	01/28/85	1000	12.5	0.5	10.0						
HB24	02/11/85	910	16.0	0.5	9.4						
HB24	03/05/85	855	21.5	0.5	8.4	2.40	7.9	62.00	0.008		0.042

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB24	02/19/80	0.210		0.210	0.120	0.540	0.870	0.660	240.0	19.00	195.0	1.10	2.10
HB24	05/20/80	0.110		0.110	0.050	0.660	0.760	0.710		21.00			
HB24	08/19/80	0.010		0.010	0.070	1.130	1.210	1.200	230.0	20.00	89.0	2.10	1.20
HB24	11/17/80	0.040		0.040	0.140	0.700	0.880	0.840	292.0	22.00	153.0	1.70	1.60
HB24	03/10/81	0.030		0.030	0.070	0.930	1.000	1.000	270.0	23.00	344.0	2.90	1.50
HB24	06/02/81	0.010		0.010	0.130	0.460	0.600	0.590	245.0	25.00	158.0	2.00	1.70
HB24	09/15/81	0.040		0.040	0.110	0.580	0.700	0.690	295.0			2.00	1.40
HB24	12/14/81							0.690	230.0		95.0	2.00	1.60
HB24	02/16/82	0.040		0.040	0.290	1.100	1.400	1.400	240.0		137.0	2.30	1.80
HB24	05/18/82	0.040		0.040	0.510	0.890	1.400	1.400	220.0		119.0		2.60
HB24	08/17/82	0.040		0.040	0.080	0.520	0.600	0.600	210.0		135.0	2.70	1.20
HB24	11/16/82	0.040		0.040	0.130	0.740	0.870	0.870	210.0		141.0	2.30	1.40
HB24	03/20/84	0.040		0.040	0.110	0.520	0.630	0.630	190.0		130.0	0.40	3.00
HB24	06/27/84	0.040		0.040	0.050	0.610	0.660	0.660			123.0	1.00	2.10
HB24	09/26/84	0.040		0.040	0.060	1.230	1.290	1.290	215.0		98.0	2.60	0.90
HB24	12/05/84	0.040		0.040	0.070	0.980	1.050	1.050	210.0		133.0	2.10	1.10
HB24	01/28/85												
HB24	02/11/85												
HB24	03/05/85	0.050		0.050	0.280	0.530	0.860	0.810	220.0		123.0	2.50	1.20

STATION: HB24—*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB24	02/19/80	9.90	35.00	3.90	4.20	100.00	10.00						
HB24	05/20/80	9.90	0.31	4.20	4.20	50.00	10.00						
HB24	08/19/80	10.00	27.00	3.60	3.80	50.00	10.00						
HB24	11/17/80	10.00	26.00	4.30	4.20	50.00	10.00						
HB24	03/10/81	11.00	30.00	4.50	4.00	50.00	1.00						
HB24	06/02/81	12.00	38.00	4.70	4.80	50.00	10.00						
HB24	09/15/81												
HB24	12/14/81	11.00	24.00	4.80	4.40	50.00	20.00	100.0	5.0	5.0	40.0	10.0	50.0
HB24	02/16/82												
HB24	05/18/82	11.00	35.00	4.60	3.80	50.00	20.00		5.0	5.0	40.0	10.0	50.0
HB24	08/17/82	12.00	24.00	4.50	3.60	50.00	20.00		5.0	5.0	40.0	10.0	50.0
HB24	11/16/82	9.00	34.00	5.00	2.40	50.00	20.00		5.0	5.0	40.0	10.0	
HB24	03/20/84	10.10	21.40	3.70	2.80	50.00	20.00		10.0	5.0	40.0	10.0	50.0
HB24	06/27/84	10.20	31.00	4.70	3.70	50.00	20.00		5.0	5.0	40.0	10.0	50.0
HB24	09/26/84	8.70	27.00	4.20	3.20	50.00	20.00		5.0	5.0	40.0	30.0	50.0
HB24	12/05/84	8.90	32.40	3.90	3.80	50.00	20.00		5.0	5.0	40.0	30.0	50.0
HB24	01/28/85	8.70	33.00	4.20	3.50	50.00	40.00	10.0	5.0	5.0	4.0	10.0	50.0
HB24	02/11/85	10.20	27.00	4.00	3.60	50.00	20.00	10.0	5.0	5.0	50.0	10.0	50.0
HB24	03/05/85	10.00	36.00	4.20	3.80	50.00	20.00	10.0	20.0	5.0	40.0	10.0	50.0
HB24	04/15/85	10.00	33.00	4.20	3.70	50.00	20.00	10.0	5.0	5.0	40.0	10.0	50.0
HB24	05/20/85	10.00	29.00	4.20	3.90	50.00	20.00	10.0	5.0	5.0	40.0	10.0	50.0
HB24	06/12/85												
HB24	07/22/85	8.64	17.60	3.78	3.29	40.00	10.00	10.0	10.0	10.0	20.0	10.0	20.0
HB24	08/12/85					21.00	17.00		37.0	0.4	17.0	52.0	
HB24	09/25/85					16.00	2.00		0.6	10.0	37.0	85.0	
HB24	10/14/85												
HB24	12/11/85				5.80	16.00	16.00		6.0	1.0	9.0	2.0	3.0
HB24	03/19/86	11.33	19.71	3.33	2.28	28.00	25.00		3.0	7.0	19.0	2.0	35.0
HB24	06/10/86	9.38	16.48	4.26	2.73	34.00	5.00		1.0	7.0	10.0	6.0	3.0
HB24	09/09/86	5.62	17.28	3.22	2.82	40.00	10.00		1.0	57.0	46.0	26.0	10.0
HB24	12/09/86	8.36	18.38	3.55	2.03		1.00	10.0	1.0		15.0	1.0	1.0
HB24	03/25/87												
HB24	06/09/87	8.25	13.49	3.79	2.78	35.00	15.00	53.0	42.0	28.0	32.0	15.0	21.0
HB24	07/29/87												
HB24	08/31/87	8.15	17.41	3.92	2.83	4.00	1.00	26.0	14.0	44.0	1.0	14.0	5.0
HB24	01/26/88	6.72	16.47	3.53	2.53	18.00	15.00	1.0	20.0	2.0	14.0	8.0	38.0
HB24	07/25/88	7.49	12.76	3.78	2.24	65.00	16.00	70.0	36.0	11.0	84.0	16.0	8.0
HB24	10/18/88	4.72	19.94	3.67	1.98	1.00	24.00	110.0	16.0	3.0	28.0	13.0	12.0
	AVG.	9.35	24.57	4.08	3.42	42.52	15.25	33.1	10.5	9.8	31.8	16.2	32.9

STATION: HB24—*Continued*

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB24	02/19/80	20	10	2.27	6.19	5.57	3.82	0.00
HB24	05/20/80	20	20	7.69	1.39	8.34	2.86	1.30
HB24	08/19/80	20	20	25.40	0.00	24.61	5.68	5.84
HB24	11/17/80	20	20					
HB24	03/10/81	20	20	15.98	2.43	17.49	1.78	3.16
HB24	06/02/81	20	20	6.41	5.70	9.80	1.25	0.40
HB24	09/15/81	20	20	10.77	1.25	11.55	1.48	0.00
HB24	12/14/81	20	20					
HB24	02/16/82	20	20	2.95	3.07	4.78	0.34	0.00
HB24	05/18/82	20	20	2.79	0.58	3.07	1.09	0.00
HB24	08/17/82	48	20	16.21	4.66	18.53	5.77	5.40
HB24	11/16/82	20	20	14.43	1.66	15.56	0.38	2.55
HB24	03/20/84	20	20	0.50	0.00		0.30	0.00
HB24	06/27/84	20	40	5.30	3.10	6.90	3.20	0.00
HB24	09/26/84	20	20	34.60	5.50	37.90	5.10	0.00
HB24	12/05/84	20	20					
HB24	01/28/85		10					
HB24	02/11/85		10					
HB24	03/05/85	20	20	11.40	0.00	11.20	0.40	0.60
HB24	04/15/85		10					
HB24	05/20/85		10					
HB24	06/12/85	20	20	20.80	4.10	23.20	3.50	1.90
HB24	07/22/85		26					
HB24	08/12/85		45					
HB24	09/25/85	20	20	14.30	3.00	16.20	0.90	3.10
HB24	10/14/85		10					
HB24	12/11/85	30	20	17.40	3.20	19.50	1.00	0.00
HB24	03/19/86	20	20	3.30	1.30	4.10	0.40	1.60
HB24	06/10/86	20	20	3.80	0.00	3.50	0.80	0.00
HB24	09/09/86	160	90	30.20	30.50	32.70	0.70	1.50
HB24	12/09/86	20	20	18.30	10.20	24.40	2.50	2.60
HB24	03/25/87	114	20	8.40	8.50	13.40	1.30	1.80
HB24	06/09/87	2	2	32.40	0.10	33.00	0.00	6.40
HB24	07/29/87							
HB24	08/31/87	36	8	11.80	0.60	12.30	0.60	5.30
HB24	01/26/88	76	14	11.00	2.00	12.30	0.90	0.20
HB24	07/25/88	62	10	27.70	1.00	29.10	0.00	1.90
HB24	10/18/88	18	6	20.80	2.90	22.50	3.30	0.00
	AVG.	32	20	13.96	3.81	16.21	1.83	1.69

STATION: HB26 LOCATION: Lake Minnehaha SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEP M	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB26	02/19/80	855	12.0	0.5	8.5	2.60	7.7	61.00	0.070		0.070
HB26	05/20/80	1010	27.0	0.5	6.4	0.80	7.8	59.00	0.070		0.080
HB26	08/19/80	900	30.0	0.5	7.3	3.90	7.9	61.00	0.030		0.060
HB26	11/17/80	910	22.5	0.5	7.8	2.60	7.1	61.00	0.010		0.050
HB26	03/10/81	925	19.0	0.5	7.7	0.40	7.8	57.00	0.020		0.020
HB26	09/15/81	935	29.0	0.5	6.8	2.40	7.4	52.00			0.070
HB26	12/14/81	950	15.0	0.5	8.5	2.50	7.0	52.00	0.015		0.051
HB26	02/16/82	940	20.0	0.5	8.2	2.50	7.5	51.00			
HB26	05/18/82	900	26.5	0.5	8.5	2.90	8.3	49.00	0.034		0.034
HB26	08/17/82	945	30.0	0.5	6.8	4.80	6.3	48.00	0.006		0.029
HB26	11/16/82	905	20.0	0.5	6.8	1.70	6.5	49.00	0.012		0.024
HB26	03/20/84	930	20.0	0.5	9.1	1.60	8.1	53.90	0.026		
HB26	06/27/84	1020	29.0	0.5	6.3	2.40	8.2	76.60	0.028		0.036
HB26	09/26/84	940	22.0	0.5	7.4	3.60	8.1	63.00	0.016		0.053
HB26	12/05/84	910	21.0	0.5	8.8	2.40	7.9	60.00	0.031		0.040
HB26	03/05/85	830	22.0	0.5	8.0	4.70	7.9	58.80	0.019		0.040
HB26	06/12/85	930	30.0	0.5	6.0	3.50	8.3	57.50	0.015		0.056
HB26	09/25/85	1025	28.0	0.5	8.1	2.30	7.7	39.90	0.015		0.032
HB26	12/11/85	935	19.0	0.5	7.6	1.40	7.3	34.00	0.017		
HB26	03/19/86	950	22.0	0.5	8.6	2.10	7.0	32.00	0.022		0.051
HB26	06/10/86	915	30.0	0.5	8.4	4.80	8.1	33.20	0.016		0.046
HB26	09/09/86	835	29.0	0.5		1.20	7.1	33.10	0.015		0.044
HB26	03/25/87	1010	22.0	0.5	8.1	2.20	7.8		0.008		
HB26	06/09/87	950	27.0	0.5	9.3	3.20	8.1	43.30	0.039	0.020	0.038
HB26	08/31/87	1000	30.0	0.5	6.7	1.70	7.0	42.00	0.010	0.020	0.022
HB26	12/16/87	1000	18.6	0.5	9.6	2.00	7.1	39.60	0.020	0.020	0.035
HB26	01/26/88	908	14.2	0.5	9.7	0.90	7.5	42.10	0.020		0.034
HB26	07/25/88	900	29.0	0.5	7.4	2.00	6.4	37.80	0.020	0.020	0.031
HB26	10/18/88	854	22.9	0.5	7.9	3.10	6.7	48.20	0.015	0.003	0.038
	AVG.		23.7	0.5	7.9	2.49	7.5	49.82	0.023	0.017	0.043

STATION: HB26–*Continued*

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB26	02/19/80	0.320		0.320	0.120	0.860	1.300	0.980	230.0	19.00	179.0	2.10	1.40
HB26	05/20/80	0.140		0.140	0.050	0.920	1.110	0.970	210.0	21.00	194.0	3.00	1.20
HB26	08/19/80	0.010		0.010	0.210	1.500	1.720	1.710	205.0	21.00	90.0	4.30	0.80
HB26	11/17/80	0.010		0.010	0.080	0.610	0.700	0.690	270.0	23.00	148.0	0.10	1.30
HB26	03/10/81	0.010		0.010	0.050	0.710	0.770	0.760	264.0	24.00	146.0	1.60	1.20
HB26	09/15/81	0.020		0.020	0.080	1.000	1.300	1.100	233.0			2.60	1.00
HB26	12/14/81							0.750	230.0		72.0	2.10	2.00
HB26	02/16/82				0.160	0.940	1.100	1.100	220.0		179.0	3.00	1.10
HB26	05/18/82	0.040		0.040	0.070	0.470	0.580	0.540	210.0		108.0		1.20
HB26	08/17/82	0.040		0.040	0.090	1.500	1.600	1.600	220.0		144.0	1.50	1.80
HB26	11/16/82	0.040		0.040	0.120	0.720	0.840	0.840	210.0		144.0	1.00	3.60
HB26	03/20/84	0.040		0.040	0.380	0.310	0.690	0.690	200.0		123.0	0.40	3.00
HB26	06/27/84	0.040		0.040	0.050	1.260	1.260	1.260			159.0	1.00	2.40
HB26	09/26/84	0.040		0.040	0.070	1.020	1.140	1.140	210.0		100.0	2.00	0.90
HB26	12/05/84	0.040		0.040	0.090	0.980	0.870	0.870	220.0		113.0	1.50	0.50
HB26	03/05/85	0.040		0.040	0.140	0.640	0.780	0.780	220.0		115.0	1.70	1.80
HB26	06/12/85	0.040		0.040	0.090	0.660	0.750	0.750	215.0		154.0	2.70	1.20
HB26	09/25/85	0.090		0.090	0.050	0.870	0.870	0.870	170.0		109.0	1.00	
HB26	12/11/85	0.040		0.040	0.650		0.210	0.210	180.0		72.0	1.00	1.80
HB26	03/19/86	0.040		0.040	0.050	0.870	0.870	0.870	175.0		64.0	3.00	1.20
HB26	06/10/86	0.040		0.040	0.080	0.940	1.020	1.020	170.0		123.0	3.80	0.70
HB26	09/09/86	0.040		0.040	0.050	0.700	0.750	0.750	160.0		157.0	1.80	1.40
HB26	03/25/87	0.030	0.010	0.020	0.040		0.070	0.040	170.0	20.13	114.0	1.70	1.80
HB26	06/09/87	0.090	0.010	0.080	0.040	0.337	0.417	0.337	200.0		122.0	2.20	0.60
HB26	08/31/87	0.080	0.010	0.020	0.040	0.387	0.387	0.387	190.0	5.50	125.0	1.10	2.70
HB26	12/16/87	0.020	0.010	0.020	0.040	0.325	0.325	0.325	1.1	4.40	115.0	1.50	2.90
HB26	01/26/88	0.080	0.070	0.116	0.053	0.359	0.528	0.412	260.0	2.50	105.0	2.10	1.00
HB26	07/25/88	0.010	0.010	0.023	0.040	0.266	0.289	0.266	190.0	1.10	108.0	1.60	2.00
HB26	10/18/88	0.010	0.010	0.020	0.066	0.154	0.240	0.220	215.0	3.30	107.0	2.20	2.80
	AVG.	0.053	0.019	0.053	0.109	0.743	0.803	0.767	201.7	13.18	124.6	1.91	1.62

STATION: HB26–*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB26	02/19/80	9.60	30.00	3.30	4.60	50.0	10.0						
HB26	05/20/80	9.90	27.00	3.50	4.60	50.0	10.0						
HB26	08/19/80	10.00	25.00	3.10	4.20	50.0	10.0						
HB26	11/17/80	10.00	28.00	3.60	4.40	50.0	10.0						
HB26	03/10/81		28.00	3.60	4.40	50.0	10.0						
HB26	09/15/81												
HB26	12/14/81	11.00	16.00	3.90	4.60	50.0	20.0	100.0	10.0	5.0	40.0	10.0	50.0
HB26	02/16/82												
HB26	05/18/82	10.00	33.00	3.20	3.40	50.0	20.0		5.0	5.0	80.0	10.0	50.0
HB26	08/17/82	11.00	32.00	4.00	3.60	50.0	20.0		5.0	5.0	40.0	10.0	50.0
HB26	11/16/82	10.00	37.00	4.50	2.60	50.0	20.0		50.0	5.0	40.0	10.0	
HB26	03/20/84	10.30	21.40	2.88	3.70	50.0	20.0		20.0	5.0	40.0	10.0	52.0
HB26	06/27/84	10.50	301.00	3.90	5.60	50.0	20.0		5.0	5.0	40.0	70.0	50.0
HB26	09/26/84	8.30	31.00	3.20	3.80	50.0	20.0		5.0	5.0	40.0	50.0	50.0
HB26	12/05/84	8.90	34.40	3.30	4.20	50.0	20.0		5.0	5.0	40.0	60.0	50.0
HB26	03/05/85	10.00	37.00	3.60	4.20	50.0	20.0		20.0	5.0	41.0	10.0	50.0
HB26	06/12/85												
HB26	09/25/85												
HB26	12/11/85				6.75	12.0	15.0		1.0	1.0	6.0	2.0	3.0
HB26	03/19/86	11.14	11.98	3.07	3.15	33.0	16.0		2.0	5.0	11.0	2.0	32.0
HB26	06/10/86	9.88	15.10	3.36	3.57	71.0	15.0		5.0	6.0	14.0	8.0	3.0
HB26	09/09/86	6.46	13.82	2.60	2.74	47.0	6.0		1.0	49.0	35.0	27.0	14.0
HB26	03/25/87												
HB26	06/09/87	8.40	12.25	3.12	3.09	29.0	13.0	51.0	29.0	23.0	1.0	21.0	22.0
HB26	08/31/87	8.13	15.52	3.09	2.89	1.0	4.0	23.0	1.0		1.0	15.0	8.0
HB26	12/16/87	8.19	15.86	2.94	2.69	26.0	43.0	50.0	50.0	12.0	4.0	20.0	17.0
HB26	01/26/88	6.62	14.18	2.79	2.67	28.0	17.0	1.0	6.0	1.0	13.0	11.0	38.0
HB26	07/25/88	7.97	11.10	2.92	2.31	67.0	16.0	10.0	152.0	11.0	11.0	20.0	11.0
HB26	10/18/88	4.60	20.95	7.07	7.69	1.0	20.0	140.0	21.0	6.0	27.0	23.0	6.0
	AVG.	9.13	35.29	3.50	3.98	42.3	16.5	46.9	20.7	8.8	27.6	20.5	30.9

STATION: HB26—*Continued*

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB26	02/19/80	24	10	5.96	7.25	9.79	5.93	0.00
HB26	05/20/80		20	12.07	8.30	16.59	6.08	0.04
HB26	08/19/80	570	22	51.51	0.13	51.07	5.78	5.56
HB26	11/17/80		20					
HB26	03/10/81	100	22	12.02	3.54	14.07	2.48	0.93
HB26	09/15/81	26	20	20.12	3.06	22.03	2.32	2.73
HB26	12/14/81	20	20	4.36	9.68	10.17	0.43	0.00
HB26	02/16/82	30	20	17.18	0.00	15.39	0.00	0.00
HB26	05/18/82	20	20	12.57	0.00	12.16	1.28	1.32
HB26	08/17/82	20	20					
HB26	11/16/82	20	20	5.22	0.70	5.74	0.00	1.34
HB26	03/20/84	20	20	3.30	0.00	1.50	0.00	0.00
HB26	06/27/84	20	20					
HB26	09/26/84	20	20	22.20	21.40	34.80	5.80	0.00
HB26	12/05/84	20	20					
HB26	03/05/85	20	20	8.30	0.00	8.20	1.10	2.50
HB26	06/12/85	36	22					
HB26	09/25/85	20	20	13.10	0.00	12.90	0.80	2.90
HB26	12/11/85	20	20	7.40	2.90	9.10	1.10	1.60
HB26	03/19/86	20	20	22.40	3.10	24.50	0.60	2.60
HB26	06/10/86	40	20	22.10	3.70	24.40	2.50	0.00
HB26	09/09/86	160	60	15.30	5.00	17.90	1.40	1.10
HB26	03/25/87	50	20	1.00	4.90	3.90	0.30	0.00
HB26	06/09/87	4	1	14.90	2.90	16.90	0.00	3.20
HB26	08/31/87	18	14	10.10	1.70	11.20	0.60	0.90
HB26	12/16/87	80	52	10.30	4.90	13.20	1.00	5.60
HB26	01/26/88	160	74	7.90	2.90	9.70	0.90	0.00
HB26	07/25/88	70	10	4.50	2.80	16.20	1.90	5.10
HB26	10/18/88	28	2	23.60	2.60	25.20	3.60	0.00
	AVG.	61	22	13.64	3.81	16.11	1.91	1.56

STATION: HB32 LOCATION: Park Lake SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEP M	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB32	03/28/89	10:00	24.4	0.5	8.6	4.30	7.4	67.9	0.024	0.002	0.064
HB32	04/25/89	08:43	25.0	0.5	10.0	4.30	8.2	71.7	0.004	0.001	0.042
HB32	08/01/89	07:59	30.1	0.5	5.6	3.30	7.3	82.1	0.003	0.003	0.055
HB32	10/23/89	08:43	22.2	0.5	8.7	6.10	7.5	72.1	0.020	0.001	0.038
HB32	03/27/90	09:05	23.5	0.5	10.3	4.10	7.9	80.0	0.011	0.002	0.038
HB32	06/25/90	08:29	30.0	0.5	6.6	5.20	8.3	78.0	0.021	0.006	0.027
HB32	09/25/90	10:15	28.4	0.5	6.4	3.90	7.5	80.0	0.042	0.006	0.042
HB32	12/11/90			0.5							
	AVG.		26.2	0.5	8.0	4.5	7.7	76.0	0.018	0.003	0.044

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB32	03/28/89	0.020	0.010	0.010	0.030	0.792	0.822	0.822	237		134.0	2.4	1.0
HB32	04/25/89	0.020	0.010	0.010	0.045	0.908	0.953	0.953	240		134.5	2.7	1.0
HB32	08/01/89	0.026	0.010	0.016	0.017	0.901	0.934	0.918	286		147.5	3.0	0.8
HB32	10/23/89	0.020	0.010	0.010	0.128	1.555	1.693	1.683	194		151.0	4.0	0.8
HB32	03/27/90	0.020	0.010	0.010	0.040	0.775	0.815	0.815	237		154.5	1.8	0.8
HB32	06/25/90	0.024	0.010	0.014	0.074	0.174	0.262	0.248	248		149.5	2.1	0.9
HB32	09/25/90	0.023	0.010	0.013	0.083	0.819	0.915	0.902	229		146.0	3.3	0.8
HB32	12/11/90												
	AVG.	0.022	0.010	0.012	0.060	0.846	0.913	0.906	239		145.3	2.8	0.9

STATION: HB32—*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB32	03/28/89	6.63	25.13	3.39	2.65	50	15	5	97	5.0	50	19	5
HB32	04/25/89												
HB32	08/01/89												
HB32	10/23/89												
HB32	03/27/90												
HB32	06/25/90	7.76	26.40	5.30	3.02	30	10	1	10	0.1	40	30	1
HB32	09/25/90												
HB32	12/11/90												
	AVG.	7.20	25.77	4.35	2.84	40	13	3	54	2.6	45	25	3

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB32	03/28/89							
HB32	04/25/89							
HB32	08/01/89	72	18	30.0	10.2	36.2	3.8	0.0
HB32	10/23/89							
HB32	03/27/90		2	21.9	0.0	19.6	3.7	2.5
HB32	06/25/90	90	34	22.5	1.1	23.4	3.9	0.0
HB32	09/25/90	460	54	32.3	0.0	32.0	0.0	0.0
HB32	12/11/90	160	120	31.7	6.1	35.1	5.9	13.5
	AVG.	196	46	27.7	3.5	29.3	3.5	3.2

