Technical Publication SJ 84-9

HOWELL BRANCH BASIN
SURFACE WATER MANAGEMENT STUDY
PHASE I

(VOLUME I)

by

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August 1984

Project Number 20 200 05

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ACKNOWLEDGEMENTS

This study was conducted by the authors within the Engineering Division of the Water Resources Department. Field-surveyed cross sections and other information related to this study were provided by Water Management Division, Orange County and Water Management Division, Seminole County.

All the graphic works were prepared by Yvonne Ross.

SUMMARY

The Howell Branch Basin Surface Water Management Study consists of two phases. Phase I deals with: (1) determination of flood elevations and delineation of floodplain areas under existing land-use conditions and assumed future development for the 10-, 25-, and 100- year design storms, and (2) determination of the effect of a change in the crest elevation of Lake Maitland weir on flood elevations upstream and downstream of the weir. The results obtained from the study can be used to identify the flood prone areas and develop floodplain regulations for future development. Phase II consists of development of a basin water management plan to reduce potential flooding and to protect the water resources of the basin. The plan will include recommended regulation schedules of weirs at Lake Maitland and Lake Killarney. In addition, the plan will include proposed modifications of the existing hydraulic structures and/or improvements of channel systems.

This report contains results obtained from the Phase I study of the Howell Branch Basin. The HEC-1 computer model was employed to determine peak discharges under existing conditions and assumed future development for selected storms. The Soil Conservation Service (SCS) methods were used for determining discharge hydrographs and peak discharges. The modified Puls method was used for reservoir routing and the Muskingum method for channel routing. Using the simulated peak discharges, the HEC-2 computer model was utilized to obtain flood elevations.

Simulated results indicate potential flood damage will be higher along Park Lake, Lake Killarney, and Bear Gully Canal, than other areas in the Howell Branch Basin. In addition, the results show that it is feasible to reduce flood elevations at Lake Maitland without significant increase in flood elevations downstream of the weir by maintaining the weir crest at a lower elevation.

The peak discharges and flood elevations estimated were compared with the estimates of the U.S. Army Corps of Engineers included in various flood insurance study reports published by Federal Emergency Management Agency. The differences in results are primarily due to (1) the updated land-use data used, (2) two additional inflows from Deer Run Subdivision included, (3) more detailed data on channel cross sections and hydraulic structures incorporated in this study, and (4) the methods used in predicting flood stages.

INTRODUCTION

In 1960, both Orange and Seminole Counties experienced substantial flood damages caused by Hurricane "Donna". As a result of that experience, Orange County developed a water management plan to alleviate flooding problems. The plan primarily relied upon the construction of a series of canal systems and lake level controls for removing flood waters from the urbanized areas to less populated agricultural areas.

While Seminole County has not developed a water management plan, it has initiated a water management study through the development of its comprehensive plan. Although recurring drainage problems have been experienced in Seminole County, the only drainage improvements funded were associated with the county road system.

The Howell Branch has been identified by both Orange and Seminole Counties as a critical basin because of rapid urbanization. As a result of recent increase in urbanization, it is anticipated that future drainage problems will be more severe in this basin and that the existing drainage systems in both counties will no longer be adequate for solving future flooding problems. In addition to flood control, there is a concern about low streamflow conditions and it is desired that lake levels during drought periods be maintained at an acceptable level. For these reasons, a more effective water management study is necessary to provide both flood control and low flow benefits.

SCOPE OF STUDY

The primary goal of the project is to develop an efficient surface water management plan for the Howell Branch Basin. The project was divided into two phases. The first phase includes: (1) determination of flood elevations and delineation of flood plain areas under existing land-use conditions and assumed future development for the 10-, 25-, and 100-year storms, with weir elevations set at 66.15 feet NGVD for Lake Maitland and 84.00 feet NGVD for Lake Killarney, and (2) determination of the effect of a change in the crest elevation of Lake Maitland weir on flood elevations upstream and downstream of the weir. The results obtained from the Phase I study will be used in the Phase II study to develop an effective basin water management plan to provide flood protection and low flow benefits. This plan will provide recommended regulation schedules for the existing water control structures at Lake Maitland and Lake Killarney. In addition, the plan will include proposed modifications of the existing hydraulic structures and/or improvements of channel systems. This report contains results obtained from the Phase I study of the Howell Branch Basin.

DESCRIPTION OF STUDY AREA

The Howell Branch Basin (Figure 1) is located in Orange and Seminole Counties in Central Florida. The area of the basin is 45.5 square miles, of which the upper half lies in Orange County and the lower half in Seminole County. The headwaters of Howell Creek originate in Lake Maitland which receives inflows from three chains of lakes via canals. The creek then flows northeasterly through Lake Howell and continues to meet Bear Creek near State Road 419; the confluence is approximately 2 miles upstream from Lake Jessup. The headwaters of Bear Creek are located in Bear Gully Lake which receives inflows from other lakes (Figure I).

The topography of the Howell Branch Basin is relatively flat with some gently rolling hills. In some areas, there are swamps and sinks. Lakes occupy about 8.6% of the total drainage area.

For the purpose of this study, the basin was divided into 28 subbasins based on hydrologic and hydraulic features. A detailed breakdown of subbasins is shown in Figure 2.

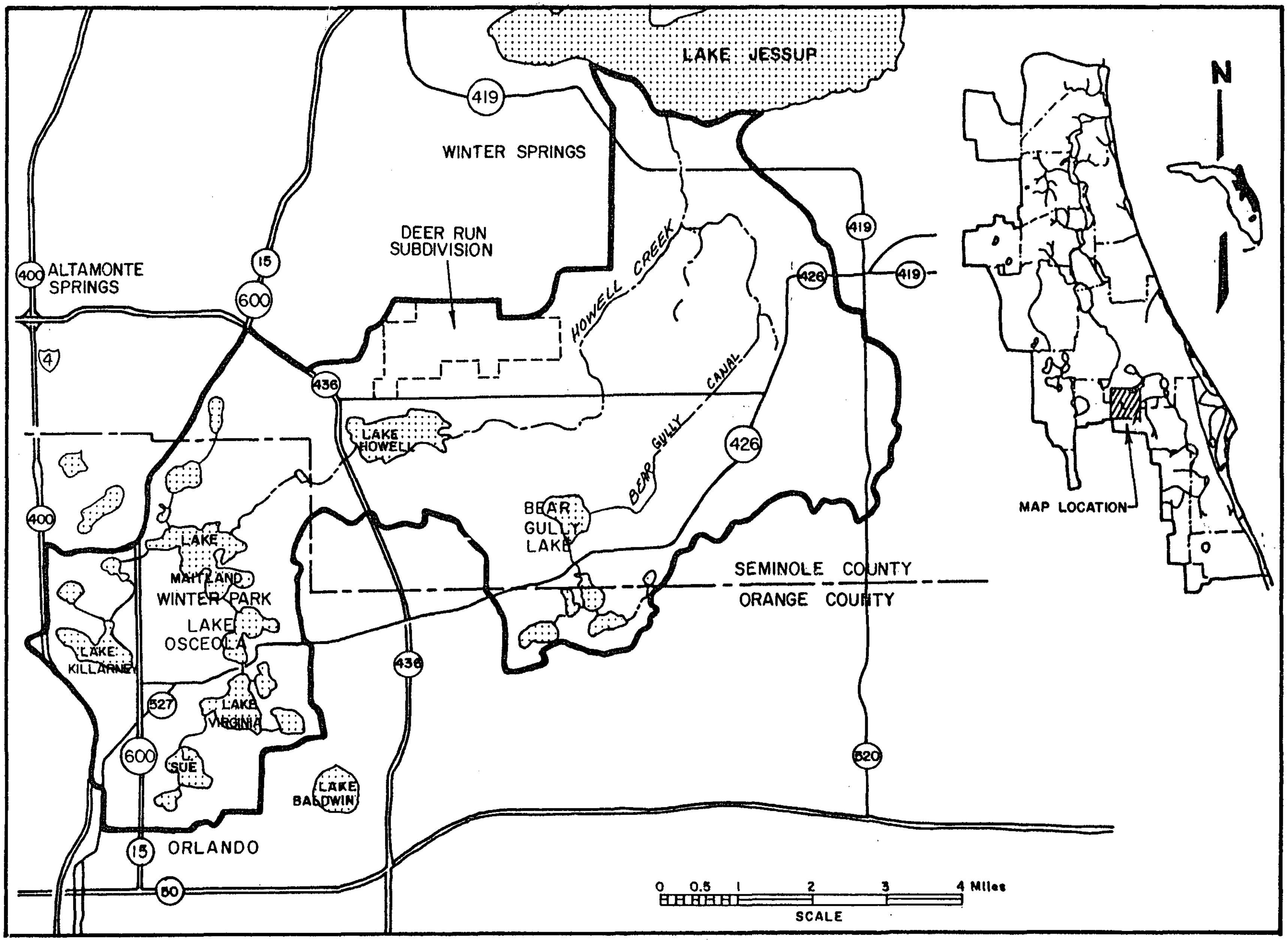


FIGURE 1. Location of Howell Branch Basin.

