

Evaluation of Non-Point Source Loadings in the Trout Lake–Hick's Ditch Drainage Basin

by

Environmental Research & Design

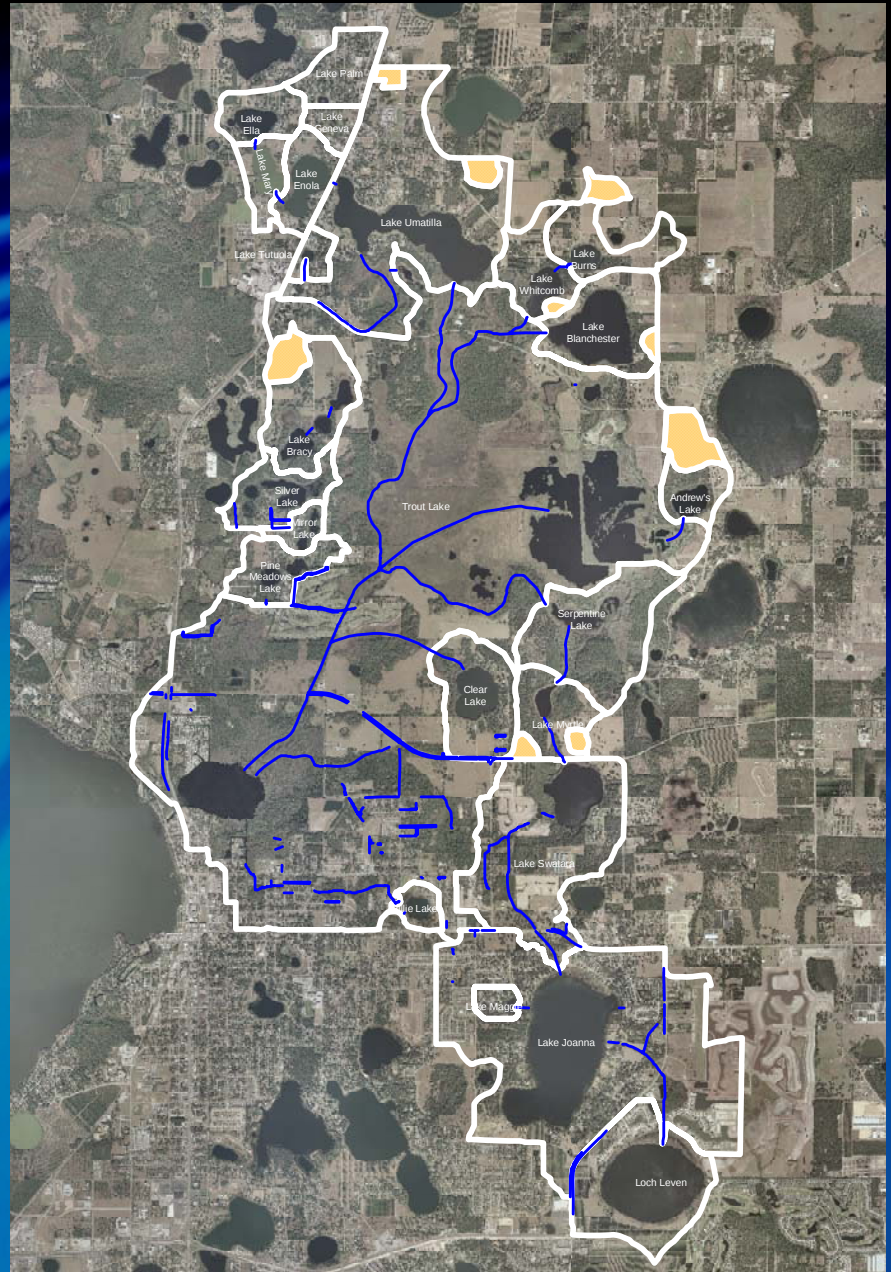
&

Professional Engineering Consultants

Overview of the Trout Lake/Hick's Ditch Drainage Basin

Land Locked Basins - ■

Drainage Basin Boundaries - —



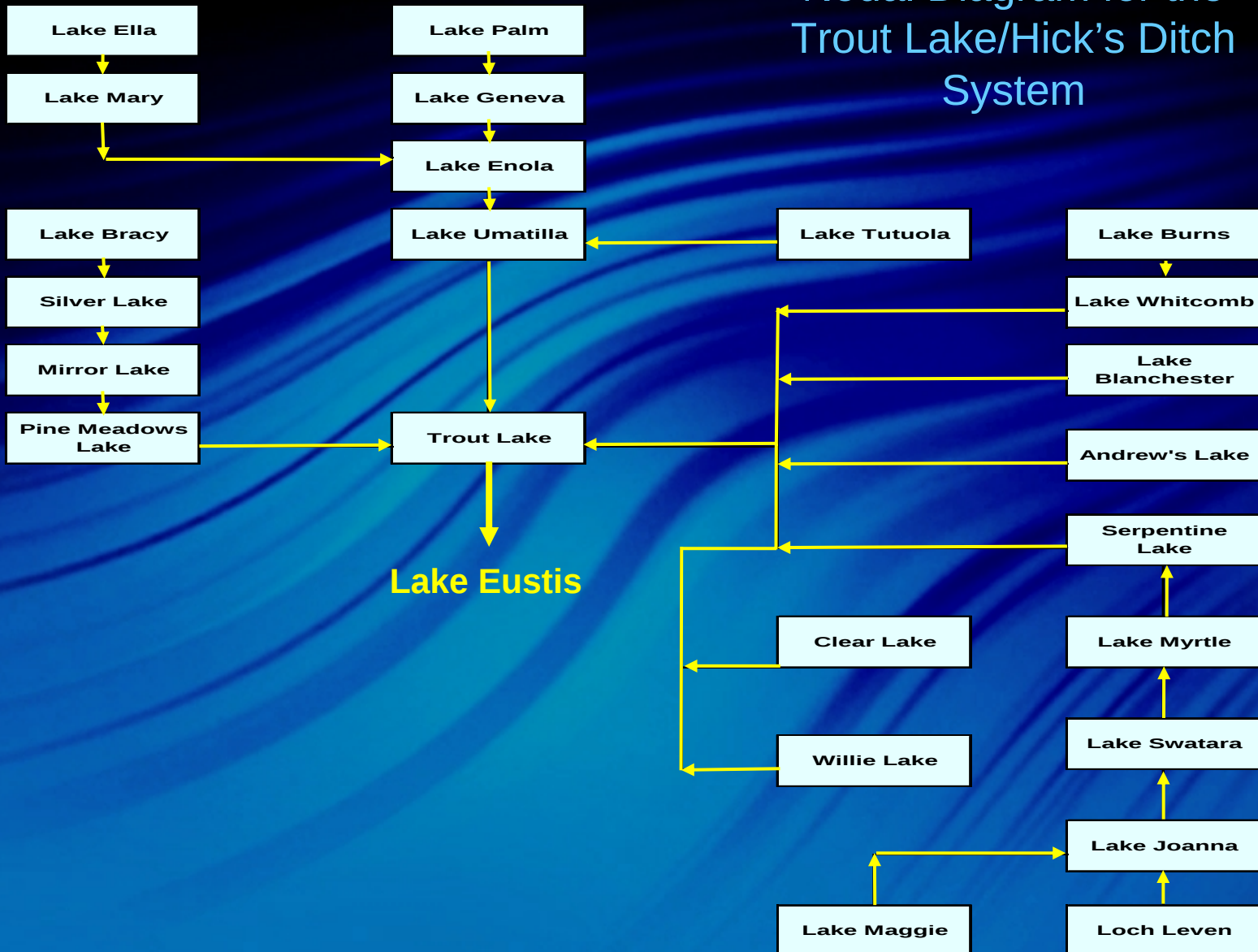
Characteristics of Lake Trout

- Surface area = 100.3 acres
- Most downstream waterbody in the Trout Lake drainage basin
- Drainage basin covers 10,410 acres
- Includes 23 interconnected waterbodies
- Discharges directly to Lake Eustis
- Drainage basin includes portions of the City of Eustis, Umatilla, Mount Dora and unincorporated Lake County
- Poor water quality and elevated nutrient levels
- Significant source of nutrient loadings to Lake Eustis