STATION: HB39 LOCATION: Lake Virginia SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB39	02/19/80	755	12.0	0.5	9.0	1.50	7.8	61.00	0.030		0.030
HB39	05/20/80	810	26.0	0.5	8.4	3.10	7.7	54.00	0.030		0.020
HB39	08/19/80	755	30.0	0.5	8.7	3.00	8.6	57.00	0.030		0.040
HB39	11/17/80	745	22.5	0.5	8.6	3.40	7.6	64.00	0.040		0.050
HB39	03/10/81	820	18.5	0.5	9.2	2.40	7.8	72.00	0.040		0.040
HB39	06/02/81	820	27.0	0.5	9.7	3.25	8.5	73.00	0.050		0.050
HB39	09/15/81	900	29.0	0.5	6.5	1.80	8.0	59.00	0.040		0.060
HB39	12/14/81	840	15.0	0.5	8.1	2.20	6.8	66.00	0.100		0.217
HB39	02/16/82	830	20.0	0.5	8.2	3.50	7.7	66.00			
HB39	05/18/82	745	26.0	0.5	9.7	2.90	8.3	58.00	0.154		0.026
HB39	08/17/82	810	30.0	0.5	7.2	3.70	6.4	60.00	0.010		0.030
HB39	11/16/82	750	19.5	0.5	6.8	2.70	6.8	53.00	0.009		0.046
HB39	03/20/84	830	20.0	0.5	9.2	2.60	7.8	61.60	0.023		0.044
HB39	06/27/84	830	29.0	0.5	7.5	3.50	8.7	70.00	0.013		0.039
HB39	09/25/84	800	26.0	0.5	7.0	2.30	7.8	60.00	0.015		0.047
HB39	12/05/84	815	20.0	0.5	8.4	2.50	8.0	55.00	0.018		0.039
HB39	01/28/85	915	13.0	0.5	9.8						
HB39	02/11/85	840	15.5	0.5	9.4						
HB39	03/05/85	950	22.0	0.5	8.9	2.40	8.0	62.00	0.014		0.036
HB39	04/15/85	915	22.0	0.5	8.4						
HB39	05/20/85	800	26.0	0.5							
HB39	06/12/85	815	29.0	0.5	8.4	2.80	8.8	64.40	0.019		0.034
HB39	07/22/85	745	27.0	0.5	6.2						
HB39	08/12/85	730	29.0	0.5	7.0						
HB39	09/25/85	930	27.0	0.5	8.2	3.30	8.1	52.50	0.021		0.034
HB39	10/14/85	800	26.0	0.5	8.8						
HB39	12/11/85	800	19.0	0.5	7.8	3.10	7.6	57.00	0.019		0.036
HB39	03/19/86	830	21.0	0.5	8.4	3.80	7.4	55.00	0.013		0.040
HB39	06/10/86	1045	30.0	0.5	9.6	2.60	8.5	59.90			0.028
HB39	09/09/86	740	29.0	0.5	4.2	2.20	7.4	50.90	0.008		0.047
HB39	12/09/86	810	21.0	0.5	6.8	3.50	7.7	53.00	0.016		0.033
HB39	03/25/87	830	21.0	0.5	7.0	3.70	8.1		0.008		
HB39	06/09/87	810	26.0	0.5	9.4	6.40	8.5	50.50	0.024	0.020	0.027
HB39	07/29/87	0	32.0	0.5			8.9	47.70		0.020	0.031
HB39	08/31/87	900	31.0	0.5	6.5	3.10	6.9	47.70		0.020	0.037
HB39	12/16/87	900	18.9	0.5		5.00	7.3	47.60	0.028	0.020	0.044
HB39	01/26/88	814	14.9	0.5	10.3	1.90	7.6	58.80	0.020		0.022
HB39	07/25/88	1001	29.3	0.5	7.8	3.10	7.1	58.30	0.020	0.020	0.035
HB39	10/18/88	937	23.4	0.5	6.0	1.90	6.9	57.80	0.015	0.002	0.028
	AVG.		23.7	0.5	8.1	3.00	7.8	58.47	0.030	0.017	0.043

STATION: HB39-*Continued*

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB39	02/19/80	0.220		0.220	0.100	0.470	0.790	0.570	230.0	19.00	182.0	2.00	1.90
HB39	05/20/80	0.190		0.190	0.050	0.470	0.710	0.520	195.0	19.00	164.0	1.40	2.20
HB39	08/19/80	0.010		0.010	0.050	1.100	1.160	1.150	205.0	20.00	145.0	3.00	0.60
HB39	11/17/80	0.020		0.020	0.060	0.810	0.890	0.870	270.0	22.00	148.0	2.60	1.20
HB39	03/10/81	0.130		0.130	0.300	0.520	0.950	0.820	264.0	23.00	174.0	3.20	1.10
HB39	06/02/81	0.010		0.010	0.110	0.520	0.640	0.630	240.0	24.00	164.0	3.10	
HB39	09/15/81	0.004		0.004	0.070	0.920	1.000	0.990	265.0			3.00	1.00
HB39	12/14/81							0.810	240.0		90.0	2.70	1.80
HB39	02/16/82	0.090		0.090	0.260	0.940	1.300	1.200	230.0			2.30	1.50
HB39	05/18/82	0.150		0.150	0.050	0.640	0.840	0.690	230.0		125.0		2.40
HB39	08/17/82	0.040		0.040	0.160	0.440	0.600	0.600	230.0		132.0	2.50	0.90
HB39	11/16/82	0.040		0.040	0.110	0.880	0.990	0.990	220.0		144.0	2.50	1.20
HB39	03/20/84	0.040		0.040	0.080	0.790	0.870	0.870	210.0		138.0	1.40	3.00
HB39	06/27/84	0.040		0.040	0.070	0.920	0.990	0.990			151.0	2.60	1.00
HB39	09/25/84	0.040		0.040	0.060	0.990	1.050	1.050	195.0		129.0	2.10	1.00
HB39	12/05/84	0.040		0.040	0.170	0.550	0.760	0.720	205.0		129.0	1.80	1.20
HB39	01/28/85												
HB39	02/11/85												
HB39	03/05/85	0.050		0.050	0.220	0.410	0.680	0.630	210.0		127.0	1.40	1.50
HB39	04/15/85												
HB39	05/20/85												
HB39	06/12/85	0.040		0.040	0.050	0.780	0.780	0.780	225.0		370.0	5.00	0.60
HB39	07/22/85												
HB39	08/12/85												
HB39	09/25/85	0.040		0.040	0.050	0.660	0.660	0.660	180.0		145.0	2.00	1.00
HB39	10/14/85												
HB39	12/11/85	0.040		0.040	0.110	0.490	0.600	0.600	200.0		506.0	1.80	1.30
HB39	03/19/86	0.040		0.040	0.050	0.780	0.780	0.780	210.0		116.0	2.00	1.50
HB39	06/10/86	0.040		0.040	0.260	0.460	0.720	0.720	200.0		120.0	2.60	1.20
HB39	09/09/86	0.040		0.040	0.050	0.950	0.950	0.950	185.0		141.0	2.10	1.10
HB39	12/09/86	0.004		0.004	0.060	0.900	0.960	0.960	205.0		128.0	2.00	1.10
HB39	03/25/87	0.010	0.010		0.147		0.157	0.147	200.0	20.29	134.0	3.30	1.50
HB39	06/09/87	0.030	0.010	0.020	0.040	0.491	0.491	0.491	235.0		138.0	2.60	0.60
HB39	07/29/87	0.087	0.013	0.074	0.063	0.298	0.448	0.361	170.0		143.0	1.50	
HB39	08/31/87	0.030	0.010	0.020	0.040	0.387	0.387	0.387	180.0		135.0	1.40	
HB39	12/16/87	0.030	0.010	0.020	0.064	0.282	0.346	0.346			121.0	1.90	
HB39	01/26/88	0.035		0.035	0.040	0.379	0.414	0.379	270.0		114.0	1.60	1.50
HB39	07/25/88	0.035	0.010	0.025	0.050	0.375	0.450	0.425	205.0		132.0	2.90	0.40
HB39	10/18/88	0.042	0.010	0.032	0.038	0.447	0.517	0.485	235.0		121.5	1.90	
	AVG.	0.053	0.010	0.053	0.098	0.635	0.738	0.705	218.0	21.04	156.9	2.33	1.26

STATION: HB39–*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB39	02/19/80	9.90	30.00	3.80	2.80	50.0	10.0						
HB39	05/20/80	9.90	25.00	3.90	2.60	50.0	10.0						
HB39	08/19/80	10.00	22.00	3.50	2.60	50.0	10.0						
HB39	11/17/80	10.00	24.00	4.10	3.00	50.0	30.0						
HB39	03/10/81	11.00	32.00	4.70	3.00	50.0	10.0						
HB39	06/02/81	12.00	40.00	5.00	3.40	50.0	10.0						
HB39	09/15/81												
HB39	12/14/81												
HB39	02/16/82												
HB39	05/18/82	11.00	38.00	4.40	2.40	50.0	20.0		5.0	5.0	40.0	10.0	50.0
HB39	08/17/82	11.00	29.00	4.80	3.00	50.0	20.0		5.0	5.0	40.0	10.0	50.0
HB39	11/16/82	9.60	37.00	4.60	2.40	50.0	20.0		5.0	5.0	40.0	10.0	
HB39	03/20/84	10.10	24.30	3.70	4.00	50.0	20.0		20.0	5.0	40.0	10.0	50.0
HB39	06/27/84	9.90	37.00	4.70	2.90	50.0	20.0		5.0	5.0	40.0	30.0	50.0
HB39	09/25/84	8.00	29.00	4.00	2.60	50.0	20.0		30.0	5.0	40.0	70.0	50.0
HB39	12/05/84	8.60	30.40	3.90	3.00	50.0	20.0		5.0	5.0	40.0	10.0	50.0
HB39	01/28/85	14.40	32.00	4.40	3.90	50.0	20.0	10.0	5.0	5.0	40.0	10.0	50.0
HB39	02/11/85	9.80	38.00	4.20	3.00	50.0	50.0	10.0	40.0	5.0	50.0	10.0	50.0
HB39	03/05/85	9.70	34.00	4.40	2.70	50.0	20.0	10.0	160.0	5.0	40.0	10.0	50.0
HB39	04/15/85	10.00	33.00	4.40	3.10	50.0	20.0	10.0		5.0	40.0	10.0	50.0
HB39	05/20/85	9.70	31.00	4.40	3.10	50.0	20.0	10.0	5.0	5.0	40.0	10.0	50.0
HB39	06/12/85	9.50	23.00	4.10	3.00	20.0	10.0	50.0	10.0	10.0	20.0	10.0	20.0
HB39	07/22/85	8.80	21.00	3.90	2.80	20.0	10.0	10.0	10.0	10.0	20.0	10.0	20.0
HB39	08/12/85					11.0	45.0			0.4	5.0		
HB39	09/25/85					37.0	1.0		18.0	10.0	36.0	87.0	
HB39	10/14/85												
HB39	12/11/85				5.67	11.0	170.0		1.0	1.0	10.0	2.0	4.0
HB39	03/19/86	11.60	24.10	3.68	2.48	7.0	12.0		7.0	6.0	36.0	2.0	29.0
HB39	06/10/86	9.24	18.36	4.26	3.33	51.0	1.0		1.0	12.0	29.0	7.0	3.0
HB39	09/09/86	6.22	19.91	3.37	2.72	35.0	14.0		3.0	42.0	27.0	17.0	13.0
HB39	12/09/86	8.34	18.06	3.92	2.10		1.0	10.0	10.0		11.0	2.0	2.0
HB39	03/25/87												
HB39	06/09/87	8.34	11.78	11.12	2.80	39.0	16.0	31.0	46.0	22.0	60.0	16.0	20.0
HB39	07/29/87												
HB39	08/31/87	7.69	17.75	3.84	2.59	6.0	6.0	20.0	72.0	19.0	1.0	7.0	4.0
HB39	12/16/87	7.55	19.34	3.63	2.51	22.0	58.0	60.0	36.0	13.0	13.0	17.0	13.0
HB39	01/26/88	5.46	17.86	3.55	2.40	14.0	23.0	1.0	13.0	1.0	14.0	12.0	46.0
HB39	07/25/88	7.01	13.99	3.81	1.80	136.0	20.0	130.0	5.0	9.0	6.0	20.0	12.0
HB39	10/18/88	8.04	20.85	3.70	1.85	1.0	14.0	40.0	3.0	7.0	19.0	16.0	7.0
	AVG.	9.41	26.39	4.33	2.89	40.9	22.8	28.7	20.8	8.6	29.5	16.3	31.0

STATION: HB39—*Continued*

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB39	02/19/80	40	10	9.21	7.20	13.10	5.32	0.64
HB39	05/20/80	20	20	9.07	3.44	11.01	2.42	2.92
HB39	08/19/80	20	20	31.22	0.21	31.44	3.72	4.26
HB39	11/17/80	120	66					
HB39	03/10/81	410	20	9.76	5.81	13.13	2.51	1.86
HB39	06/02/81	100	20	18.85	2.88	20.59	2.79	1.36
HB39	09/15/81	20	20	25.60	0.00	25.22	3.43	2.36
HB39	12/14/81	20	20	9.73	6.84	13.71	2.22	0.00
HB39	02/16/82	30	20	7.20	0.44	7.61	0.00	0.00
HB39	05/18/82	20	20	5.76	1.20	6.34	1.94	0.32
HB39	08/17/82	42	20	24.63	7.12	28.50	3.82	5.58
HB39	11/16/82	20	20	25.65	2.22	27.74	0.60	2.68
HB39	03/20/84	20	20	4.20	0.00	3.30	0.00	0.00
HB39	06/27/84	116	28	30.60	2.40	32.10	4.20	0.00
HB39	09/25/84	16	20	26.40	3.00	28.10	3.80	0.00
HB39	12/05/84	44	20					
HB39	01/28/85							
HB39	02/11/85		10					
HB39	03/05/85	20	32	9.40	0.00	9.50	0.00	0.00
HB39	04/15/85		12					
HB39	05/20/85		10					
HB39	06/12/85	180	22	43.80	0.70	45.00	0.00	1.80
HB39	07/22/85		46					
HB39	08/12/85		60					
HB39	09/25/85	20	20	21.20	1.90	22.60	0.60	4.30
HB39	10/14/85		10					
HB39	12/11/85	26	20	28.20	3.90	30.70	2.80	3.40
HB39	03/19/86	40	20	15.10	1.90	16.40	0.80	3.00
HB39	06/10/86	20	20	15.60	0.90	16.30	1.10	1.00
HB39	09/09/86	160	48	20.40	2.60	22.20	0.90	0.60
HB39	12/09/86	32	20	32.10	0.00	26.90	2.10	0.00
HB39	03/25/87	20	20	15.60	7.80	20.20	2.10	2.40
HB39	06/09/87	16	2	28.60	2.40	30.50	0.00	6.60
HB39	07/29/87			25.40	1.30	26.90	0.00	3.10
HB39	08/31/87	52	8	11.30	1.60	12.40	0.90	2.00
HB39	12/16/87	68	14	17.20	5.10	20.50	0.00	5.80
HB39	01/26/88	160	86	16.20	4.60	19.10	1.60	2.40
HB39	07/25/88	40	2	27.10	2.00	28.40	3.00	8.20
HB39	10/18/88			20.80	3.90	23.20	3.20	0.00
	AVG.	64	24	19.53	2.78	21.09	1.86	2.22

STATION: HB436 LOCATION: Howell Creek at S.R. 436 SOURCE: Orange County

STATION NAME	DATE	TIME	TEMP C 10	DEP M	D.O. mg/l 299	BOD mg/l 310	pH 403	T.ALK mg/l 410	TP/f mg/l 666	PO4 mg/l 70507	TP mg/l 665
HB436	08/16/83	750	26.5	0.5	3.6	1.30	7.3	40.00			0.115
HB436	11/08/83	755	21.5	0.5	4.4	2.70	7.6	47.00	0.058		0.064
HB436	02/28/84	755	17.5	0.5	6.6	1.20	7.0	49.50	0.055		0.073
HB436	05/08/84	1155	27.0	0.5	6.7	6.00	7.3	56.10	0.257		0.296
HB436	08/22/84	830	26.0	0.5	3.5	3.30	7.2	53.00	0.038		0.121
HB436	11/27/84	800	18.5	0.5	5.1	6.30	7.4	56.00	0.037		0.117
HB436	02/26/85	830	27.0	0.5			6.9	74.60	0.097		0.127
HB436	05/29/85	830	23.0	0.5	2.4	1.00	6.8	72.00	0.129		0.186
HB436	08/20/85	835	27.0	0.5	4.0	4.50	6.9	40.50	0.049		0.108
HB436	11/19/85	900	24.0	0.5		3.00	6.7	41.00	0.037		0.068
HB436	02/26/86	850	14.0	0.5	4.9	2.60	6.7	46.80	0.054		0.070
HB436	05/21/86	900	22.0	0.5	1.7	2.40	6.8	8.80	0.082		0.097
HB436	08/13/86	745	27.0	0.5	2.6		7.0	45.90	0.014		0.048
HB436	11/19/86	830	23.0	0.5	2.4	1.20	8.0	54.10	0.092		0.124
	AVG.		23.1	0.5	4.0	2.9583	7.1	48.95	0.077		0.115

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3 mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND. mmhos 95	Cl mg/l 940	TS mg/l 500	TURB FTU 76	SEC.D M 78
HB436	08/16/83	0.130		0.130	0.320	0.430	0.880	0.750	190.0		120.0	1.50	
HB436	11/08/83	0.380		0.380	0.140	0.460	0.980	0.600	190.0		131.0	1.40	
HB436	02/28/84	0.100		0.100	0.120	0.640	0.910	0.810	205.0		119.0	0.90	
HB436	05/08/84	0.600		0.600	0.550	0.920	2.070	1.470	260.0		143.0	1.50	
HB436	08/22/84	0.130		0.130	0.150	0.990	1.270	1.140	210.0		137.0	2.80	
HB436	11/27/84	0.240		0.240	0.280	0.920	1.440	1.200	235.0		153.0	5.00	
HB436	02/26/85	0.680		0.680	0.220	0.110	1.010	0.330	250.0		192.0	2.00	
HB436	05/29/85	0.260		0.260	0.230	0.940	1.430	1.170	260.0		171.0	1.60	
HB436	08/20/85	0.050		0.050	0.090	0.630	0.770	0.720	260.0		156.0	1.50	
HB436	11/19/85	0.180		0.180	0.150	0.950	1.280	1.100	160.0		157.0	1.60	
HB436	02/26/86	0.130		0.130	0.120	0.650	0.900	0.770	195.0		104.0	1.30	
HB436	05/21/86	0.420		0.420	0.150	0.420	0.990	0.570	320.0		200.0	2.80	
HB436	08/13/86	0.110		0.110	0.680	0.220	1.010	0.900	180.0		132.0	1.30	
HB436	11/19/86	0.440		0.440	0.240	0.600	1.280	0.840	24.0		148.0	2.30	
	AVG.	0.275		0.275	0.246	0.634	1.159	0.884	209.9		147.4	1.96	

STATION: HB436—*Continued*

STATION NAME	DATE	Na mg/l 929	Ca mg/l 916	Mg mg/l 927	K mg/l 937	Fe ug/l 1045	Cu ug/l 1042	Pb ug/l 1051	Zn ug/l 1092	Cd ug/l 1027	Ni ug/l 1067	Mn ug/l 1055	Cr ug/l 1034
HB436	08/16/83	11.00	17.00	3.90	2.20	50.0	20.0		10.0	5.0	40.0	10.0	50.0
HB436	11/08/83	11.00	20.00	4.20	2.40	50.0	20.0		5.0	5.0	40.0	10.0	50.0
HB436	02/28/84	9.09	32.30	3.60	2.88	160.0	20.0		5.0	5.0	40.0	5.0	50.0
HB436	05/08/84	11.40	37.30	4.00	3.40	90.0	20.0		5.0	5.0	40.0	5.0	50.0
HB436	08/22/84	8.50	34.70	3.80	3.50	50.0	20.0		5.0	5.0	40.0	10.0	50.0
HB436	11/27/84	11.20	36.40	4.60	3.40	50.0	20.0		5.0	5.0	40.0	60.0	50.0
HB436	02/26/85	11.80	49.00	5.60	3.70	300.0	20.0		5.0	5.0	40.0	10.0	50.0
HB436	05/29/85	14.10	35.00	5.20	4.10	300.0	20.0		5.0	5.0	40.0	10.0	50.0
HB436	08/20/85												
HB436	11/19/85	23.70			6.60	23.0	10.0		25.0	5.0	11.0	11.0	
HB436	02/26/86	11.05	20.08	3.45	2.61	96.0	26.0		1.0	6.0	13.0	2.0	51.0
HB436	05/21/86	5.76	75.70	5.80	1632.00	273.0	51.0		12.0	18.0	88.0	47.0	23.0
HB436	08/13/86	11.60	16.72	4.05	1.98	72.0	1.0		1.0	3.0	5.0	15.0	12.0
HB436	11/19/86	5.62	24.07	4.51	1.63	118.0	1.0	158.0	1.0	1.0	46.0	23.0	12.0
	AVG.	11.22	33.19	4.39	128.49	125.5	19.2	158.0	6.5	5.6	37.2	16.8	41.5

STATION NAME	DATE	T.Coli /100ml 31501	F.Coli /100ml 31616	Chl.a F mg/m3 32211	Chl.a NF mg/m3 32218	Chl.a mg/m3 32210	Chl.b mg/m3 32212	Chl.c mg/ml 32214
HB436	08/16/83	800	490	4.80	3.80	6.90	2.40	0.00
HB436	11/08/83	800		2.00	0.00	1.70	0.90	1.40
HB436	02/28/84	108	60	0.30	0.30	0.50	0.00	0.00
HB436	05/08/84	160	120	8.30	2.60	9.60	4.10	0.00
HB436	08/22/84		270	14.10	7.50	18.40	3.30	0.00
HB436	11/27/84		600	31.30	6.00	35.00	4.30	0.90
HB436	02/26/85		34	2.30	1.40	3.10	0.00	0.00
HB436	05/29/85	160	120	12.50	5.20	15.70	1.30	1.70
HB436	08/20/85	160	120	3.90	3.30	5.90	0.90	1.10
HB436	11/19/85	490	110	5.60	4.80	8.40	0.70	0.00
HB436	02/26/86	46	54	0.90	1.20	1.60	0.00	0.00
HB436	05/21/86							
HB436	08/13/86	800	150	3.60	4.00	6.00	0.90	1.80
HB436	11/19/86	1400	270	2.20	3.50	4.30	0.70	1.60
	AVG.	492	200	7.06	3.35	9.01	1.50	0.65

STATION: BG1 LOCATION: Bear Gully Creek at S.R. 426 SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C	DEPTH M	D.O. mg/l	BOD mg/l	COD mg/l	pH	T.ALK mg/l	TP mg/l	PO4 mg/l
			10	97	299	310	335	403	410	665	70507
BG1	01/22/80	0	16.0	0.3	7.1	0.60	17.50		24.50		0.017
BG1	03/19/80	0		0.3	7.6	0.60		6.9	29.10	0.010	0.010
BG1	04/22/80	0	25.0	0.2	8.8			6.9	20.50	0.020	0.010
BG1	05/23/80	0	24.0	0.3	3.8		30.60	6.6	34.30	0.153	0.131
BG1	10/12/82	0	26.0		1.9	1.50		6.3	25.00	0.018	0.007
BG1	01/21/83	0	15.0	0.3	5.1	1.70		6.4	40.00	0.019	0.010
BG1	07/01/83	0	29.0		2.7	1.00		7.0	29.50	0.024	0.014
BG1	08/01/83	910	29.0		2.9	0.60	24.62	6.4	31.00	0.023	0.020
BG1	02/01/84	0	10.5		4.7		24.80	7.4	26.50	0.192	0.055
BG1	03/28/84	0	21.0		3.0		27.40	6.3	28.50	0.029	
BG1	07/10/84	0	21.5		2.5	1.50	27.80	6.0	24.40	0.011	0.007
BG1	11/19/84	0	19.0		3.0		37.00	6.6	25.74		0.017
BG1	08/27/85	0	28.0		2.4		37.00		21.40	0.078	0.000
BG1	01/14/86	0	14.0		5.8		27.90	6.4	22.90	0.030	0.014
	AVG.		21.4	0.3	4.4	1.07	28.29	6.6	27.38	0.051	0.024

STATION NAME	DATE	NOX mg/l	NO2 mg/l	NO3 mg/l	NH3N mg/l	TOTORGN mg/l	TN mg/l	TKN mg/l	COND mmhos	CL mg/l	TURB FTU	SEC.D M
		630	615	620	610	605	600	625	95	940	76	78
BG1	01/22/80				0.01	0.36	0.370	0.370	110.0		0.80	0.30
BG1	03/19/80	0.140		0.140			0.140		120.0		1.40	0.30
BG1	04/22/80	0.090		0.090	0.09	0.44	0.620	0.530	110.0		1.30	0.15
BG1	05/23/80	0.088		0.088	0.05	0.53	0.668	0.580	130.0		1.50	0.30
BG1	10/12/82	0.094		0.094	0.05	0.84	0.984	0.890	137.0		1.70	
BG1	01/21/83	0.145	0.005	0.140	0.21	0.74	1.095	0.950	170.0		1.00	
BG1	07/01/83	0.068	0.003	0.065	0.08	0.64	0.788	0.720	165.0		0.50	
BG1	08/01/83	0.162	0.002	0.160	0.07	0.56	0.792	0.630	155.0		0.70	
BG1	02/01/84	0.062	0.003	0.059	0.07	0.54	0.672	0.610	151.0		0.30	
BG1	03/28/84	0.091	0.004	0.087	0.07	0.50	0.661	0.570	141.0		0.50	
BG1	07/10/84	0.053	0.002	0.051			0.753	0.700	127.2		1.00	
BG1	11/19/84	0.035	0.004	0.031			0.565	0.530	137.4		0.54	
BG1	08/27/85	0.495	0.003	0.492			1.575	1.080	121.5		2.10	
BG1	01/14/86	0.159		0.159			1.259	1.100	119.0		1.30	
	AVG.	0.129	0.003	0.127	0.08	0.57	0.782	0.712	135.3		1.05	0.27