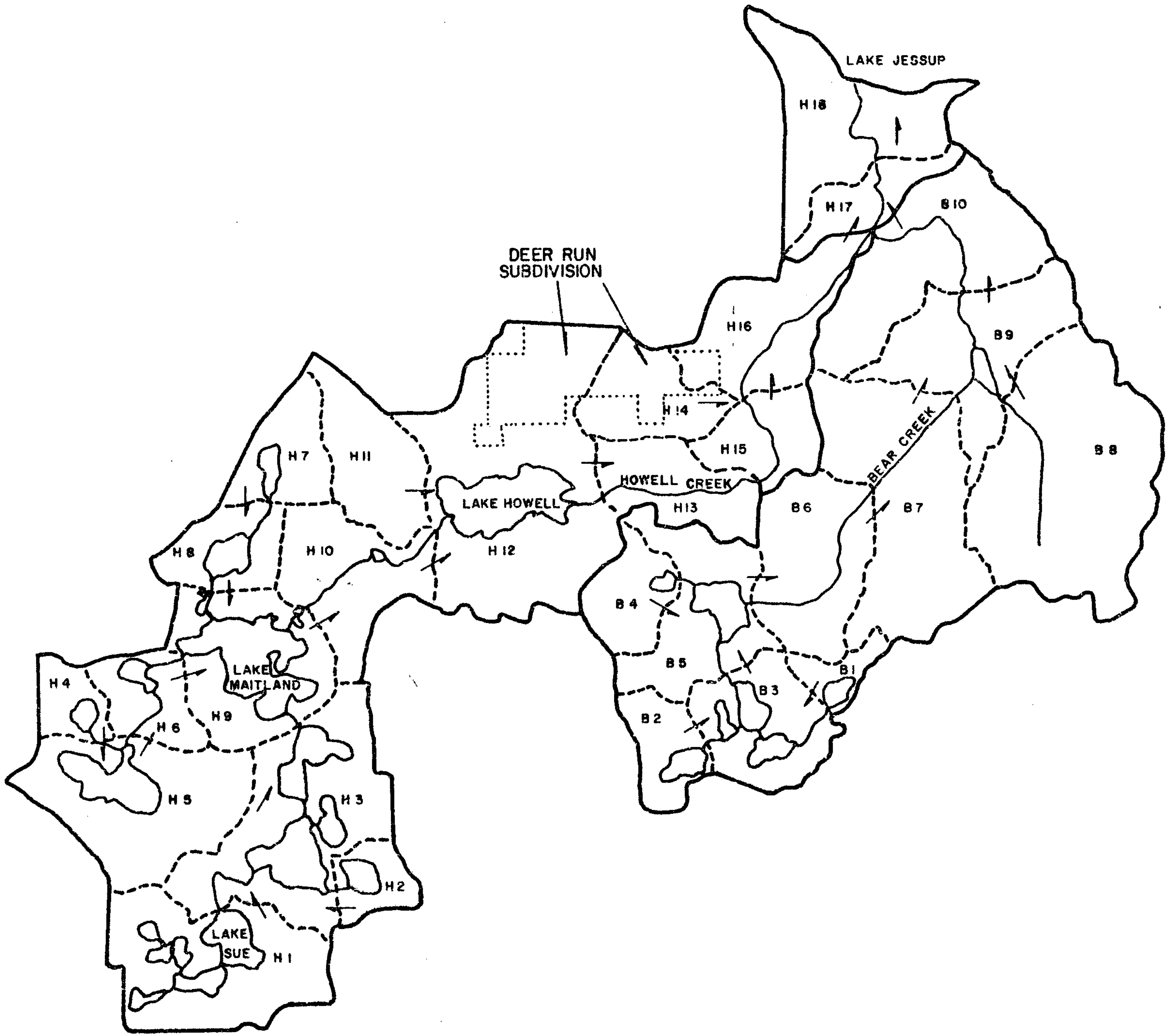


FIGURE 2. Detailed Breakdown of Howell Branch Basin.

DESCRIPTION OF INPUT DATA

Input data can be classified into two major groups: hydrologic and hydraulic. Hydrologic data are required in the simulation of flood hydrographs and hydraulic data are used in computation of water surface elevations. Some of the selected hydrologic and hydraulic data are discussed below.

Rainfall

Rainfall data used in this study was obtained from two sources. The 24-hour rainfall values for different frequencies were obtained from the U. S. Army Corps of Engineers (1). These rainfall data were based on the analysis of eight rainfall stations in and near Orange and Seminole Counties. The rainfall depths for 10-, 25- and 100-year storms were found to be 6.6 inches, 8.1 inches and 11.3 inches, respectively. The SCS type II (modified) distribution was adopted to calculate rainfall depth for each time interval. The rainfall depth and the distribution of the 6-hour duration 25-year storm were provided by Water Management Division, Seminole County.

Soil

Soil data were taken from the U. S. Department of Agriculture, Soil Conservation Service (SCS) Soil Surveys (2,3). Orange County consists of 7 soil associations; Seminole County consists of 11 soil associations. These soil associations were grouped into four SCS hydrologic soil groups according to their drainage properties. The percentage areas of hydrologic soil groups A, B, C, and D were found to be 34.9%, 13.8%, 2.3%, and 30.0%, respectively. Lakes and swamps account for the rest of the area.

Land Use

A preliminary land-use map for the Howell Branch Basin was drawn based on a land-use map prepared in 1973 by the Wetlands Center, University of Florida. For the purpose of this study, general land uses were grouped into 10 different categories. To determine existing land-use, the preliminary land-use map was updated based on aerial photographs taken in 1981. A summary of existing land uses is presented in Table 1.

Proposed land-use changes given by Seminole County were used to estimate future land-use conditions in Seminole County. Since Orange County does not have information on future land-use changes within the study area and the average increase in Runoff Curve Numbers resulting from future development in Seminole County is approximately 5.5%, it was assumed that future land-use changes would result in a 5% increase in the Runoff Curve Numbers for the subbasins within Orange County. This assumption was made with the concurrence of Water Management Division, Orange County.

SCS Runoff Curve Number

The SCS Runoff Curve Number (CN) was used to determine soil moisture storage of a given soil and land-use complex, which in turn was used to compute surface runoff (See Appendix A). Estimates of Runoff Curve Number for the selected soil and land-use complexes are given in Table 2. The weighted Runoff Curve Numbers for each subbasin are listed in Table 3.

TABLE 1. Summary of Existing Land Uses.

TYPE OF LAND USE	AREA (Acres)	PERCENTAGE (%)
Open Land, Recreation	445	1.5
Residential - Low Density	1435	4.9
Residential - High Density	10090	34.6
Improved Pasture	2315	8.0
Cropland	1120	3.9
Woods	7600	26.1
Swamp	3000	10.3
Marsh	110	0.4
Open Water	2515	8.6
Sink or Detention Pond	495	1.7
Total	29125	100.0

TABLE 2. Runoff Curve Numbers for Selected Soil and Land-Use Complexes.

(Antecedent Moisture Condition II)

DESCRIPTION OF LAND USE	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Open land, recreation	44	65	76	82
Residential - low density	57	72	81	86
Residential - high density	85	90	92	94
Improved pasture	53	74	82	86
Cropland	70	80	86	90
Woods	36	60	73	79
Swamp	80	85	90	95
Marsh	95	95	95	95
Open Water	100	100	100	100
Sink	50	50	50	50

TABLE 3. Runoff Curve Numbers for Existing Conditions and Future Development.

SUBBASIN	EXISTING CN	FUTURE CN
H1	88	91
H2	76	80
H3	83	87
H4	74	77
H5	84	88
H6	81	85
H7	84	88
H8	74	78
H9	86	90
H10	78	83
H11	80	85
H12	82	86
H13	70	72
H14	75	79
H15	61	76
H16	75	79
H17	76	78
H18	75	78
B1	65	73
B2	73	77
B3	70	73
B4	72	78
B5	73	80
B6	73	78
B7	77	80
B8	74	77
B9	74	78
B10	73	76

Lag Time

The purpose of lag time is to provide timing of flows. It is primarily a function of the length of overland flow, slope of drainage basin, and surface cover. Lag time is a critical parameter in determining the shape of a hydrograph and can have significant effect on estimation of peak flow.

