Lake Griffin Stormwater Management Program
Final Report

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1.0 PROJECT OVERVIEW

Lake Griffin is recognized as one of the most seriously impaired water bodies in the state of Florida, due primarily to excessive nutrient loading. This loading is partly the result of poor or non-existent control of nutrient-rich stormwater discharging to the lake. Lake Griffin is 9,327 acres in size and has a contributing drainage basin area of approximately 44,000 acres. The Florida Department of Environmental Protection (FDEP) proposed a load reduction of 50,936 pounds per year of total phosphorus in its draft (July, 2003) Total Maximum Daily Load (TMDL) analysis for the lake.

Lake County proposed to initiate a very unique approach to stormwater management within the Lake Griffin basin. The County wanted to avoid spending extensive time and funds conducting studies of the Lake Griffin watershed. The County wanted to begin project implementation as quickly as possible by utilizing available information and knowledge of the Lake Griffin basin area that various stakeholders could bring to the table. Lake County specifically desired to use the Lake Griffin project as a template for future watershed projects. Specifically, the County established the following general objectives:

- Assess and inventory stormwater management features in the basin
- Establish drainage subbasins
- Estimate pollutant loads from the subbasins
- Prioritize subbasins by load contribution to Lake Griffin
- Develop conceptual projects for pollutant load reduction
- Develop grant application support documents for the top ranked conceptual projects

The ultimate goal of this project was to reduce phosphorus-rich stormwater discharges to Lake Griffin as phosphorus has been identified as the limiting nutrient in Lake Griffin. Lake County Public Works contracted with BCI Engineers and Scientists, Inc. to assist the County

with this project. This project was divided into four major tasks that are outlined below.

A “Navigation Team” consisting of personnel from Lake County, Lake County Water Authority, SJRWMD and BCI was developed early on in the project. This group was tasked with steering the project through administrative decision-making duties such as basin and project ranking criteria as interim results were brought to the group by BCI.

2.0 TASK 1– VERIFICATION OF STORMWATER OUTFALL INVENTORY & OTHER DATA

2.1 Verification of Lake Griffin Outfalls

The first task involved verifying all stormwater outfalls listed in the County's existing outfall inventory as having potential discharge to Lake Griffin. The inventory was comprised of outfall structures identified by County, municipal and FDOT personnel. The outfalls are maintained by the respective entities. The purpose of this task was to identify sources of stormwater runoff entering Lake Griffin so that best management practices (BMPs) could be implemented where appropriate.

The outfall verification process included visiting all outfalls listed in the inventory, photographing them, noting their physical condition and collecting GPS location information so that the County's existing GIS mapping could be updated. Approximately 39 stormwater outfalls in the County inventory were identified as potentially discharging to Lake Griffin, to smaller water bodies hydrologically connected to Lake Griffin, or to landlocked water bodies located within the Lake Griffin watershed. Two of these outfalls were not found and were deleted from the inventory, while nine additional outfalls were discovered in the field and added to the County inventory. BCI was not tasked with searching for additional outfalls; however the nine additions were primary outfalls that were readily identified in the field.

Seven outfalls serving US Highway 27 and US Highway 441 were also added to the County's inventory. The outfalls were included in the inventory to facilitate potential future opportunities of cooperative stormwater quality projects between FDOT and Lake County. A complete list of known outfalls discharging to Lake Griffin, as well as an aerial with photographs for these outfalls, is included as **Appendix A**.

2.2 Review of County Plat Database

A review of the County's plat database maintained by the Lake County Property Appraiser's Office was conducted to identify and define areas within the Lake Griffin watershed that are currently served by stormwater management systems. These areas would be the ones in

which a “credit” for existing BMPs would be incorporated into the sub-basin pollutant loading task. It was assumed that any subdivision platted after 1982 would have some form of stormwater management system in place, as this was the first year that stormwater regulations on new development was being fully implemented by FDEP. Only residential subdivisions were assessed in this manner as such analysis for other land uses was not easily facilitated by this process. It was assumed that field assessments during draft basin prioritization would allow for the addition of BMP credits to other landuse areas. A polygon coverage was created for the subdivision blocks assumed to have BMPs in place. These areas are identified with hatching on the landuse map located in **Appendix A**.

2.3 Development of Drainage Sub-Basins within the Lake Griffin Watershed

Drainage basins for the inventoried outfalls were delineated using available topographic information and limited observations made in the field. This drainage basin delineation process of the original outfalls inventory supported the fact that the County’s outfalls are not significant contributors of stormwater runoff directly to Lake Griffin. This was due in large part to the fact that the outfalls were in areas sufficiently distant from Lake Griffin that the discharge flow paths allowed for dispersion of the discharges and a resultant pollutant load reduction prior to discharge into the lake. Additionally, many of the outfalls are simply crossdrains for movement of water from depressional (wetland) areas from one side of the road to the other.

In order to achieve overall project objectives, drainage basins were subsequently developed for all portions of the Lake Griffin basin. The drainage divides previously developed by SJRWMD were used for the entire Lake Griffin watershed limits, with some adjustments being made where appropriate. To maintain the intent of the project, prioritizing upland contributing drainage basins and pollutant loads to Lake Griffin, drainage basins were delineated with the following considerations:

- Wetland and other natural low-lying areas adjacent and interconnected to Lake Griffin were differentiated from upland areas where anthropogenic activities have occurred.

- Large individual development areas were considered as a “basin”. Therefore even if a development had numerous outfalls, the land mass could be treated as a single basin, with the intent of facilitating basin prioritization during future tasks.

- Upland areas adjacent to the lake and having dispersed “sheetflow” toward the lake were considered as a single drainage basin. This approach also was justified with the fact that a number of lakeside developments have access canals to the lake that serve as the primary conduit for the development’s stormwater to reach the lake.

Once the sub basins were developed using existing topographic information, a number of them were field-verified. This was done not only as a means of checking the basin delineation work accomplished with aerials and topographic data, but also for checking particular points within the basins where questions remained about actual stormwater volume contribution to Lake Griffin. The majority of soils within the upland portions of the Lake Griffin basin are of Hydrologic Soil Group (HSG) A. Such soils have high infiltration capacity and low runoff potential. As a result, field investigation also verified the presence of depressional areas not evident on the topographic maps. These areas were noted and were considered in the basin ranking process later in the project. The resulting sub-basin delineations are shown on the aerial map and landuse map in **Appendix A**.

3.0 TASK 2 – STORMWATER MANAGEMENT NEEDS EVALUATION

3.1 Compilation of Available Stormwater Management Information

All available stormwater management information, such as maps, reports, studies) and management strategies were located, reviewed and compiled to establish existing management activities, including determination of all non-structural practices that Lake County and the municipalities are currently implementing.

A series of meetings was held with individual stakeholders within the Lake Griffin watershed. These stakeholders included individuals, regulatory agencies, and municipal personnel. The purpose of these meetings was to obtain more information and insight into the Lake Griffin drainage basin. Information sought from stakeholders included identification of significant problem areas within the basin, any existing or proposed stormwater related activities that were not identified in earlier work, and the character and type of stormwater projects that were being proposed or implemented. These projects included both water quality projects and flood control activities. A summary of the meetings is attached as **Appendix B**.

3.2 Pollutant Loading Modeling

In order to prioritize the drainage basins, pollutant loading modeling was conducted to estimate the stormwater pollutant loads associated with each basin. The pollutant loading modeling was accomplished using an approach developed in-house by BCI that is based on the US Environmental Protection Agency's (EPA) Simple Method (Schueler, 1987).