STATION: BG3 LOCATION: Bear Gully Creek at Tuskawillow Road SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
BG3	01/22/80	0	15.0	0.3	7.5	0.90	41.50		76.00		0.113
BG3	03/19/80	0		0.3	7.6	1.40		7.0	51.00	0.130	0.110
BG3	04/22/80	0	28.0	0.3	9.6			7.2	33.50	0.070	0.040
BG3	05/23/80	0	24.0	0.3	5.2		50.00	6.8	49.30	0.246	0.220
BG3	07/01/80	0	31.0	0.3	8.9		69.00	7.5	44.00	0.120	0.120
BG3	10/07/80	0	21.0	0.3	6.3	1.50	29.00	7.4		0.105	0.077
BG3	01/12/81	0	9.0	0.3	3.3	1.60	44.60	6.8	87.50	0.164	0.114
BG3	04/15/81	0	30.0	1.8	3.1	5.20	33.50	7.1	60.00	0.137	0.095
BG3	09/30/81	0	22.0	0.6	2.1			5.5	84.00	0.312	0.280
BG3	12/29/81	0							66.50	0.207	0.182
BG3	05/28/82	0	24.0	0.3	4.5	0.70		6.7	85.00	0.069	0.008
BG3	01/21/83	0	17.0	0.6	6.3			6.7	61.50	0.155	0.154
BG3	07/01/83	0	29.0		3.4	1.60		7.0	21.00	0.024	0.005
BG3	08/01/83	0	30.0		3.9	1.50	43.79	6.2	22.00		
BG3	10/12/83	0	24.0		5.0	1.10		6.6	39.50	0.132	0.090
BG3	02/01/84	0	12.0		7.8		37.10	6.5	23.50	0.490	0.412
BG3	03/28/84	0	21.5		6.7		37.00	6.7	25.75	0.075	
BG3	07/10/84	0	23.0		5.7	1.40	41.40	6.8	28.30	0.022	0.017
BG3	11/19/84	0	19.0		6.1		39.30	6.7	25.74	0.029	0.018
BG3	08/27/85	0	28.5		2.8		43.60		26.40	0.099	0.000
BG3	01/14/86	0	14.5		6.1		38.50	6.0	21.40	0.052	0.000
	AVG.		22.2	0.5	5.6	1.69	42.18	6.7	46.59	0.139	0.108

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76	SEC.D M 78
BG3	01/22/80				0.02	0.48		0.500	160.0		4.00	0.30
BG3	03/19/80	0.360		0.360					149.0		3.20	0.30
BG3	04/22/80	0.150		0.150	0.03	0.60	0.780	0.630	130.0		2.30	0.30
BG3	05/23/80	0.617		0.617	0.11	0.89	1.617	1.000	197.0		1.30	0.30
BG3	07/01/80	0.270		0.270	0.09	0.62	0.980	0.710	140.0		6.10	0.30
BG3	10/07/80											0.30
BG3	01/12/81	0.130		0.130	0.08	0.70	0.910	0.780	240.0		1.00	0.20
BG3	04/15/81	0.404	0.004	0.400	0.12	3.01	3.534	3.130	155.0		2.50	0.15
BG3	09/30/81	0.013	0.013		0.01	1.04	1.063	1.050	270.0	14.17	1.10	0.61
BG3	12/29/81	1.862	0.242	1.620	0.32	1.97	4.152	2.290	390.0	18.32	3.50	
BG3	05/28/82	0.167	0.007	0.160	0.00	0.90	1.067	0.900	265.0		15.00	0.30
BG3	01/21/83	0.958	0.018	0.940	0.65	2.64	4.248	3.290	260.0			
BG3	07/01/83	0.062	0.003	0.059	0.14	1.06	1.262	1.200	150.0		1.60	
BG3	08/01/83	0.110	0.110		0.00	0.96	0.138	0.028	140.0		2.00	
BG3	10/12/83	0.374		0.374	0.16	1.69	2.224	1.850	161.0		3.00	
BG3	02/01/84	0.102	0.004	0.098	0.15	0.84	1.092	0.990	144.0		1.70	
BG3	03/28/84	0.179	0.005	0.174	0.12	0.95	1.249	1.070	150.0	19.99	2.40	
BG3	07/10/84	0.045	0.001	0.044			1.205	1.160	145.9		3.60	
BG3	11/19/84	0.058	0.004	0.054			1.028	0.970	143.5		2.30	
BG3	08/27/85	0.022	0.003	0.019			1.132	1.110	127.5		2.20	
BG3	01/14/86	0.283		0.283			1.163	0.880	130.0		1.00	
	AVG.	0.325	0.035	0.338	0.13	1.22	1.602	1.239	182.4	17.49	3.15	0.31

STATION: BG4 LOCATION: Bear Gully Creek at Red Bug Lake Road SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
BG4	01/22/80	0	17.0	1.2	5.8	0.70	25.80		81.00		0.155
BG4	03/19/80	0		1.2	7.7	0.50		7.5	88.80		0.180
BG4	04/22/80	0	20.0	0.9	7.0			7.5	80.50	0.190	0.140
BG4	05/23/80	0	23.0	1.2	5.5		39.30	6.7	68.80		
BG4	07/01/80	0	25.0	0.8	6.2		10.00	7.7	86.50	0.190	0.170
BG4	08/11/80	0	25.0	0.6	5.4	0.30	2.00	7.9		0.190	0.180
BG4	10/07/80	0	21.0	0.9	6.9	0.50	17.70	7.7		0.141	0.131
BG4	01/12/81	0	10.0	0.6	8.6	0.30	0.44	7.2	97.00	0.134	0.119
BG4	04/15/81	0	22.0	0.3	6.9	0.80	43.00	7.5	91.50	0.199	0.183
BG4	09/30/81	0	26.0	0.6	6.9			6.0	69.00	1.245	1.240
BG4	12/29/81	0							76.00	0.306	0.304
BG4	05/28/82	0	24.0	0.5	5.3			6.4	82.00	0.172	0.980
BG4	01/21/83	0	16.0	0.9	5.4	2.30		6.5	40.00	0.060	0.049
BG4	07/01/83	0	26.0		4.6	1.60		7.1	44.00	0.094	0.080
BG4	08/01/83	950	27.0		4.3	1.00	62.07	6.6	42.50	0.143	0.096
BG4	02/01/84	0	12.0		9.0		36.20	6.5	40.50	0.395	0.350
BG4	03/28/84	0	21.0		6.7		42.20	6.6	49.75	0.175	
BG4	07/10/84	0	19.5		5.0	1.20	68.70	6.4	29.70	0.125	0.038
BG4	11/19/84	0	19.0		6.0		37.10	7.1	37.65	0.046	0.037
BG4	04/17/85	0	21.0		5.5	0.20		7.2	95.80	0.175	0.150
BG4	08/27/85	0	26.0		3.8		85.50		45.40	0.303	0.002
BG4	01/14/86	0	13.0		7.7		49.30	6.0	23.00	0.078	0.000
	AVG.		20.7	0.8	6.2	0.85	37.09	7.0	63.47	0.230	0.229

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76	SEC.D M 78
BG4	01/22/80				0.01	0.29		0.300	240.0		1.00	1.22
BG4	03/19/80	0.760		0.760					252.0		1.20	0.61
BG4	04/22/80	0.240		0.240	0.00	0.27	0.510	0.270	280.0		1.00	0.91
BG4	05/23/80	0.954	0.954			0.74	1.233	0.279	310.0		0.90	1.22
BG4	07/01/80	0.250		0.250	0.05	0.41	0.710	0.460	310.0		0.90	0.76
BG4	08/11/80											0.61
BG4	10/07/80											0.91
BG4	01/12/81	0.132		0.132	0.07	0.43	0.632	0.500	290.0		0.98	0.61
BG4	04/15/81	0.365	0.005	0.360	0.02	2.00	2.385	2.020	290.0		0.75	0.30
BG4	09/30/81	0.031	0.031		0.00	1.11	1.144	1.113	328.0	37.00	4.10	0.31
BG4	12/29/81	2.927	0.397	2.530	0.21	1.97	5.107	2.180	500.0	40.84	2.50	
BG4	05/28/82	0.390	0.010	0.380	0.00	0.66	1.050	0.660	360.0		10.00	0.43
BG4	01/21/83	0.292	0.012	0.280	0.46	1.43	2.182	1.890	310.0		4.90	
BG4	07/01/83	0.167	0.006	0.161	0.17	0.99	1.327	1.160	180.0		2.40	
BG4	08/01/83	0.232	0.012	0.220	0.21	1.15	1.592	1.360	165.0		1.90	
BG4	02/01/84	0.165	0.006	0.159	0.12	0.69	0.975	0.810	168.0		1.60	
BG4	03/28/84	0.231	0.006	0.225	0.13	1.01	1.371	1.140	170.0	15.50	3.00	
BG4	07/10/84	0.254	0.008	0.246			1.814	1.560	158.4		10.10	
BG4	11/19/84	1.089	0.013	1.076			1.909	0.820	163.8		1.60	
BG4	04/17/85	0.170	0.010	0.160			1.770	1.600	227.0		1.30	
BG4	08/27/85	0.144	0.010	0.134			1.634	1.490	157.0		3.30	
BG4	01/14/86	0.226		0.226			1.216	0.990	129.0		2.50	
	AVG.	0.475	0.106	0.443	0.11	0.94	1.587	1.084	249.4	31.11	2.80	0.72

STATION: BG6 LOCATION: Bear Gully Creek just upstream of Howell Creek SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
BG6	02/01/84	0	10.5		8.7		33.00	6.9	73.00	0.014	0.007
BG6	03/28/84	0	20.0		7.2		31.20	7.1	82.35	0.316	
BG6	07/10/84	0	18.0		6.0	1.30	36.20	6.8	76.50	0.291	0.221
BG6	11/19/84	0	20.0		7.0		17.10	7.6	89.60	0.164	0.135
BG6	04/17/85	0	21.0		7.1	0.10		7.7	95.30	0.202	0.198
BG6	08/27/85	0	25.0		5.0		59.60		54.60	0.296	0.009
BG6	01/14/86	0	13.0		7.6		49.30	6.5	45.80	0.238	0.009
	AVG.		18.2		6.9	0.70	37.73	7.1	73.88	0.217	0.097

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76	SEC.D M 78
BG6	02/01/84	0.277	0.009	0.268	0.14	0.81	1.227	0.95	269.0		1.50	
BG6	03/28/84	0.329	0.013	0.316	0.07	0.71	1.109	0.78	287.0	42.74	3.90	
BG6	07/10/84	0.263	0.012	0.251			1.113	0.85	279.4		2.40	
BG6	11/19/84	0.430	0.010	0.420			0.920	0.49	208.0		1.30	
BG6	04/17/85	0.401	0.011	0.390			1.081	0.68	270.0		1.20	
BG6	08/27/85	0.283	0.012	0.271			1.403	1.12	196.0		4.20	
BG6	01/14/86	0.288		0.288			1.318	1.03	180.0		2.40	
	AVG.	0.315	0.11	0.76	1.167	0.8428	241.3	42.74	2.41			

STATION: HB5 LOCATION: Howell Creek at Tuskawillow Road SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
HB5	08/01/83	1020	27.0		4.7	1.40		7.2	45.50	0.362	0.304
HB5	10/05/83	0	25.0		5.3	1.40	27.52	3.5	38.50	0.175	0.116
HB5	01/25/84	0	16.0	0.5	7.3	1.30		6.8	38.50	0.253	0.111
HB5	04/23/84	1200	22.5	0.5	3.5	3.00	43.10	6.5	38.50	0.255	0.211
HB5	07/24/84	1200	20.0		5.2	2.05	39.40	6.8	36.60	0.128	0.057
HB5	10/23/84	1200	23.0	0.3	5.1		26.90	6.9	45.99	0.261	0.175
HB5	01/21/85	1200	10.0	0.4	10.4	1.40		8.4	42.87	0.156	
HB5	04/24/85	1200	23.5	0.2	6.1	0.95		6.9	31.60	0.433	0.431
HB5	09/03/85	1200	28.0		5.7	1.65		6.8	41.80	0.208	0.018
HB5	01/06/86	1200	16.0	0.2	6.4			7.1	46.20	0.346	0.309
HB5	03/03/86	1200	18.5	0.3	7.9	3.25		7.2	38.36	0.098	0.035
	AVG.		20.9	0.3	6.1	1.82	34.23	6.7	40.40	0.243	0.177

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76.00	SEC.D M 78
HB5	08/01/83	0.471	0.021	0.450	0.16	1.11	1.741	1.270	180.0		2.70	
HB5	10/05/83	0.298	0.018	0.280	0.27	1.04	1.608	1.310	195.0		2.80	
HB5	01/25/84	0.131	0.006	0.125	0.29	1.30	1.721	1.590	163.0		2.00	0.50
HB5	04/23/84	0.430	0.033	0.397			2.100	1.670	158.0		7.50	
HB5	07/24/84	0.173	0.013	0.160			1.393	1.220	165.1		4.50	
HB5	10/23/84	0.677	0.037	0.640			1.547	0.870	185.0		2.60	
HB5	01/21/85	0.855	0.028	0.827			1.615	0.760	205.0		1.65	
HB5	04/24/85	1.241	0.021	1.220			1.921	0.680	259.0		1.80	
HB5	09/03/85	0.304	0.050	0.254			2.064	1.760	171.0	15.60	5.70	
HB5	01/06/86	0.195		0.195			1.865	1.670	190.0		3.70	
HB5	03/03/86	0.145	0.011	0.134			2.055	1.910	151.0		3.60	
	AVG.	0.447	0.024	0.426	0.24	1.15	1.785	1.337	183.8	15.60	3.50	0.50

STATION: HB7 LOCATION: Howell Creek at Dyson Road SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
HB7	08/01/83	950	26.0		6.8	1.40		7.3	43.00	0.336	0.259
HB7	10/05/83	0	24.0		6.5	1.10		3.5	36.50	0.143	0.114
HB7	01/25/84	0	17.0	0.5	8.0	1.50		6.7	39.50	0.203	0.116
HB7	04/23/84	1200	22.0	0.3	5.8	2.80	65.50	6.3	38.00	0.248	0.175
HB7	07/24/84	1200	20.0		5.9	1.80	51.70	6.8	34.60	0.122	0.070
HB7	10/23/84	1200	22.5	0.3	7.3		27.20	7.3	44.80	0.191	0.146
HB7	01/21/85	1200	10.0	0.3	12.6	1.25		7.0	31.21	0.197	
HB7	04/24/85	1200	26.0	0.2	5.4	1.15		7.5	50.80	0.340	0.302
HB7	09/03/85	1200	27.0	0.4	6.5	2.00		6.9	40.50	0.079	0.019
HB7	01/06/86	1200	15.0	0.5	6.5			7.2	41.30	0.350	0.244
HB7	03/03/86	1200	19.0	0.3	8.4	3.58		7.6	37.32	0.089	0.030
	AVG.		20.8	0.4	7.2	1.84	48.13	6.7	39.78	0.209	0.148

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76	SEC.D M 78
HB7	08/01/83	0.452	0.010	0.442	0.18	1.19	1.822	1.370	160.0		3.50	
HB7	10/05/83	0.473	0.023	0.450	0.20	0.88	1.553	1.080	185.0		5.40	
HB7	01/25/84	0.180	0.011	0.169	0.29	1.35	1.820	1.640	162.0		2.40	0.50
HB7	04/23/84	0.546	0.033	0.513			2.326	1.780	155.0		8.50	
HB7	07/24/84	0.338	0.018	0.320			1.578	1.240	157.4		6.80	
HB7	10/23/84	0.612	0.022	0.590			1.352	0.740	176.0		3.40	
HB7	01/21/85	0.690	0.017	0.673			1.310	0.620	177.0		13.00	
HB7	04/24/85	0.978	0.008	0.970			1.498	0.520	200.0		8.40	
HB7	09/03/85	0.350	0.053	0.297			1.930	1.580	158.0	14.30	6.30	
HB7	01/06/86	0.219		0.219			1.709	1.490	180.0		3.90	
HB7	03/03/86	0.163	0.009	0.154			1.863	1.700	151.0		3.90	
	AVG.	0.455	0.020	0.436	0.22	1.14	1.706	1.251	169.2	14.30	5.95	0.50

STATION: HB8 LOCATION: Howell Creek at S.R. 419 SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
HB8	08/01/83	930	25.0		6.6	1.00		7.5	65.50	0.269	0.230
HB8	10/05/83	0	23.0		6.7	0.60	16.54	6.7	55.50	0.164	0.140
HB8	01/25/84	0	18.0	0.5	7.6	1.00		6.9	41.50	0.244	0.196
HB8	04/23/84	1200	21.5	0.4	6.1	1.60	41.60	5.0	54.20	0.223	0.195
HB8	07/24/84	1200	18.0		5.0	1.60	71.10	6.6	33.00	0.464	0.396
HB8	10/23/84	1200	22.0	0.8	7.6		27.10	7.5	61.01	0.167	0.133
HB8	01/21/85	1200	10.0	0.5	11.4	1.28		7.3	52.06	0.206	
HB8	04/24/85	1200	25.0	0.3	5.5	1.70		7.6	85.30	0.208	0.196
HB8	09/03/85	1200	26.0	0.4	6.5	1.25		6.7	44.50	0.203	0.008
HB8	01/06/86	1200	15.0	0.2	6.7			6.9	41.30	0.216	0.193
HB8	03/03/86	1200	18.0	0.5	7.8	1.60		7.8	47.14	0.135	0.097
	AVG.		20.1	0.4	7.0	1.29	39.09	7.0	52.82	0.227	0.178

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76	SEC.D M 78
HB8	08/01/83	0.446	0.009	0.437	0.17	1.01	1.626	1.180	210.0		2.00	
HB8	10/05/83	0.422	0.012	0.410	0.11	0.80	1.332	0.910	245.0		3.80	
HB8	01/25/84	0.319	0.010	0.309	0.16	1.48	1.959	1.640	250.0		1.60	0.50
HB8	04/23/84	0.481	0.018	0.463			1.571	1.090	202.0		5.00	
HB8	07/24/84	0.734	0.024	0.710			2.144	1.410	182.4		7.20	
HB8	10/23/84	0.583	0.013	0.570			1.293	0.710	221.0		3.70	
HB8	01/21/85	0.463	0.017	0.446			0.963	0.500	250.0		5.60	
HB8	04/24/85	0.508	0.008	0.500			0.928	0.420	276.0		1.60	
HB8	09/03/85	0.366	0.032	0.334			1.896	1.530	169.0	16.10	4.60	
HB8	01/06/86	0.244		0.244			1.734	1.490	200.0		2.40	
HB8	03/03/86	0.350	0.018	0.332			1.920	1.570	155.0		3.70	
	AVG.	0.447	0.016	0.432	0.15	1.10	1.579	1.132	214.6	16.10	3.75	0.50

STATION: LH2 LOCATION: Outlet of Lake Howell SOURCE: Seminole County

STATION NAME	DATE	TIME	TEMP C 10	DEPTH M 97	D.O. mg/l 299	BOD mg/l 310	COD mg/l 335	pH 403	T.ALK mg/l 410	TP mg/l 665	PO4 mg/l 70507
LH2	08/01/83	1355	30.0	1.6	11.2	5.90		8.7	65.50	0.348	0.211
LH2	10/05/83	0	29.0	1.8	12.4	4.30	15.75	9.1	41.50	0.120	0.048
LH2	01/25/84	0	16.0	2.3	12.0	3.60		6.6	42.00	0.181	0.034
LH2	04/25/84	0	20.0	4.6	7.0	4.60	50.70	9.0	44.40	0.240	0.136
LH2	07/24/84	0	21.0	1.7	5.7	2.70	34.70	7.5	33.40	0.075	0.019
LH2	10/24/84	0	25.0	2.1	5.8		36.60	7.7	48.02	0.043	0.026
LH2	01/21/85	0	11.0	1.7	11.4	6.30		8.0	37.88	0.201	
LH2	04/24/85	0	27.0	0.3	10.6	11.40		9.8	53.90	0.932	0.011
LH2	09/03/85	0	28.0		9.8	4.05		8.4	40.30	0.077	
LH2	01/06/86	0						7.8	41.20	0.063	0.026
LH2	03/03/86	0	18.5		7.0	3.55		8.9	38.79	0.123	0.034
	AVG.		22.6	2.0	9.3	5.16	34.44	8.3	44.26	0.218	0.061

STATION NAME	DATE	NOX mg/l 630	NO2 mg/l 615	NO3 mg/l 620	NH3N mg/l 610	TOTORGN mg/l 605	TN mg/l 600	TKN mg/l 625	COND mmhos 95	CL mg/l 940	TURB FTU 76	SEC.D M 78
LH2	08/01/83	0.077	0.001	0.076	0.00	1.81	1.887	1.810	175.0		3.10	0.60
LH2	10/05/83	0.118	0.008	0.110	0.02	0.72	0.858	0.740	200.0		3.00	0.50
LH2	01/25/84	0.030	0.005	0.025	0.19	1.23	1.450	1.420	168.0		3.10	0.70
LH2	04/25/84	0.077	0.002	0.075			2.157	2.080	160.0	17.36	8.50	0.49
LH2	07/24/84	0.052	0.002	0.050			1.072	1.020	181.4		2.80	0.80
LH2	10/24/84	0.063	0.003	0.060			1.263	1.200	160.0		4.70	0.50
LH2	01/21/85	0.030	0.001	0.029			1.570	1.540	188.0		6.80	0.40
LH2	04/24/85	0.083	0.003	0.080			7.383	7.300	198.0			
LH2	09/03/85	0.013	0.003	0.010			1.553	1.540	167.0	15.20	4.10	
LH2	01/06/86	0.014		0.014			1.124	1.110	151.0		4.40	
LH2	03/03/86	0.046	0.005	0.041			2.016	1.970	151.0		4.30	
	AVG.	0.055	0.003	0.052	0.07	1.25	2.030	1.975	172.7	16.28	4.48	0.57

Appendix E—Wetland Diagnostic Characteristics

FRESHWATER WETLANDS

Baygall (BG): Forested wetlands typically dominated by one or more species of evergreen bay trees or less commonly by dahoon holly, deciduous hardwoods, or pine. Located at the bases of sandy slopes and maintained by downslope seepage. Soils organic and nearly constantly saturated but infrequently flooded.

Bayhead (BH): Forested wetlands dominated by one or more species of broad-leaved, evergreen bay trees (*Gordonia lasianthus, Persea palustris,* or *Magnolia virginica*). Dahoon holly (*Ilex cassine*) may be occasionally dominant. Soils usually organic and nearly constantly saturated as well as at least occasionally being flooded. The canopy of some sites may be dominated by pines, but bays and other indicators will be prevalent in the subcanopy and understory.

Bottomland Hardwoods (BL): Deciduous forest communities lying in the floodplains of rivers and streams subject to rapid rise and fall of floodwaters. At other times, they may be relatively well drained, or at most, saturated by lateral seepage. Associated soils are alluvial.

Cypress (CY): Forested wetlands dominated by bald cypress or pond cypress (*Taxodium distichum* or *T. ascendens*) and flooded annually for periods of long duration—typically 4 to 8 months in any given year. Includes cypress dome, cypress stand, and lakeshore variants.

Deep Marsh (DM): Deep water wetlands dominated by a mixture of water lilies and deep water emergent species. Semipermanently to permanently flooded.

Floating Marshes (FF): Communities of free-floating plants (such as water hyacinth, water lettuce, or lemna) or floating mats of rhizomatous species (such as alligator weed or various grasses and sedges).

Forested Flatwoods Depressions (FD): Typically pond cypress, pine, deciduous hardwood, bay, or cabbage palm dominated communities occupying shallow depressions in mesic flatwoods sites. Understory vegetation consists of hydrophytic shrubs, grasses, and herbs. Saw palmetto, gallberry and other typical mesic flatwoods species generally absent. In the absence of fires, or as a result of forest management practices, understory or associated species (such as loblolly bay) may dominate these sites. Soils usually sandy and subject to brief (1–2 months) seasonal inundation or prolonged soil saturation.

Freshwater Flats and Barren Areas (BA): Sandy or muddy sites subject to occasional or regular inundation with less than 33% vegetation cover during the growing season.

Hardwood Swamp (HS): Forested wetlands dominated by one or more deciduous hardwood species typically including black gum, red maple, water ash, water elm, and willows. Cypress is often a significant component of this type. Subject to annual, seasonal periods of prolonged flooding.

Hydric Hammock (HH): Forested systems dominated by a mixture of broad-leaved evergreen and deciduous tree species. Cabbage palmetto (CP) may be dominant in some variants of this type. Seldom inundated but with saturated soils during much of the year.