Lag time was calculated using the equation developed by the SCS (See Appendix A). Lag time was used in the SCS unit hydrograph method for computation of runoff hydrograph. The SCS unit hydrograph method tends to overestimate peak discharges for very flat swampy basins. In order to overcome this probelm, the estimated lag time was multiplied by a factor ranging from 1.0 to 1.5 based on topographic conditions. No adjustments were made in the lag time for the subbasins with high degree of urbanization. For subbasins with flat, swampy, or/and depression areas, a factor of 1.5 was used to adjust the estimated lag time. A factor of 2.0 was applied to the subbasins in which the detention pond is connected to or located near the channel. Estimates of lag time for existing conditions and future development are listed in Table 4.

Channel Cross Sections

Cross sections are necessary for determining the shape and geometry of channels which are required in the hydraulic computations of flood profiles. Field-surveyed channel cross sections and engineering data on control structures and bridges were provided by Orange and Seminole Counties. Locations of cross sections were selected according to the guidelines suggested by the HEC-2 users manual (4). Locations of surveyed data are shown in Exhibits A and B.

Photogrammetric maps taken in 1981 were used to locate channel cross sections and obtain cross-sectional data on flood plains. The photogrammetric maps used have a scale of 1 inch equals 200 feet with 1-foot contour interval.

TABLE 4. Estimates of Lag Time for Existing Conditions and Future Development.

SUBBASIN	AREA (Sq. Mi.)	EXISTING LAG TIME (hrs.)		FUTURE LAG TIME (hrs.)	
		ESTIMATED	ADJUSTED	ESTIMATED	ADJUSTED
H1	2.44	1.8	1.8	1.6	1.6
H2	0.53	1.0	1.0	1.0	1.0
H3	2.88	2.1	2.1	1.9	1.9
H4	0.43	1.2	2.4	1.1	2.2
H5	2.40	1.5	1.5	1.3	1.3
H6	0.77	1.3	2.0	1.2	1.8
H7	0.87	2.0	2.0	1.8	1.8
H8	0.77	1.5	1.5	1.4	1.4
H9	2.07	1.5	1.5	1.3	1.3
H10	1.58	3.0	4.5	2.7	4.0
H11	1.27	3.0	6.0	3.0	6.0
H12	3.94	2.6	3.8	2.4	3.6
H13	1.16	2.7	3.3	2.7	3.2
H14	0.90	1.5	1.9	1.4	1.8
H15	0.62	2.1	2.7	1.9	2.5
H16	1.69	3.0	6.0	3.0	6.0
H17	0.71	1.6	1.8	1.5	1.8
H18	2.01	2.2	2.8	2.1	2.8
B1	0.33	1.4	2.0	1.3	1.9
B2	0.66	1.8	2.5	1.7	2.3
B3	1.60	2.7	4.0	2.6	3.8
B4	0.83	1.9	2.8	1.7	2.5
B5	1.86	2.6	3.9	2.4	3.6
B6	1.82	3.0	4.3	2.8	4.0
B7	3.12	2.6	3.5	2.4	3.3
B8	3.88	2.7	4.1	2.6	4.0
B9	1.95	2.5	3.4	2.3	3.1
B10	2.42	2.0	3.1	1.9	3.0

Channel Roughness Coefficients

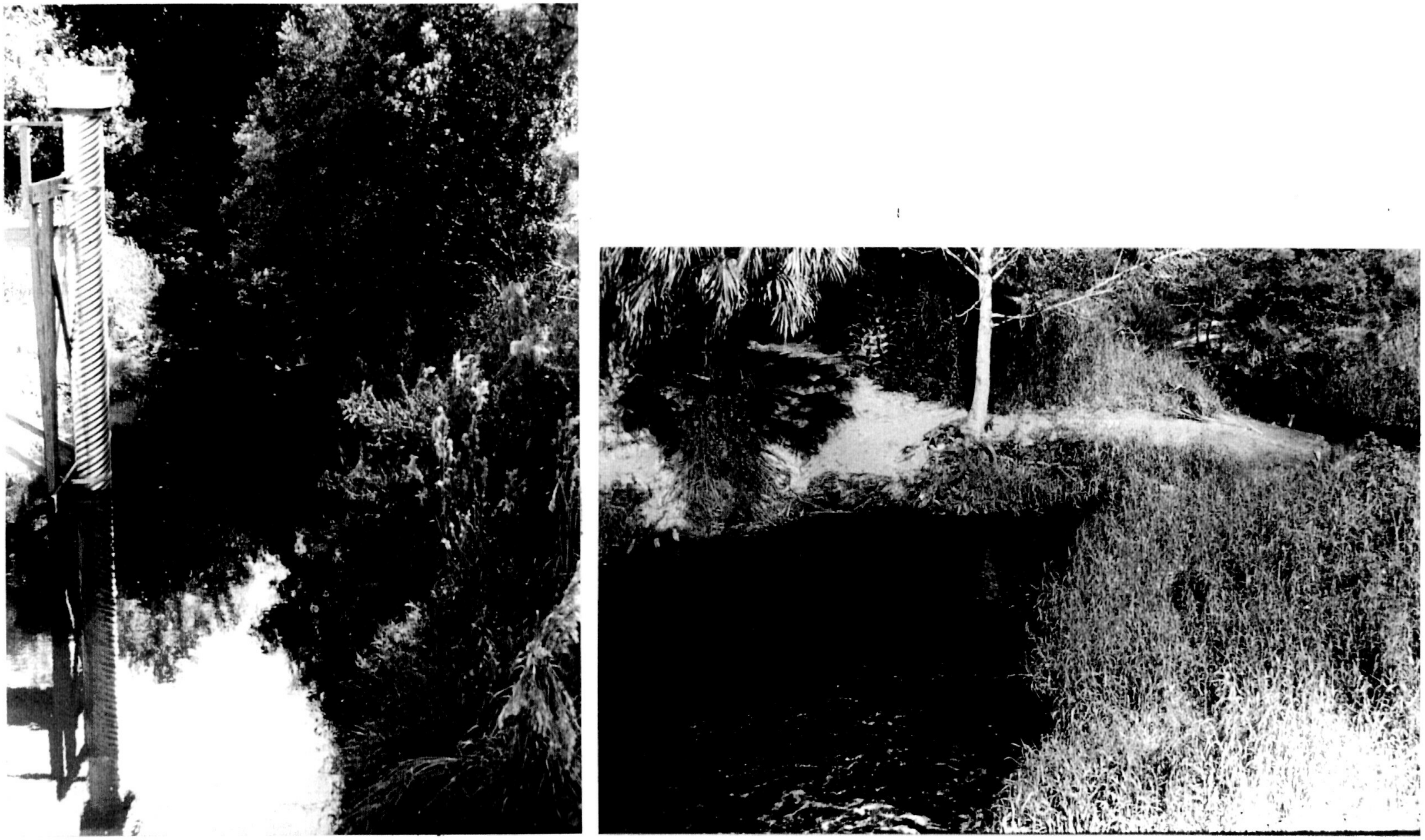
Analysis of flow in open channels requires information on the roughness characteristics of the channel. Channel roughness coefficients are dependent on a number of factors such as stage and discharge, vegetation, size and slope of channel, degree of irregularity, and obstructions. Estimation of channel roughness coefficients requires considerable experience and judgement. This parameter can have significant effect on the simulated flood elevations.

The roughness coefficients of the channels were assessed based on field inspections and color photographs taken at various sites on Howell Creek and Bear Creek. Channel characteristics of selected sites are shown in Figures 3-9. Roughness coefficients of floodplain areas were estimated from aerial maps. The roughness coefficients used ranged from 0.015 to 0.080 for channels, and from 0.040 to 0.120 for floodplain areas.

Upstream

Downstream

FIGURE 3. Howell Creek at State Road 419.