The pollutant loading model utilized a grid-based approach that divided the entire watershed into numerous small cells. The stormwater runoff for each cell was estimated by assigning a runoff coefficient and an average rainfall amount of 50.5" based on review of historical rainfall data. Pollutant loads were subsequently estimated using the estimated runoff volume and event mean concentration (EMC) values for each pollutant. The EMCs are estimated average load concentrations from specific land uses based on past monitoring activities conducted throughout the State of Florida (**Table 1A, Appendix C**). The runoff coefficients and EMC values were determined for each drainage sub-basin by overlaying the grid with the most

current (at the time, 1995) land-use GIS coverage for Lake County to determine the land use type for each grid cell. Refer to **Appendix A** for a copy of the landuse map.

The Navigation Team determined that Total Phosphorus (TP) and Total Suspended Solids (TSS) would be the two primary pollutant parameters used for ranking purposes. Work conducted previously by SJRWMD has identified TP as the limiting nutrient to the lake.

Runoff and pollutant load reduction factors were applied to areas that were identified as having stormwater management or treatment systems (BMPs) already in place. The depressional areas identified in field reconnaissance as noted previously were considered as BMPs and given a load reduction factor as well.

The pollutant loading program was executed and sums of the individual runoff volume, TSS loading and P loading for all grid cells within each drainage sub-basin were calculated. Results were expressed as total pounds of TSS or TP on an annual basis. A "normalized" value of pollutant loading contributed by each basin (pounds per acre per year) was also determined as this is a useful planning tool and provides a gauge of "load intensity" for a given basin.

Please refer to **Appendix C** for results of the pollutant loading modeling. Pollutant loading results are sorted by normalized total loads per basin (in pounds per acre) in Tables 2 and 4 for TP and TSS, respectively. Pollutant load results are sorted by annual loads (pounds per year) in Tables 3 and 5 for TP and TSS, respectively.

3.3 Basin Prioritization

The results of the pollutant loading modeling were used to prioritize the basins relative to their need for water-quality improvement. This prioritization was the first step in determining an ultimate ranking of the basins for consideration for water-quality improvement projects. Approximately 40 basins, located within Lake County and within various municipal jurisdictions, were selected for further prioritization.

A simple matrix-based system was developed in consultation with the Navigation Team

to grade the 40 basins selected above on various factors. There were six factors used for prioritization as follows:

- Total P loadings for the basin,
- Total TSS loadings for the basin,
- Normalized P loadings for the basin,
- Normalized TSS loadings for the basin,
- Approximate potential for nutrient uptake along the conveyance path for stormwater within the basin,
- Approximate availability of land within the basin.

While the pollutant loading factors were quantitative, the conveyance uptake and availability factors were subjective in nature and reasonable, conservative engineering judgment had to be used to evaluate these factors. Conveyance uptake potential was scored between 0 and 100 with low scores being given to conveyances in which high pollutant load reduction was anticipated under present conditions (and therefore a reduced load to Lake Griffin).

The land availability ranking was based on a coarse review of digital infrared aerial photography of the Lake Griffin area (Year 2000). Each sub-basin was given a numerical score between zero and 100 for land availability (**Table 6, Appendix C**). Areas where land availability was low was given a low score as costs related to potential parcel acquisition and/or difficulty of construction would escalate the overall project cost. All ranking factors used in the matrix were assigned weighting factors to increase or decrease their importance in relation to one another. These weighting factors were determined through use of engineering judgment as well as through consultations with Navigation Team members. Table 7 in **Appendix C** lists the weighting factors ultimately used for this project.

The Navigation Team desired to achieve project implementation in the most rapid way

possible and this ranking approach helped to achieve that objective. Once the weighting factors were finalized, the matrix was used to derive a final score for each sub-basin – the higher the final score, the higher the priority placed on the sub-basin for consideration of water quality retrofit. Tables 8 and 9 identify the sequential ranking and sorting of the sub-basins. The sub-basins were ranked inclusive of (Table 10) and exclusive of (Table 11) municipal jurisdiction. However, at this early period of the County's stormwater management program, the County desired to exclude the municipal sub-basins from the final list of prioritized sub-basins. Table 12 lists the top fifteen basins with management considerations for each. The Navigation Team selected the following 5 sub-basins for further evaluation. Two additional sub-basins were added after several iterations of the Navigation Team reviewing potential projects and revisiting the sub-basin priority list.

BASIN ID	BASIN NAME
73-A	Haines Creek
65-H	Dead River
34-AJ	Harbor Oaks
34-C	Lakeside Village
34-O	Eagles Nest
34-AF	Brittany Estates
34-P	Fish Camp

The selected basins listed above are mapped below.

SUB-BASINS SELECTED FOR PROJECT IMPLEMENTATION

3.4 Detailed Characterization of Top Five Basins

The top five basins (expanded to seven) were evaluated in much greater detail for the feasibility of placing stormwater treatment systems in various areas within them. This was accomplished by conducting field visits throughout the sub-basins and carefully evaluating drainage patterns, availability of property or rights-of-way for potential projects, and minimal geotechnical investigations (hand auger samples at possible project sites). In addition, residents were interviewed when possible and asked about drainage patterns and/or problems they had observed in the past.

Much of the attention during this phase of the project was given to the directly connected impervious area (DCIA) in the sub-basins. Due to the predominance of Type A HSG soils in the basins, the predominant stormwater pollutant load was expected to be associated with the DCIA fraction of each sub-basin.

3.5 Identification of Potential Stormwater Projects

Using the information developed during the detailed evaluation phase, potential stormwater projects were defined in the top five priority sub-basins, as well as in the two additional sub-basins. Each of the seven basins had at least one project defined, and the larger sub-basins had several.

In most cases, the areas found to be of highest significance for pollutant loads were not associated with the County's infrastructure but rather the private developments adjacent to the lake. The older developments having a high DCIA fraction and pre-dating stormwater regulations were found to be the highest priorities for immediate retrofit project consideration.

The projects were developed at a conceptual level, and then assessed for provided benefits, generalized costs, ability to secure permitting through St. John's Water Management District (SJRWMD), and other factors.

Provided benefits were assumed to include, primarily, cost per pound of pollutants removed as

well as aesthetics, opportunities for public education / raising of public awareness, and recreational opportunities. The final list of potential projects is included as **Appendix D**. It is noted that the cost estimates and some additional findings since the original report (2001) was issued have been updated. Costs now more accurately reflect elevated construction costs that are typical for relatively small but challenging projects such as those contemplated in this report.

3.6 Conceptual Design of Priority Projects

Once the list of potential projects was completed a meeting was held with the Navigation Team to discuss the projects and to select the five best candidates. The five selected projects were as follows:

1. Brittany Estates in sub-basin 34-AF
2. Lazy Oaks in sub-basin 34-AJ
3. Griffwood in sub-basin 34-AJ
4. Haines Creek Park in sub-basin 73-A
5. Mid-Florida Lakes in sub-basin 73-A

These projects were then advanced to the conceptual design level through preparation of estimates of construction and engineering costs and associated exhibits sufficient to support a stormwater funding grant application, and to facilitate pre-application meetings with SJRWMD and other regulatory agencies. The conceptual design exhibit packages for the selected projects are described in detail in **Appendix E**.

It should be noted that the conceptual designs were prepared using only readily available topographical and existing infrastructure information. No additional survey work was performed at this time. Additionally, only coarse-level hydrologic /hydraulic calculations were performed to demonstrate the adequacy of each conceptual project. Detailed costs estimates were prepared

that itemized individual pay items, and quantities, as well as construction, engineering and surveying costs.