Lakeshore Emergents (DM-LS): Emergent vegetation growing along lake shores and usually semipermanently flooded. *Panicum hemitomon* and species of *Scirpus* are most common.

Shallow Marsh (SM): Herbaceous or graminoid communities dominated by species such as sawgrass, maidencane, cattails, pickerel weed, arrowhead, or other grasses and broad leaved herbs. Occurs most often on organic soils that are subject to lengthy seasonal inundation. Subject to occasional fire.

Shrub Bog (SB): Dominated by shrubby vegetation occupying typical bayhead sites. Often developing in bayheads destroyed by fire or other disturbance. Hydrology similar to that of bayhead communities.

Shrubgall (SG): Wetlands dominated by shrubby vegetation occupying typical baygall sites and having similar hydrologies and soils.

Shrub Swamp (SS): Dominated by willows, buttonbush, or similar appearing vegetation. Hydrology similar to that of cypress, hardwood swamp, or shallow marsh communities.

Submerged Aquatic Beds (AB): Communities of aquatic plants rooted in the sediments of shallow waterbodies and having the majority of their photosynthetic tissues below the water surface. Generally permanently flooded.

Transitional Shrub (TS): Dominated by transitional shrubby vegetation at upland margins of wetter community types or on clear cut hydric sites. Also, develops on wet prairie sites that have been protected from fire. Wax myrtle (*Myrica cerifera*) and *Baccharis halimifolia* are typical species.

Water (W): Unvegetated or sparsely vegetated sites subject to prolonged or semipermanent flooding. Includes lakes, streams, ponds, and other waterbodies.

Water Lilies (DM-N): Floating leaved species in the genera *Nymphaea, Nuphar, Nelumbo, Brasenia,* and *Nymphoides.* Usually semipermanently to permanently flooded.

Wet Prairie (WP): Communities of grasses, sedges, rushes, and herbs typically dominated by sand cordgrass, maidencane, or a mixture of species. Usually on mineral soils that are inundated for a relatively short duration each year, but with prolonged soil saturation. Subject to frequent fire.

Appendix F—Flood Profiles for 10-Year, 25-Year, and 100-Year 24-Hour Storm Events Under Existing Conditions

Flood Profiles

Note: HS denotes a hydraulic structure (culverts, bridges, weirs, or any water control structure)

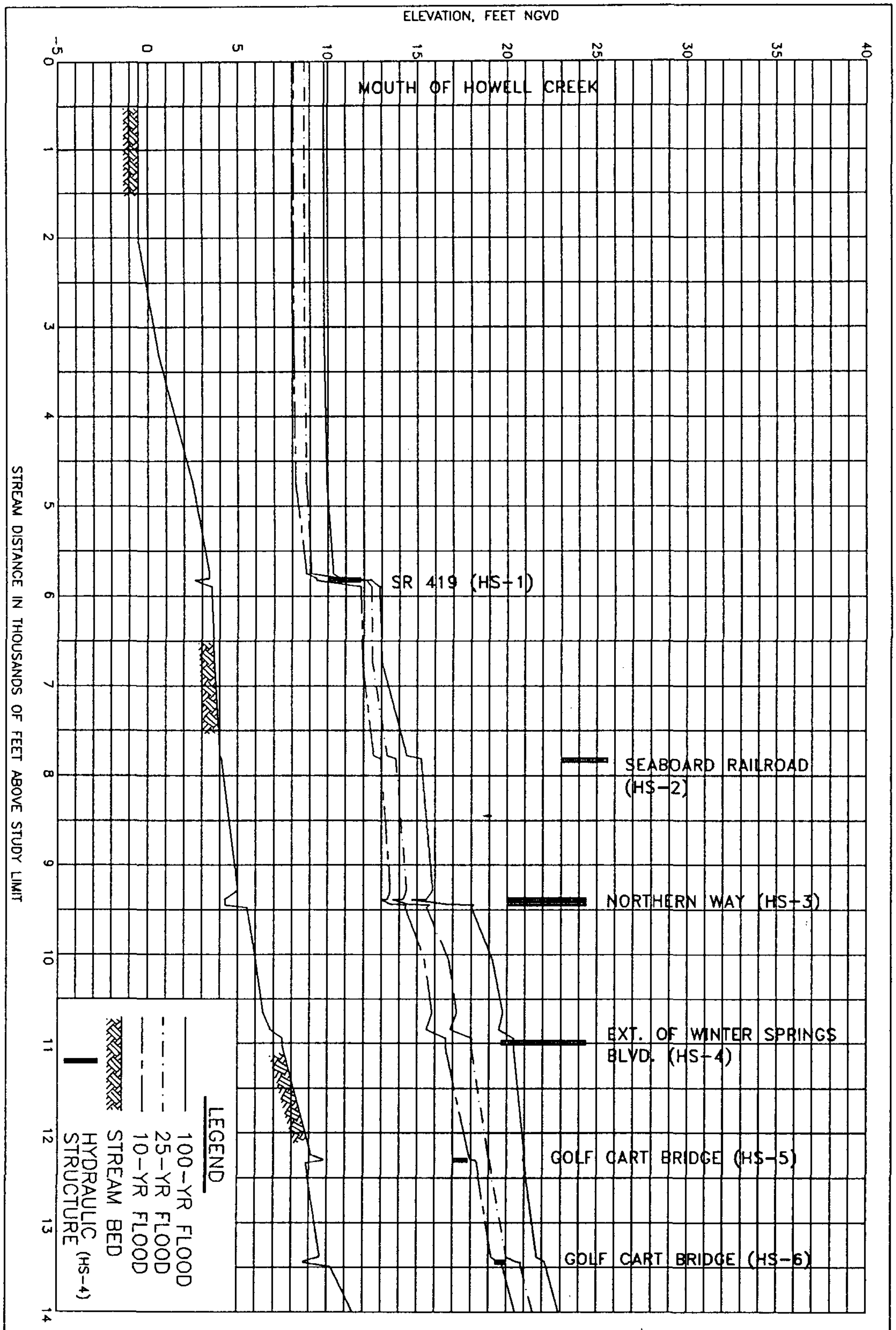


Plate No. 1	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 0+00 TO 140+00

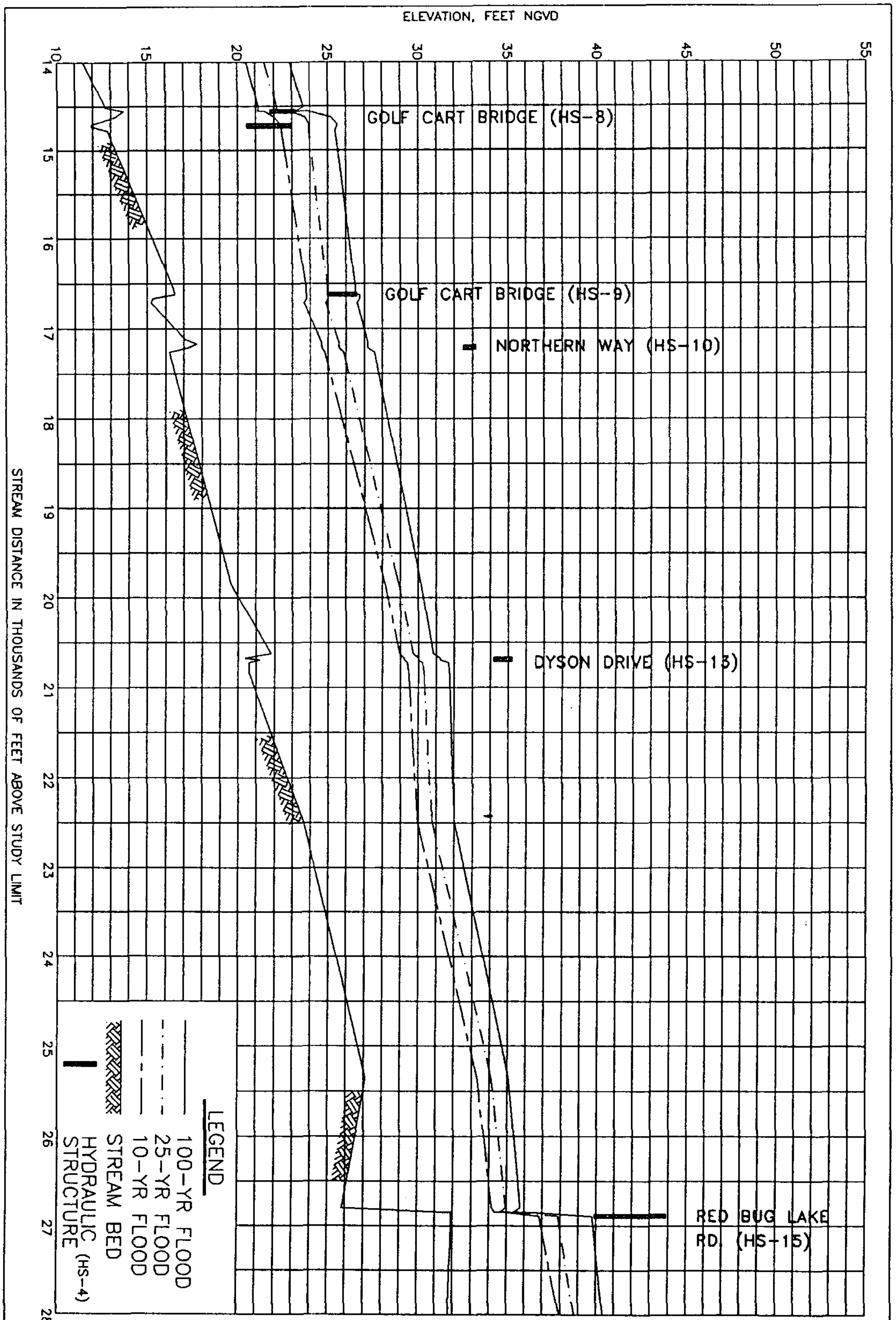


Plate No. 2	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 140+00 TO 280+00

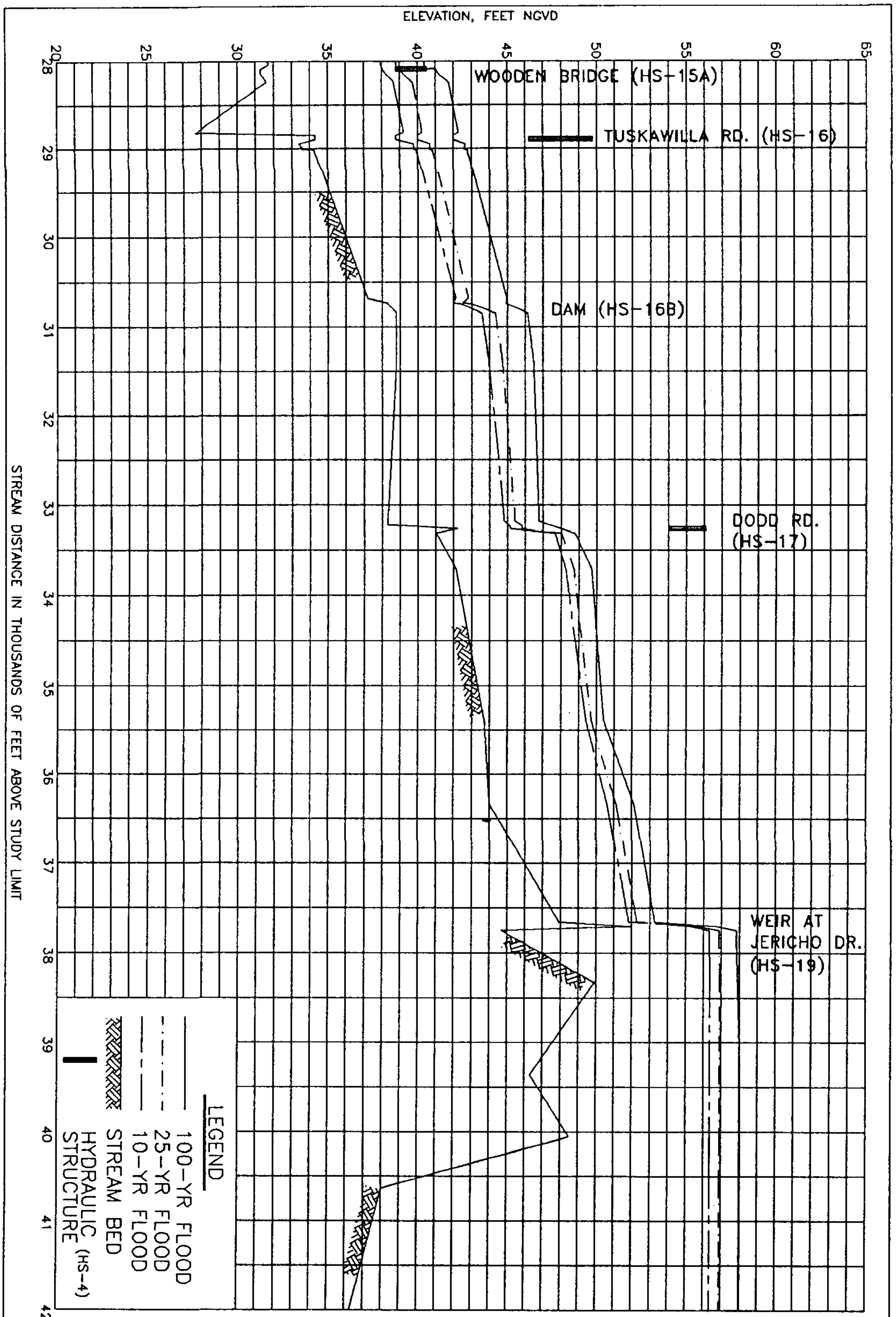


Plate No. 3	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 280+00 TO 420+00

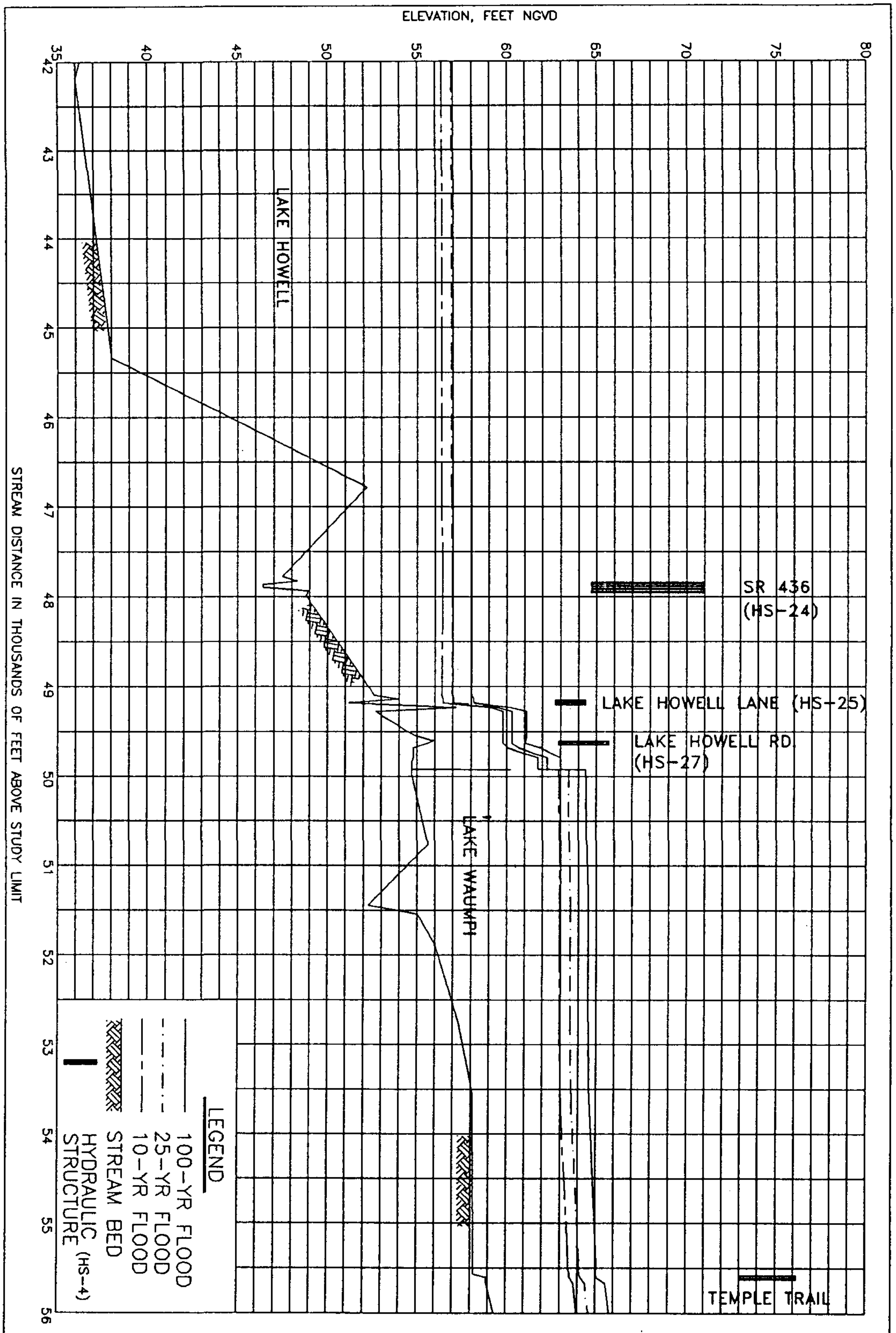


Plate No. 4	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 420+00 TO 560+00

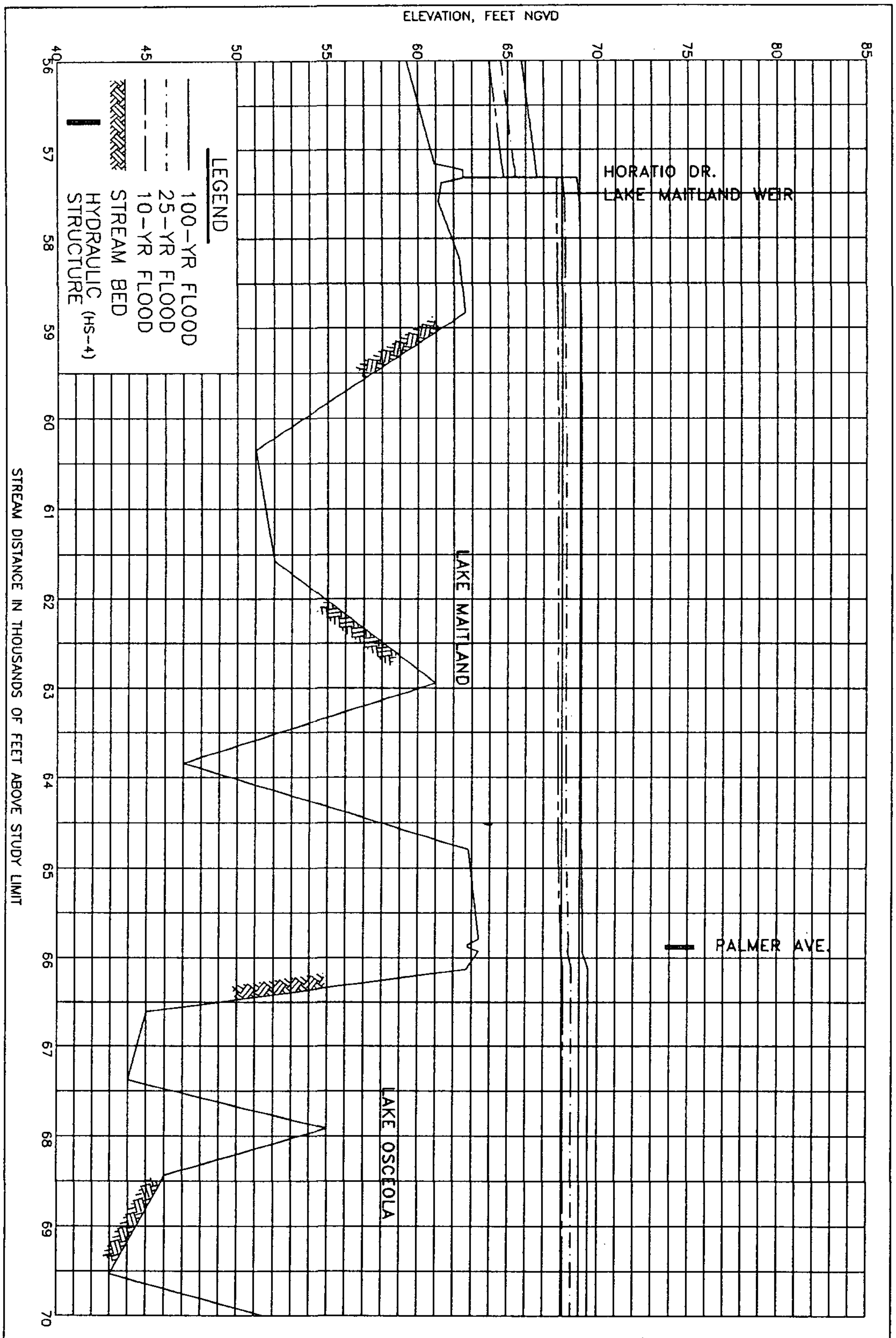


Plate No. 5	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 560+00 TO 700+00

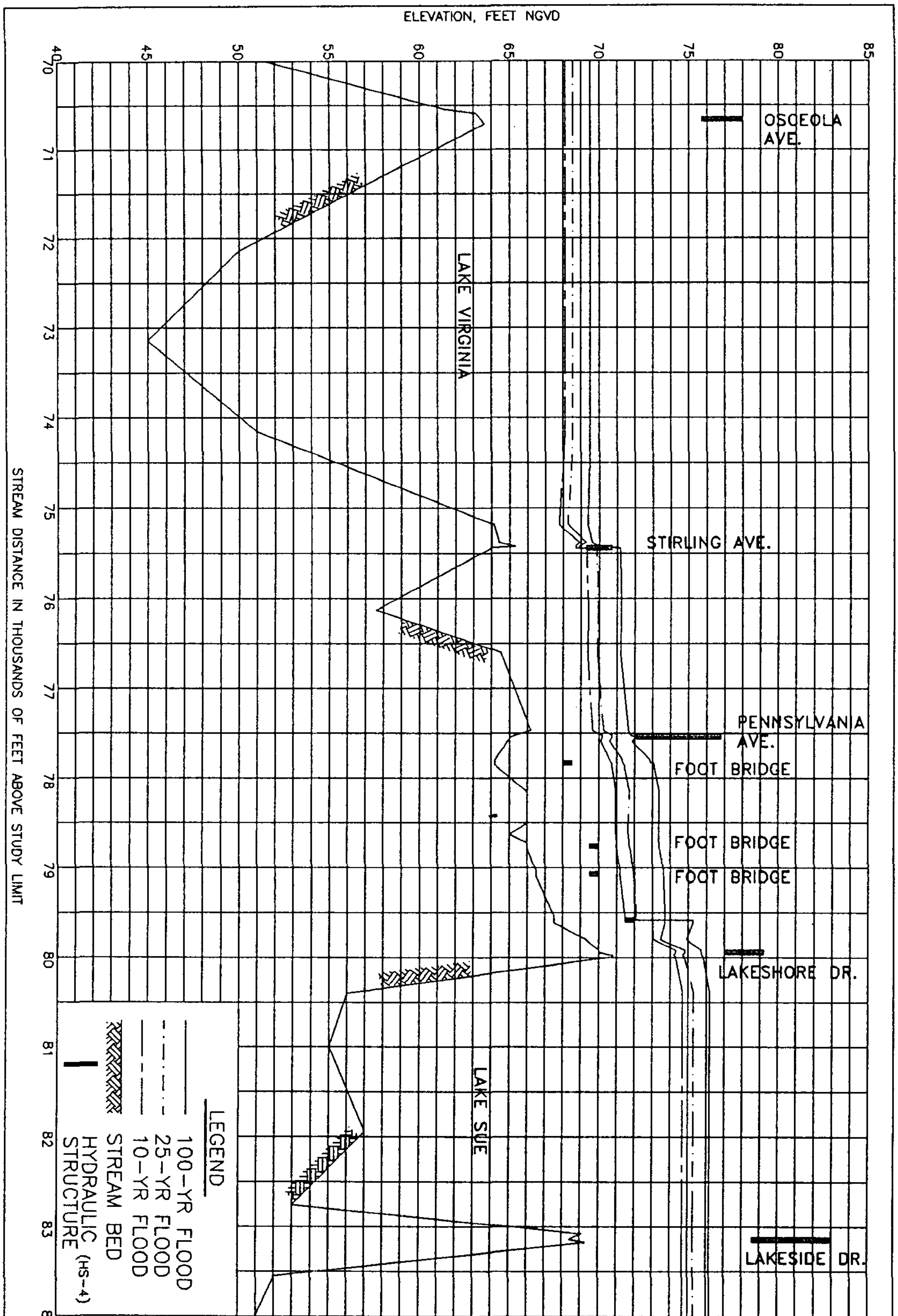


Plate No. 6	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 700+00 TO 840+00