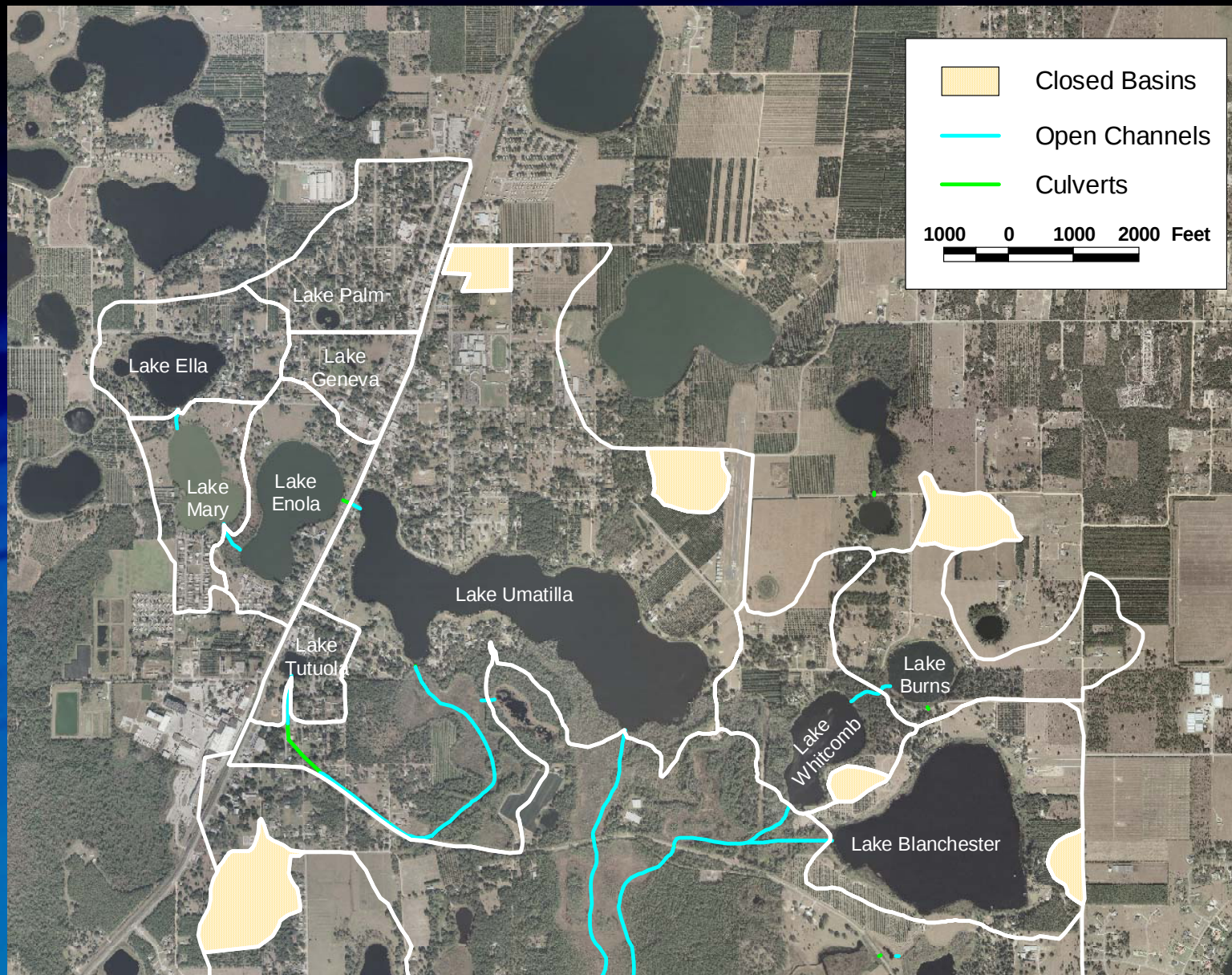
Study Objectives

- Evaluate sources of elevated phosphorus loadings to Trout Lake
- Develop hydrologic and nutrient budget models for waterbodies in the Trout Lake basin
- Evaluation based on available information supplemented by basin surveys by PEC
 - No field or water quality monitoring performed for this study

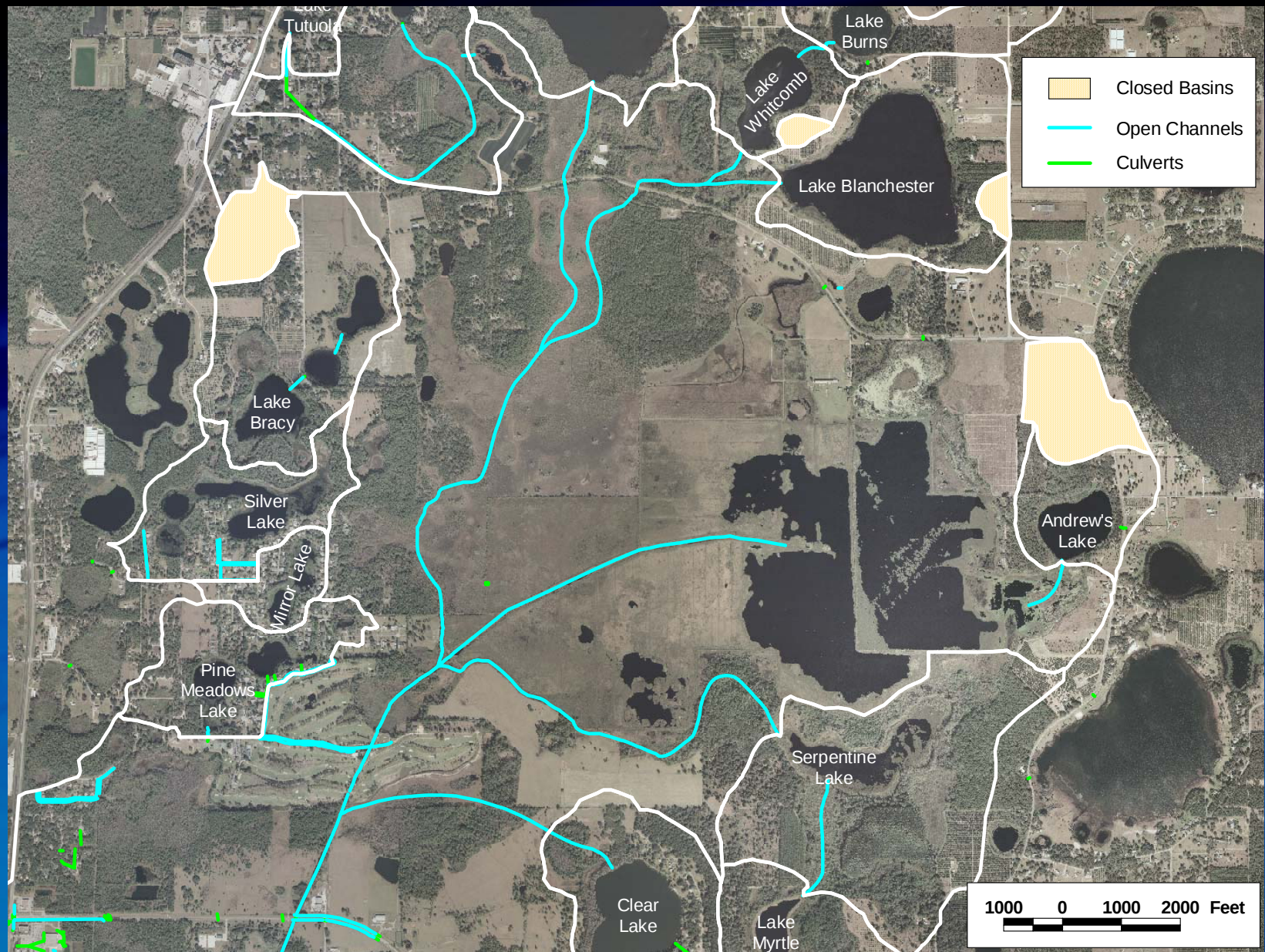
Nodal Diagram for the Trout Lake/Hick's Ditch System