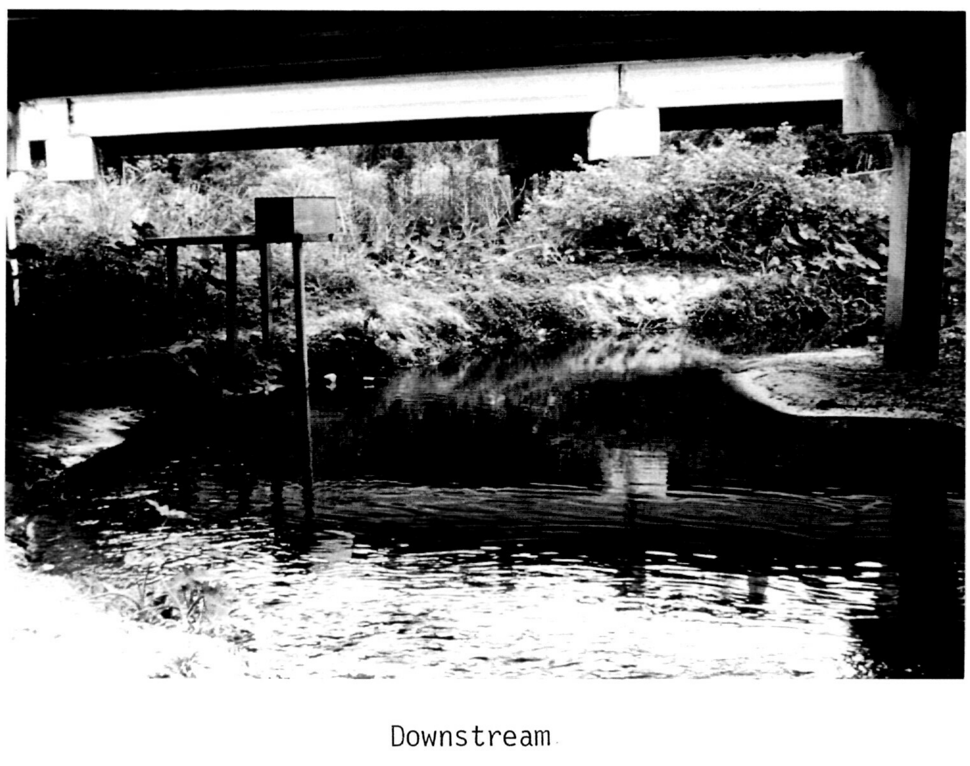


Upstream

Downstream

FIGURE 4. Howell Creek at Red Bug Lake Road.

Upstream



Downstream

FIGURE 5. Howell Creek at State Road 436.

FIGURE 6. Howell Creek at Palmer Avenue.

Upstream

Downstream

FIGURE 7. Bear Creek near Confluence with Howell Creek.

Upstream

Downstream

FIGURE 8. Bear Creek at Red Bug Lake Road.

Upstream

Downstream

FIGURE 9. Bear Creek at Tuskawilla Road.

METHODS OF COMPUTATION

The HEC-1 computer model was used to determine the 10-, 25-, and 100- year storm hydrographs from the 24-hour storm and the 25-year storm hydrographs from the 6-hour storm. The HEC-2 computer model was used to generate water surface profiles for the selected storm events. Both HEC-1 and HEC-2 programs were developed by the U. S. Army Corps of Engineers (4,5).

The major steps involved in this study can be summarized as follows:

1) Initial flood profiles were estimated for selected frequencies using peak discharges and starting flood elevations given in flood insurance study reports available for this basin (6, 7, 8, 9).
2) The estimated flood profiles were then used to develop stage-discharge-storage relationships for each lake. The stage-discharge relationships developed were refined until results obtained from HEC-1 and HEC-2 models had good agreement. The final stage-discharge-storage relationships obtained from level pool assumption were plotted in Figures B1 through B9 (Appendix B). These relationships together with other hydrologic data were used to simulate peak discharges.
3) The final flood profiles for the selected frequencies were calculated based on the peak discharges obtained from Step 2.

Determination of Initial Lake Stages

Initial lake stage, storage, or outflow is required in reservoir routing. Since long-term stage records are not available for most lakes in the Howell Branch Basin, the following sources of information were used to estimate initial lake stages under normal conditions: point measurements, lake stages given on USGS topographic maps and photogrammetric maps. The existing crest elevation of Lake Maitland weir has been maintained at 66.15 feet NGVD and therefore this elevation was used in the computation of discharge hydrographs for the existing conditions and future development. The initial water surface elevation above the weir was assumed to be at 66.20 feet NGVD. Because a very small outflow rate was given at this elevation, the initial water surface elevations in the Osceola chain of lakes (Osceola, Virginia, Mizell) and Lake Minnehaha were also assumed to be at 66.20 feet NGVD. The crest elevation of Lake Killarney weir was set at 84.00 feet NGVD and the initial water surface elevation at the weir was estimated to be at 82.9 feet NGVD based on historical records.

In order to study the impact of maintaining Lake Maitland weir at a lower elevation on flood elevations, it was decided to set the crest elevation two feet lower to 64.15 feet NGVD and assume the initial water surface elevation above the weir to be at 64.40 feet NGVD. As a result of the higher discharge through the weir at this elevation, a water surface drawdown curve would exist above the weir. This drawdown would cause initial lake elevations upstream of the weir in the Osceola chain of lakes and Lake Minnehaha to exceed 64.4. Therefore, the initial stages of the Osceola chain of lakes and Lake Minnehaha were estimated to be at 64.90 feet NGVD. The HEC-2 results obtained earlier indicate that water surface elevations on Park Lake, Lake of the Woods, and Lake Berry were controlled by critical depths and were independent of water conditions downstream. The initial lake stages for the remaining lakes in the basin were not changed because the impact of a lower crest elevation on these lakes was assumed to be negligible. The initial lake stages used for the two different crest elevations are compared in Table 5.

TABLE 5. Initial Lake Stages Assumed in the HEC-1 Model.

LOCATION	INITIAL STAGE, FT. (NGVD) (1)	(2)
Chain of Lakes: Sue, Rowena, Formosa, Winyah, and Estelle (H1)	71.7	71.7
Lake Berry (H2)	69.6	69.6
Chain of Lakes: Osceola, Virginia, and Mizell (H3)	66.2	64.9
Lake Bell (H4)	89.0	89.0
Lake Killarney Weir (H5)	82.9	82.9
Park Lake (H6)	70.0	70.0
Lake of the Woods (H7)	75.8	75.8
Lake Minnehaha (H8)	66.2	64.9
Lake Maitland Weir (H9)	66.2	64.4
Lake Howell (H12)	53.6	53.6
Deep Lake (B1)	56.0	56.0
Lake Waunatta (B2)	62.5	62.5
Chain of Lakes: Burkett, Martha, and Pearl (B3)	53.0	53.0
Garden Lake (B4)	53.0	53.0
Bear Gully Lake (B5)	49.0	49.0

Note: Numbers in parentheses denote sub-basin numbers.

(1) Existing conditions.
(2) Existing with Lake Maitland weir lowered by two feet.

Determination of Peak Discharges

In the HEC-1 program, the SCS methods were selected to generate a runoff hydrograph for each subbasin. The modified Puls method was used for reservoir routing and the Muskigum method was employed for channel routing.

The following assumptions were made in determining peak discharges.

1) Antecedent moisture condition II was used throughout the study.
2) There are two additional inflows into the Howell Branch Basin from Deer Run Subdivision located north of Lake Howell (Figure 2). The outflow hydrograph from the eastern portion of Deer Run Subdivision as calculated and given by Water Management Division, Seminole County was added to the runoff hydrograph of subbasin H15. The outflow hydrograph from the western portion, as computed by Land Engineering Company, was added to Lake Howell.
3) There are two drainage wells located just upstream of Lake Killarney weir. The stage-discharge relationship was developed for the drainage wells so that flows into the wells could be computed and subtracted from the total outflows.

Determination of Flood Elevations

The HEC-2 program employs the Standard Step Method to determine water surface elevations at successive cross sections and Manning's equation to calculate the energy loss within a channel reach. The basic input requirements of this program consist of channel cross-sectional profiles (perpendicular to the direction of flow), channel roughness coefficients, and geometric details on culverts and bridges.

The basic assumptions associated with computation of flood elevations can be summarized as follows:

1) The bridges and culverts were not obstructed by trees or other debris during the flood period.

2) All structures were of sufficient strength to sustain the magnitude of the floods studied.

3) Stage frequencies at Lake Jessup from Flood Insurance Studies (6, 7, 8, 9) were used as the starting water surface elevations for backwater calculations. The stage frequencies were assumed to coincide with the discharge and rainfall frequencies.

DISCUSSION OF RESULTS

Peak discharges and flood elevations were determined under existing conditions and future development for the chosen return periods. The chosen return periods are 10-, 25-, and 100-years for the 24-hour storm and 25-years for the 6-hour storm. The simulated results obtained from this study are discussed below.