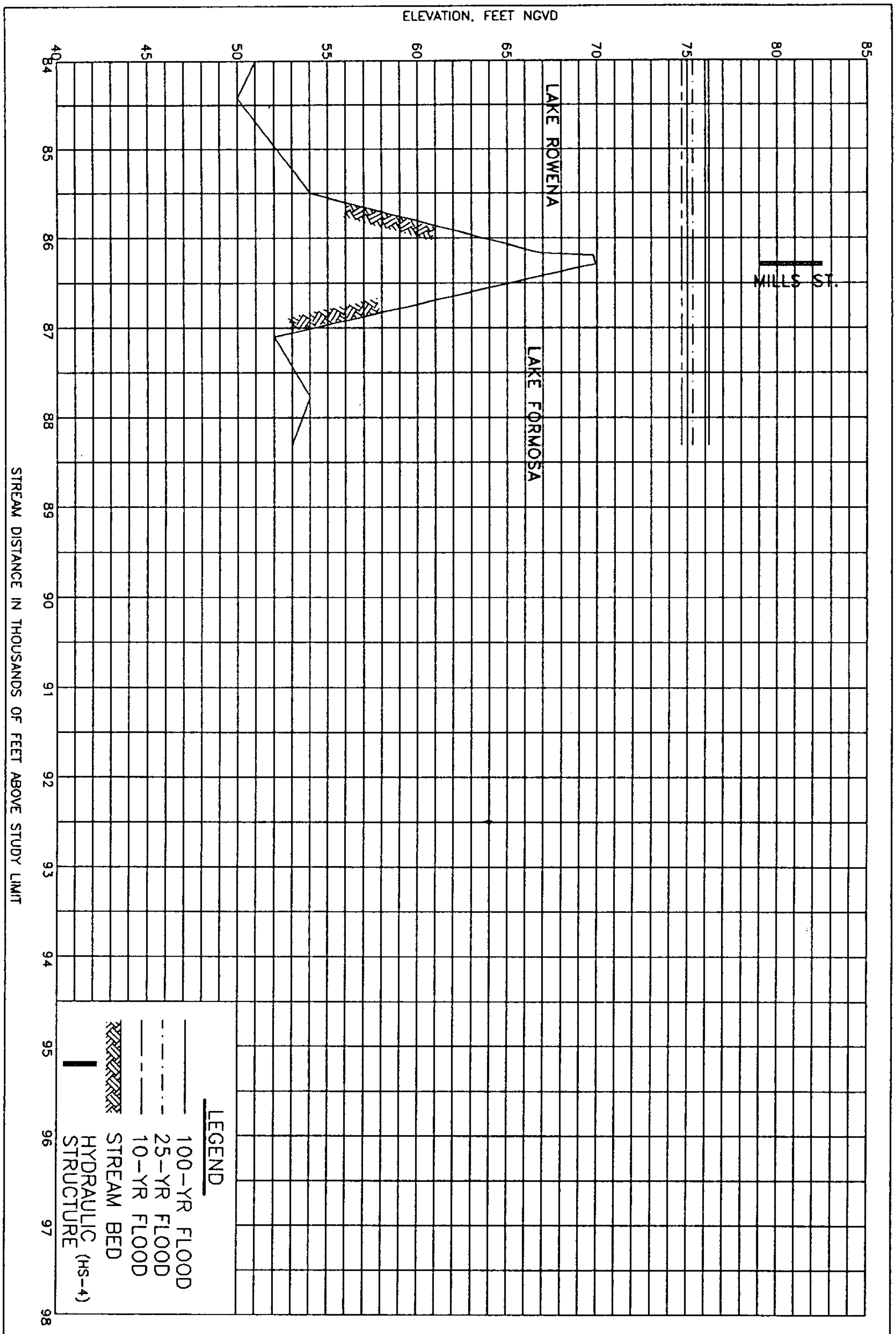


Plate No. 7	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK STA 840+00 TO 980+00

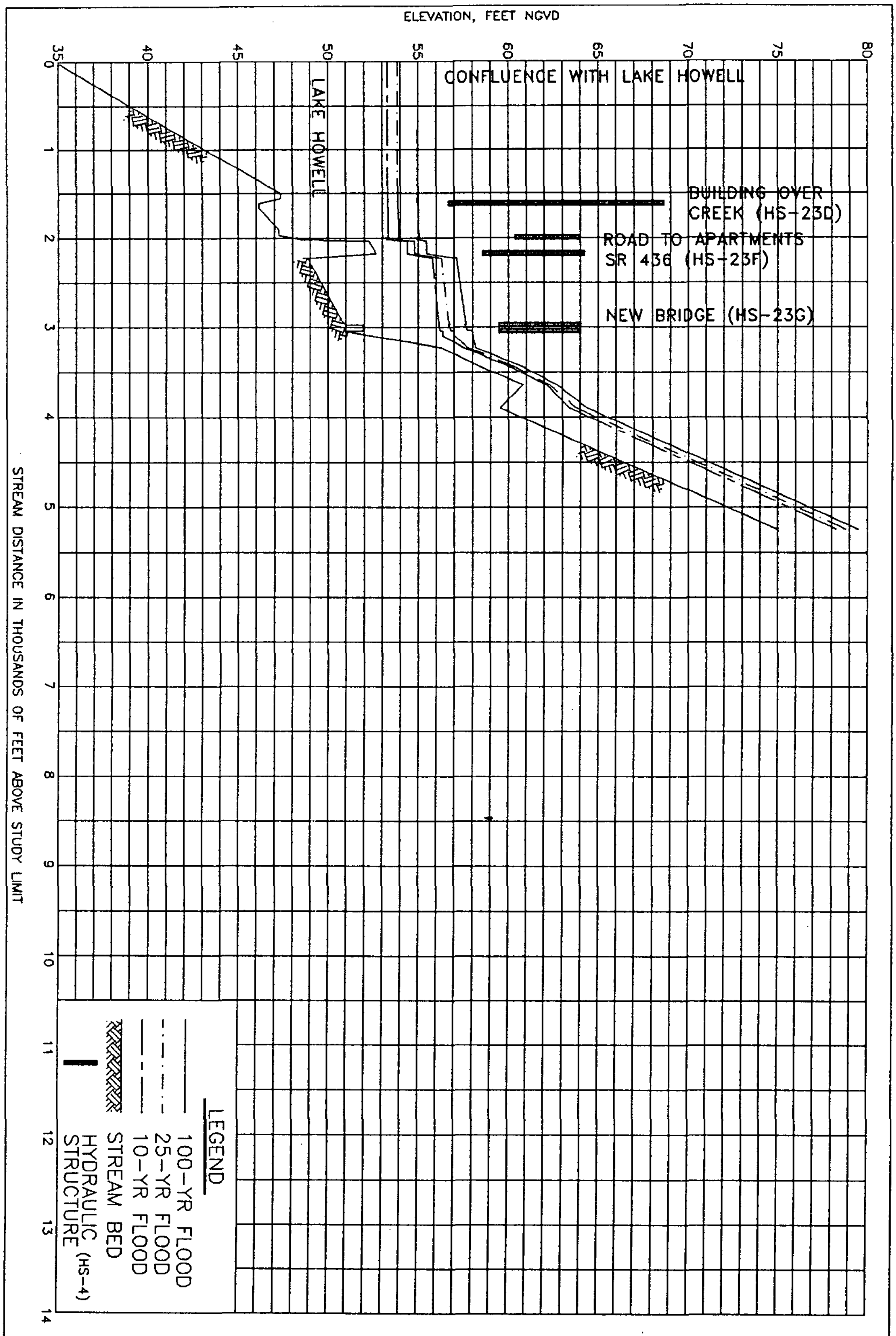
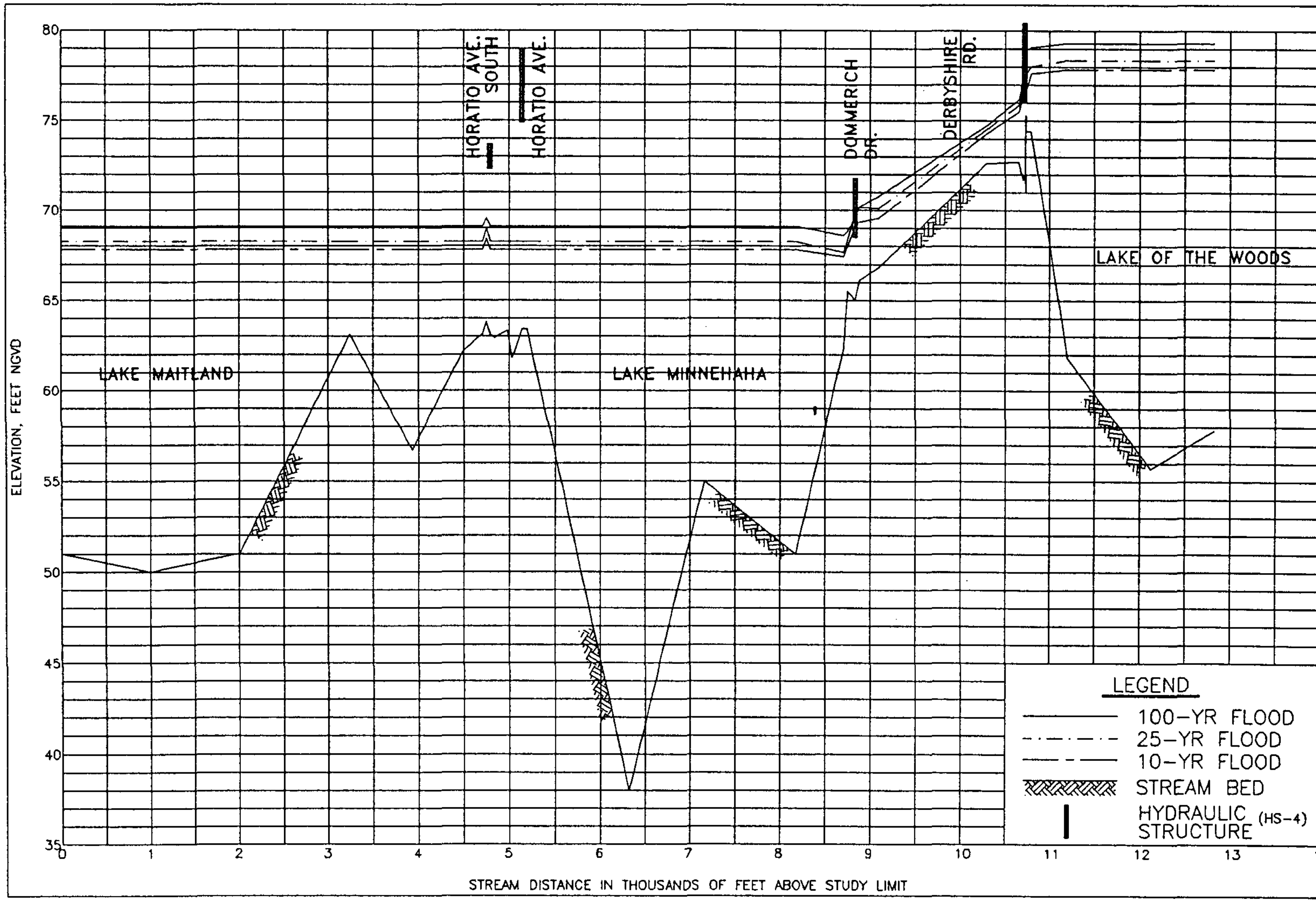


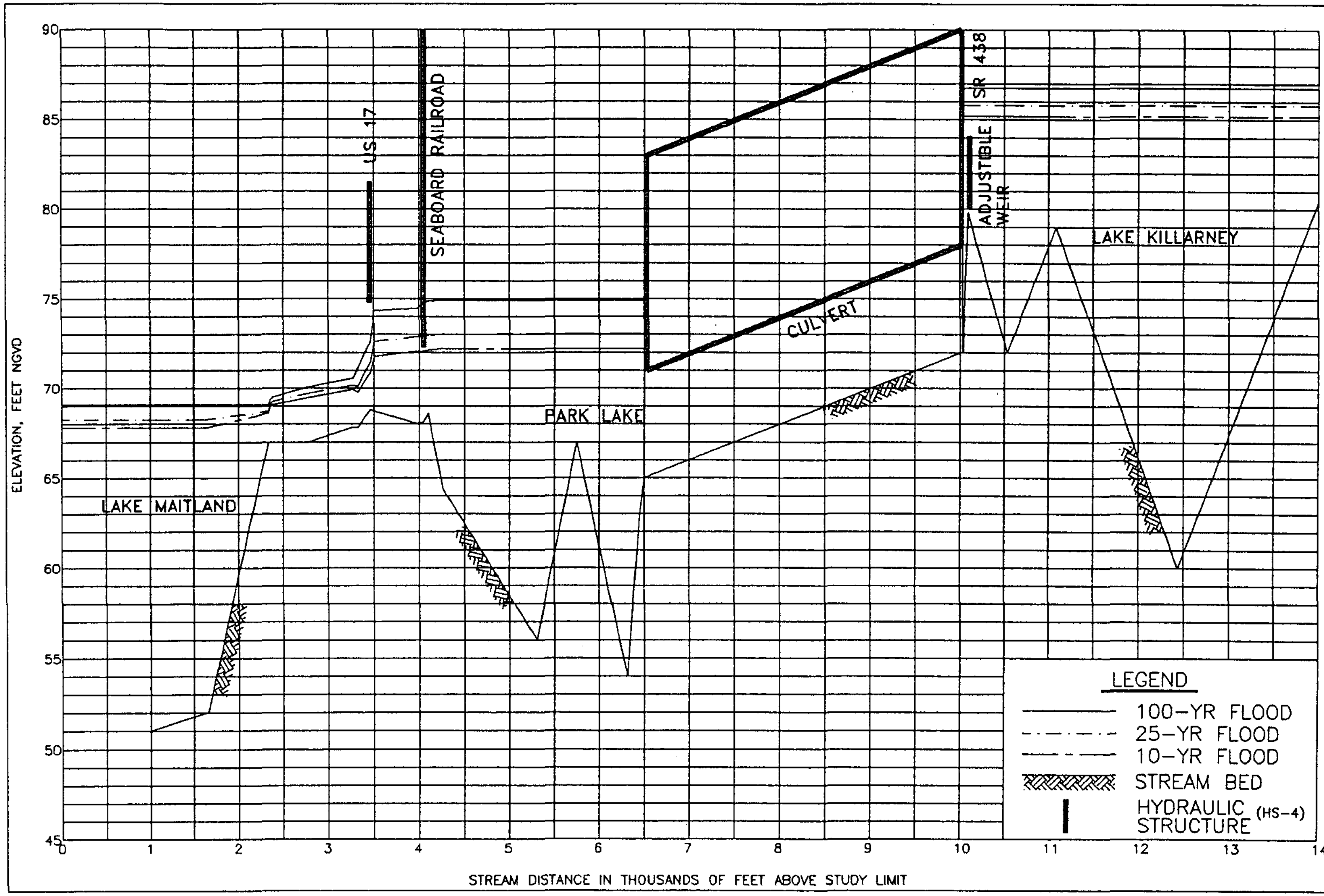
Plate No. 8	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK TRIBUTARY 1 STA 0+00 TO 140+00



ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
THE HOWELL CREEK BASIN

FLOOD PROFILES – EXISTING CONDITIONS
HOWELL CREEK TRIBUTARY 2
STA 0+00 TO 140+00

Plate No. 9



FLOOD PROFILES – EXISTING CONDITIONS
HOWELL CREEK TRIBUTARY 3
STA 0+00 TO 140+00

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT
THE HOWELL CREEK BASIN

Plate No.
10

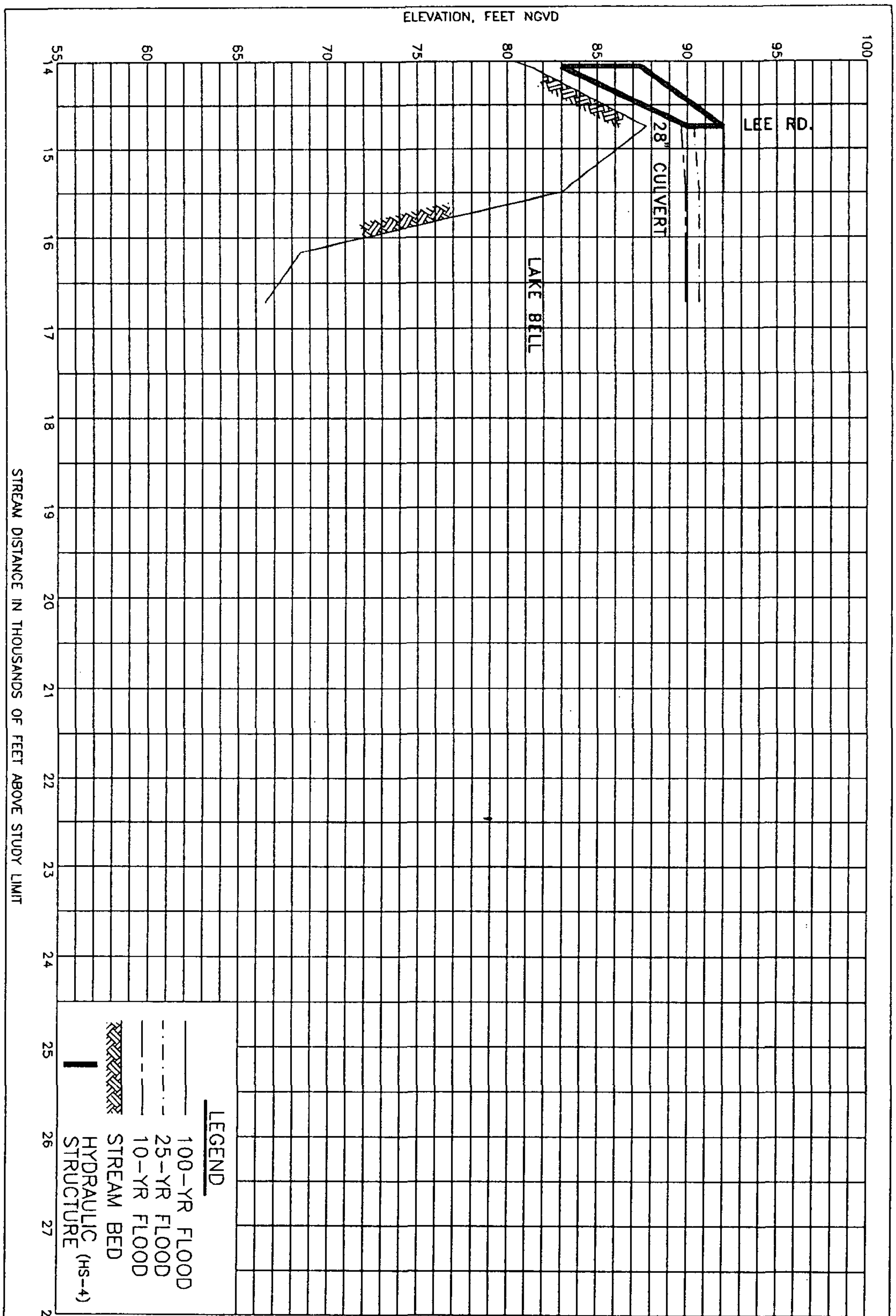


Plate No. 11	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK TRIBUTARY 3 STA 140+00 TO 280+00

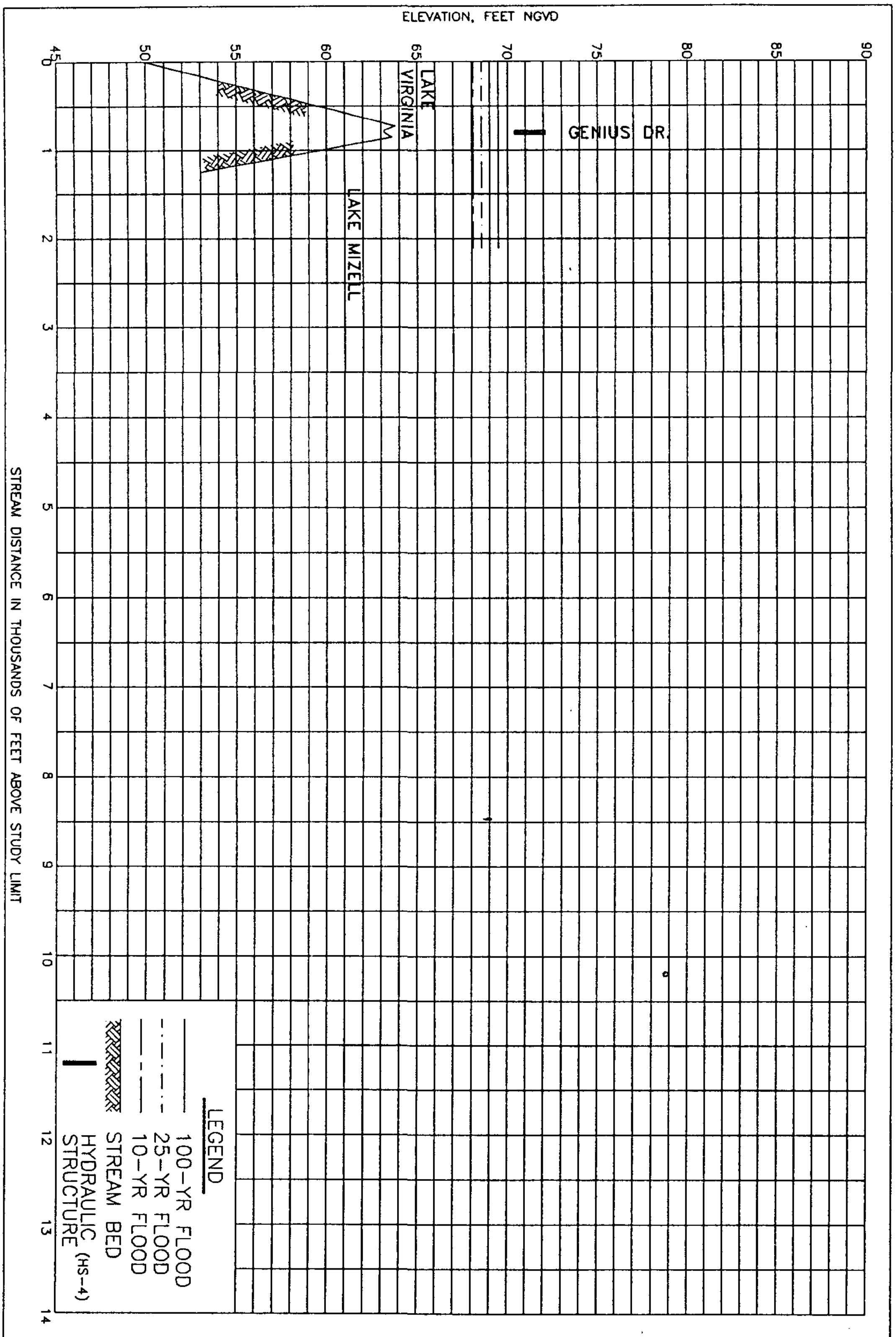


Plate No. 12	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK TRIBUTARY 4 STA 0+00 TO 140+00

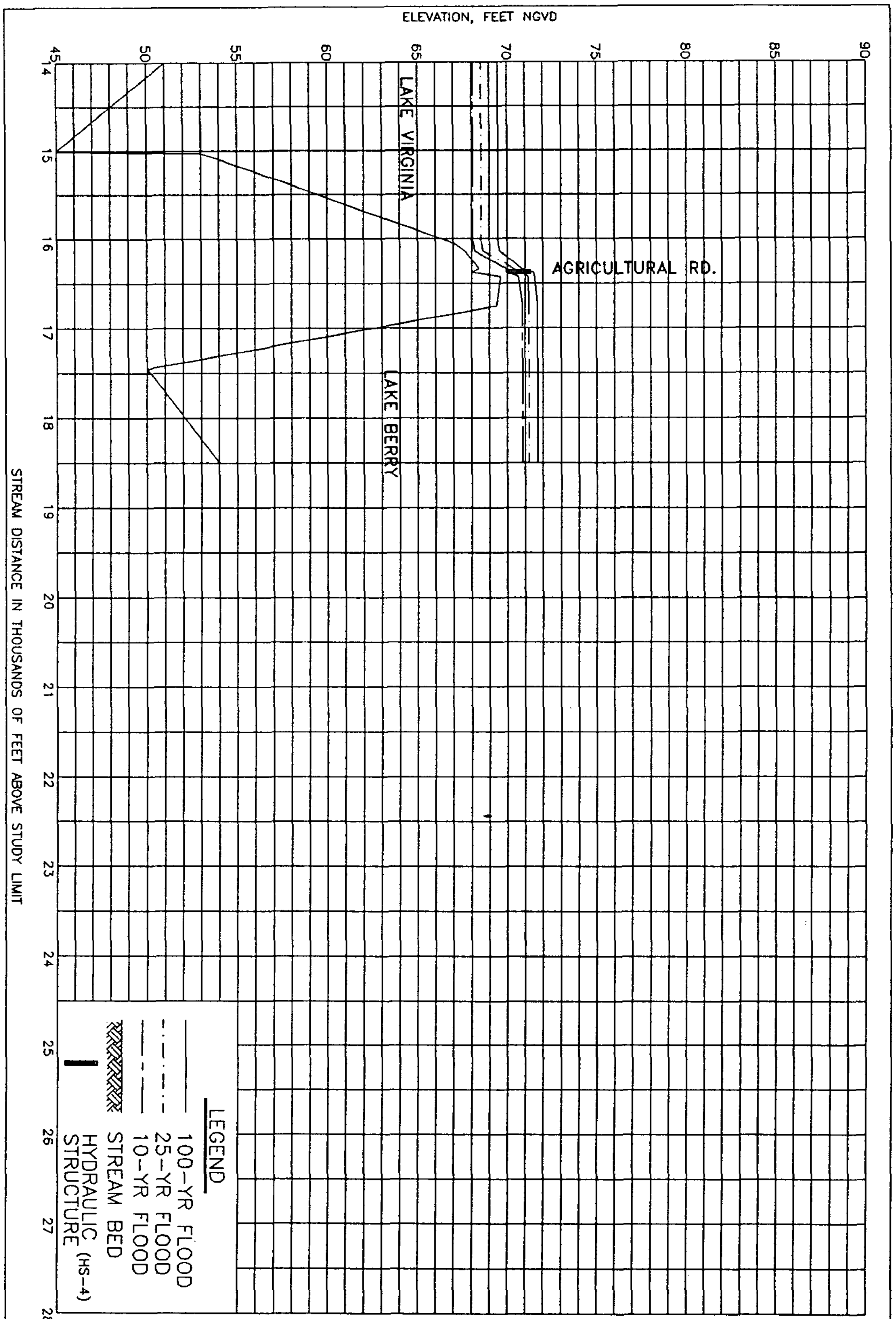


Plate No. 13	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK TRIBUTARY 5 STA 140+00 TO 280+00