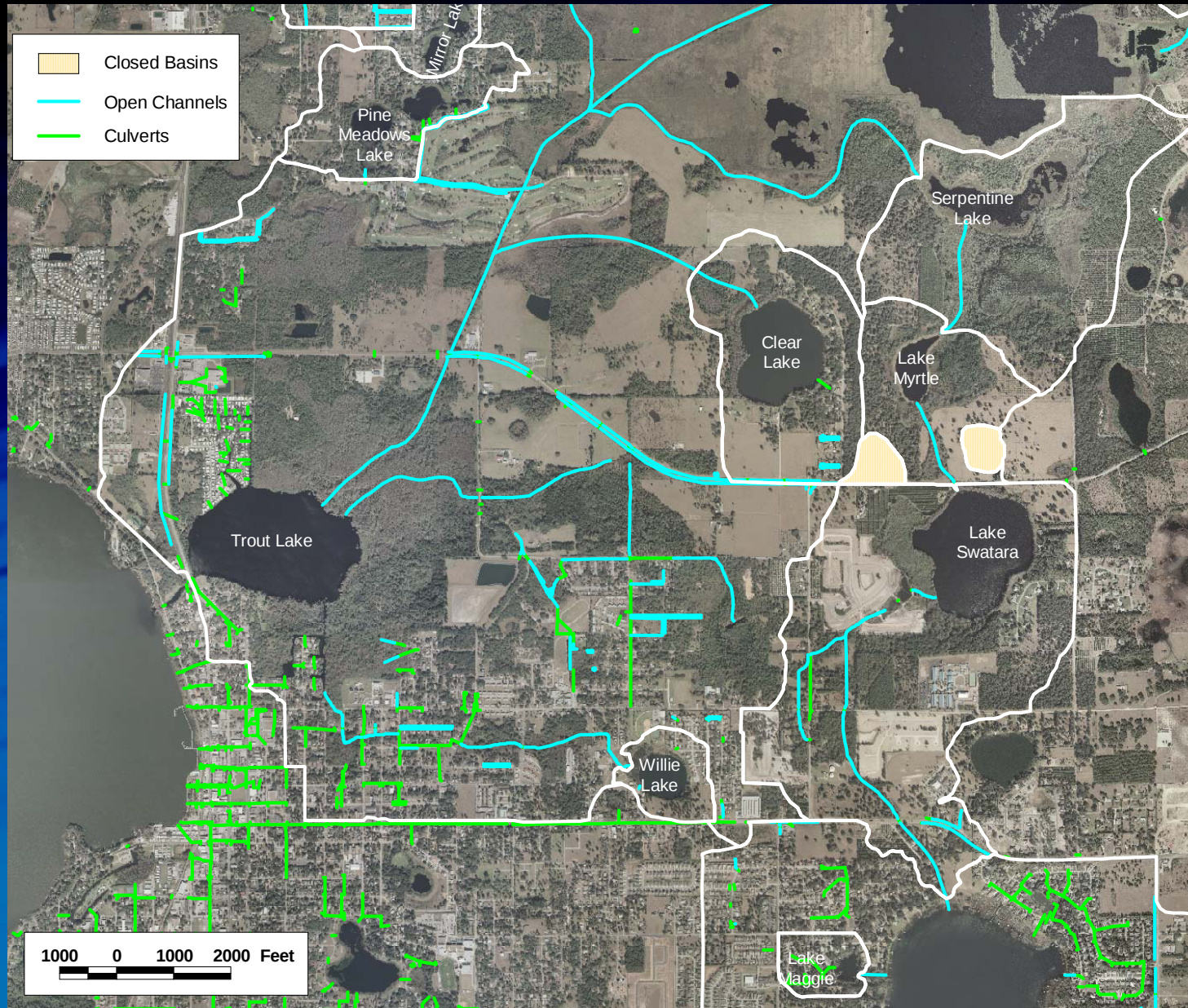
Northern Portions of the Trout Lake/Hick's Ditch Drainage Basin



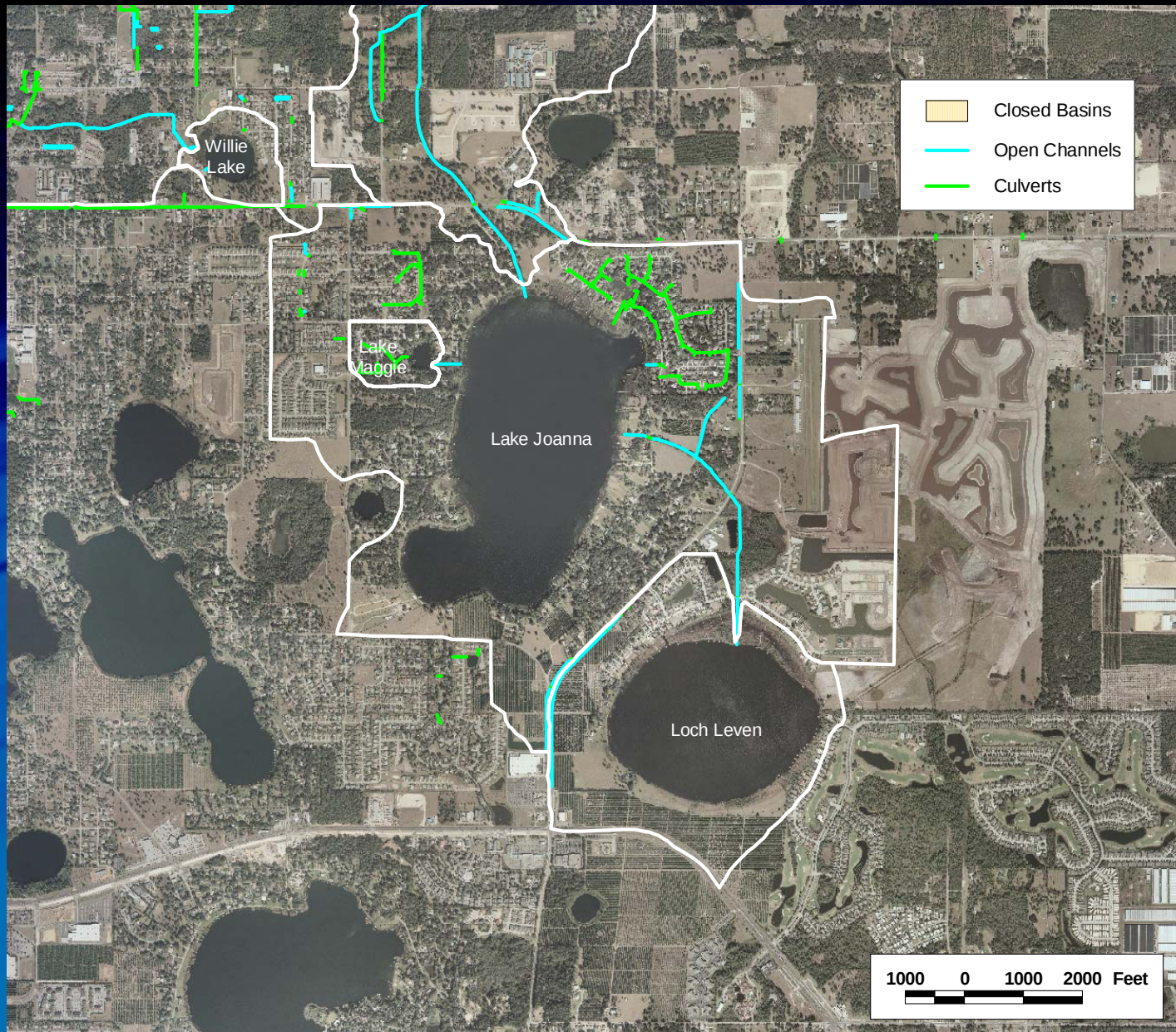
Northern Central Portions of the Trout Lake/Hick's Ditch Drainage Basin