Comparison of Peak Discharges

Peak discharges under existing land-use conditions and future development for the selected storm frequencies are compared in Table 6. In every case, peak discharges resulting from future development are higher than those under existing conditions. The percent increase in 100-year peak discharges ranged from 3.8% to 42.6% depending on location, and the average increase was 11.6%.

Discharge hydrographs under different conditions for the selected storm frequencies are compared and shown in Figures B10 through B57 (Appendix B) for the major locations in Howell Creek and Bear Creek. For Lake Killarney weir, Lake Maitland weir, and Lake Howell, stage hydrographs under different conditions are compared in Figures B58 through B69 (Appendix B).

The peak discharges estimated by this study (St. Johns River Water Management District, SJRWMD) are compared to the U. S. Army Corps of Engineers' (USACOE) estimates as shown in Table 7. The differences in peak discharge estimates are primarily due to (1) changes in land use occurring since the earlier study, (2) two additional inflows from Deer Run subdivision included in this study, and (3) more detailed data collection and modeling effort made by SJRWMD.

TABLE 6. Comparison of Peak Discharges under Existing Conditions and Future Development.

LOCATION	DRAINAGE AREA (Sq. Mi.)	PEAK DISCHARGE (cfs) EXISTING CONDITIONS				PEAK DISCHARGE (cfs) FUTURE DEVELOPMENT			
		25-yr 6-hr	10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-hr	25-yr 24-hr	100-yr 24-hr
HOWELL CREEK									
At the Osceola Chain of Lakes	5.85	50	70	105	185	60	80	115	200
At Park Lake	3.60	140	125	185	350	160	145	210	375
At Lake Minnehaha	1.64	65	75	110	190	75	85	120	205
At Lake Maitland Weir	13.16	185	220	335	615	215	245	370	665
At SR 436	14.74	605	550	740	1160	730	665	870	1320
At Lake Howell	19.95	460	510	715	1310	520	570	800	1420
At Tuskawilla Road	21.11	530	535	750	1380	580	605	840	1510
At Subbasin H15	22.63	1000	920	1270	2300	1120	1040	1410	2490
At Confluence with Bear Creek	24.32	1350	1230	1680	2900	1480	1360	1820	3070
At SR 419	43.50	3180	2910	3970	6600	3540	3260	4390	7130
At Mouth of Howell Creek	45.51	3170	3060	4180	6930	3570	3410	4590	7460

TABLE 6 - Continued

LOCATION	DRAINAGE AREA (Sq. Mi.)	PEAK DISCHARGE (cfs) EXISTING CONDITIONS 25-yr 6-hr	EXISTING CONDITIONS 10-yr 24-hr	EXISTING CONDITIONS 25-yr 24-hr	EXISTING CONDITIONS 100-yr 24-hr	FUTURE DEVELOPMENT 25-yr 6-hr	FUTURE DEVELOPMENT 10-yr 24-hr	FUTURE DEVELOPMENT 25-yr 24-hr	FUTURE DEVELOPMENT 100-yr 24-hr
BEAR CREEK									
At the Burkett Chain of Lakes	2.82	45	50	65	100	50	55	70	115
At Garden Lake	0.83	80	75	120	270	110	95	150	330
At Bear Gully Lake	5.28	35	55	90	270	50	70	120	385
At Subbasin B7	7.10	540	495	675	1080	655	595	795	1230
At Subbasin B8	10.22	485	490	670	1050	545	550	735	1090
At Subbasin B10	16.05	1410	1330	1920	3260	1580	1490	2090	3470
At Confluence with Howell Creek	18.47	1730	1590	2250	3810	1960	1790	2440	4050

TABLE 7. Comparison of Peak Discharges under Existing Conditions as Estimated by SJRWMD and USACOE.

LOCATION	PEAK DISCHARGE (CFS) 10-YEAR SJRWMD	10-YEAR USACOE	100-YEAR SJRWMD	100-YEAR USACOE
HOWELL CREEK				
At Lake Maitland Weir	220	440	615	880
At SR 436	550	440	1160	880
At Mouth of Lake Howell	510	500	1310	1200
At Confluence with Bear Creek	1230	750	2900	2280
At SR 419	2910	2030	6600	6240
At Mouth of Howell Creek	3060	2080	6930	6420
BEAR CREEK				
At Confluence with Howell Creek	1590	1430	3810	4800

Comparison of Flood Elevations

Flood elevations under existing land-use conditions and future development for the chosen frequencies are compared in Table 8. In all cases, flood elevations resulting from future development are higher than those under the existing conditions. The increases in 100-year flood elevations ranged up to 0.6 feet and the average increase was approximately 0.2 feet.

The predicted flood profiles for the 24-hour storms are shown in Appendix C for the existing conditions and in Appendix D for future development. The flood profiles under existing conditions and future development for the 6-hour storm are shown in Appendix E. The 10- and 100-year floodplain areas under existing conditions were delineated on the photogrammetric maps. The 100-year floodplain areas were also delineated on USGS topographic maps (1:24000) as an illustration (Appendix F). For more accurate delineation of floodplain areas, the photogrammetric maps should be reviewed. (Exhibits A and B)

Flood elevations estimated by SJRWMD and USACOE are presented in Table 9. The differences between the two estimates are basically due to (1) variations in peak discharges discussed earlier (2) more detailed channel cross sections and hydraulic structure data used in the present study, and (3) the methods used in determining lake stages.

Flood Prone and Flood Damage Areas

The floodplain maps (Exhibits A and B) indicate significant flood prone areas are located along Howell Creek between Lake Maitland and Lake Waumpi, along Lake Howell, at the lower portions of Howell Creek and Bear Creek, along Bear Gully Canal, Bear Gully Lake, Lake Burkett, Lake Martha, Lake Pearl and Deep lake.

TABLE 8. Comparison of Flood Elevations under Existing Conditions and Future Development.

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS				FUTURE DEVELOPMENT			
		10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-yr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
HOWELL CREEK									
0 + 00	Mouth of Howell Creek	8.1	8.7	9.8	8.7	8.1	8.7	9.8	8.7
58 + 95	SR 419 (HS-1)	11.6	13.3	14.9	12.0	12.2	13.6	15.1	13.3
78 + 30	Seaboard Railroad (HS-2)	12.8	14.1	15.9	13.1	13.3	14.4	16.2	14.0
94 + 40	Northern Way (HS-3)	14.2	15.2	17.6	14.4	14.5	15.6	18.1	14.9
100 + 60	Confluence with Bear Creek	15.6	16.9	19.5	15.9	16.0	17.3	19.9	16.4
108 + 95	Ext. of Winter Springs Blvd	18.1	18.7	20.7	18.3	18.3	18.9	21.0	18.5
123 + 40	Golf Cart Bridge (HS-5)	18.9	19.6	21.3	19.1	19.1	19.8	21.6	19.3
135 + 00	Golf Cart Bridge (HS-6)	20.2	21.1	22.5	20.4	20.5	21.3	22.7	20.7
147 + 75	Golf Cart Bridge (HS-8)	22.8	24.3	26.2	23.2	23.3	24.6	26.6	23.7
166 + 70	Golf Cart Bridge (HS-9)	24.0	25.3	27.5	24.3	24.3	25.7	27.8	24.7
172 + 70	Northern Way (HS-10)	25.0	26.2	28.5	25.3	25.4	26.6	28.9	25.7
207 + 25	Dyson Drive (HS-13)	29.7	30.7	32.8	30.0	30.0	31.0	33.1	30.3
269 + 00	Red Bug Lake Road (HS-15)	34.9	35.3	36.3	35.0	35.0	35.5	36.5	35.1
281 + 55	Wooden Bridge (HS-15A)	38.8	39.8	41.3	39.1	39.2	41.1	41.5	39.4
289 + 50	Tuskawilla Road (HS-16)	40.0	41.0	42.9	40.1	40.3	41.4	43.3	40.4
308 + 40	Dam (HS-16B)	43.5	44.5	46.7	43.5	43.8	44.9	47.0	43.7

TABLE 8. Continued . . .