4.0 TASK 3 – IDENTIFICATION OF FUNDING SOURCES AND PREPARATION OF GRANT APPLICATION

This task involved researching possible sources of funding for the conceptual projects. Stormwater grants from state, federal and other agencies were considered. A summary report was prepared that identified grants for which the conceptual projects would meet eligibility requirements. Information presented in this report included application deadlines, available funds and fund distribution goals, contact names and telephone numbers and application requirements. The funding sources report was submitted under separate cover and because of its size is not reproduced for this report.

A grant application package was assembled by completing the Lake County Water Authority (LCWA) grant form and attaching exhibits from the conceptual projects. The completed grant application, as submitted, is included as **Appendix E**.

5.0 FUTURE PROJECT CONSIDERATIONS

Lake County has implemented design and construction for the first five projects in the Lake Griffin basin. Additionally, the County is presently pursuing design scopes for the next three priority projects in the basin. The majority of remaining significant stormwater load contributors to Lake Griffin is located in or around the municipal limits. Lake County will likely need to consider cooperative projects in the future for additional appreciable pollutant reductions for stormwater discharges.

Many Lake County roads within the Griffin basin lack stormwater conveyance features (roadside swales). This often is because the roads were constructed before much development existed in the area and stormwater runoff was not a concern due to the predominance of Type A soils in the area. Through implementation of the Lake Griffin stormwater project, it is evident that much of the stormwater load occurs as a result of directly connected impervious areas discharging to the Lake. It is where such offsite areas "pass through" the Lake County road right-of-way that the County has an opportunity of reducing the associated pollutant loads. Therefore in areas such as near County outfalls or cross-drains, roadside swale construction should be considered where possible. Such swale construction will be primarily for water quality purposes and not for conveyance purposes. With such an approach, Lake County can slowly and methodically address its stakeholder share of the pollutant load for its roads and the pre-1982 development which "passes through" County-owned infrastructure.

APPENDIX A

Characteristics Table of Outfalls

Aerial Map of Drainage Sub-Basins

Landuse Map (1995) of Lake Griffin Basin

APPENDIX B

Stormwater Management Information

APPENDIX C

POLLUTANT LOADING ESTIMATES

Table 1A: Landuse-Based Event Mean Concentrations

Table 1B: Generalized Efficiencies for Best Management Practices

Table 2: Total Phosphorus (Pounds/Ac) Annual Load Estimates

Table 3: Total Phosphorus (Pounds) Load Estimates

Table 4: Total Suspended Solids (Pounds/Ac) Annual Load Estimates

Table 5: Total Suspended Solids (Pounds) Load Estimates

Table 6: Land Availability Assessments

Table 7: Weighting Factors

Table 8: Unsorted Basin Rankings by Individual Variables

Table 9: Sub Basin Rankings by Summation of Variables

Table 10: Priority Basins Including Basins Within Municipal (Non-County) Jurisdiction, Sorted by Weighted Sum

Table 11: Priority Basins - Lake County Jurisdiction Only - Sorted by Weighted Sum

Table 12: Priority Basins With Management Comments

APPENDIX D

Concept Projects within Select Sub-Basins

Sub-basin 73-A (Haines Creek
Sub-basin 65-H ((Dead River)
Sub-basin 34-AJ (Harbor Oaks)
Sub-basin 34-C (Lakeside Village)
Sub-basin 34-O (Eagle's Nest)
Sub-basin 34-P (Fish Camp)
Sub-basin 34-AF (Brittany Estates)

APPENDIX E

Selected Stormwater Retrofit Projects – Conceptual Design
(Presented as Completed Stormwater Grant Application Package)
Summary Table – Potential Funding Sources (8/01)

LAKE GRIFFIN STORMWATER PROJECT
LAKE COUNTY PUBLIC WORKS

TABLE 1A- EVENT MEAN CONCENTRATIONS BY LANDUSE

LAND USE CATEGORY	EMC (mg/L)			
	TOTAL N	TSS	Total P	BOD
Agricultural Active	2.68	94.3	0.442	5.1
Agricultural Passive	2.48	16.3	0.125	2.55
Commercial	2.83	68.5	0.209	8.58
Community Facilities	1.78	63.29	0.146	7.21
Conservation	1.25	11.1	0.05	1.45
Industrial	1.79	48.99	0.769	9.66
Institutional Public Use	2.29	63.29	0.146	7.21
Mining	1.18	93.9	0.15	9.6
Residential High	2.42	62.13	0.453	10.46
Residential Low	1.77	27	0.3	7.4
Residential Medium	2.29	62.38	0.675	10.93
Recreational Open Space	1.25	11.1	0.047	1.45
Residential Rural	1.77	31.9	0.32	7.63
Vacant-Undeveloped	1.25	11.1	0.05	1.45
Roads	2.0	50	0.34	13
Water	1.6	2.0	0.13	13
Wetland	1.6	10.2	0.19	

Source: Various Central Florida studies and NPDES monitoring data.

TABLE 1B- GENERALIZED EFFICIENCIES FOR SELECT BEST MANAGEMENT PRACTICES

BMP	ESTIMATED POLLUTANT REMOVAL EFFICIENCY						
	TSS	Phosphorus	Nitrogen	O_2 Demand	TraceMetals	Bacteria	Efficiency
NO BMP PRESENT	0	0	0	0	0	0	
Off-Line Retention	80	80	80	80	80	80	high
On-Line Retention	60	50	30	40	60	40	moderate
Overland Flow - Grass/Soil	80	40	30	60	60	80	moderate to high
Swales	60	40	30	10	60	30	moderate to low
Water Quality Inlets - Skimmers and Trash Screens	5	10	10	10	10	5	low
Wet Detention	80	60	50	50	60	40	moderate to high

LAKE GRIFFIN STORMWATER PROJECT
LAKE COUNTY PUBLIC WORKS

TABLE 8: UNSORTED BASIN RANKINGS BY INDIVIDUAL VARIABLES

SUB BASIN NAME	COARSE APPROX. OF LAND AVAILABILITY	ESTIMATED STORMWATER RUNOFF LOADINGS				APPROX. UPTAKE ALONG CONVEYANCE	BASIN ACRES
		EFFECTIVE BASIN TSS (LBS/ACRE) SCALED RANK	BASIN TSS SUBTOTAL (LBS) SCALED RANK	EFFECTIVE BASIN TOTAL P (LBS/ACRE) SCALED RANK	BASIN TOTAL P SUBTOTAL (LBS) SCALED RANK		
34-AD	40	52.86	3.86	67.57	4.43	100	46.85
34-AF	20	68.49	20.13	45.39	11.97	10	188.38
34-AJ	60	100.00	18.86	88.97	15.06	100	120.87
34-AK	20	51.36	16.23	55.30	15.68	10	202.56
34-AL	60	56.59	18.21	67.73	19.56	10	205.58
34-AM	40	84.84	8.59	100.00	9.08	10	64.87
34-C	100	77.92	19.68	63.26	14.34	50	161.90
34-J	80	67.88	11.54	63.76	9.73	100	108.92
34-L	60	84.40	0.67	99.49	0.70	100	5.06
34-O	20	74.58	12.94	56.26	8.76	50	111.21
34-P	40	64.64	5.76	56.58	4.52	100	57.11
48-A	40	27.01	59.68	25.51	49.71	10	1393.25
48-C	40	31.69	77.58	25.07	54.30	100	1479.62
59-A	80	37.15	62.06	30.23	44.44	100	1057.17
65-A	100	48.67	9.83	51.08	9.26	10	129.44
65-D	80	46.96	1.31	56.86	1.42	50	17.81
65-E	100	77.07	9.92	68.07	7.86	10	82.50
65-H	100	39.10	76.97	43.41	76.68	10	1261.53
73-A	60	46.71	100.00	52.04	100.00	100	1372.15
80-A	80	37.89	68.37	37.86	61.30	10	1156.34
80-B	60	39.51	12.11	49.08	13.50	10	196.44
80-C	100	52.39	13.47	33.36	7.70	10	164.83
80-D	100	72.02	2.71	37.82	1.28	10	24.13
88-A	100	50.13	19.97	37.83	13.52	50	255.26
88-B	80	57.81	3.88	31.35	1.89	10	43.01
97-A	80	67.10	31.31	49.66	20.79	100	299.03
97-C	100	61.98	1.02	29.03	0.43	100	10.53