Southern Central Portions of the Trout Lake/Hick's Ditch Drainage Basin



Southern Portions of the Trout Lake/Hick's Ditch Drainage Basin



Designated Sub-basin Areas Discharging To Waterbodies In The Trout Lake / Hick's Ditch Drainage Basin

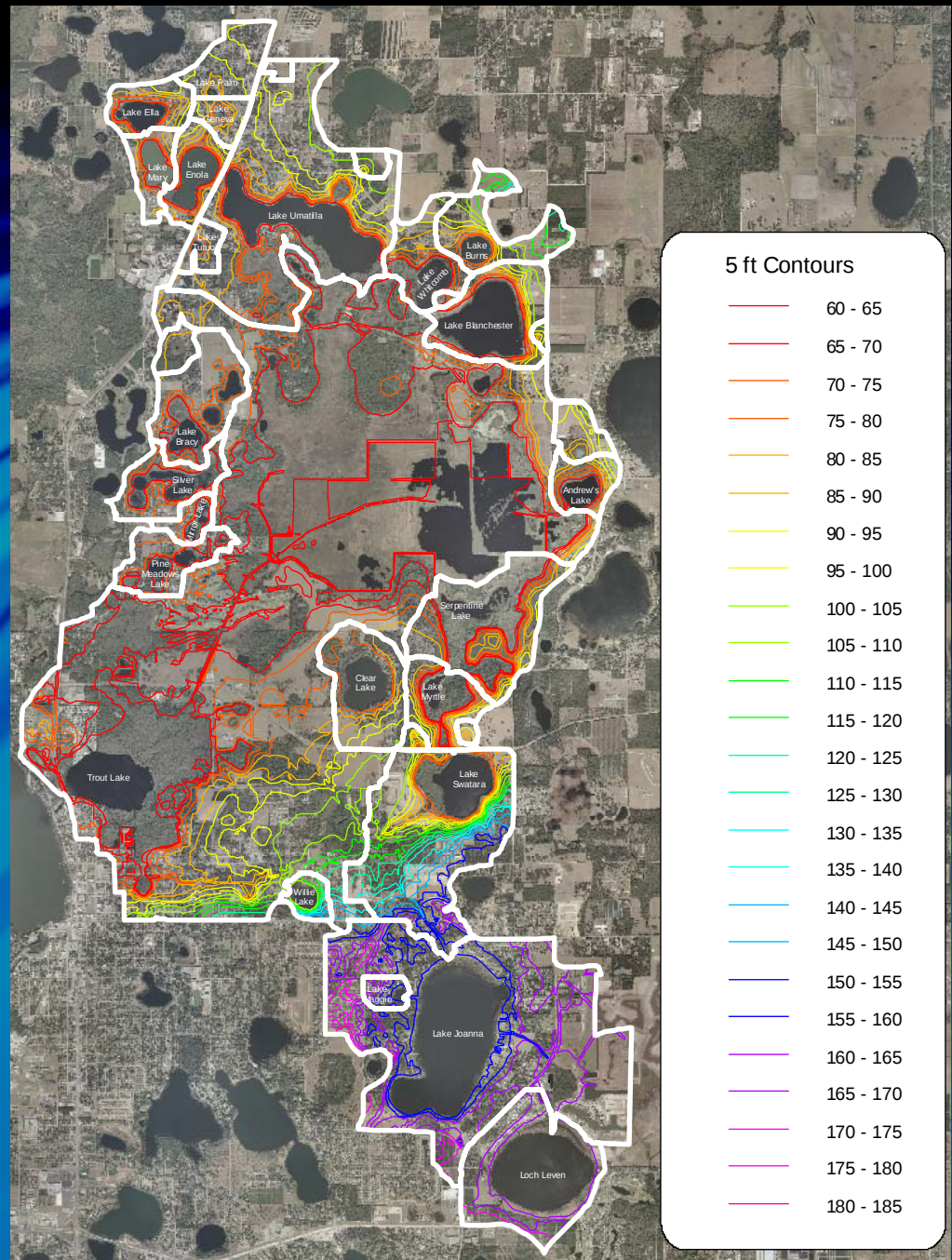
Watershed/Lake Area Ratio

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1. Excluding lake areas
2. Weighted average

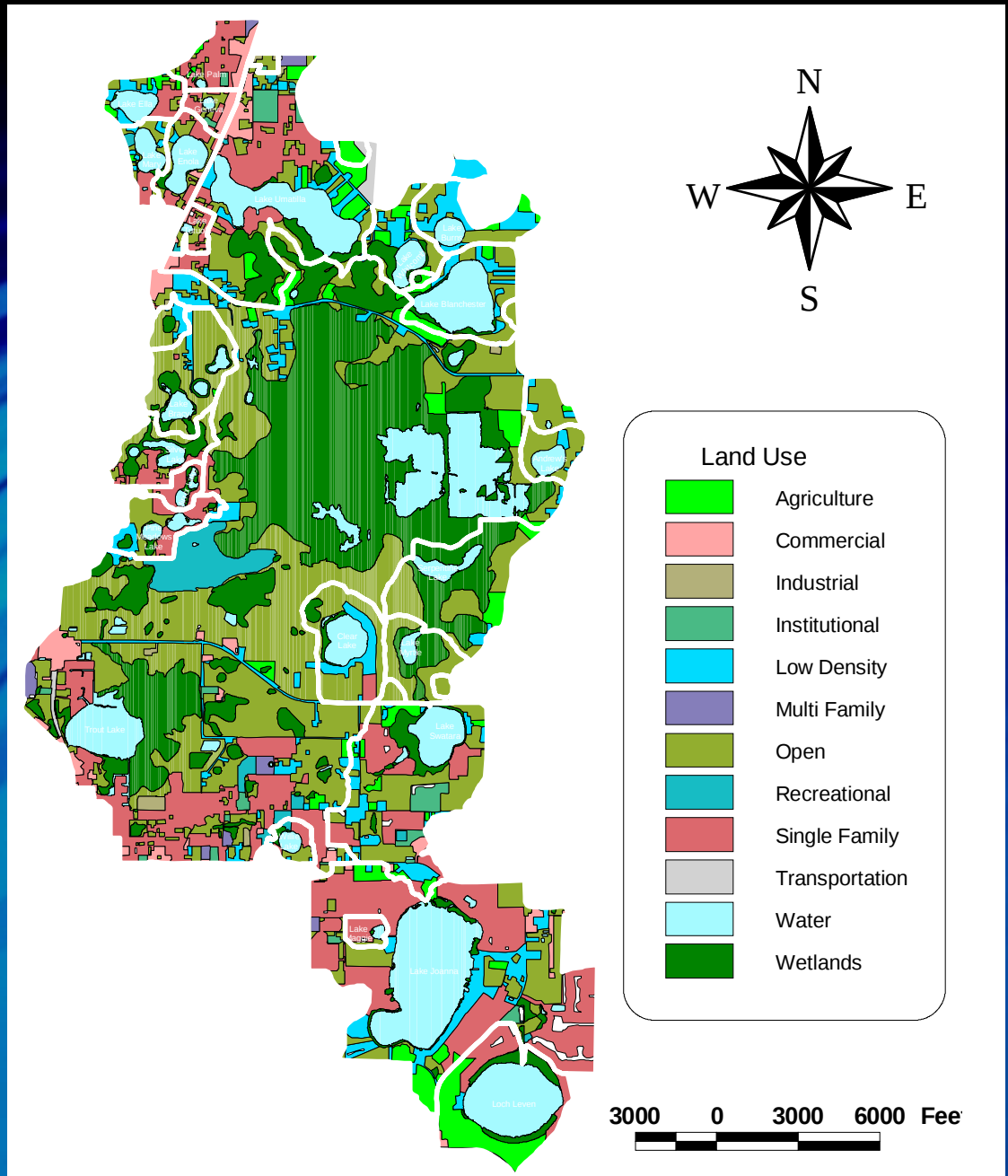
Drainage Basin	Lake Area (Acres)	Drainage Basin (Acres)	Total (Acres)	Watershed/ Lake Area Ratio
Lake Palm	2.45	127.21	129.66	51.9
Lake Geneva	3.78	49.73	53.51	13.2
Lake Ella	31.93	76.42	108.35	2.4
Lake Mary	28.49	58.74	87.23	2.1
Lake Enola	45.91	75.43	121.35	1.6
Lake Umatilla	169.28	709.66	878.94	4.2
Lake Witcomb	31.15	115.02	146.17	3.7
Lake Burns	21.89	135.09	156.98	6.2
Lake Blanchester	122.48	134.17	256.65	1.1
Lake Tutuola	2.85	41.31	44.16	14.5
Lake Bracy	22.40	193.52	215.92	8.6
Silver Lake	19.65	125.31	144.96	6.4
Mirror Lake	9.53	38.01	47.54	4.0
Pine Meadows	10.45	114.21	124.66	10.9
Serpentine Lake	29.47	339.90	369.37	11.5
Andrews Lake	23.93	68.26	92.19	2.9
Clear Lake	51.70	183.11	234.81	3.5
Lake Myrtle	14.25	133.63	147.88	9.4
Lake Swatara	72.68	540.74	613.42	7.4
Willie Lake	12.42	35.59	48.01	2.9
Lake Joanna	287.56	1011.96	1299.52	3.5
Lake Maggie	3.98	31.59	35.57	7.9
Loch Leven	170.52	233.34	403.86	1.4
Trout Lake	100.28	4627.51	4727.79	46.2
TOTAL:	1289.04	9199.45¹	10,488.53	7.1²