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS 10-yr 24-hr	EXISTING CONDITIONS 25-yr 24-hr	EXISTING CONDITIONS 100-yr 24-hr	EXISTING CONDITIONS 25-yr 6-hr	FUTURE DEVELOPMENT 10-yr 24-yr	FUTURE DEVELOPMENT 25-yr 24-hr	FUTURE DEVELOPMENT 100-yr 24-hr	FUTURE DEVELOPMENT 25-yr 6-hr
333 + 15	Dodd Road (HS-17)	47.7	48.1	49.3	47.7	47.8	48.2	49.6	47.7
377 + 50	Dam at Jericho Drive (HS-19)	56.3	57.0	58.1	56.3	56.5	57.2	58.3	56.4
429 + 00	Lake Howell	56.4	57.1	58.4	56.4	56.6	57.3	58.6	56.5
481 + 00	SR 436 (HS-24)	56.5	57.2	58.5	56.4	56.7	57.4	58.7	56.6
494 + 45	Lake Howell Lane (HS-25)	60.7	61.1	61.9	60.8	60.9	61.4	62.1	61.1
498 + 45	Lake Howell Road (HS-27)	61.3	62.0	63.5	61.5	61.7	62.5	64.1	61.9
516 + 00	Mouth of Lake Waumpi	62.0	62.7	64.2	62.2	62.4	63.2	64.7	62.6
558 + 75	Temple Trail	65.9	66.5	67.3	66.0	66.2	66.7	67.5	66.3
575 + 45	Lake Maitland Weir	67.4	67.8	68.6	67.2	67.5	67.9	68.7	67.4
605 + 60	Lake Maitland	67.7	68.3	69.1	67.5	67.8	68.5	69.2	67.7
660 + 90	Palmer Avenue	67.9	68.5	69.3	67.6	68.0	68.6	69.4	67.8
681 + 20	Lake Osceola	67.9	68.5	69.4	67.6	68.0	68.7	69.5	67.8
708 + 20	Osceola Avenue	67.9	68.5	69.4	67.6	68.0	68.7	69.5	67.8
733 + 00	Lake Virginia	67.9	68.5	69.4	67.6	68.0	68.7	69.5	67.9
756 + 10	Stirling Avenue	68.1	68.7	69.9	67.7	68.2	68.9	70.1	68.0
776 + 90	Pennsylvania Avenue	68.3	68.9	70.1	67.9	68.4	69.1	70.3	68.1
805 + 50	Lake Sue	73.3	73.7	74.5	73.2	73.4	73.8	74.6	73.4

TABLE 8. Continued . . .

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS				FUTURE DEVELOPMENT			
		10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-yr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
833 + 25	Lakeside Drive	73.5	73.9	74.9	73.4	73.6	74.1	75.0	73.6
835 + 70	Lake Rowena	73.5	73.9	74.9	73.4	73.6	74.1	75.0	73.6
864 + 40	Mills Street	73.5	73.9	74.9	73.4	73.6	74.1	75.0	73.6
884 + 50	Lake Formosa	73.5	73.9	74.9	73.4	73.6	74.1	75.0	73.6
TRIBUTARY 1									
0 + 00	Lake Howell	56.4	57.1	58.4	56.4	56.6	57.3	58.6	56.5
16 + 10	Building Over Creek (HS-23D)	56.4	57.1	58.4	56.4	56.7	57.4	58.6	56.6
20 + 35	Road to Apartments	57.4	57.8	58.5	57.6	57.6	58.0	58.6	57.7
22 + 20	SR 436 (HS-23F)	58.8	59.3	60.2	58.9	59.0	59.4	60.4	59.1
30 + 40	New Bridge (HS-23G)	59.2	60.0	61.1	59.6	59.5	60.0	61.0	59.6
50 + 40	Near Treatment Plant	81.3	81.8	82.6	81.5	81.5	81.9	82.7	81.6
TRIBUTARY 2									
0 + 00	Lake Maitland	67.7	68.3	69.1	67.5	67.8	68.5	69.2	67.7
51 + 90	Horatio Avenue	68.2	68.9	70.1	68.0	68.4	69.1	70.3	68.2
71 + 60	Lake Minnehaha	68.2	68.9	70.1	68.0	68.4	69.1	70.3	68.2

TABLE 8. Continued . . .

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS 10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	FUTURE DEVELOPMENT 10-yr 24-yr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
88 + 80	Dommerich Drive	68.3	69.1	70.7	68.1	68.5	69.3	71.0	68.3
107 + 30	Derbyshire Road	77.0	77.9	79.3	77.3	77.3	78.2	79.4	77.6
128 + 20	Lake of the Woods	77.9	78.4	79.5	78.0	78.0	78.6	79.7	78.2
TRIBUTARY 3									
0 + 00	Lake Maitland	67.7	68.3	69.1	67.5	67.8	68.5	69.2	67.7
34 + 90	U. S. 17	72.1	73.0	75.2	72.4	72.4	73.3	75.5	72.6
40 + 90	Seaboard Railroad	72.3	73.3	75.9	72.6	72.7	73.7	76.3	72.9
53 + 0	Park Lake	72.4	73.4	76.0	72.7	72.7	73.8	76.4	73.0
100 + 85	Lee Road, SR 438	84.6	85.1	86.1	84.8	85.0	85.5	86.5	85.0
124 + 25	Lake Killarney	84.9	85.4	86.3	84.8	85.0	85.5	86.5	85.0
166 + 00	Lake Bell	90.3	90.7	91.4	90.3	90.4	90.8	91.4	90.4
TRIBUTARY 4									
0 + 00	Lake Virginia	67.9	68.5	69.4	67.6	68.0	68.7	69.5	67.9
21 + 10	Lake Mizell	67.9	68.5	69.4	67.6	68.0	68.7	69.5	67.9

TABLE 8. Continued . . .

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS 10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	FUTURE DEVELOPMENT 10-yr 24-yr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
TRIBUTARY 5									
0 + 00	Lake Virginia	67.9	68.5	69.4	67.6	68.0	68.7	69.5	67.9
39 + 20	Agricultural Road	70.6	71.3	71.5	70.6	71.0	71.3	71.6	71.0
60 + 00	Lake Berry	70.8	71.4	71.9	70.8	71.1	71.4	71.9	71.1
TRIBUTARY 6									
0 + 00	Lake Rowena	73.5	73.9	74.9	73.4	73.6	74.1	75.0	73.6
23 + 30	Lake Estelle at US 17	73.6	74.1	75.1	73.6	73.7	74.2	75.3	73.7
44 + 00	Lake Winyah	73.6	74.1	75.1	73.6	73.7	74.2	75.3	73.7
BEAR CREEK									
0 + 00	Confluence with Howell Creek	15.6	16.9	19.5	15.9	16.0	17.3	19.9	16.4
3 + 55	Ext. of Winter Springs Blvd	17.9	18.8	20.5	18.2	18.3	19.2	20.6	18.5
16 + 10	Ext. of Winter Springs Blvd	19.1	20.0	21.3	19.4	19.5	20.2	21.4	19.7
36 + 00	Northern Way (BS-2A)	20.2	21.2	22.7	20.5	20.5	21.4	22.9	20.8
71 + 20	X-Section at Power line	21.5	22.5	24.2	21.7	21.8	22.7	24.4	22.1
110 + 80	X-Section N. of Runway	26.9	27.4	27.9	27.0	27.1	27.5	28.0	27.1
154 + 80	Dirt Road (BS-3)	29.8	31.3	33.3	29.0	30.2	31.7	33.7	30.4

TABLE 8. Continued . . .

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS				FUTURE DEVELOPMENT			
		10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-yr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
172 + 80	Dirt Road (BS-4)	30.5	31.9	33.8	30.6	30.9	32.2	34.1	31.0
192 + 05	Red Bug Lake Road (BS-5)	30.9	32.5	33.9	30.9	31.3	33.2	34.1	31.4
220 + 85	Michler Road (BS-7)	42.7	43.1	43.5	42.8	42.9	43.3	43.6	43.0
239 + 70	Ext. of Dike Road (BS-8)	42.8	43.2	43.7	42.9	43.0	43.3	43.8	43.1
260 + 40	Bruce Lane (BS-9)	42.9	43.3	43.8	43.0	43.1	43.5	44.0	43.2
280 + 90	Michael Drive (BS-10)	46.0	46.9	47.6	46.0	46.7	47.2	47.7	46.9
328 + 10	Tuskawilla Road (BS-12)	51.9	52.5	53.3	51.7	52.2	52.7	53.5	51.9
351 + 60	Bear Gully Lake	51.9	52.5	53.3	51.7	52.2	52.7	53.6	51.9
366 + 00	Bear Gully Road (BS-15)	54.1	54.4	55.2	53.5	54.5	54.7	55.2	54.1
379 + 20	Seaboard Railroad (BS-14)	54.1	54.4	55.2	53.5	54.5	54.7	55.4	53.9
400 + 00	Lake Burkett	54.8	55.4	57.1	54.4	55.2	55.6	57.2	54.8
430 + 20	Lake Pearl	54.8	55.4	57.1	54.4	55.2	55.6	57.2	54.8
480 + 80	Deep Lake	57.1	57.3	57.7	57.1	57.2	57.4	57.8	57.2

TABLE 8. Continued . . .