NOTES

1 Ranking Variables:
- A. Land Availability- is based on coarse review of 2000 aerial photography and is by no means based c parcel records or ground truthing.
- B. Effective Basin Total Suspended Solids (TSS) in pounds per acre.
- C. Basin TSS Subtotal (total pounds of TSS for basin).
- D. Effective Basin Total Phosphorus (P) in pounds per acre.
- E. Basin Total P Subtotal (total pounds of P for basin).
- F. Nutrient Uptake Along Conveyance Route (a subjective judgement based on apparent in-system treatment potential of conveyance - using 2000 aerial photos).

Note: "Effective" loading accounts for BMP load reduction factors applied to subdivision areas built after the stormwater regulations of 1982. Determination of pre/post 1982 status was strictly based on subdivision plat database information and no field truthing.

2 Scaled scores are derived by assigning maximum value for each variable (Effective TSS, Total TSS, Effective P and Total P) a score of 100, then assigning proportional scores for all other values under each variable.

3 Unweighted Sum is the sum of scaled ranking variables with no weighting factors applied to the ranking variables.

4 Weighted Sum is the sum of scaled (if applicable) ranking variables, with each variable weighted by the factor given in Table 4. A weighting factor of 3 means this variable's scores are increased by 3 times for emphasis.

5 Top 5 basins for weighted and unweighted sums are identifed as priorities in Table 3 (Sorted Data)

6 All basins ranked above are in unincorporated areas of Lake County.

Figure 1 Picciola Road Drainage Basin

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Figure 2 Harbor Oaks Drainage Basin

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Figure 3 Lakeside Village Drainage Basin

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Basin 73-A
Mid Florida Lakes Mobile Home Park

Drainage Area Characteristics
Good Soils, Flat Topography, Dense Mobile Home Development. Many lots are adjacent to canals with direct access to Haines Creek.

Land Ownership
Private Homes, Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Replace Existing Inlets Outfalling to Canals with Exfiltration Systems, place fren chdr at select areas near clubhouse.	11.5 acres	$110,800.00	42 lbs/yr	$2,638.10 per lb	Minimal Impact	Y	Y	
2	Place exfiltration pipe system in back yards of lots with canal access. Tie gutter inlets into this system. To be placed between lots to capture sheet flow as well.	20 acres	$28,000.00	27.79 lbs/yr	$1,007.56 per lb	Minimal Impact	Y	Y	
3	Install 30± yard inlets with exfiltration pipes and filter media in selected yards adjacent to roads to supplement (1) above.	12 acres	$7,500.00	16.66 lbs/yr	$450.18 per lb	Minimal Impact	Y	Y*	
4	Improve existing wet pond at east end of development. Improvements to include selective plantings in the pond and adding bleed down to existing structure for some detention time.	20 acres	$7,250.00	3.97 lbs/yr	$1,826.20 per lb	Positive impact if attractive species are planted and proper maintenance is performed.	Y	Y	Bleed down could cause SHWT concerns w/ WMD. Existing pond is intensely managed at this time.

Y - Yes
N - No
P - Possibly

Basin 73-A
RV Park West of Tara Village MHP

Drainage Area Characteristics
Moderate slope to creek with hardpan road. Small dry retention pond at foot of hill appears designed to capture road runoff. Soils OK.

Land Ownership
RVs on Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
6	Maintain Existing Retention Pond	0.3 acre	$350.00	0.42 lbs/yr	$833.33 per lb	Positive Impact	Y	N/A	Routine Maintenance by Owners

Y - Yes
N - No
P - Possibly

Bonfire MHP

Drainage Area Characteristics
Permitted outfall to Haines Creek installed approx. 1 yr. ago (flood control reasons). 2 small lakes (Lisa and Tammi) Lisa pumped to Tammi, outfall from Tammi to Haines Creek. Divide along Lock Rd. Property north of Lock Rd. drains mainly overland to Haines Creek (2 small inlets).

Land Ownership
Private Homes, Resident -Owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
7	Retrofit Lake Tammi overflow and outfall. Install bleed down device on pond outlet box to provide some detention, selectively plant pond.	23 acres	$9,000.00	4.56 lbs/yr	$1,973.68 per lb	Positive impact if select attractive species are planted and proper maintenance is performed.	Y	N/A	Bleed down could cause SHWT drawdown concerns with WMD.
8	Construct swales from existing inlets North of Lock Rd. to capture runoff and provide treatment.	0.9 acres	$1,500.00	1.26 lbs/yr	$1,190.48 per lb	Moderate Impact	Y	Y	Minor foot traffic concerns possible
9	Pipe inlets together and convey runoff to pond to be constructed at Cypress Dr. and Lock Rd.	1.25 acres	$12,000.00	1.75 lbs/yr	$6,857.14 per lb	Some impact - adverse with poor draining soil and lack of maintenance	Y	Y	May require acquisition of a few lots to provide adequate treatment volume

Y - Yes
N - No
P - Possibly

Basin 73-A
Haines Creek Park

Drainage Area Characteristics
Moderate slope on S. Haines Creek Rd with minimal storage from Ocklawaha Rd. to park. Water drains down road with appreciable velocity, creating erosion and sedimentation of park property. Adjacent property owner has problems with flooding during storms.

Land Ownership
County park in area with deeded lots.

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
10	Linear retention area to be constructed on park property. Ditch pavement constructed along current preferential flow path to convey water from south. Place berm along driveway of adjacent property owner (Poston) to convey drainage from east and to attenuate flooding of Mr. Poston's property.	8.2 acres	$23,200.00	6.4 lbs/yr	$3,625.00 per lb	Positive Impact	Y	N	Coordinate with Parks and Recreation

Y - Yes
N - No
P - Possibly

Jasper Bay Island

Drainage Area Characteristics
Small island drainage area with cottages. Moderate quality soils with obvious low cover runoff.

Land Ownership
Private

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
11	V-swales in selected back lots to attenuate runoff.	0.5 acres	$6,000.00	0.7 lbs/yr	$8,571.43 per lb	Some Impact	Y	Y	

Y - Yes
N - No
P - Possibly

The Cove

Drainage Area Characteristics
Small drainage area, U-shaped access drive. Very small lots with cottages and small trailers. Soils good, but some runoff is evident.
East end of drive tends to discharge most runoff. Existing inlet on east drive.

Land Ownership
Private

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
12	V-swales along creek frontage.	1.2 acres	$3,500.00	1.68 lbs/yr	$2,083.33 per lb	Some Impact	Y	Y	
13	Fit existing inlet on east drive with exfiltration pipe. Will require construction of "speed bump" diverter to more effectively convey runoff to inlet	0.4 acres	$2,000.00	0.56 lbs/yr	$3,571.43 per lb	Minimal Impact	Y	Y	Minor foot traffic concerns possible

Y - Yes
N - No
P - Possibly

Basin 73-A
Sparky's Fish Camp

Drainage Area Characteristics
Small drainage area with cottages on small lots. Runoff from cottages and drive runs straight to Haines Creek. One existing inlet . Soils moderate to good.