Land Surface Elevations in the Trout Lake/Hick's Ditch Drainage Basin

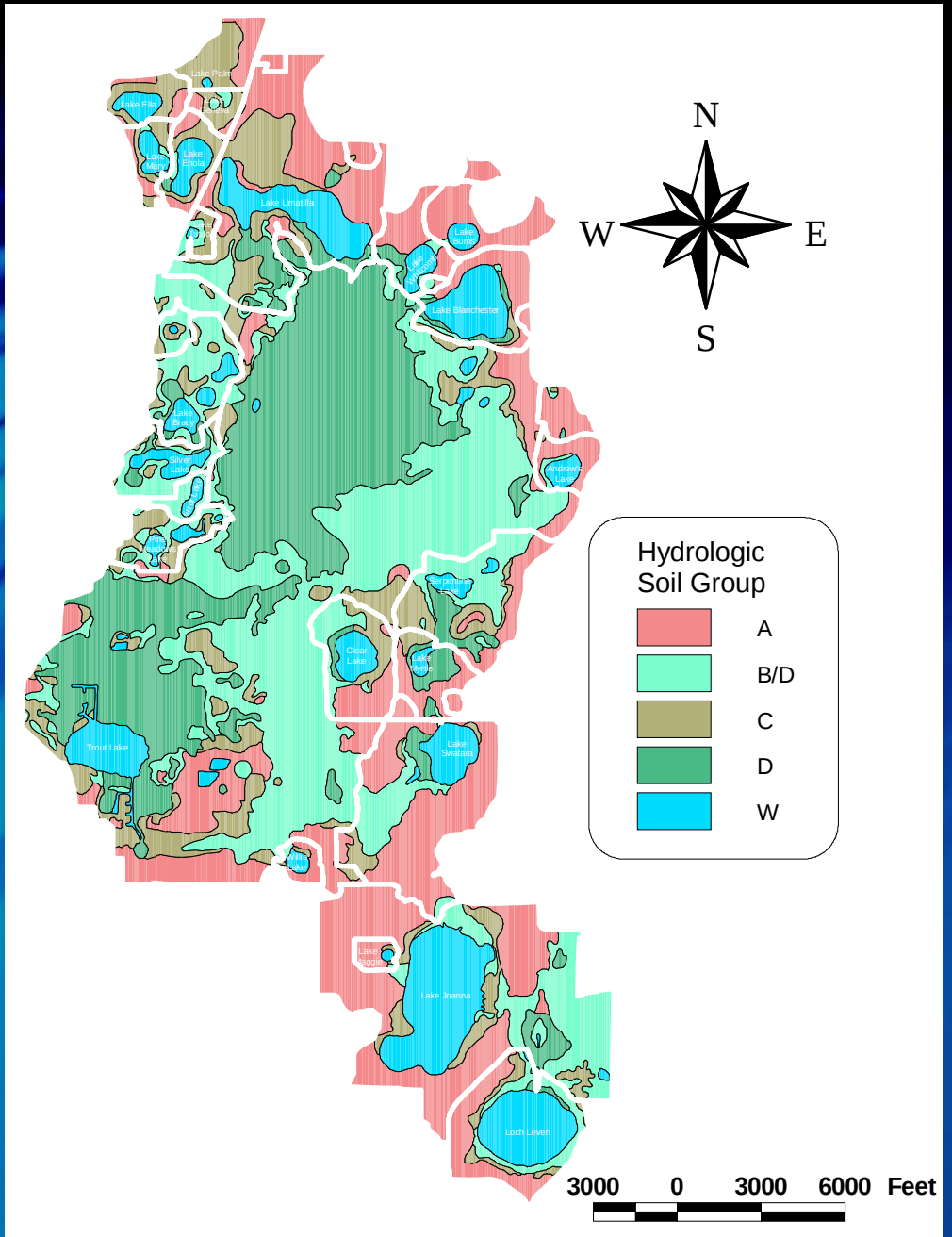


Land Use in the Trout Lake/Hick's Ditch Drainage Basin (9200 ac.)

Land Use	%
LD Residential	7.7
MD Residential	18.3
Multi-Family	0.6
Commercial	2.5
Industrial	0.3
Institutional	1.2
Recreational	2.1
Transportation	0.4
Agriculture	15.3
Undeveloped	34.5
Wetlands	27.1



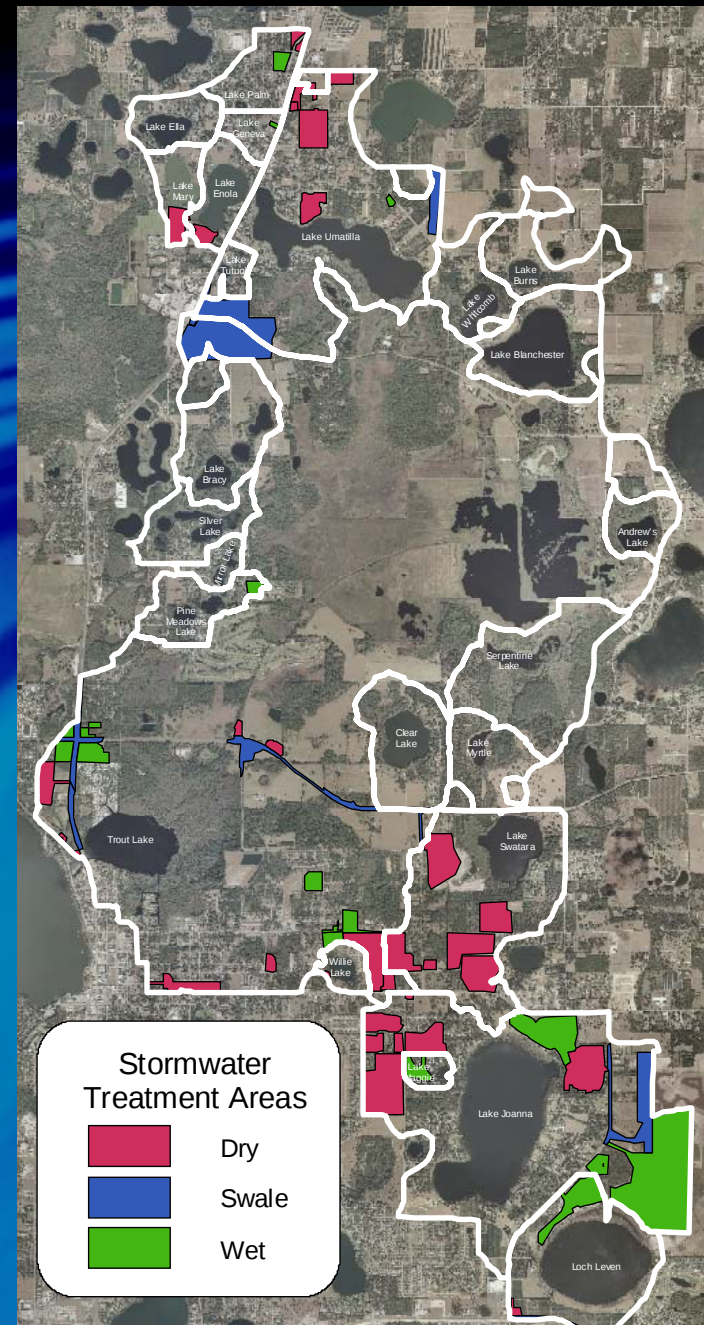
Hydrologic Soil Groups in the Trout Lake/Hick's Ditch Drainage Basin