STATION	IDENTIFICATION	FLOOD ELEVATION (ft.) EXISTING CONDITIONS 10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	FUTURE DEVELOPMENT 10-yr 24-yr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
TRIBUTARY 1									
0 + 00	Bear Gully Lake	51.9	52.5	53.3	51.7	52.2	52.7	53.6	51.9
41 + 25	Dodd Road (BS-16)	53.8	54.9	55.0	53.7	54.6	55.0	55.2	54.9
44 + 85	Dirt Road (BS-17)	55.7	56.3	57.0	55.9	56.2	56.6	57.1	56.3
51 + 00	Garden Lake	55.8	56.4	57.2	55.9	56.2	56.6	57.4	56.3
TRIBUTARY 2									
0 + 00	Lake Burkett	54.8	55.4	57.1	54.4	55.2	55.6	57.2	54.8
9 + 00	Lake Martha	54.8	55.4	57.1	54.4	55.2	55.6	57.2	54.8
39 + 60	Hall Road	62.9	63.5	64.2	63.1	63.2	63.6	64.4	62.9
59 + 10	Lake Waunatta	63.8	64.2	64.7	63.9	63.9	64.3	64.9	63.9

TABLE 9. Comparison of Flood Elevations under Existing Conditions as Estimated by SJRWMD and USACOE.

LOCATION	FLOOD ELEVATION (ft) 10-YEAR SJRWMD	10-YEAR USACOE	100-YEAR SJRWMD	100-YEAR USACOE
HOWELL CREEK				
At Lake Jessup	8.1	8.1	9.8	9.8
At SR 419	11.6	13.9	14.9	15.3
At Confluence with Bear Creek	15.6	15.1	19.1	18.4
At Tuskawilla Road	40.0	39.2	42.9	43.5
At Lake Howell	56.4	55.2	58.4	56.6
At SR 436	56.5	57.0	58.5	58.4
At Lake Waumpi	62.0	61.6	64.2	63.5
At Lake Maitland	67.7	67.7	69.1	68.3
At Lake Osceola	67.9	67.7	69.4	68.3
At Lake Virginia	67.9	67.7	69.4	68.3
At Lake Mizell	67.9	67.7	69.4	68.3
At Lake Minnehaha	68.2	67.7	70.1	68.3
At Lake Berry	70.8	70.7	71.8	71.7
At Lake Sue	73.3	73.7	74.5	74.8
At Lake Rowena	73.5	73.7	74.9	74.8
At Park Lake	72.4	71.9	76.0	72.7
At Lake Killarney	84.9	84.2	86.3	85.4
At Lake Bell	90.3	90.8	91.4	92.4
BEAR CREEK				
At Bear Gully Lake	51.9	51.2	53.3	53.3
At Garden Lake	55.8	55.2	57.2	55.7

TABLE 9. Continued . . .

LOCATION	FLOOD ELEVATION (ft) 10-YEAR SJRWMD	10-YEAR USACOE	100-YEAR SJRWMD	100-YEAR USACOE
At Lake Burkett	54.8	54.7	57.1	56.0
At Lake Waunatta	63.8	62.8	64.7	63.8

In general, these areas are flat and consist of marshy and/or agricultural lands. Flood damage to agricultural lands is significant along Bear Gully Canal. The potential flood damage to existing residential development is significant along Park Lake and Lake Killarney.

Tables 10 and 11 list the structures that will be overtopped during the 10-, 25-, and 100-year storm under existing conditions and future development. The following structures will be overtopped more than 2.0 feet during the 100-year storm: HS-4, HS-5, HS-6, HS-8, BS-1, BS-2, BS-4, and BS-8. These structures are located near the confluence of Howell Creek and Bear Creek and along Bear Gully Canal. In the case of 100-year storm event, 10 out of 43 structures on Howell Creek will be overtopped under both existing conditions and future development. On Bear Creek, 10 out of 21 structures will be overtopped under existing conditions and 14 out of 21 structures under future development. Some of these structures were installed without proper engineering design. Improper design can adversely affect flood elevations. For example, structure BS-7 caused flood elevations to increase by 8-9 feet for all the storm events simulated (Figures C-8b, D-8b, and E-8b).

Effect of a Change in Crest Elevation of Lake Maitland Weir

Peak discharges obtained with two different crest elevations of Lake Maitland weir (Existing Conditions) are compared in Table 12. Simulated results indicate that the effect of the change in weir crest elevation on peak discharge is significant at the Osceola chain of lakes, Lake Minnehaha, and Lake Maitland weir. This effect dampens out further downstream of the weir until it becomes negligible near the outlet of the basin. In the case of 10-year storm, peak discharges at the Osceola chain of lakes and Lake Minnehaha were decreased by

TABLE 10. List of Structures Overtopped under Existing Conditions.

LOCATION	ROAD ELEVATION (ft.)	DEPTH OF OVERTOPPING (ft.) 10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
HOWELL CREEK					
SR 419 (HS-1)	13.5	-	-	0.1	-
Ext. of Winter Springs Blvd. (HS-4)	15.8	1.8	2.1	4.0	1.9
Golf Cart Bridge (HS-5)	17.8	0.9	1.6	3.5	1.1
Golf Cart Bridge (HS-6)	19.9	0.2	1.1	2.5	0.5
Service Road (HS-7)	23.2	-	-	0.2	-
Golf Cart Bridge (HS-8)	23.0	-	1.3	3.3	0.3
Golf Cart Bridge (HS-9)	26.6	-	-	0.8	-
Wooden Bridge (HS-15A)	40.5	-	-	0.6	-
TRIBUTARY 3					
Lee Road	90.7	-	-	0.7	-
TRIBUTARY 5					
Agricultural Road	71.3	-	-	0.2	-
BEAR CREEK					
Ext. of Winter Springs Blvd. (BS-1)	16.8	-	0.9	2.7	0.1
Ext. of Winter Springs Blvd. (BS-2)	16.6	2.4	3.4	4.7	2.8
Dirt Road (BS-3)	32.3	-	-	1.0	-
Dirt Road (BS-4)	28.1	2.4	3.8	5.7	2.5
Red Bug Lake Road (BS-5)	32.9	-	-	1.0	
Michler Road (BS-7)	42.3	0.4	0.7	1.2	0.5
Ext. of Dike Rd. (BS-8)	40.0	2.8	3.1	3.7	2.9

TABLE 10. Continued

LOCATION	ROAD ELEVATION (ft.)	DEPTH OF OVERTOPPING (ft.) 10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
E. of Tuskawilla Rd. (BS-11)	51.3	0.1	0.6	1.3	0.2
SR 426 (BS-13)	56.9	-	-	0.1	-
TRIBUTARY 1					
Dirt Road (BS-17)	55.6	-	0.6	1.3	0.1

TABLE 11. List of Structures Overtopped under Future Development.

LOCATION	ROAD ELEVATION (ft.)	DEPTH OF OVERTOPPING (ft.)			
		10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
HOWELL CREEK					
SR 419 (HS-1)	13.5	-	-	0.4	-
Ext. Winter Springs Blvd. (HS-4)	15.8	1.9	2.2	4.6	2.1
Golf Cart Bridge (HS-5)	17.8	1.1	1.8	3.8	1.3
Golf Cart Bridge (HS-6)	19.9	0.5	1.3	2.8	0.8
Service Road (HS-7)	23.2	-	0.3	0.8	-
Golf Cart Bridge (HS-8)	23.0	0.3	1.6	3.7	0.8
Golf Cart Bridge (HS-9)	26.6	-	-	1.1	-
Wooden Bridge (HS-15A)	40.5	-	-	0.8	-
TRIBUTARY 3					
Lee Road	90.7	-	0.1	0.7	-
TRIBUTARY 5					
Agricultural Road	71.3	-	-	0.2	-
BEAR CREEK					
Ext. Winter Springs Blvd. (BS-1)	16.8	0.1	1.0	2.7	-
Ext. Winter Springs Blvd. (BS-2)	16.6	2.8	3.6	4.8	3.1
Dirt Road (BS-3)	32.3	-	-	1.4	-
Dirt Road (BS-4)	28.1	2.8	4.2	6.0	2.9
Red Bug Lake Road (BS-5)	32.9	-	0.2	1.1	-
Michler Road (BS-7)	42.3	0.6	0.9	1.3	0.7
Ext. of Dike Road (BS-8)	40.0	3.0	3.3	3.8	3.1

TABLE 11. Continued

LOCATION	ROAD ELEVATION (ft.)	DEPTH OF OVERTOPPING (ft.) 10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
Bruce Lane (BS-9)	43.8	-	-	0.2	-
E. of Tuskawilla Rd. (BS-11)	51.3	0.4	0.8	1.6	0.1
Tuskawilla Rd. (BS-12)	53.3	-	-	0.2	-
SR 426 (BS-13)	56.9	-	-	0.3	-
TRIBUTARY 1					
Dodd Road (BS-16)	54.9	-	0.1	0.3	-
Dirt Road (BS-17)	55.6	0.5	0.8	1.5	0.6
TRIBUTARY 2					
Hall Road	63.6	-	-	0.3	-

TABLE 12. Comparison of Peak Discharges Obtain with Two Different Crest Elevations of Lake Maitland Weir (Existing Conditions).