Land Ownership
Private

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
14	V-swales along creek frontage.	0.7 acres	$3,500.00	0.973 lbs/yr	$3,597.12 per lb	Some Impact	Y	Y	
15	Replace existing inlet with exfiltration pipe	0.2 acres	$2,500.00	0.28 lbs/yr	$8,928.57 per lb	Minimal Impact	Y	Y	

Y - Yes
N - No
P - Possibly

Shady Oaks Island RV Park

Drainage Area Characteristics
Small island drainage area with RVs and small mobile homes. Island surrounded by sheet piling. No storage onsite

Land Ownership
Private

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
16	Swale and exfiltration system along back yards adjacent to sheet piling	2 acres	$8,000.00	2.8 lbs/yr	$2,857.14 per lb	Minimal Impact	Y	Y	

Y - Yes
N - No
P - Possibly

Engineering & Permitting	**$16,000**	**to**	**$20,000**
TOTAL COST FOR BASIN	**#REF!**	**to**	**#REF!**

Basin 34-AJ
CR 466A (Picciola Rd.) at Morgan's Fish Camp

Drainage Area Characteristics
County highway sloping toward lake accounts for the majority of runoff. Deep ditches on west side of highway collect runoff from adjacent mobile home parks and small businesses. Fish camp on east side of highway has very small drainage area with small cottages and trailers. No drainage storage volume is presently available.

Land Ownership
County Highway - adjacent property privately owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Place 2 small retention ponds with exfiltration pipes along east side of highway to capture road runoff. Place ditch blocks on west side of highway.	14 acres	$29,000.00	11.00757 lbs/yr	$2,634.55 per lb	Minimal Impact - May be positive	N	P	Minor foot traffic concerns possible

Y - Yes
N - No
P - Possibly

Harbor Oaks MHP

Drainage Area Characteristics
Well sloped, with moderate to good soils at upper areas. Soils not as good toward the lake. Inverted-crown roads convey drainage downhill, with most runoff captured by inlet at Harbor Oaks Drive and Riverview Drive intersection (inlet discharges directly to lake). Other smaller inlets capture some runoff from side roads. Most lakefront lots sheet flow to lake, though a few preferential flow paths exist.

Land Ownership
Private Homes, Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
2	Place exfiltration inlets and pipes at strategic locations within park, in upland areas with good soils.	15 acres	$80,000.00	20.79 lbs/yr	$3,848.00 per lb	Minimal Impact	Y	Y	Easement acquisition costs not included
3	Construct retention pond near existing inlet at Harbor Oaks Drive and Riverview Drive.	12 acres	$50,000.00	16.66 lbs/yr	$3,001.20 per lb	Impact could be adverse. Pond will be in marginal soils Nuisance vegetation could become a problem	Y	Y*	Would require county to acquire several lots (approx. 7) to provide sufficient treatment volume. Compensation to park (lost future lot rentals) and residents (mobile homes, relocation costs) would be needed. These costs are not included in estimate
4	V-swales in backyards of lots which do not provide storage	5 acres	$8,000.00	6.93 lbs/yr	$1,154.40 per lb	Moderate Impact	Y	Y	Intended to slow down runoff from lakefront lots. Option would need to be considered in conjunction with 2 or 3. Easement acquisition costs not included.

Y - Yes
N - No
P - Possibly

Basin 34-AJ
Griffwood Mobile Home Park

Drainage Area Characteristics
Steeply sloped near lake, with good soils. Yards fronting streets on slope are terraced with brick walls, providing good conveyance of runoff down streets
Dense tree cover in park - high organic load. Open area at bottom of hill with good to moderate soils, just south of boat docks. Runoff will have considerable velocity at bottom of hill.

Land Ownership
Private Homes, Resident -Owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
5	Construct french drain system at open area south of boat docks. Construct 2 inlets at bottom of hill to capture runoff and pipe to french drain.	9 acres	$59,000.00	33 lbs/yr	$1,787.88 per lb	Minimal Impact	Y	Y	

Y - Yes
N - No
P - Possibly

Citrus Circle

Drainage Area Characteristics
Relatively flat drainage area located back from lake Griffin - no lake front lots. Fern nurseries located on slope near lake. Development has BMP in place (wet pond with no discharge). Pond is very poorly maintained - may discharge during significant events in wet years.

Land Ownership
Private Homes, Resident -Owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
6	Maintain current BMP. Clear pond of excessive vegetation and repair any erosional areas.	10 acres	$3,500.00	1.98 lbs/yr	$1,767.68 per lb	Positive Impact	Y	N	Routine Maintenance Required

Y - Yes
N - No
P - Possibly

Lakeside Terrace Mobile Home Park

Drainage Area Characteristics
Moderate slope near CR 466A, steeply sloping nearer lake. Good soils with BMPs in place (dry retention ponds). Downslope pond on Grove Drive shows evidence of runoff overtopping berm on downslope side. Otherwise, ponds in good condition.

Land Ownership
Private Homes, Resident -Owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
7	Maintain current BMP. Clear pond of excessive vegetation and repair any erosional areas.	29 acres	$500.00	5.75 lbs/yr	$86.96 per lb	Minimal Impact	Y	N	Routine Maintenance Required

Y - Yes
N - No
P - Possibly

Basin 34-AJ
Neighborhood at South End of Basin (N. Lakeview Drive, Moss Ln, Grove Rd., N. Griffin Drive)

Drainage Area Characteristics
Sharply sloping lots with moderate soils near N. Griffin Drive. Lakeside residents experience moderate to severe runoff onto their property with sediment deposition in yards and garages. Small cottage development (Lazy Oaks) at north end of Griffin Drive which may be abandoned.

Land Ownership
Private Homes, Rented Lots
Lazy Oaks - Status Unknown

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
8	Construct infiltration/retention areas in back yards of lakeside lots. Will require means to safely convey runoff to treatment system.	26 acres	$33,000.00	36.12 lbs/yr	$913.62 per lb	Minor to Moderate Impact	Y	Y	Negotiation possibilities exist due to runoff problem of some lakeside residents
9	Construct frenchdrain system at location of Lazy Oaks development and in adjacent neighborhood roads to south	8 acres	$72,000.00	19 lbs/yr	$3,789.47 per lb	Minor Impact	Y	Y*	

Engineering & Permitting	**$16,000**	**to**	**$22,000**
TOTAL COST FOR BASIN	**$238,000.00**	**to**	**$235,000.00**

Y - Yes
N - No
P - Possibly

Basin 34-AF
Brittany Estates Mobile Home Park

Drainage Area Characteristics
Moderately sloped mobile home park with average soils. One small dry detention depression near lakeside.

Land Ownership
Private Homes on Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Enlarge and improve dry detention depression.	10 acres	$67,160.00	36 lbs/yr	$1,865.56 per lb	Some Impact	Y	Y	Easement acquisition costs not included. Assume permit exemption and Coarse Level Engineering
2	Construct dry retention ditch at lakeside area of park	9 acres	$4,000.00	12.46 lbs/yr	$321.03 per lb	Some Impact	Y	Y	Easement acquisition costs not included

Engineering & Permitting	$3,000	to	$5,000
TOTAL COST FOR BASIN	$7,000	to	$76,160

Y - Yes
N - No
P - Possibly

Basin 34-C
Lake Griffin Harbor Mobile Home Park

Drainage Area Characteristics
Moderately sloped mobile home park with good soils. 12-year-old permitted stormwater system consists of two dry retention/wet bottom ponds and one wet pond- one pond drains I

Land Ownership
Private Homes on Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Improve current BMP by select vegetation for additional nutrient uptake.	34.5 acres	$5,000.00	6.84 lbs/yr	$730.99 per lb	Positive	Y	N	Requires agreement by MHP

Y - Yes
N - No
P - Possibly

Lakeside Village Mobile Home Park

Drainage Area Characteristics
Moderately sloped, with good to moderate soils. Northern half of park is newer and has dry detention swales in series. May be a permitted system. Southern half of park is older an no BMPs in place.