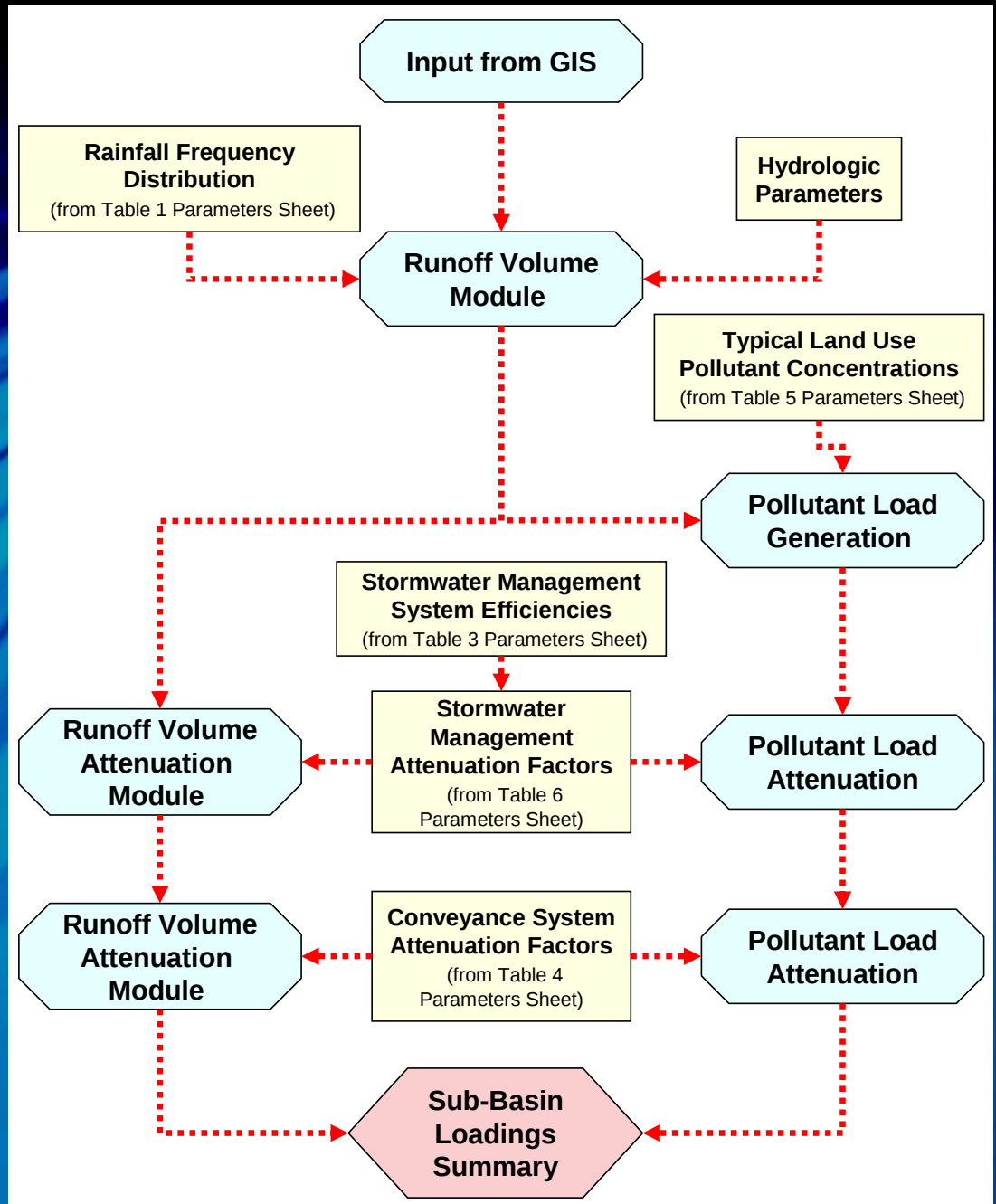
Stormwater Treatment Systems in the Trout Lake/Hick's Ditch Drainage Basin

Annual Hydrologic And Mass Removal Efficiencies
For Common Stormwater Management Systems

System Type	Annual Removal (%)			
	Volume	Total N	Total P	TSS
Dry Pond	60	60	60	60
Wet Pond	20	25	65	80
Swales	25	10	25	50



Nodal Diagram for the Trout Lake/Hick's Ditch Drainage Basin Runoff Hydrologic and Pollutant Loading Model



Summary Of
Hydrologic
Inputs And
Losses For
Waterbodies In
The Trout Lake
/ Hick’s Ditch
Drainage Basin

Waterbody	Hydrologic Inputs (Ac-ft/yr)				Hydrologic Losses (Ac-ft/yr)			Detention Time (Days)
	Precip.	Runoff	Lake Inflow	Total	Evap.	Outfall	Total	
Lake Ella	128	132	0	260	125	135	260	643
Lake Mary	114	102	135	351	112	239	351	305
Lake Palm	10	5	0	14	10	5	14	311
Lake Geneva	15	3	5	23	15	8	23	201
Lake Enola	184	154	248	586	180	406	586	381
Lake Tutuola	11	39	0	51	11	40	51	103
Lake Umatilla	678	755	445	1878	663	1215	1878	366
Lake Bracy	90	235	0	324	88	237	324	185
Silver Lake	79	165	237	480	77	403	480	50
Mirror Lake	38	57	403	498	37	460	498	27
Pine Meadows	42	131	460	633	41	592	633	24
Lake Burns	88	68	0	155	86	70	155	842
Lake Whitcomb	125	111	70	305	122	183	305	299
Lake Blanchester	490	377	0	867	480	387	867	424
Andrew's Lake	96	76	0	172	94	78	172	372
Loch Leven Lake	682	581	0	1263	668	596	1263	412
Lake Maggie	16	30	0	46	16	31	46	209
Lake Joanna	1151	1343	626	3120	1126	1994	3120	213
Lake Swatara	291	368	1994	2652	285	2367	2652	107
Lake Myrtle	57	76	2367	2500	56	2444	2500	8
Serpentine Lake	50	224	2444	2718	49	2670	2718	27
Clear Lake	207	219	0	426	202	223	426	339
Willie Lake	118	50	0	167	115	52	167	216
Trout Lake	401	3970	5400	9771	393	9378	9771	21

Summary Of Annual Hydrologic Inputs To Trout Lake

Source	Annual Input (ac-ft/yr)	Percent Of Total
Direct Precipitation	401	4.1
Runoff	3970	40.6
<u>Lake Inflow</u>		
Pine Meadows	592	6.1
Umatilla	1215	12.4
Whitcomb	183	1.9
Blanchester	387	4.0
Andrews	78	0.8
Serpentine	2670	27.3
Clear	223	2.3
Willie	52	0.5
Totals:	9771	100.0

Summary Of Annual Hydrologic Losses From Trout Lake

Source	Annual Losses (ac-ft/yr)	Percent Of Total
Evaporation	393	4.0
Outflow to Lake Eustis	9378	96.0
TOTALS:	9771	100.0