LOCATION	EXISTING CONDITIONS				EXISTING WITH MAITLAND WEIR LOWERED BY TWO FEET			
	25-yr 6-hr	10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-hr	25-yr 24-hr	100-yr 24-hr
HOWELL CREEK								
At the Osceola Chain of Lakes	50	70	105	185	20	25	35	60
At Lake Minnehaha	65	75	110	190	40	50	75	145
At Lake Maitland Weir	185	220	335	615	205	225	320	540
At SR436	605	550	740	1160	630	575	770	1210
At Lake Howell	460	510	715	1310	475	530	740	1340
At At Confluence with Bear Creek	1350	1230	1680	2900	1350	1230	1690	2900
At SR419	3150	2910	3970	6600	3150	2910	3980	6610
At Mouth of Howell Creek	3170	3060	4180	6930	3170	3060	4180	6940

64.3% and 33.3%, respectively. This decrease in peak discharges was a result of additional lake storage available when initial lake stages were lower. Peak discharges at the weir and Lake Howell have increased by 2.3% and 2.0%, respectively. This increase in peak discharges was caused by the higher initial outflow rate assumed. Peak discharges at the weir and Lake Howell would have been slightly lower than those under existing conditions if the same initial outflow rate had been assigned. It should be noted that a change in the weir elevation should not have any effect on peak discharges in Bear Creek, peak discharges at Park Lake and upstream of Park Lake, and peak discharges upstream of the Osceola chain of lakes and Lake Minnehaha.

Flood elevations obtained with two different crest elevations of Lake Maitland weir (Existing Conditions) are presented in Table 13. The results show that the impact of the change in the weir crest elevation on flood elevations downstream of Lake Maitland weir is insignificant. The increase in flood elevations downstream of the weir ranged from 0.0 to 0.2 feet. In Lake Howell, the change in flood elevations is less than 0.1 feet.

In Lake Maitland, the flood elevations were substantially reduced by 0.6 feet and 0.4 feet for the 10-year and 25-year storms, respectively. In the case of 100-year storm, flood elevations remained practically the same as with the existing conditions. In analyzing the results, it was noticed that flood elevations downstream of the weir obtained from the HEC-2 model were higher than the peak elevations at the weir obtained from the HEC-1 model. This indicates that backwater occurs during the storms when the weir crest was set at 64.15 feet NGVD and its effect becomes more pronounced for more severe storms. As a result, flood elevations in the Osceola chain of lakes were decreased the least during the 100-year storm. For the 10-year and 100-year storms, the flood elevations were reduced by 0.6 feet and 0.2 feet, respectively. In Lake

TABLE 13. Comparison of Flood Elevations Obtaining with Two Different Crest Elevations of Lake Maitland Weir (Existing Conditions).

STATION	IDENTIFICATION	EXISTING CONDITIONS				EXISTING WITH MAITLAND WEIR LOWERED BY TWO FEET			
		10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
HOWELL CREEK									
0 + 00	Mouth of Howell Creek	8.1	8.7	9.8	8.7	8.1	8.7	9.8	8.7
58 + 95	SR419 (HS-1)	11.6	13.3	14.9	12.0	11.6	13.3	14.9	12.0
100 + 60	Confluence with Bear Creek	15.6	16.9	19.5	15.9	15.6	16.9	19.5	15.9
429 + 00	Lake Howell	56.4	57.1	58.4	56.4	56.4	57.2	58.4	56.4
481 + 00	SR436 (HS-24)	56.5	57.2	58.5	56.4	56.5	57.2	58.6	56.4
516 + 00	Mouth of Lake Waumpi	62.0	62.7	64.2	62.2	62.1	62.8	64.4	62.3
575 + 45	Lake Maitland Weir	67.4	67.8	68.6	67.2	66.6	67.2	68.1	66.6
605 + 60	Lake Maitland	67.7	68.3	69.1	67.5	67.1	67.9	69.1	67.0
681 + 20	Lake Osceloa	67.9	68.5	69.4	67.6	67.3	68.2	69.2	67.2
733 + 00	Lake Virginia	67.9	68.5	69.4	67.6	67.3	68.2	69.2	67.2
805 + 50	Lake Sue	73.3	73.7	74.5	73.2	73.2	73.6	74.3	73.2
835 + 70	Lake Rowena	73.5	73.9	74.9	73.4	73.4	73.8	74.7	73.4
884 + 50	Lake Formosa	73.5	73.9	74.9	73.4	73.4	73.8	74.7	73.4
TRIBUTARY 2									
71 + 60	Lake Minnehaha	68.2	68.9	70.1	68.0	67.6	68.2	69.5	67.3

TABLE 13. Continued . . .

STATION	IDENTIFICATION	EXISTING CONDITIONS				EXISTING WITH MAITLAND WEIR LOWERED BY TWO FEET			
		10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr	10-yr 24-hr	25-yr 24-hr	100-yr 24-hr	25-yr 6-hr
TRIBUTARY 4									
21 + 10	Lake Mizell	67.9	68.5	69.4	67.6	67.3	68.2	69.2	67.2
TRIBUTARY 6									
44 + 00	Lake Winyah	73.6	74.1	75.1	73.6	73.5	74.0	74.9	73.5

Minnehaha, the flood elevations were approximately reduced by 0.65 feet for every storm simulated. In the chain of lakes consisting of Lakes Sue, Rowena, Formosa and Estelle, the decrease in flood elevations ranged up to 0.2 feet.

CONCLUSIONS

The conclusions of this study are as follows:

1. The floodplain maps delineated indicate that major flood prone areas are located along Howell Creek between Lake Maitland and Lake Waumpi, along Lake Howell, at the lower portions of Howell Creek and Bear Creek, along Bear Gully Canal, Bear Gully Lake, Lake Burkett, Lake Martha, Lake Pearl, and Deep Lake. Significant flood damages can occur to agricultural lands located along Bear Gully Canal and to existing residential areas located along Park Lake and Lake Killarney.

2. The results obtained from this study were based on average antecedent soil moisture condition and initial lake stage conditions that would be expected to occur under normal conditions. As a result, peak discharges and flood elevations would be higher than those given in the report for a given storm frequency if the antecedent conditions are extreme. In addition, this study assumed no loss of conveyance on the floodplain areas due to future development. If conveyance of the floodplains is decreased because of additional development, flood elevations may be greater than those under future development, especially along Howell Creek below Lake Maitland.

3. There are several small dams along Howell Creek that obstruct flows and cause water surface elevations to increase considerably during flood periods. In addition, these dams may restrict streamflows and deplete flows downstream during low flow periods. The Phase II study may include recommendations for modifying those structures.

4. A preliminary analysis indicates that flood elevations upstream of Lake Maitland weir can be reduced, without causing significant increase in flood elevations downstream, by maintaining the weir crest at a lower elevation.

With the crest elevation of Lake Maitland weir set 2.0 feet lower than the current elevation of 66.15 feet NGVD, flood elevations in Lake Maitland and the Osceola chain of lakes (Osceola, Virginia, and Mizell) can be significantly reduced especially for less severe storms. However, as the severity of storm increases, lowering the crest elevation of Lake Maitland weir may not effectively reduce flood elevations in Lake Maitland and the Osceola chain of lakes because of the backwater effect from downstream of the weir. Simulated results show that the flood elevations in Lake Minnehaha have reduced by approximately 0.65 feet and the decrease in flood elevations in the Sue chain of lakes (Sue, Rowena, Formosa, and Estelle) ranged up to 0.2 feet. This study did not consider the effect of maintaining the weir crest at a lower elevation on low flow. The Phase II study will further investigate and formulate regulation schedules that will provide optimum benefits both upstream and downstream of the weir during flood and low flow periods.

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