Land Ownership
Private Homes on Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
2	Improve existing system for north half of park. Place ditch blocks in detention swales to provide actual retention volume	11.8 acres	$4,500.00	11.7 lbs/yr	$384.62 per lb	Positive	Y	Y	Requires agreement by MHP
3	Place Retention swale adjacent to docks on lakeside area on south half of park. Place inlet at beginning of ditch to capture sediment and convey water to ditch. Provide overflow to allow emergency runoff	9.5 acres	$6,500.00	13.16 lbs/yr	$493.92 per lb	Some Impact	Y	Y	Minor foot traffic concerns possible

Y - Yes
N - No
P - Possibly

Engineering & Permitting	**$3,000**	to	**$6,000**
TOTAL COST FOR BASIN	**$19,000**	to	**$22,000**

Basin 34-O
Eagle's Nest Mobile Home Park

Drainage Area Characteristics
Gently sloped to flat drainage area with good soils. Mobile homes on small lots-some storage available on lots away from lake. Small flag pond captures some runoff.

Land Ownership
Private Homes on Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Construct shallow retention swales on some lakefront lots to capture runoff	5 acres	$5,000.00	6.93 lbs/yr	$721.50 per lb	Minor Impact	Y	Y	Minor foot traffic concerns possible

Engineering & Permitting	$2,000 to	$3,000	
TOTAL COST FOR BASIN	$7,000 to	$8,000	

Y - Yes
N - No
P - Possibly

Basin 34-P
East End of Bertsville Road

Drainage Area Characteristics
Gently sloping with average to good soils. County boat ramp at end of Bertsville Rd. conveys significant runoff during large storm events. Runoff to north of Bertsville Rd. sheet flows to wooded wetlands.

Land Ownership
Private, though boat ramp is county-owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Construct shallow retention swales at fish camp south of boat ramp	3.7 acres	$8,000.00	5.11 lbs/yr	$1,565.56 per lb	Minor Impact	N	Y	Must make trafficable for pedestrians
2	Construct shallow swales along Bertsville Rd. to capture road runoff to reduce demand on (3)	2.6 acres*	$2,000.00	3.64 lbs/yr	$549.45 per lb	Minor Impact	Y	P	Tight R/W
3	Construct inlets to exfiltration pipes on Bertsville Rd. to capture runoff before it reaches boat ramp	* -(Part of (2))	$2,000.00	3.64 lbs/yr	$549.45 per lb	Minor Impact	N	N	

Engineering & Permitting	**$2,000 to**	**$3,000**	
TOTAL COST FOR BASIN	**$14,000 to**	**$15,000**	

Y - Yes
N - No
P - Possibly

Basin 65-H
Griffin Isles Mobile Home Park

Drainage Area Characteristics
Relatively flat drainage area with good soils. Most of park has BMPs in place (dry retention ponds) except for lots along boat canal in south section of park.

Land Ownership
Private Homes on Rented Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
1	Place shallow swales in back yards of lots along boat canal	0.9 acres	$5,000.00	1.246 lbs/yr	$4,012.84 per lb	Moderate Impact	Y	Y	-Easement acquisition not included in cost -Slopes not conducive to storage

Y - Yes
N - No
P - Possibly

County Road 466B Right of Way North of Boat Canal

Drainage Area Characteristics
Concrete block "weir" structure is located in ditch north of boat canal.

Land Ownership
County

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
2	Improve weir structure in ditch and maintain (excavate) ditch to provide more treatment volume	1 acre	$3,000.00	1 lbs/yr	$3,000.00 per lb	Positive	N	N	Routine Maintenance/ Slight Upgrade

Y - Yes
N - No
P - Possibly

County Road 466B and Old Unity Lake Road Intersection

Drainage Area Characteristics
24" RCP crossdrain collecting runoff from ditches on CR 466B and draining to preferential flow path to canal. Residential area with lots along road approx 1/2 acre in size. Type A

Land Ownership
County Highway - adjacent lots privately owned

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
3	Construct drainage ditch along preferential flow path to canal. Construct ditch blocks in new ditch and in ditch to east of CR 466B to provide some retention volume	18 acres	$5,000.00	17.85 lbs/yr	$280.11 per lb	Some Impact	N	Y	-Easement needed for outfall

Y - Yes
N - No
P - Possibly

Basin 65-H
Crescent Drive

Drainage Area Characteristics
Gently sloped, average soils. Residential area with large (approx. 1/2 acre) lots. Runoff sheet flows to canal

Land Ownership
Private, Deeded Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
4	Construct shallow retention swales in back yards to capture sheet flow	10 acres	$12,000.00	13.86 lbs/yr	$865.80 per lb	Some Impact	Y	Y	-Easement acquisition not included in cost

Y - Yes
N - No
P - Possibly

Mulholland Drive

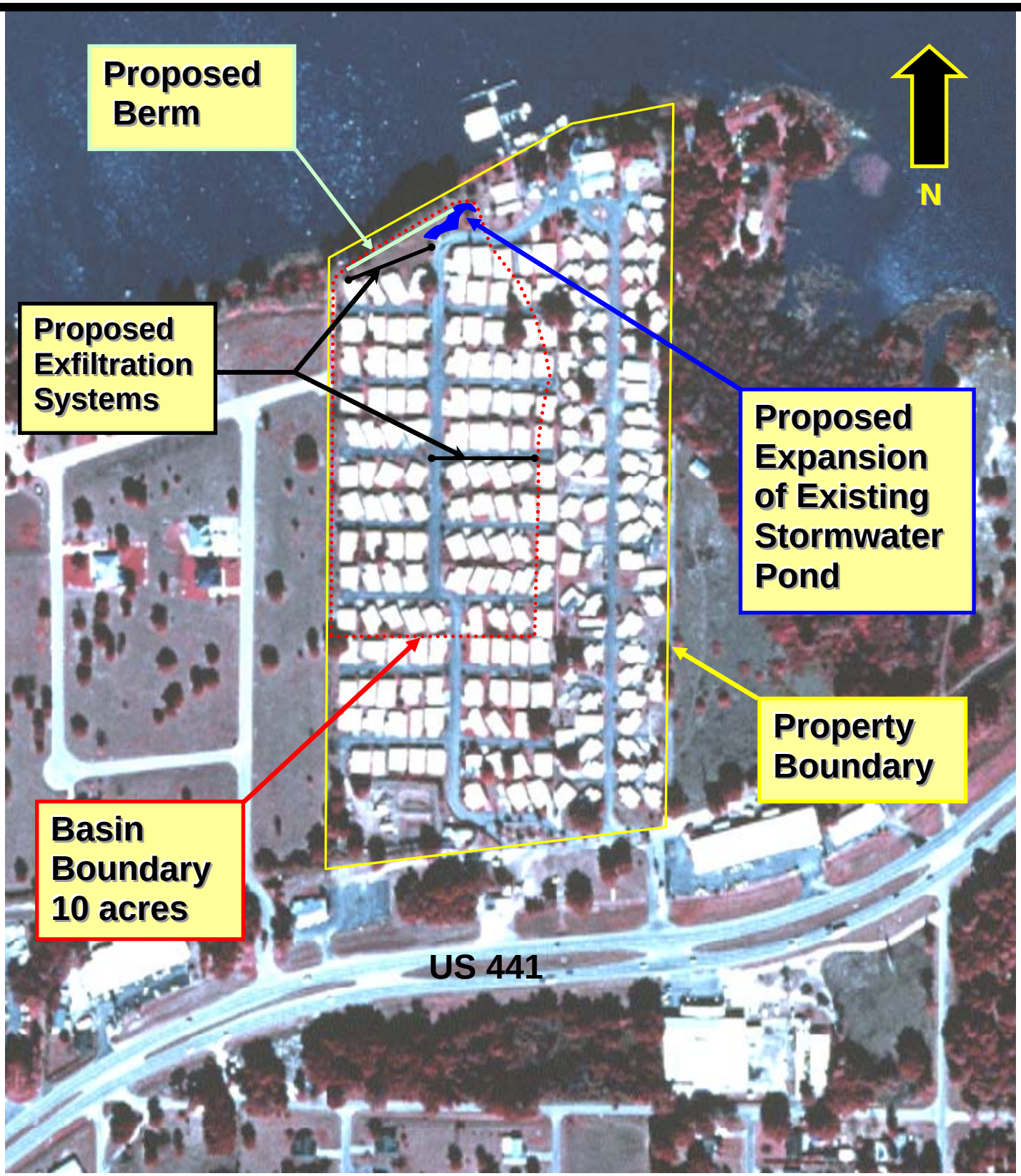
Drainage Area Characteristics
Gently sloped, average to good soils. Residential area with approx. 1/2 acre lots. One existing inlet discharging to canal.