Example of Interconnected Water Quality Model

Hydrologic and Phosphorus Loading Model for Lake Ella

Hydrologic and Mass Inputs												Hydrologic and Mass Losses				Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2-yr)	Mean TP Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Direct Precipitation			Stormwater		Lake Inflow		Unidentified Inputs		Total Inputs			Evaporation		Lake Outflow								
(in)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(kg P)	(kg P/ac)	(ac-ft)	(kg P)	(mg/l)	(in)	(ac-ft)	(ac-ft)	(kg)							
48.03	127.8	7.09	132	20.9	0.0	0.00	129	4.05	260	157	0.490	47.00	125	135	7.7	643	0.901	1.157	0.046	22.7	1.1	70

Hydrologic and Phosphorus Loading Model for Lake Mary

Hydrologic and Mass Inputs												Hydrologic and Mass Losses				Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2-yr)	Mean TP Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Direct Precipitation			Stormwater		Lake Inflow		Unidentified Inputs		Total Inputs			Evaporation		Lake Outflow								
(in)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(kg P)	(kg P/ac)	(ac-ft)	(kg P)	(mg/l)	(in)	(ac-ft)	(ac-ft)	(kg)							
48.03	114.0	6.33	102	11.1	135.0	7.69	115.4	4.05	351.1	141	0.324	47.00	112	239	13.8	305	0.840	1.098	0.047	23.0	1.1	70

Hydrologic and Phosphorus Loading Model for Lake Palm

Hydrologic and Mass Inputs												Hydrologic and Mass Losses				Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m2-yr)	Mean TP Conc. (mg/l)	Chyl-a Conc. (mg/m3)	Secchi Disk Depth (m)	Florida TSI Value
Direct Precipitation			Stormwater		Lake Inflow		Unidentified Inputs		Total Inputs			Evaporation		Lake Outflow								
(in)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(kg P)	(kg P/ac)	(ac-ft)	(kg P)	(mg/l)	(in)	(ac-ft)	(ac-ft)	(kg)							
48.03	9.8	0.54	4.5	1.50	0.0	0.00	9.92	4.05	14.3	12.0	0.678	47.00	9.6	4.7	0.6	311	0.841	1.147	0.102	52.5	0.7	85

Hydrologic and Phosphorus Loading Model for Lake Geneva

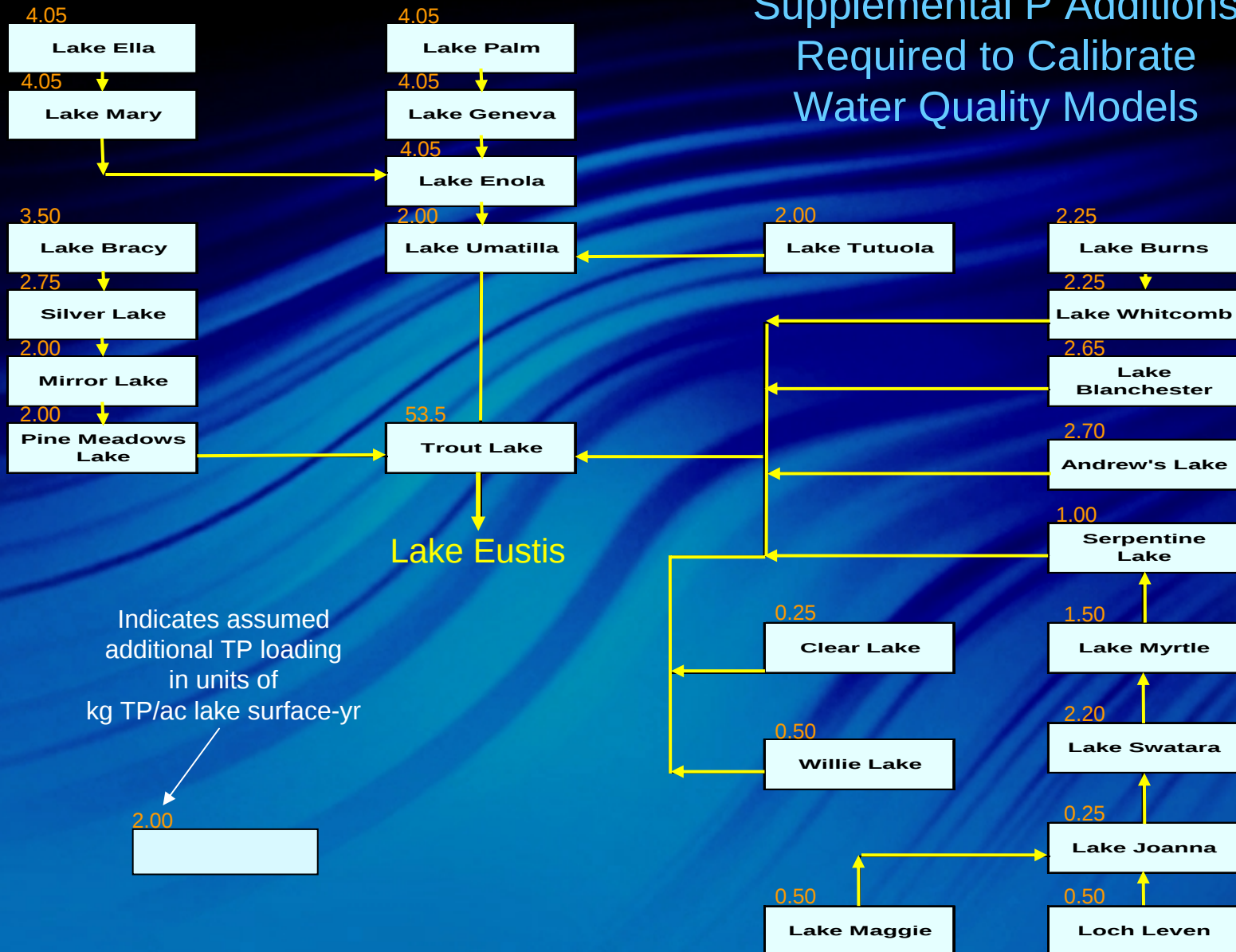
Hydrologic and Mass Inputs												Hydrologic and Mass Losses				Detention Time (days)	P Ret. Coeff.	Areal P Loading (g/m ² -yr)	Mean TP Conc. (mg/l)	Chyl-a Conc. (mg/m ³)	Secchi Disk Depth (m)	Florida TSI Value
Direct Precipitation			Stormwater		Lake Inflow		Unidentified Inputs		Total Inputs			Evaporation		Lake Outflow								
(in)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(ac-ft)	(kg P)	(kg P)	(kg P/ac)	(ac-ft)	(kg P)	(mg/l)	(in)	(ac-ft)	(ac-ft)	(kg)							
48.03	15.1	0.84	3.2	0.80	4.7	0.59	15.27	4.05	23.0	17.5	0.616	47.00	14.8	8.2	1.1	201	0.807	1.072	0.112	57.6	0.7	86

Summary Of Mean Water Quality Data For Lakes In The Trout Lake / Hick's Ditch Drainage Basin

Lake	Mean Total Nitrogen (µg/L)	Mean Total Phosphorus (µg/L)	TN/TP Ratio	Number Of Samples (TN/TP)	Period Of Record
Clear Lake	495	12	41	262 / 267	6/98 – 3/06
Lake Joanna	534	15	36	490 / 461	1/90 – 3/06
Loch Leven	542	15	36	217 / 214	6/98 – 6/05
Lake Mirror	893	22	41	216 / 217	10/97 – 1/06
Hick's Ditch	1923	95	20	56 / 114	6/97 – 4/07
Trout Lake	1967	236	8.3	519 / 524	2/93 – 3/07
Lake Umatilla	876	28	31	25 / 22	7/95 – 7/05
Lake Swatara	583	16	36	18 / 17	10/92 – 9/05
Lake Blanchester	755	45	17	4 / 2	3/01 – 8/02
Lake Enola	890	40	22	2 / 1	6/01
Lake Bracy	1270	47	27	5 / 3	7/01 – 7/05
Lake Satkin	1300	90	14	1 / 1	10/97