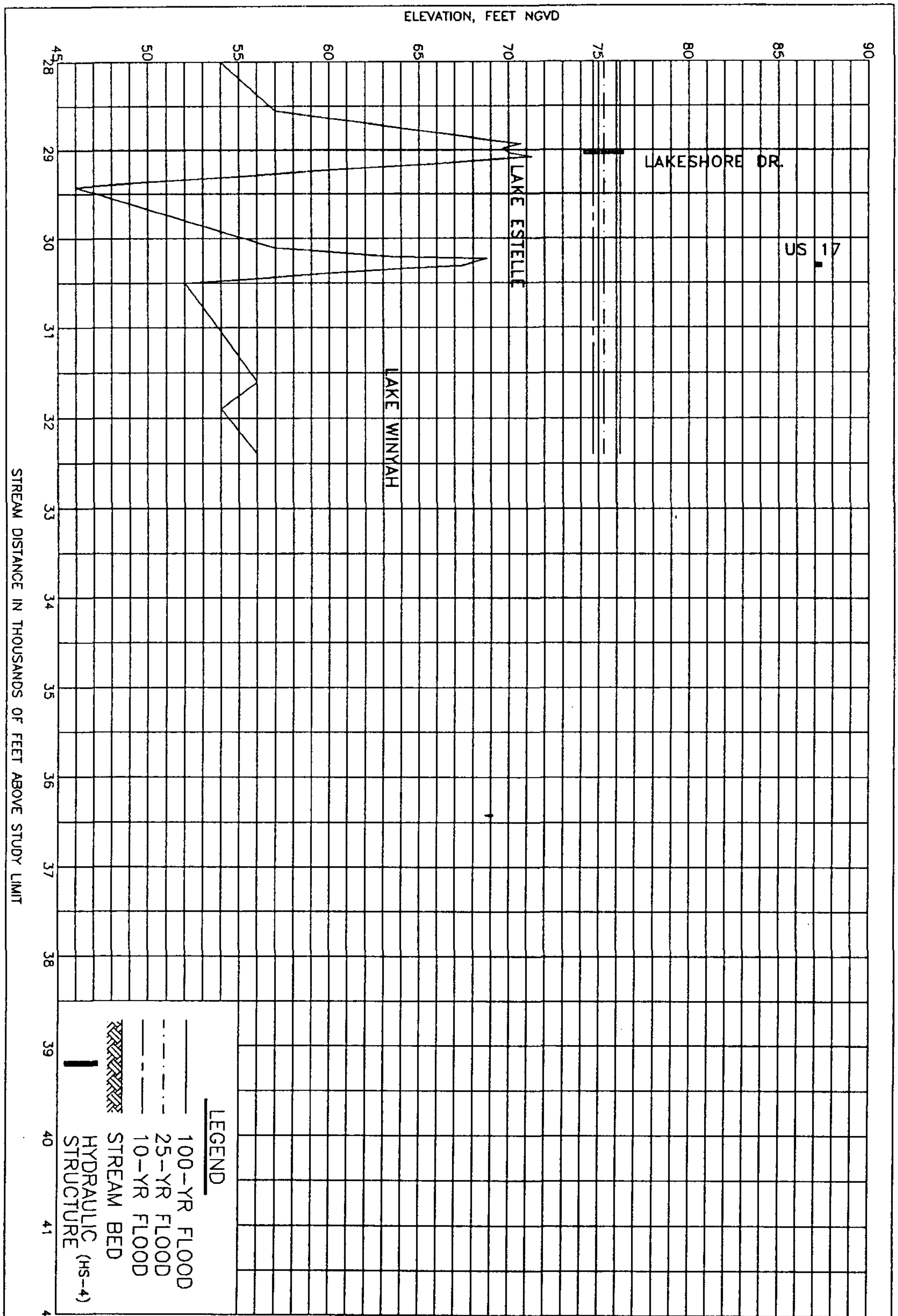


Plate No. 14	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE HOWELL CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS HOWELL CREEK TRIBUTARY 6 STA 280+00 TO 420+00

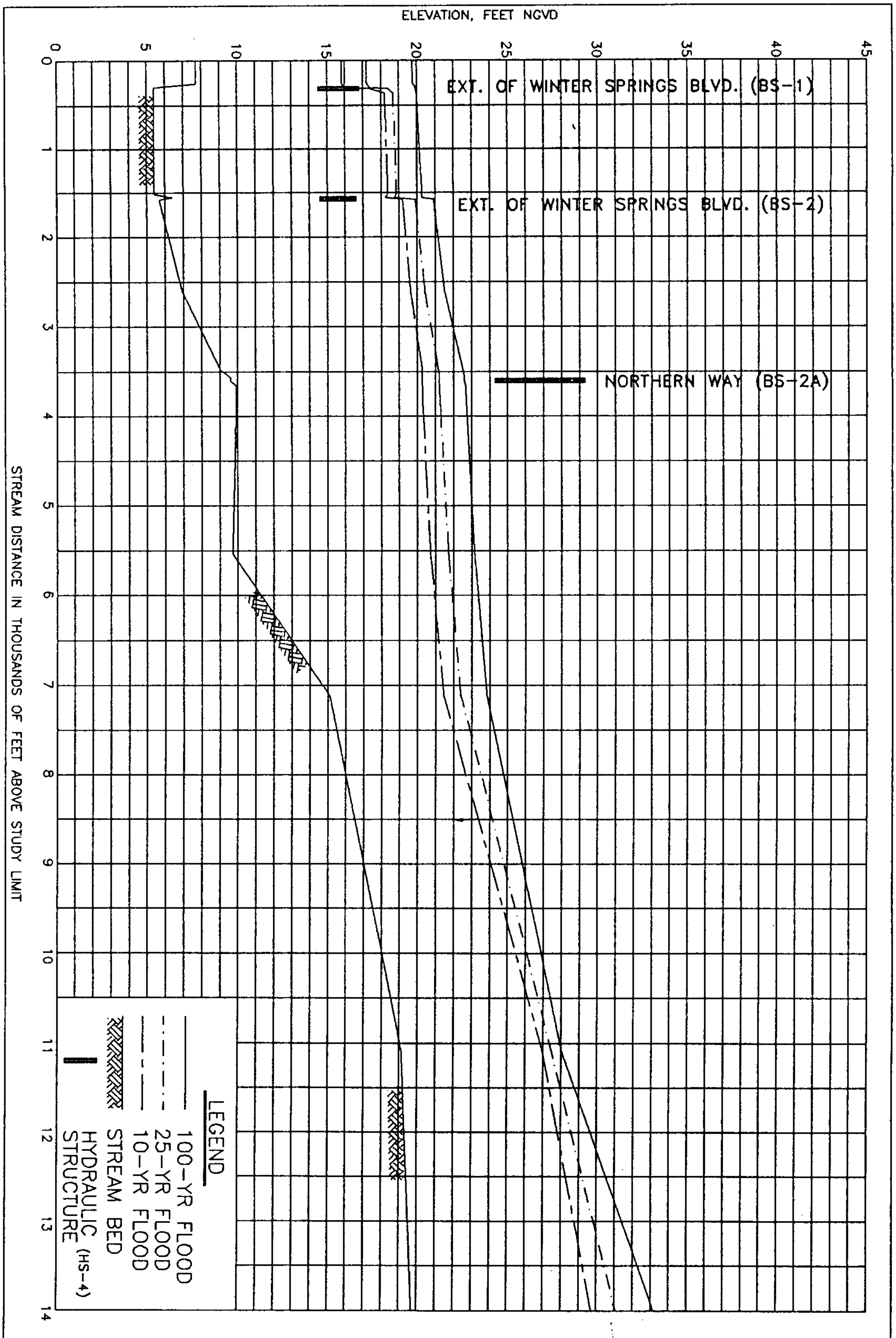


Plate No. 15	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE BEAR CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS BEAR CREEK STA 0+00 TO 140+00

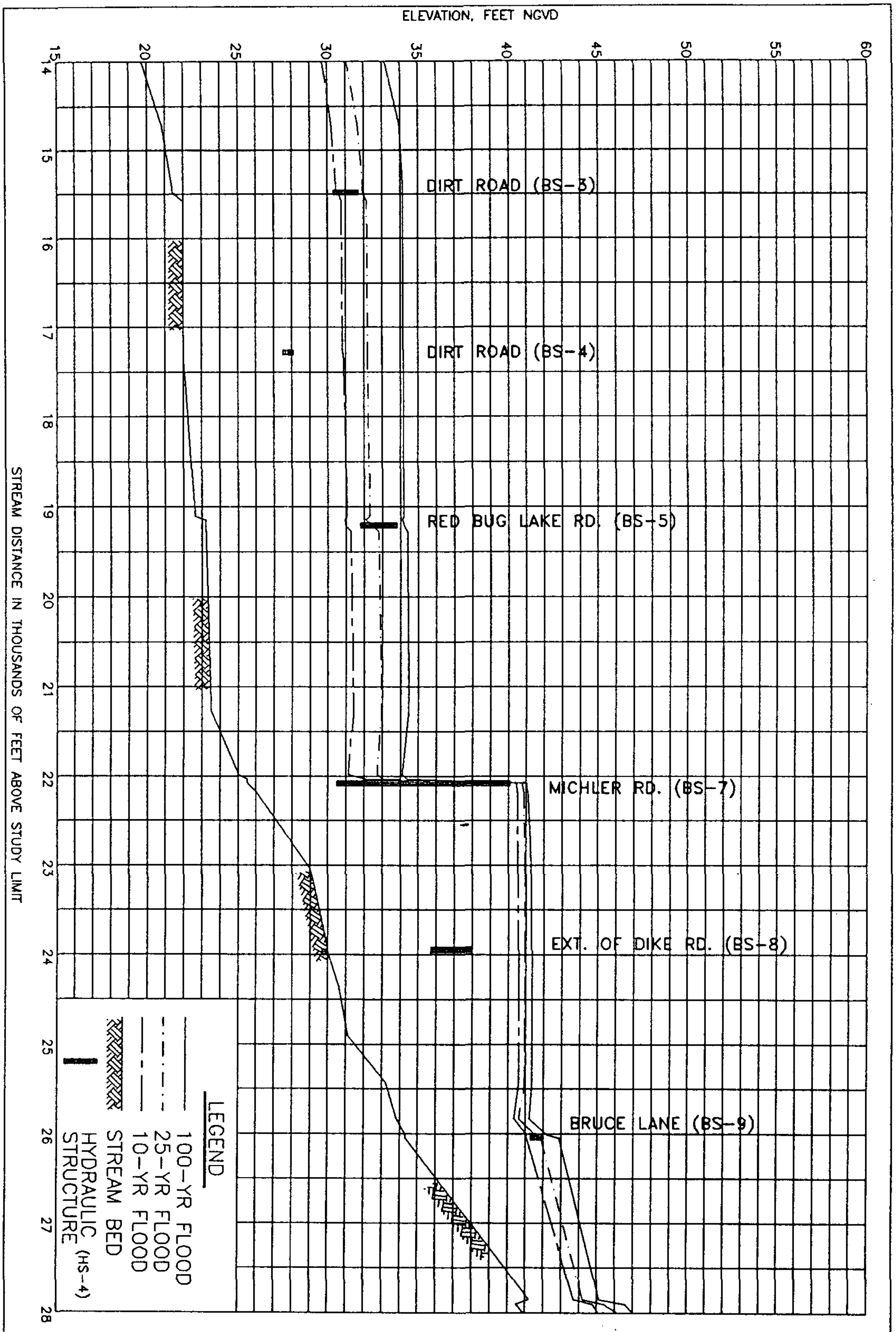


Plate No. 16	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE BEAR CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS BEAR CREEK STA 140+00 TO 280+00

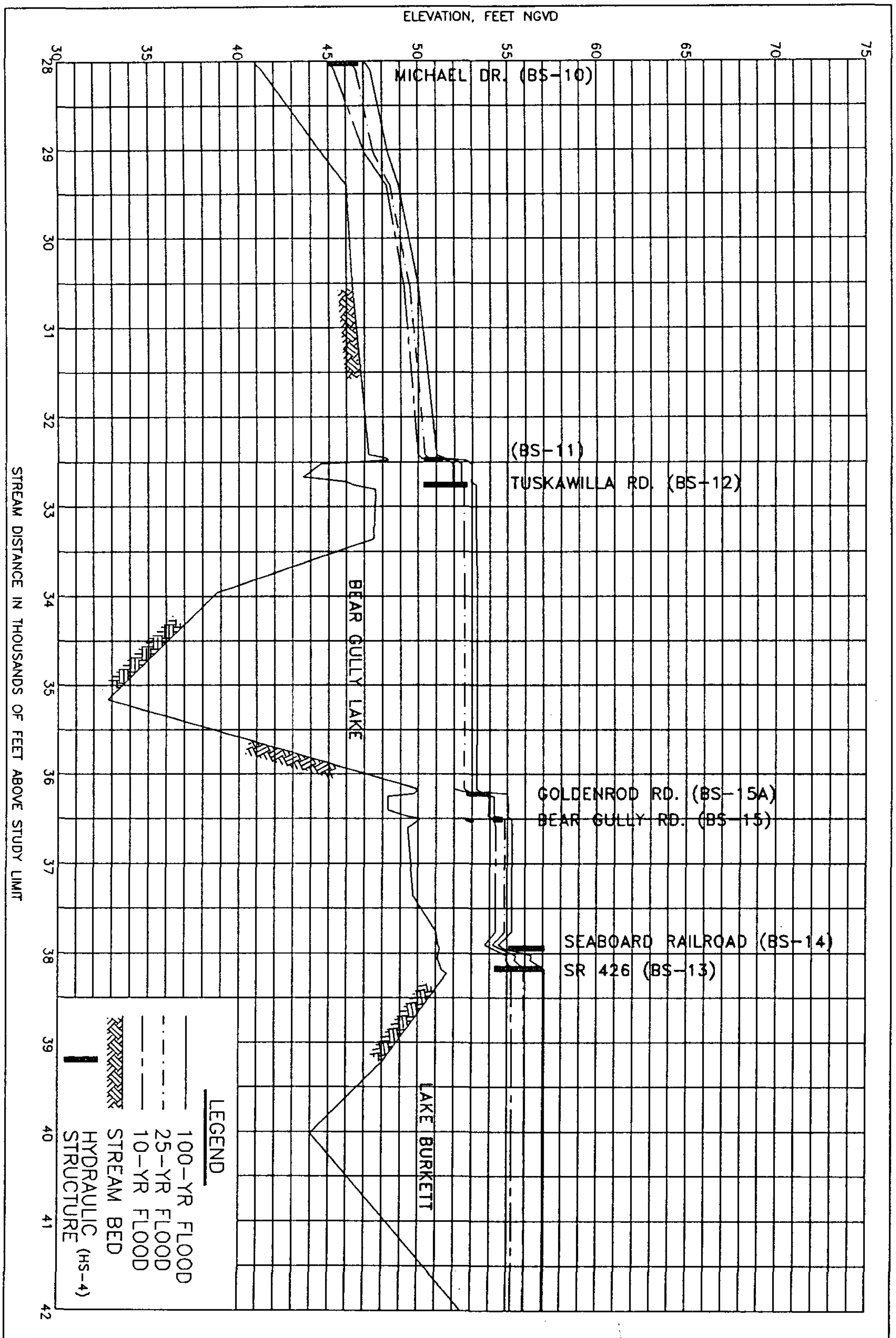


Plate No. 17	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE BEAR CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS BEAR CREEK STA 280+00 TO 420+00

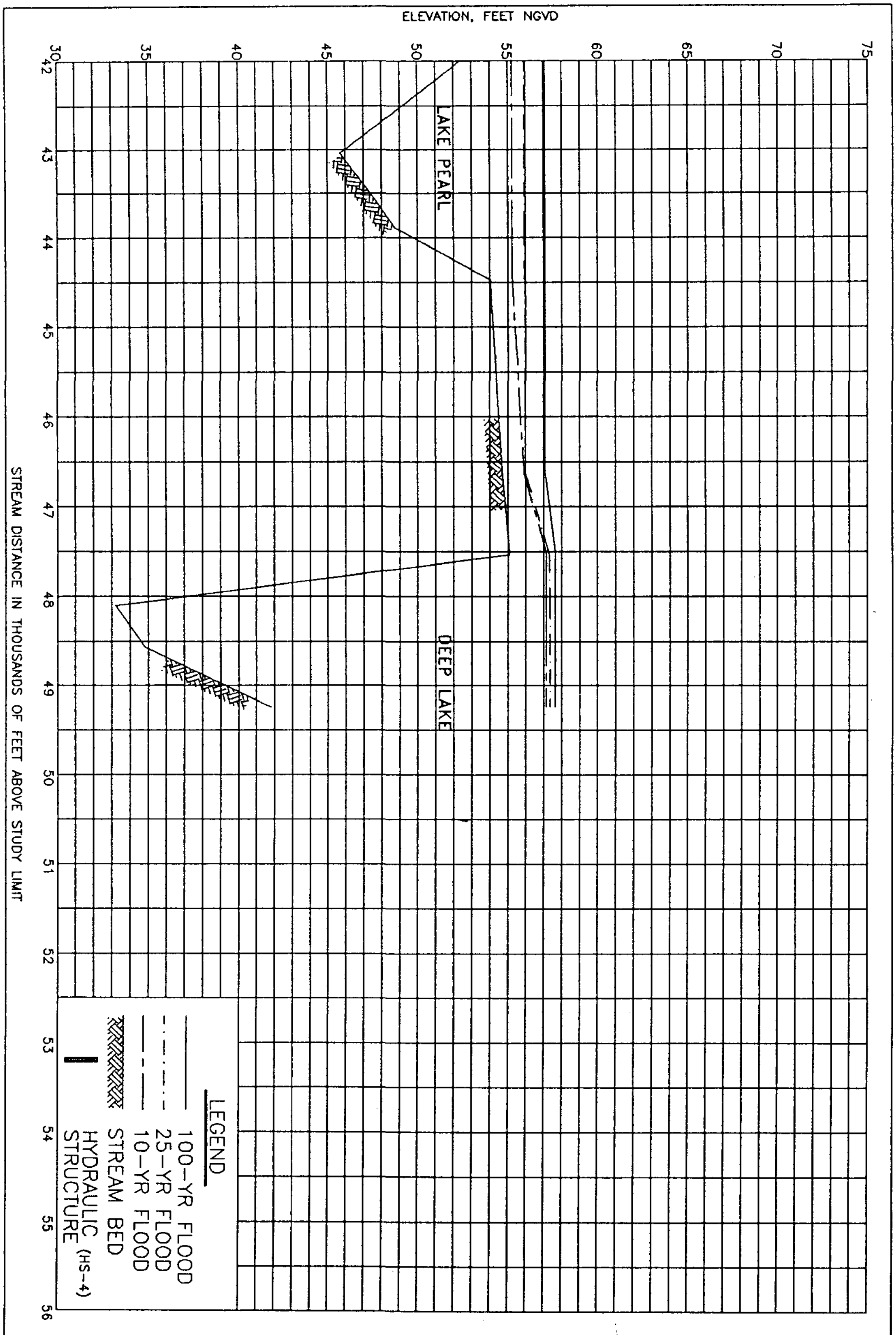


Plate No. 18	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE BEAR CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS BEAR CREEK STA 420+00 TO 560+00

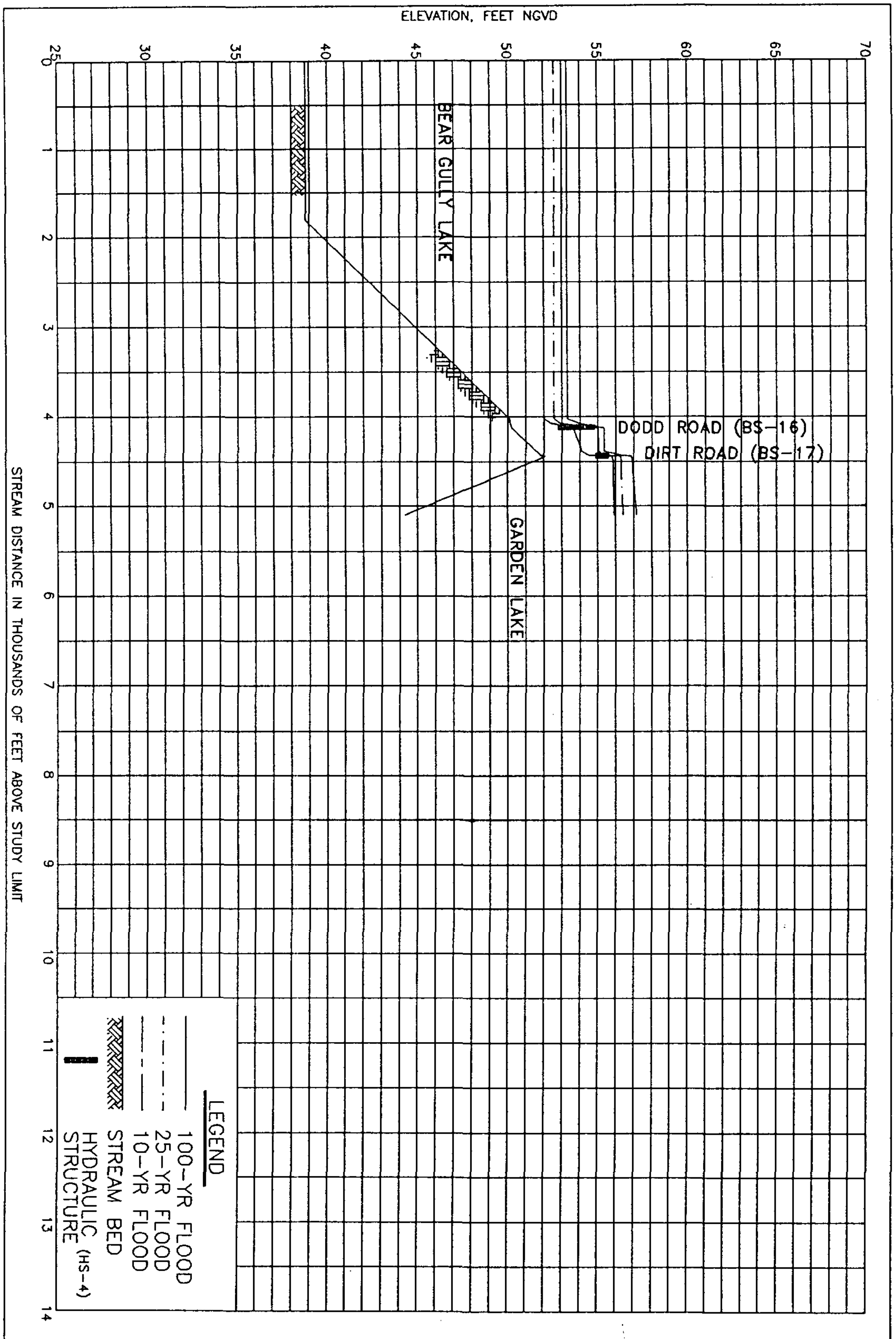


Plate No. 19	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE BEAR CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS BEAR CREEK TRIBUTARY 1 STA 0+00 TO 140+00

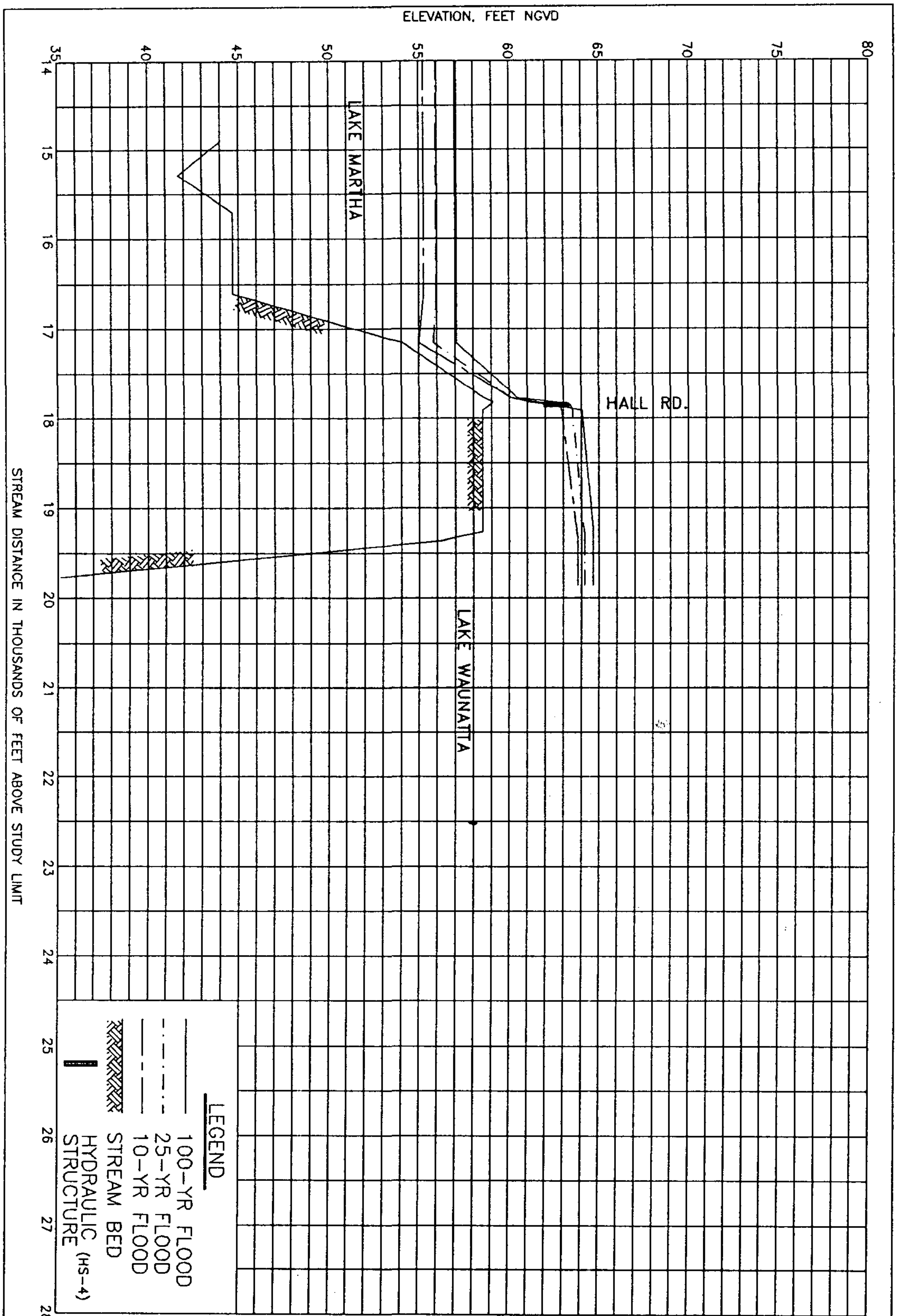


Plate No. 20	ST. JOHNS RIVER WATER MANAGEMENT DISTRICT THE BEAR CREEK BASIN	FLOOD PROFILES – EXISTING CONDITIONS BEAR CREEK TRIBUTARY 2 STA 140+00 TO 280+00

APPENDIX G—PUBLIC COMMENTS

20-218
(not dated)

PETITION

1. We, the undersigned waterfront residents on the northern part of the Maitland/Winter Park Chain of Lakes disagree with and are vehemently opposed to the St. Johns River Water Management District flood management plan to lower the chain's water level by two feet for the following reasons:

   A. Lowering of the water level from its present level by 24 inches would make the Long Branch Canal with its nine homes a large mud bottom ditch. There would not be sufficient water for us to get out boats and into the Chain of Lakes.