Land Ownership
Private, Deeded Lots

	Options	Effective Drainage Basin Area	Generalized Cost	Est. Annual Load Reduction	Est. Cost/LB P Removed	Aesthetics	Educational Opportunities	Easement Required	General Notes
5	Replace existing inlet and outfall pipe with retention swales and upgraded outfall capacity.	9 acres	$9,500.00	12.46 lbs/yr	$762.44 per lb	Some impact	Y	Y	Easement acquisition costs not included. County needs easement for outfall

Engineering & Permitting	**$4,000**	**to**	**$6,000**
TOTAL COST FOR BASIN	**$38,500**	**to**	**$40,500**

Y - Yes
N - No
P - Possibly



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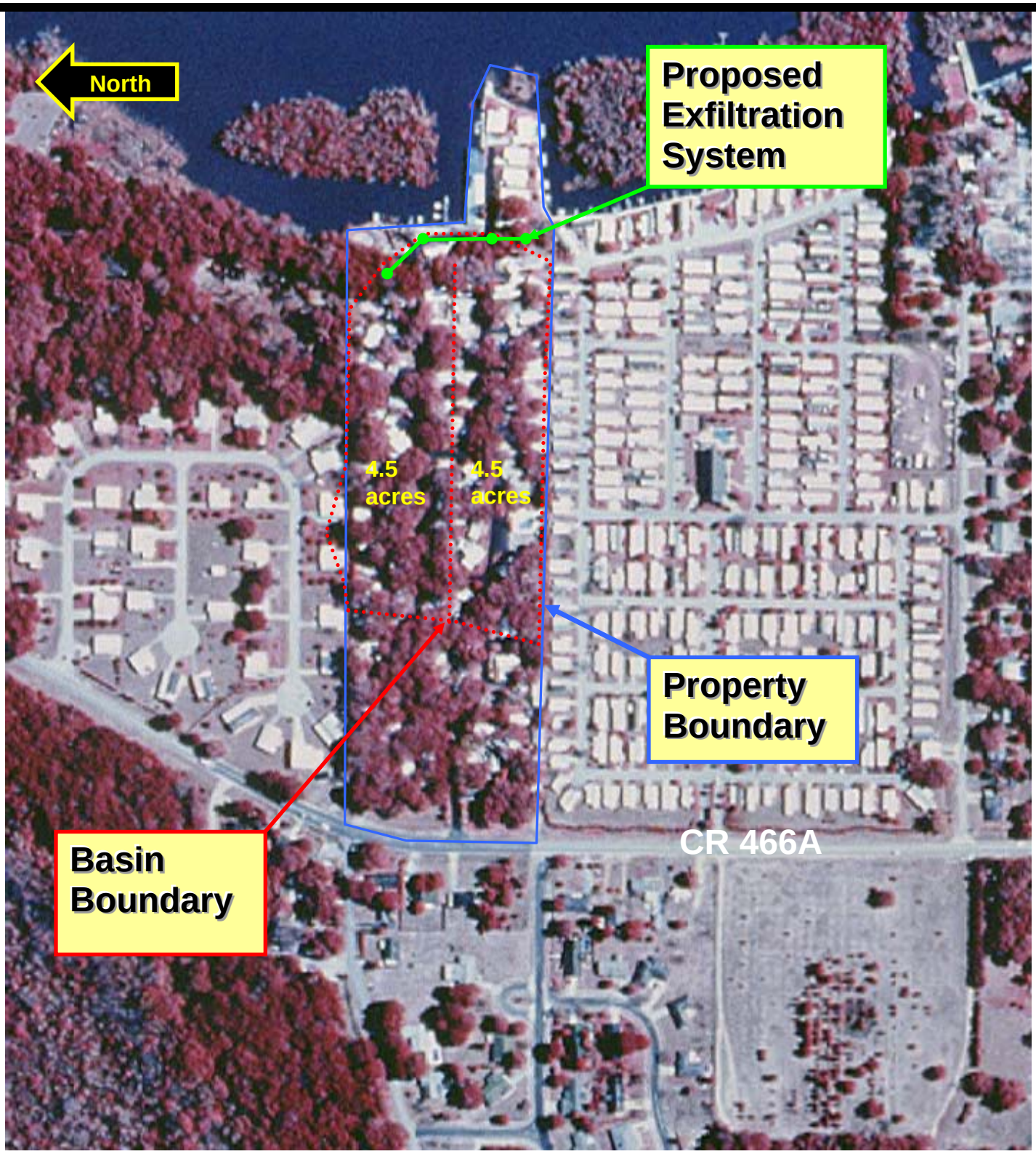
Brittany Estates Stormwater Project

Figure BE-1
2000 Digital Orthoquad
Lake County (19-19S-25E)

Date: 8/12/03	Modified By: SJK	Scale: NTS	Project No.: 12-11258	Lake County Public Works