   B. The action to lower the water level would leave our boat houses, boat hoists and boat docks useless.

   C. By making our canal system useless (a large muddy ditch) the plan would have a most devastating impact on the value of our water/canal front homes by decreasing their value by a minimum of 1/4 to 1/3 of their total value.

2. We respectfully ask that the St. Johns Water Managment District in coordination with Orange County, the Cities of Orlando, Winter Park and Maitland representatives reconsider this plan and re-evaluate the impact on all water front homes on the entire Maitland/Winter Park Chain of Lakes shoreline, not just a few homes on Lake Maitland.

NAMES	HOMES ADDRESS	WATERWAY
1 Ray T. Klein	650 Old Horatio Ave	Long branch Canal
2 Ronald H. Klein	610 East Horatio Ave	Long Branch Canal
3 Elias Gongora	630 East Horatio Ave	Long Branch Canal
4 Francis V. Young	620 E Horatio	Long Branch
5 Ronald Aspinwall	640 E Horatio	Long Branch
6 Charles A. Rembergt	680 E. Old Horatio Ave,	Long Branch
7) Joe Glynn	131 Woodstream Ct	Lake Minnehaha
8) Richard Krebs	100 Woodstream Ct, Maitland, FL	Nina Canal
9 Lola VanZandt	690 Old Horatio Ave Maitland	Long Branch Canal

George W. Thorpe, Jr.
151 Trismen Terrace
Winter Park, FL 32789

Phone H (407) 628-4856
O (407) 628-4856

(1) ~~Lowering lake levels may cause aquatic plants to die.~~

(1) Winter Park requires landscaping waterfront with aquatic plants when undesirable aquatic plants such as torpedo grass is removed. Lowering of lake levels may cause many aquatic plants to die or decline

(2). In Winter Park docks are only allowed to extend 30 feet into lake from the high water mark. Lowering lakes levels will increase the probability the boats will not be able to be launched from boat houses.

(3) Lowering lake levels ~~made~~ will increase the probability ~~that~~ the canals on the Winter Park Chain of lakes will become impassable more often They have been impassable in ~~the~~ past droughts

(4) Reduction in property values of waterfront properties considered in cost benefit analysis.

20-219-PUB-14-04
X-20-219-DAT-30-00

14 MAY 85 11:50

May 8, 1985

Mr. Jim Braden
St. Johns Water District
P.O. Box 1429
Palatka, Fla. 32077

Dear Sir:

This is a request for your assistance in getting a natural flow of water in Howell Creek.

This is not a private creek but it belongs to the State of Florida. The State should maintain the natural flow.

Some years back, Orange County was permitted to construct a dam on Horatio. This has resulted in Orange County controling the flow of water. They only let us have water when they don't want it, as in the wet season. I fail to understand why one County can do this to a State stream.

The wild life is suffering down stream. There was once plenty of wildlife - ducks - birds - etc. Now we have nothing but snakes trying to find water.

This stream is the source of water for the [illegible] to protect our property.

We need [illegible] out the sewage and opening [illegible] gates on Horatio to allow [illegible] water to flow naturally. [illegible] permission for [illegible] through

property off Lake Howell Road.
Your help in this matter will be greatly appreciated by all who live on the creek and all those who depend on it for fire protection.

Sincerely,
Bernard R Brumfield
503 Brookside Ct.
Maitland, Fla. 32751

C.C.
Eng. Mr. Henry Dean
St. Johns Water District
P.O. Box 1429
Palatka, Fla. 32077

Alex Alexander
State Dept. Environmental Regulations
3319 Maguire Blvd.
Orlando, Fla. 32803

Commissioner Sandra Glenn
Board of County Commissioners
Seminole County Court House
North Park Ave.
Sanford, Fla. 327[illegible]

20-219 DAT-04-08

Orange County

Public Works Division
George W. Cole, P.E., Director
Stormwater Management Department
M. Krishnamurthy, Ph.D., P.E., Manager
4200 Whitcomb Avenue
Orlando, Florida 32839-9205
Telephone (407) 836-7990
FAX (407) 836-7999

March 12, 1991

Mr. Tom Ziegler, P.E.
Department of Resources Management
St. Johns River Water Management District
Post Office Box 1429
Palatka, FL 32178-1429

Subject: A proposed Flood Management Plan for The Howell Creek Basin

Dear Mr. Ziegler:

We have completed our review of the proposed Flood Management Plan for the Howell Creek Basin and offer the following comments:

(a) The methodology used to determine the discharge rating curve for Lake Maitland control structure under all the proposed three alternatives needs to be explained. Was the downstream tailwater effect taken into consideration in the analysis?

(b) For the control structure at Lake Maitland, a practical gate operating schedule should be given. To achieve the stage discharge relationship as presented in Figure 5-1 of the report, a curve between the gate openings and the water levels in the downstream canal and in Lake Maitland should be given.

(c) Comments (a) and (b) are also applicable for Lake Killarney's control structure.

(d) Orange County should get an assurance from the District that all the proposed improvements are permittable from the various agencies. The District should exempt Orange County from its own permit requirements for the construction and operation of their suggested proposed flood control measures for Lake Maitland and Lake Killarney. If such exemption cannot be granted, all back up computations to obtain such permits should be given to Orange County. As you recall, the original study was requested in the 1980's to obtain a rew operating schedule for the gates in Lake Maitland. Orange County should not be put in a position to undertake another lengthy study or questioning process to implement the proposed operating schedule.

(e) In the study report, there is no consideration of a regional flood control structure which may benefit the regional governments? Your agency is the proper institution to objectively look at a regional solution for the watershed rather than a piece-meal approach.

(f) What will be the role of the district in undertaking the construction of the proposed improvement, if local governments are willing to participate in a cost sharing program ?

(g) We would like to receive a copy of the all the comments received from various agencies.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

M Krishnamurthy

M. Krishnamurthy

MK/DB/mhf

cc: George W. Cole, P.E., Director, Public Works Division
William P. Baxter, P.E., Deputy Director, Public Works Division
Deodat Budhu, P.E., Staff Engineer, Stormwater Management Department

30-217

Orange County

Public Works Division
George W. Cole, P.E., Director
Stormwater Management Department
M. Krishnamurthy, Ph.D., P.E., Manager
4200 Whitcomb Avenue
Orlando, Florida 32839-9205
Telephone (407) 836-7990
FAX (407) 836-7999

January 10, 1992

ST. JOHNS RIVER WATER MGT. DISTRICT
JAN 15 1992
MAIL ROOM

Thomas K. Ziegler, P.E.
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subject: **Data for flood damage assessment on Lake Rowena and Sue Howell Creek Water Management Study**

Dear Mr. Ziegler:

As per your request outlined in your letter dated December 4, 1991, we gave a top priority in surveying the 33 homes around Lake Rowena and Lake Sue. Our staff has completed the collection of data including first floor elevations and appraised values of these homes. I am sending you the original copy of the photographs and the structure survey field forms. We are pleased to assist you in the completion of Howell Creek Water Management Study.

We are awaiting for the completion of this study for a long time. It is our understanding that your district will give Orange County the options to operate the gate for Lake Maitland, and that Orange County does not have to undertake any additional study to obtain the operating permit from your agency.

If you have any questions or need additional information, please do not hesitate to call our office.

Sincerely,

MKrishnamurthy

M. Krishnamurthy

Attachments:

MK/MJD/gr

cc: Linda W. Chapin, Orange County Chairman
Commissioner Bill Donegan, District 5
Thomas W. Ackert, Assistant County Administrator
George W. Cole, P.E., Director, Public Works Division
William P. Baxter, P.E., Deputy Director, Public Works Div.
Henry Dean, Executive Director, St. Johns River Management District

City of Casselberry

INCORPORATED 1940
95 TRIPLET LAKE DRIVE
CASSELBERRY, FLORIDA 32707

ENGINEERING DEPARTMENT 407 831-3551

March 16, 1992

ST. JOHNS RIVER WATER MGT. DISTRICT
MAR 19 1992
MAIL ROOM

St. Johns River Water Management
District
P.O. Box 1429
Palatka, FL 32178-1429

Attention: Mr. Thomas K. Ziegler
Project Manager

RE: Comments on February 1992 Draft of A Proposed Flood Management Plan for the Howell Creek Basin, Orange and Seminole Counties, Florida

Dear Mr. Ziegler:

Attached are my comments to the subject draft Flood Management Plan. My comments are primarily limited to the general sections and specific impacts related to the City of Casselberry and adjacent areas.

Appendix F is to contain 100-year Floodplain maps for Orange and Seminole Counties. If these are different from the FIRM maps, I would like to request a copy of the Map for Seminole County.

Sincerely,

William C. Goucher, P.E.
Engineering Manager
City of Casselberry

Attachment

cc: File

WCG/jam

Howell Creek Basin Flood Management Plan

Page	Comment
12	The text states that there is "contents" damage at a flood level of 1.0 ft. below first floor, yet the table indicates that a value of zero was assumed for this study. That seems contradictory. I would suggest assuming any value between 0 and 10 (maybe 5 - 7) would be better than zero.
15	1) The note "square represents 0.1 X $200,000 = $20,000" is unclear. Does the "0.1" refer to the 10 percent probability? If this is so, that would indicate that a 2 1/2-yr storm (probability = 40%) would do approximately 0.4 X $600,000 = $80,000 of damage, whereas a 25-yr storm (probability = 4%) would do only approximately 0.04 X $600,000 = $24,000 of damage. Am I interpreting this wrong? Suggest clarifying this curve.
	2) Related to the above comment, it would appear that the curve should be much lower in the 10 to 40 plus range, as little, if any, damage would occur for the 10-yr and more frequent storms. Practically all systems are designed to handle at least a 10-yr storm.
23	1) <u>Bank Construction</u> - Please define.
	2) <u>Widening Channels</u> - It seems the comments regarding tree canopy and benthic community removal are also applicable to channel widening.
24	1) <u>Lowering Lake Stages</u> - This paragraph seems somewhat contradictory to me. It states that fluctuation is necessary for healthy wetlands and that the benefit depends on the amount of fluctuation. Lowering of water levels during wet periods reduces the magnitude of the desirable fluctuations. It could also preclude the higher bank areas from being exposed to any inundation if anticipated rainfall does not occur. Higher water levels also increase the hydraulic head which could drive greater recharge.
	2) <u>Constructing Wetlands</u> - Great idea, but considering the historical loss of wetlands to development, and the continuation of that trend - Good Luck!
161	Building 104 should be in Oviedo, not Casselberry.
164	Where are the costs and descriptions of the IMP7 series?
Plate 3	Label area on right as Lake Howell.
	Wetlands Vegetation Maps - It would help locate these wetlands if other improvements (notably streets) were shown.

20 210-10 1

KCA

KISINGER CAMPO and associates corp.

engineers • planners • land surveyors

ALLEN F. KISINGER, P.L.S. (1904-1981)

RECEIVED MAY 4

Office of Executive Director

April 29, 1992

Mr. Henry Dean, Executive Director
St. Johns River Water Management District
Post Office Box 1429
Palatka, Florida 32178-1429

Dear Mr. Dean;

Dr. Rao has informed me that the Howell Branch Study is in a draft copy form and has been released to the appropriate agencies for review. He suggested that I submit to you a formal request to obtain a copy of this study.

We have a contract with the Florida Department of Transportation, District 5, Deland, Florida (Mr. Frank Jewell, Project Manager) to provide design and engineering services to widen and resurface SR436 in Seminole County from the Orange County \ Seminole County line to north of Lake Howell Road. This study will aide our efforts.

Thank you for your attention to this matter. If you have any questions or require additional information, please call.

Sincerely,

Doug Burkhart

Douglas J. Burkhart, P.E.

ST. JOHNS RIVER WATER MGT. DISTRICT
MAY 1992
MAIL ROOM

Home Office/P.O. Box 25261 • Tampa, Florida • 33622-5261
2203 N. Lois Avenue • Suite 410 • Tampa, Florida 33607 • 813/871-5331 • FAX: 813/871-5135
535 A&B Scotty's Lane • Tallahassee, Florida 32303 • 904/385-8800 • FAX: 904/386-2298
3015 Hartley Road • Suite 1 • Jacksonville, Florida 32257 • 904/260-6011

20-6107 / DAT/30-00
20-219

Orange County

Public Works Division
George W. Cole, P.E., Director
Stormwater Management Department
M. Krishnamurthy, Ph.D., P.E., Manager
4200 Whitcomb Avenue
Orlando, Florida 32839-9205
Telephone (407) 836-7990
FAX (407) 836-7999

June 15, 1992

ST. JOHNS RIVER WATER MGT. DISTRICT
18 1992
MAIL ROOM

Dr. C. Charles Tai, Director
Division of Engineering
Department of Surface Water Programs
St. Johns River Water Management District
Post Office Box 1429
Palatka, Florida 32178-1429

Subject: Publication SJ 92-xx, A Proposed Flood Management Plan for the Howell Creek Basin, Orange and Seminole Counties, Florida

Dear Dr. Tai:

This letter is in reference to the proposed public workshop for the above subject publication.

Prior to scheduling a public workshop, we would like to receive your response to our comments concerning the report. In addition, we would like to have your staff prepare an operating schedule that can be implemented with the existing control structure.

Once this information is provided, and any major conflicts with Seminole County's study are addressed, we will schedule a public workshop site as soon as possible.

We look forward to your comments on this important project.

Sincerely,

M. Krishnamurthy

M. Krishnamurthy

MK/RL/mhf

Attachment

cc: George W. Cole, P.E., Director, Public Works Division
William P. Baxter, P.E., Deputy Director, Public Works Division
John Bateman, Manager, Environmental Protection Department
Mina Samadi, Seminole County, Water Management
Rodney J. Lynn, P.E., Senior Engineer, Stormwater Management Department

ST. JOHNS RIVER
WATER MANAGEMENT DISTRICT

Henry Dean, Executive Director
John R. Wehle, Assistant Executive Director

POST OFFICE BOX 1429 PALATKA, FLORIDA 32178-1429
TELEPHONE 904/329-4500 SUNCOM 904/860-4500
FAX (EXECUTIVE/LEGAL) 329-4125 (PERMITTING) 329-4315 (ADMINISTRATION/FINANCE) 329-4508

FIELD STATIONS

618 E. South Street
Orlando, Florida 32801
407/894-5423

7775 Baymeadows Way
Suite 102
Jacksonville, Florida 32256
904/730-6270

PERMITTING:
305 East Drive
Melbourne, Florida 32904
407/984-4940

OPERATIONS:
2133 N. Wickham Road
Melbourne, Florida 32935-8109
407/254-1762

April 22, 1992

M. Krishnamurthy, P.E., PhD., Manager
Stormwater Management Department
Orange County Public Works Division
4200 Whitcomb Avenue
Orlando, Florida 32839-9205

RECEIVED
APR 27 1992
Stormwater Management

Re: Public Workshop about the results produced by the District Publication SJ 92-xx, A Proposed Flood Management Plan for the Howell Creek Basin, Orange and Seminole Counties, Florida

Dear Dr. Krishnamurthy:

Thank you for your recent review and comments on the Howell Creek report. We are preparing responses to those comments and portions of the report will be expanded and clarified in response to those comments.

The Howell Creek study was completed at the request of Orange and Seminole Counties. If the local governments wish to arrange a public workshop to disseminate the results of the study prior to its publication, the District will participate in the workshop. We will make a presentation of the report results and answer any questions.

We ask that one or more of the affected local governments sponsor the public workshop and make all necessary arrangements. Please coordinate with: our Middle St. Johns River Basin Project Manager, Tom Ziegler for District participation; and other local governments for their participation. Tom may be reached by telephone at (904)329-4359.

Sincerely,

C Tai

C. Charles Tai, Ph.D., Director
Division of Engineering
Department of Surface Water Programs

CCT/TZ/cb

Charles A. Padera
SWP Reader File
Dave Zeno
L. T. Kozlov
Anthony Leffin
Joan Budzynski
Sheila Hill

ROBERT ANDREW
1092 HOWELL HARBOR DRIVE
CASSELBERRY, FL 32707

ST. JOHNS RIVER WATER MGMT.
OCT 16 1992
MAIL ROOM

October 14, 1992

Mr. Tom Ziegler, P.E.
Div of Engineering
Dept of Surface Water Mgmt.
P.O. Box 1429
Palatka, Fl 32178-1429

SUBJECT: "A Proposed Flood Mgmt. Plan for the Howell Branch Creek Basin Orange & Seminole Counties, Florida"

Dear Mr. Ziegler:

I understand that there is a public hearing on 10/20/92 concerning the above subject. Regretfully, I will be unable to attend that meeting.

I am on the Board of Directors of the Howell Harbor Homeowners Assn. and we are curious as to how this proposed plan will affect Lake Howell. Is there a permanent water control structure planned at the outfall of Lake Howell? Is there any plans for Hydrilla Control in Lake Howell? If there are any particulars in the plan that would effect lake Howell, we would appreciate knowing about them.

Looking forward to hearing from you in these matters.

Sincerely,

Robert Andrew

Robert Andrew

RA:djw
cc: Tracey Gase
(w/ enclosure)

10/20/92

Steve Patterson 20-218
2500 Venetian Way Winter Park, FL 32789
2430 Venetian Way " "

Re: Howell Creek Basin Concerns

- Lowering water elevation would eliminate lake access from Howell Creek to Lake Maitland Would also eliminate access between lakes on chain

- Lowering water elevation would negatively effect adjacent wetlands due to ground water draw down.

- Lowering water elevation would further aggrivate existing water vegetation and quality problems.

- ~~[illegible]~~ Please contact newspaper and advise that no action is currently being taken Explain that you are only gathering information.

CITY OF MAITLAND FLORIDA

October 23, 1992

Mr. Tom Zeigler, P.E.
St. Johns River Water Management District
Post Office Box 1429
Palatka, Florida 32078-1429

Dear Mr. Zeigler:

The proposed reduction in the elevation of the Maitland Chain of Lakes, as noted in the Flood Management Plan draft, would create significant hardship for all waterfront property owners and would upset the ecological balance of the lakes themselves.

There are over 170 single family homes and four (4) large condominiums within the City of Maitland that would be directly affected by any reduction in elevation. Many of the existing boatdocks, as well as the three (3) private and one (1) community boat launch sites would be rendered unusable, not to mention the canal front property owners whose access to the main lakes would be eliminated.

The environmental ramifications of such a proposal are of equal cause for concern. The reduced depth in the canals would make most impassable. In fact, some lakes may become hydrologically isolated from the rest of the chain. This isolation would prevent the natural flushing action from occurring. Pollutants, heavy metals and organic nutrients would continue to accumulate at an accelerated rate. The effects of this pollution would be manifest in excessive aquatic plant growth and bioaccumulation of heavy metals in fish and predatory birds.

For the above stated reasons, the City of Maitland strongly objects to the present proposals submitted on October 20, 1992, by the St. Johns River Water Management District.

Sincerely,

CITY OF MAITLAND

H. Darcy Bone

H. Darcy Bone
Mayor

HDB:w

407/539-6200 1776 Independence Lane Maitland, Florida 32751

Nov 6, 1992

MR. TOM ZIEGLER
ST JOHNS RIVER WATER MGMT
PO BOX 1429
PALATKA, FL 32178-1429

DEAR MR. ZIEGLER

Following up on the public meeting that you had concerning the lowering of the water level in the Winter Park Chain.

A. The economic impact of the real estate values by lowering the water in the summer would be staggering. Most canals would be impassable and homes facing them would not have lake access.

B. The environmental impact to the wetlands surrounding the lakes could be felt for many years. By drying the wetlands, you would drive out native wildlife and affect the water filtering that these areas provide.

C. Recreational activity would be curtailed, if not totally stopped. The lower water level will make some boat ramps and boat docks useless. Many canals will again be impassable, and recreational activity will be limited to the one lake that you could get access to.

D. The tour of the Winter Park Chain which brings in tourists, would not be able to operate.

E. The water temperature of the lakes would increase since some canals would not allow water to circulate.

F. Weed growth will increase because of higher temperatures, higher concentration of fertilizer runoff and less circulation.

G. The possibility of amoebic infection, which killed two Central Florida growth in 1984 would be increased. This would be due to higher temperatures and the increased likelihood of stirring the bottom muck with the lower levels.

Undoubtedly, there are other valid reasons not to lower the water level. However, I would hope that this is sufficient justification for any reasonable person to leave the situation as it is now. This is especially true in light of the fact that the lower water level is being considered in order to protect only ten homes in the 100 year flood zone. These homes are all required to carry flood insurance by their mortgage companies, and are thus protecting the owners.

This is my first experience of dealing with the St John's Water Management District, and it raises some real concerns in my mind.

I understand that the study was requested, however, when you saw that only ten homes were involved, why didn't the study cease. This appears to be a situation where bureaucracy is feeding on itself, and is entirely self-serving. With the public concern about the unrestricted growth of all governmental agencies, I would think that your management would better control your budget.

Sincerely,

Dick Schneeberger

DICK SCHNEEBERGER 77 EASTWIND LN MAITLAND 32751

November 9, 1992

Mr. Tom Ziegler, P.E.
St. Johns River Water Management
P.O. Box 1429
Palatka, FL 32178-1429

Dear Mr. Ziegler:

I am a homeowner at 66 Eastwind Lane and my access to Lake Maitland is by canal. Should you lower the lake by 2 feet it would make the canal impassable and the value of my home would be significantly impacted.

Surely if a big storm is forecast you could lower the lake simply by monitoring the depth so that the few homes in the 100 year flood zone could be protected.

Also we would be impacted with mosquitoes in the canals and more weeds and control is barely adequate now.

As an environmental issue it would seem that there would be significantly less circulation of water and consequently more pollution and algae.

Sincerely,

M A Hendrix

Margaret A. Hendrix

20-218

Mrs. Marianne Levy
906 Poinciana Lane
Winter Park, Florida 32789

11/12/92

Dear Mr. Ziegler:

The proposed lowering of the water on the chain of lakes will adversely impact us and other residents with increased weeds and lake polution because of exposure and lack of circulation. This will also impact the wetlands and the canals that we boaters use to go between the lagoon and smaller lakes will be completely impassible.

We believe this will decrease our property values and lower our quality of living.

We have gone for years without doing this and we believe this to be an over reaction.

Yours very truly,
Marianne Levy

410 West Trotters Drive
Maitland, Florida, 32751

November 17, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, Florida 32178-1429

REFERENCE: HOWELL BRANCH CREEK BASIN STUDY

On behalf of the citizens of Delroy Park, Maitland Florida, We wish to register our opposition to the artificial drawdown of the Maitland Chain of Lakes. Delroy Park is an association composed of 55 single family residences, of which 16 homes border both Lake Maitland and the natural waterway connecting Lakes Maitland, Nina, and Minnehaha. Many people in the Deroy Park area spend time on and invest money in Lake related activities.

The proposed flood management plan for the Howell Creek Basin would severely limit if not destroy many of the amenities that the people now have come to expect from the Maitland Chain of Lakes. Recreational and environmental values should be protected, not destroyed. Property values in the area depend on access to the Lakes and the aesthetic value of the Lakes help maintain property values. Your proposed artificial lowering of the Lake level will significantly reduce recreational, environmental, and property values.

Any decisions regarding the level of our Lakes should be fully discussed after a complete economic, social, and environmental analysis. We request that any additional considerations for any type of lake management include correspondence with us.

Sincerely,

Kathleen M Magruder
Mrs. Kathy Magruder
President, Delroy Park
(407) 647-4706

Joe Cascio
Mr. Joe Cascio
Vice-President, Delroy Park
(407) 644-9737

Copy: Mr. Darcy Bone, Mayor, City of Maitland

Pierre L. Steward
Attorney at Law
1412 East Robinson Street
Orlando, Florida 32801

Area Code 407
Telephone 843-0100

Mailing Address
P.O. Box 459
Orlando, Florida 32802

November 17, 1992

Mr. Tom Ziegler, P.E.
St. Johns River Water Management
P. O. Box 1429
Palatka, Florida 32178-1429

Dear Mr. Ziegler:

It is my understanding that there is a movement to lower the water levels in the Winter Park Chain of Lakes based upon the fear of several property owners that there might be a flooding problem as a result of a potential hurricane.

My wife and I reside at 2064 Venetian Way, Winter Park, Florida 32789, which is on the north side of Lake Maitland.

I have lived on the Winter Park Chain of Lakes for over 40 years and have been through numerous hurricanes and if anything, these Lakes need more water, not less water.

If the water levels are lowered the canal between the Chain of Lakes would be impassable, the weed problem is now to the point that you can hardly boat in the lakes without running into large clumps of weeds.

I could go on and on having lived on lakes for 40 years but in short I vigorously object to this taking place, and so do my numerous neighbors.

It would undoubtedly depreciate the value of numerous lake front homes and I do feel that if this is done to satisfy the whims of a few property owners that the other property owners would certainly have a class action suit against anyone involved in lowering the water levels of the Winter Park Chain of Lakes.

Therefore, before this is done I do think that serious consideration should be taken.

Very truly yours,

Pierre L. Steward

Pierre L. Steward

PLS:lc

10-218

Icardi Law Offices, P.A. . . . . A Professional Association for the Practice of Law

Aldo Icardi
Jeffrey A. Icardi

November 23, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
Post Office Box 1429
Palatka, Florida 32178-1429

RE: HOWELL BRANCH CREEK BASIN STUDY

Dear Mr. Ziegler:

My wife and I own the property known as 931 Pace Avenue, Maitland, Florida 32751, which is located in the Delroy Park Subdivision. You may have by now received a copy of a letter dated November 12, 1992, from Mrs. Kathy Magruder and Mr. Joe Cascio, representatives of Delroy Park Homeowners Association ("DPHA"). If you have not, enclosed is a copy with this letter.

This is to advise you that my wife and I are in support of the position taken by the DPHA and request that you proceed with further study before implementing any plan which would substantially affect the property surrounding the Maitland chain of lakes.

Thank you very much for your consideration.

Very truly yours,

Jeffrey A. Icardi
Icardi Law Offices, P.A.

JAI/gl

cc: Mrs. Kathy Magruder
410 W. Trotters Drive
Maitland, FL 32751

990 Lewis Drive · P.O. Box 879 · Winter Park, · Florida · 32790
Telephone · 407 647-1859 · Fax 407 647-3224

20-218 11/24/92

Dr. and Mrs. Joel Greenberg
2048 Venetian Way
Winter Park, Florida 32789

ST. JOHNS RIVER WATER MGT. DISTRICT
NOV 30 1992
MAIL ROOM

Dear Sir,

We are residents of "Maitland Shores" in Winter Park. Our home fronts Lake Maitland with a two hundred fifty plus foot shore line. Discussion of proposed changes in the water level of the Winter Park Chain of Lakes is naturally of extreme importance to us. Please advise us as to the status of these discussions.

Sincerely,

Joel & Carolyn Greenberg

20-219-PLA-2 8-16
(all sheets)

ST. JOHNS RIVER WATER MGT. DISTRICT
DEC 4 1993
MAIL ROOM

670 Old Horatio Ave.
Maitland, Fl. 32751
30 November, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

I wish to register my opposition to the artificial drawdown of the Maitland Chain of Lakes. My single family residence is located on the Longbranch canal leading to this chain of lakes. There has never been a problem from high water level on this canal; however, almost annually there is a problem with low water level during the dry season. If you lower the water level as proposed, it will worsen an already bad situation, causing the canal to be unnavigable (and a dry ditch) most of the year. This will have a detrimental effect on (a) spawning fish, (b) wildlife (please note that there is a designated, established wildlife refuge on the other side of the canal), (c) recreational pleasures such as fishing and boating, and (d) a definite lowering of property values. I did not see these issues addressed properly in the studies you have released so far.

I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

Barbara Steinman

Barbara Steinman

By Phyllis Kemp

20-215

ST. JOHNS RIVER WATER MGT. DISTRICT
DEC - 7 1992
MAIL ROOM

630 Old Horatio Ave.
Maitland, Fl. 32751
30 November, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

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I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

Elias Gongora

Elias Gongora

Elena Gongora

Elena Gongora

20-219

ST. JOHNS RIVER WATER MGT. DISTRICT
DEC - 9 1992
MAIL ROOM

620 E. Horatio Ave.
Maitland, Fl. 32751
30 November, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

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I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

Francis V Young

LTC Francis V. Young
U.S. Army Retired

20-219

690 Old Horatio Ave.
Maitland, Fl. 32751
30 November, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

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I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

Mrs Lola VanZandt

Lola VanZandt

20-219

Pax T. Robinson
650 Old Horatio Ave.
Maitland, Fl. 32751
30 November, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

I wish to register my opposition to the artificial drawdown of the Maitland Chain of Lakes. My single family residence is located on the Longbranch canal leading to this chain of lakes. There has never been a problem from high water level on this canal; however, almost annually there is a problem with low water level during the dry season. If you lower the water level as proposed, it will worsen an already bad situation, causing the canal to be unnavigable (and a dry ditch) most of the year. This will have a detrimental effect on (a) spawning fish, (b) wildlife (please note that there is a designated, established wildlife refuge on the other side of the canal), (c) recreational pleasures such as fishing and boating, and (d) a definite lowering of property values. I did not see these issues addressed properly in the studies you have released so far.

I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

Pax T. Robinson

Pax Robinson

20-219

ST. JOHNS RIVER WATER MGT. DISTRICT
DEC 21 1992
MAIL ROOM

660 Old Horatio Ave.
Maitland, Fl. 32751
30 November, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

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I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

William Clark

William Clark

Betty Clark

Betty Clark

20-219

ST. JOHNS RIVER WATER MGT. DISTRICT

DEC 28 1992

610 E. Horatio Ave.
Maitland, Fl. 32751
2 December, 1992

Mr. Tom Ziegler
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Subj: Howell Branch Creek Basin Study

I wish to register my opposition to the artificial drawdown of the Maitland Chain of Lakes. My single family residence is located on the Longbranch canal leading to this chain of lakes. There has never been a problem from high water level on this canal; however, almost annually there is a problem with low water level during the dry season. If you lower the water level as proposed, it will worsen an already bad situation, causing the canal to be unnavigable (and a dry ditch) most of the year. This will have a detrimental effect on (a) spawning fish, (b) wildlife (please note that there is a designated, established wildlife refuge on the other side of the canal), (c) recreational pleasures such as fishing and boating, and (d) a definite lowering of property values. I did not see these issues addressed properly in the studies you have released so far.

I hereby request that you address the four issues stated above and send a copy of the results to me at the above address.

Sincerely,

Ronald H. Klair

Ronald H. Klair

20-218-Data-30-01

942 Poinciana Lane
Winter Park, FL 32789

February 25, 1993

Mr. Tom Ziegler, P.E.
St. John's River Water Management
P. O. Box 1429
Palatka, FL 32178-1429

Dear Mr. Ziegler:

Several months ago I was advised of possible lowering of water levels in the Winter Park Chain of Lakes this summer.

I'm very concerned about the magnitude of the lowering as are most other home owners in the area, and this includes literally hundreds of families. This will likely have a devastating effect on the water quality in these lakes, and also on the wild life both in and around the lake.

The bodies of water that I know of in the immediate Winter Park area will be devastated if they are lowered two feet, making them essentially useless to most of the residents in the area, and create major problems if we end up with a drought cycle again.

Apparently there is some concern about a few houses, I think ten total, on the Chain of Lakes that are in the 100 year flood zone.

It seems completely out of line with the needs of the majority of people to do this kind of damage to the eco systems in and around the Winter Park Chain of Lakes on the remote possibility that a few houses may experience some flood problems.

Kindly consider the needs of all of the people in this area, as well as the impact upon the environment before proceeding with such an overwhelming change in our lake levels.

These lakes would tolerate a small change in water level, but the amount proposed seems to be extremely dangerous to our wet lands and will contribute major problems to circulation of water through the Chain of Lakes.

I have seen what happens to these lakes when the water level does go down in a drought cycle and it's not a pretty sight.

I would appreciate your consideration of these issues.

Sincerely,

John G. Langdon, M.D.

20-218-Data-30-00

ST. JOHNS RIVER WATER MGT. DISTRICT
MAR - 3 1993
MAIL ROOM

Marty Wanielista
221 W. Trotters Drive
Maitland, Florida 32751

February 28, 1993

Mr. Tom Ziegler, Project Manager
St. Johns River Water Management District
P. O. Box 1429
Palatka, Florida 32178-1429

Dear Tom:

Re: Second Draft: A proposed Flood Management Plan for the Howell Creek Basin, Orange and Seminole Counties, Florida.

I appreciate you asking me for comments on the second draft of the referenced work, dated in your letter as February 22, 1993. Available for review was a 269 page report with plates. You have compiled in one source a significant amount of information. I encourage you to continue with your own recommendations. I believe the most important recommendations are:

1. Perform a continuous simulation of lake levels calibrated on historical data and verified if data bases permit.
2. Any proposed regulation schedule must be evaluated with potential effects on environmental and recreational impacts, plus the affects on property values.

As a first evaluation of flooding potential, hydrologic single event models such as HEC-1/HEC-2 were used in the draft report. I believe this was an appropriate first step and the results indicate that some additional work is now required to substantiate the preliminary results. The single event models are dependent on the selection of "starting" values. As such, the probability of the occurrence of the starting values affect the outcome chances. Thus, I concur with your recommendation for a continuous simulation. The continuous simulation should include stormwater volume controls, possibly using the "SMART" pond designs to return stormwater to the ground and save on the use of potable water.

After living on the Maitland Chain of Lakes for 16 years and being involved in water quality analyses for some 30 years, I would expect that a lowering of the lakes would cause a reduction in recreational activities and have an affect on internal recycling of sediment pollutants. Recycling would increase because of a decrease in water volume and fresh water exchange, both of which affect dissolved oxygen. Recycling would increase the nutrients and certain metals in the water column.

You now have an extreme problem with some heavy metals in the lakes. You should be using Class III standards (Chap 17.302 F.A.C., dated 8/92). You are using the old standards. However, I sympathize with you because it is difficult to keep up with rule changes. As an example using the current State class III standards for copper, for station 3 (Lake Maitland HB24), the standard is based on hardness which averages about 75.5 mg/l. The current copper standard is calculated as 9.3 ug/l, compared to the old standard of 30 ug/l. The lakes are in worst water quality conditions than your conclusions lead one to believe.

Assuming the majority of heavy metals in the Maitland chain of lakes come from stormwater runoff, any plans to lower the lake levels should also consider a reduction in stormwater pollutant mass. An additional mass of stormwater pollutants into a reduced lake volume will only increase the concentrations that are already above the state standards.

Please call on me if you need additional information. I hope I have been of some help to you. I look forward to additional correspondence.

Sincerely,

Marty

Marty Wanielista

cc: Mr Joe Cascio, VP
Delroy Park

LAKE HOWELL
ENVIROMENTAL PROTECTION ASSOCIATION

March 15, 1993

Tom Ziegler, P.E.
Project Manager
St. Johns River Water Management District
P.O. BOX 1429
Palatka, Florida 32178-1429

Tom:

As an interested party, directly impacted by the proposed Flood Management Plan for Howell Creek Basin, I had the opportunity to view the Second Draft JJ92XX.

On behalf of the LHEPA, I would like to offer the following comments.

Where it was stated that one of the original objectives of Phase II was to develope an operating schedule for the existing structures at Lakes Killarney & Maitland, no recommendation for such a schedule is made in this report since the enviromental effects of Lake regulation are not evaluated. A future study would develope this schedule. We strongly request and offer our resources and extensive information, be utlized if and when such a study is begun.

Pg xii - Lake Howell - Flood damage would not be significant to development before 1981. If calculations for new houses are found to be significant...flood profiles is recommened. There has been significant growth along Howell Creek and Lake Howell since 1981...Brittany Gardens, The Vinnings, Lost Creek(future) as well as private homes... to mention a few. We would request futher explanation of 'flood protection by Levees or Flood Profiles' in this paragraph.

Pg xiii - Enviromental Recommendations

The study indicated a number of programs that should be implemented to monitor potential water quality problems. We, through our affiliation with Lake Watch and other organizations, have some data and offer our properties as possible sampling sites. I have included water analysis on Lake Howell from Lake Watch.

SJRWMD JJ92XX
(continued 2@2)

There are other issues that we would like to have further discussions on...once this study is finalized.

Imparticular, the current and future condition and importance of the debris pile that acts a 'wier' at the eastern outflow of Lake Howell, in Howell Creek. This point of outflow, as well as the two (2) points of inflow...Howell Creek West & Cassel Creek...play critical roles in our long term inter--grated Lake Management Plans & Objectives.

We look forward to our continued good working relationship with the District and again, offer our assistance and support in your tireless efforts to help Central Florida co-exist with Nature.

Respectfully,

Ken Anderson
Lake Howell Enviromental Association
407 834-8096
407 834-4297 fax

cc: Pat Frost, Director
SJRWMD - Orlando Division

Joan Budzynski, P.E.
SJRWMD - Orlando Division

LHEPA Files

Orange County

Public Works Division
George W. Cole, P.E., Director
Stormwater Management Department
M. Krishnamurthy, Ph.D., P.E., Manager
4200 Whitcomb Avenue
Orlando, Florida 32839-9205
Telephone (407) 836-7990
FAX (407) 836-7999

June 2, 1993

Mr. Charles A. Padera, Director
Department of Resources Management
St. Johns River Water Management District
Post Office Box 1429
Palatka, Florida 32178-1429

Subject: A Proposed Flood Management Plan For The Howell Creek Basin, Orange and Seminole Counties, Florida, 1993

Dear Mr. Padera:

In the above referenced study, an operating schedule for the existing water control structures at Lakes Killarney and Maitland were to be developed. However, this study indicates that this operating schedule was not done because the environmental effects of the Lake Regulations need to be evaluated. In our meeting on March 11, 1993, you stated that the District has neither the plans or the staff to undertake such a study at this time, and you suggested that the municipalities involved take the lead, initiate, and fund such an environmental assessment. You also indicated that the District may assist in the funding for this study.

We have met with staff from Seminole County and concurred that such a study would be critical for this basin, and would resolve the differences among the municipalities involved regarding the operation of these control structures. However, we feel the District should coordinate this study to assure its objectivity and to define a scope that would satisfy the District's guidelines for this basin. Therefore, we would like to suggest that the District develop a scope to undertake this environmental assessment with a private consultant firm and inform all the municipalities involved of the task required to do such a study. We are confident that all municipalities will be willing to get this issue resolved, and would be able to help the District either with the funding or with inkind services.

Please review this information and advise us on the feasibility of this study. If you need additional information on this matter, do not hesitate to contact me at the number above.

Sincerely,

Eduardo Avellaneda, P.E.,
Senior Engineer

EA/DB/mhf

cc: George W. Cole, P.E., Director, Public Works Division
William P. Baxter, P.E., Deputy Director, Public Works
M. Krishnamurthy, Ph.D., P.E., Manager, Stormwater Management
Anthony Leffin, Director, Public Works, City of Maitland
James S. Williams, P.E., Director, Public Works Division, City of Winter Park
Mina Samadi, Engineer, Seminole County
Tom Ziegler, Staff Engineer, St. Johns River Water Management District

20-218-0a2a-30-00

RESOLUTION NO. 11-93

A RESOLUTION OF THE CITY OF MAITLAND, FLORIDA, OPPOSING THE LOWERING OF THE WATER LEVEL IN THE WINTER PARK CHAIN OF LAKES; AND, PROVIDING FOR AN EFFECTIVE DATE.

WHEREAS, the City of Maitland is a community that takes great pride in its high quality of life; and

WHEREAS, the lakes of Maitland are a great asset to the community and add immensely to the recreational and scenic beauty of the city, and to the property values of the city; and

WHEREAS, three (3) of the lakes in Maitland are part of the Winter Park chain of lakes and are connected to the other lakes in the chain via shallow canals; and

WHEREAS, a study conducted by the St. Johns Water Management District calls for a lowering of the water level in the Winter Park chain of lakes; and

WHEREAS, in the opinion of the City of Maitland a lowering of the water level in the Winter Park chain of lakes would render the canals to be non-navigable and thus it would have a serious detrimental impact on the use of the lakes;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Maitland, Florida, that:

SECTION 1. The City of Maitland is strongly opposed to the proposed lowering of the water level in the Winter Park chain of lakes.

SECTION 2. A copy of this resolution shall be forwarded to the St. Johns Water Management District, the City of Winter Park and the City of Maitland Lakes Advisory Committee by the City Clerk.

SECTION 3. This resolution shall become effective immediately upon its passage.

PASSED and **APPROVED** by the City Council of the City of Maitland, Florida, this 12th day of July, 1993.

CITY OF MAITLAND

W. Harey Lane

MAYOR

ATTEST:

Donna L. Williams

CITY CLERK

I CERTIFY THIS IS A TRUE AND CORRECT COPY.

Donna L. Williams

CITY CLERK, CITY OF MAITLAND

7/14/93

20-218-Data-30-00

DONALD W. McINTOSH Associates, Inc. 2200 PARK AVENUE NORTH, WINTER PARK, FLORIDA 32789 • (407) 644-4068

VIA FAX (904) 329-4315

July 13, 1993

ST. JOHNS RIVER WATER MGT. DISTRICT
JUL 15 1993
MAIL ROOM

Mr. Tom Ziegler, P.E.
Division of Engineering
Department of Surface Water Programs
St. Johns River Water Management District
P. O. Box 1429
Palatka, FL 32178-1429

RE: Lake Maitland

Dear Tom:

Hope this note finds you well.

I presently live on Lake Maitland and am very concerned (as are many others) over the contemplated control structure adjustments to the Winter Park chain.

Simply put, major problems will result from any substantive lake lowering including but not limited to:

- Non-navigable chain of lakes connections
- Extensive boat slip and dock use difficulty due to shallower lakes
- Aggravated weed problems which are already out of control
- Resultant significant property value damage

I am sure there are many other reasons this proposal should not be implemented. I wanted you to know that I am very, very concerned and would appreciate your advising me as to the direction of this initiative.

Thank you.

Sincerely,

DONALD W. McINTOSH ASSOCIATES, INC.

Donald W. McIntosh, Jr.
President

DWMjr/jh

CIVIL ENGINEERS

20-218-Data-30-01

MATTHEW N. APTER, M.D.
DIPLOMATE OF THE AMERICAN BOARD OF INTERNAL MEDICINE, IN MEDICINE AND IN THE SUBSPECIALTY OF GASTROENTEROLOGY.

IRA SHAFRAN, M.D.
DIPLOMATE OF THE AMERICAN BOARD OF INTERNAL MEDICINE, IN MEDICINE AND IN THE SUBSPECIALTY OF GASTROENTEROLOGY.

THE GASTROENTEROLOGY GROUP

APTER, SHAFRAN & SPRUNG, M.D.

DOUGLAS J. SPRUNG, M.D.
DIPLOMATE OF THE AMERICAN BOARD OF INTERNAL MEDICINE, IN MEDICINE AND IN THE SUBSPECIALTY OF GASTROENTEROLOGY.

BARRY R. KATZ, M.D.
DIPLOMATE OF THE AMERICAN BOARD OF INTERNAL MEDICINE, IN MEDICINE AND IN THE SUBSPECIALTY OF GASTROENTEROLOGY.

July 14, 1993

Tom Ziegler, P.E.
Division of Engineering
Department of Surface Water Programs
St. Johns River Water Management District
P. O. Box 1429
Palatka, Florida 32178-1429

Dear Mr. Ziegler:

This letter is intended to represent my opposition to the draft of the St. Johns River Water Management District which proposes possibly lowering the water level of Lake Maitland by 1.2 feet. I would very much be opposed to this, since it would impinge upon the ability to use the canals in order to get from one part of the chain of lakes to another. I view this as a specific hardship for all of the lakefront owners and impingement upon our heretofore rights to enjoy the chain of lakes, as they have always been, i.e., a connecting series of individual lakes. Although I understand the purpose of your proposal, I would hope that alternative measures could be entertained and much more seriously considered than this proposal, to which I am vehemently opposed. I will plan to join the Maitland Waterfront Property Owners Association in order to lend my support to a concerted effort against this proposal.

Sincerely,

D. Sprung

Douglas J. Sprung, M.D.

DJS/sbs
cc: Arthur Whitehill

100 E. SYBELIA AVE. • SUITE 250
MAITLAND, FLORIDA 32751
TELEPHONE: (407) 628-4949
FAX: (407) 645-3776

521 WEST S. R. 434 • SUITE 100
LONGWOOD, FLORIDA 32750
TELEPHONE : (407) 332-8181
FAX: (407) 332-8111

721 OAK COMMONS BLVD. • SUITE C
KISSIMMEE, FLORIDA 34741
TELEPHONE: (407) 846-0303
FAX: (407) 238-0065

20-218-Data-30-00

ST. JOHNS RIVER WATER MGT DISTRICT
JUL 19 1993
MAIL ROOM

July 15, 1993

Dear Mr. Ziegler,

I attended the Orange County Public meeting last evening regarding the draft technical Publication "A proposed Flood management Plan for the Howell Branch Creek Basin, Orange + Seminole Counties, Florida. My thought + comment, stop wasting my tax dollars -- STOP the studies!

Sincerely,
Marlene Gregory

20-218-0026-30-00

Vista del Lago

14465 Vista del Lago Blvd. Winter Garden, Fl. 34787 • (407) 239-0366

ST. JOHNS RIVER WATER MGT DISTRICT
JUL 28 1993
MAIL ROOM

July 26, 1993

Mr. Tom Ziegler
Division of Engineering
Surface Water Programs
St. John River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Dear Mr. Ziegler:

I am writing in reference to a proposition to lower Lake Maitland in Winter Park. I reside on the Winter Park chain of lakes and in exercising my rights of a concerned resident, I want you to know that I absolutely oppose the proposition to lower Lake Maitland by one and one-half feet.

I appreciate you taking the time to listen to my point of view.

Sincerely,

William N. Leary
Vista del Lago

WNL:rm

PETERSON AFFILIATED COMPANIES
1115 EAST LIVINGSTON STREET
ORLANDO, FLORIDA 32803-5717
PHONE NUMBER (407) 425-1115

20-218-D0t0-30-00

Peterson Affiliated Companies

ST JOHNS RIVER WATER MGT DISTRICT
JUL 28 1993
MAIL ROOM

July 26, 1993

Mr. Tom Ziegler
Division of Engineering
St. John River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Dear Mr. Ziegler:

I was appalled to hear of the proposition to lower Lake Maitland one and one-half feet. I live on Lake Maitland and frequently use the lake for recreation purposes with my family and friends as well as just enjoying its beauty. Please be aware that my family and I strongly oppose this idea.

Sincerely,

J. Chris Peterson
Peterson Affiliated Companies

JCP:rm