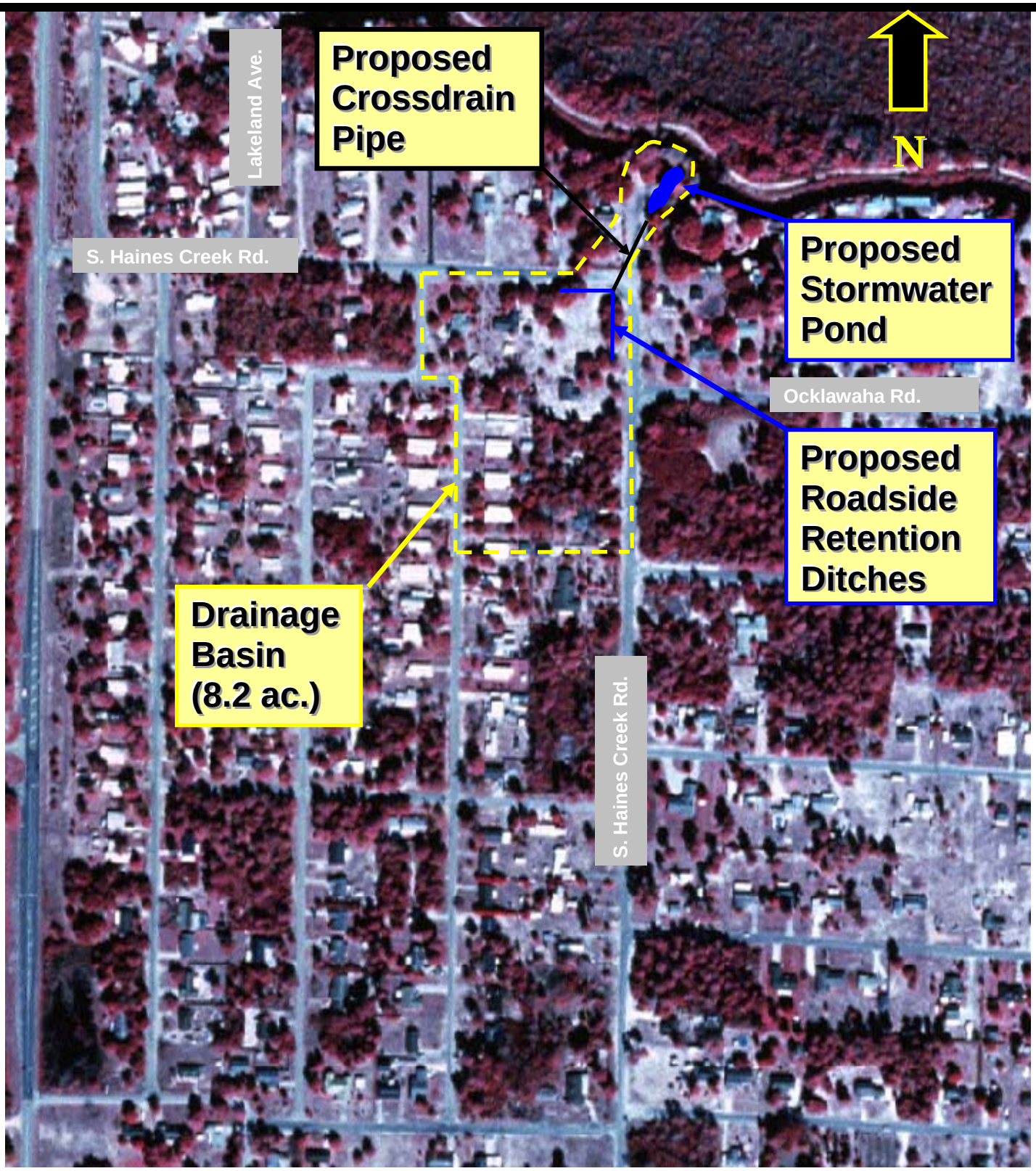
BCI ENGINEERS & SCIENTISTS, INC.

Griffwood MHP Stormwater Project

Figure GW-1
2000 Digital Orthoquad
Lake County (11-19S-24E)

Date: 8/12/03	Modified By: SJK	Scale: NTS	Project No.: 12-11258

Lake County Public Works



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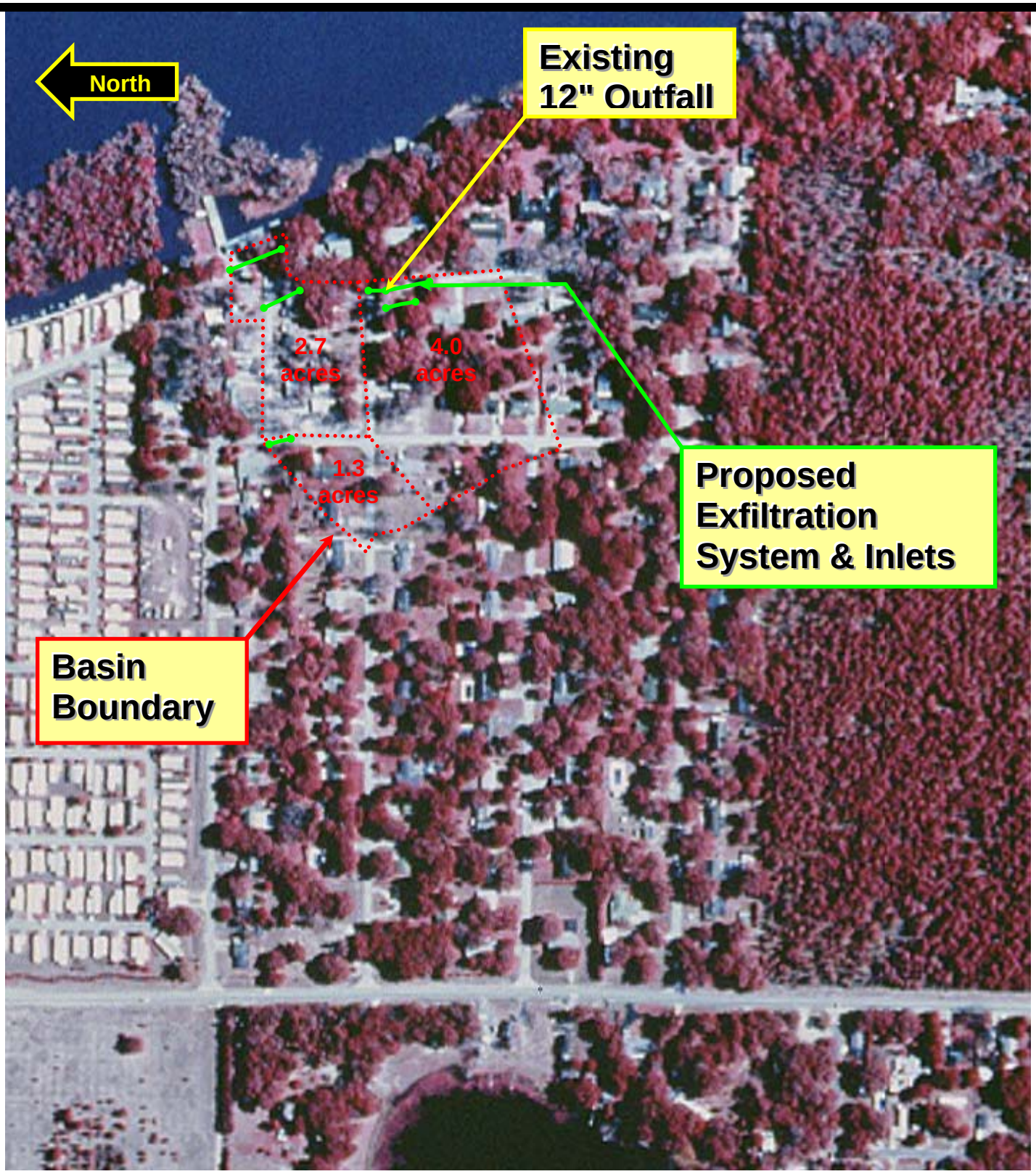
Haines Creek Park Stormwater Project

Figure HCP-1
2000 Digital Orthoquad
Lake County (12-19S-25E)

Date: 8/12/03	Drawn By: SJK	Scale: NTS	Project No.: 12-11258	Lake County Public Works



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Lazy Oaks Stormwater Project

Figure LO-1
2000 Digital Orthoquad
Lake County (11-19S-24E)

Date: 8/12/03	Modified By: SJK	Scale: NTS	Project No.: 12-11258

Lake County Public Works

SUB-BASINS SELECTED FOR PROJECT IMPLEMENTATION