Source: FDEP STORET

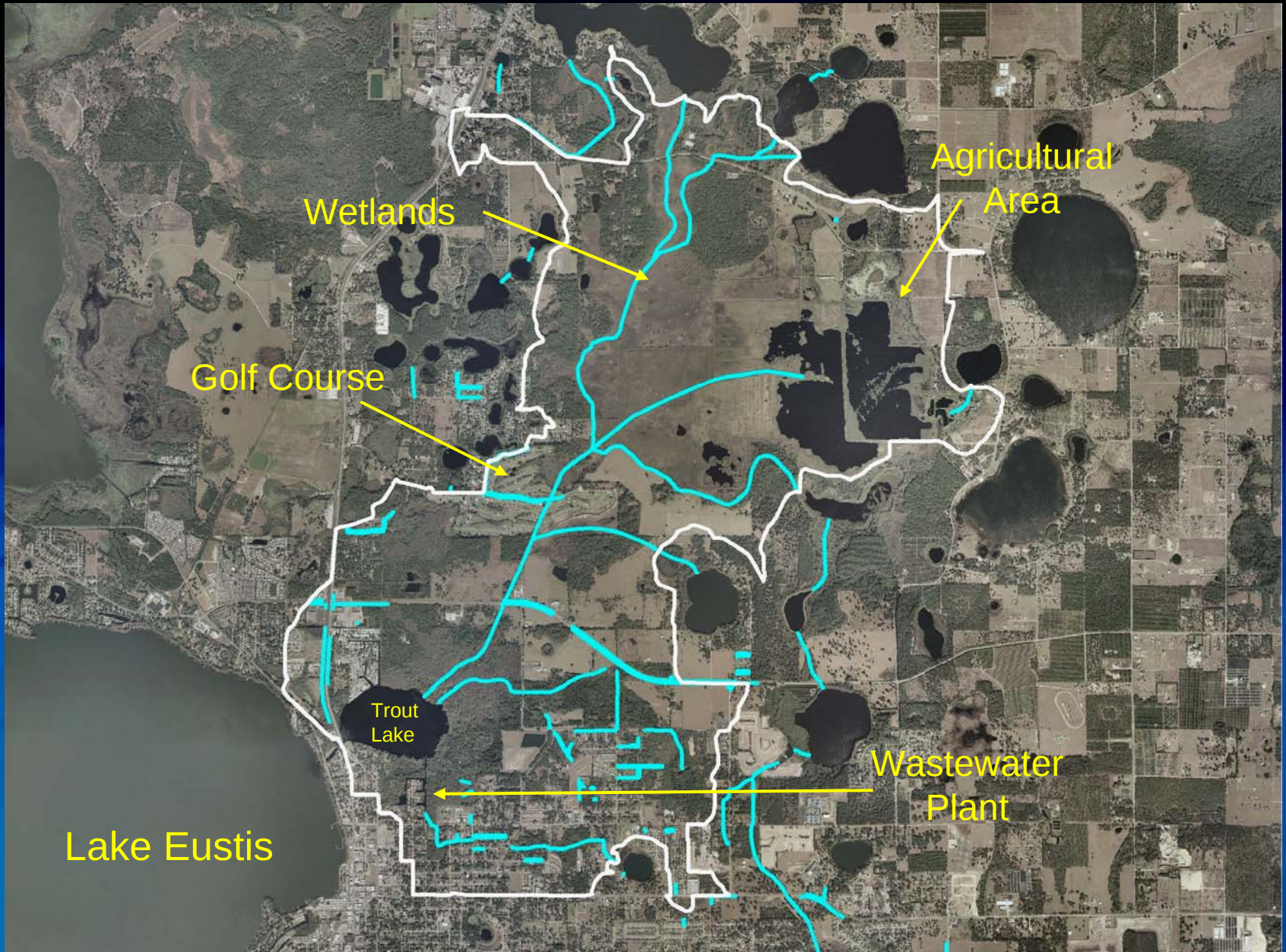
Supplemental P Additions Required to Calibrate Water Quality Models



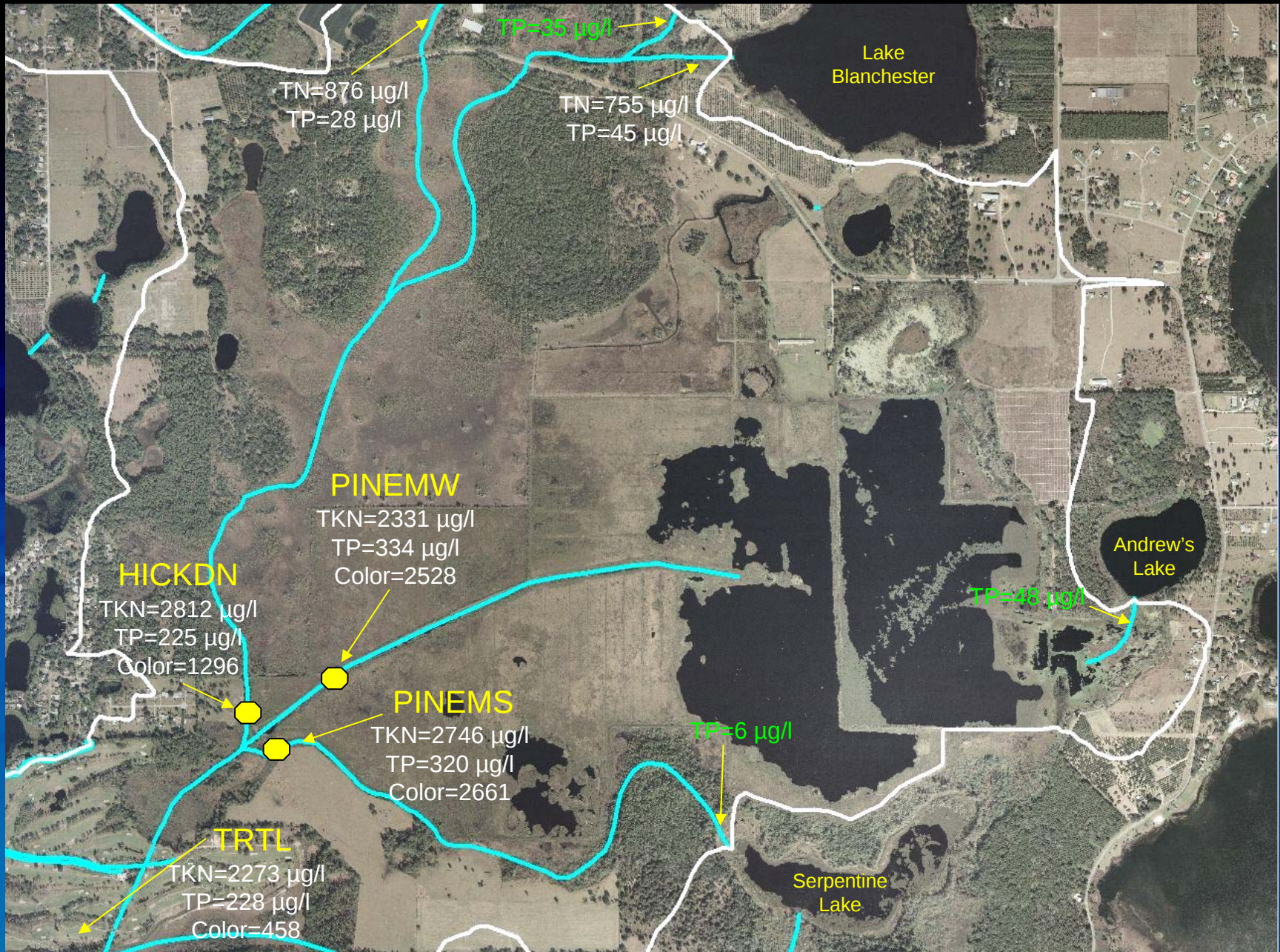
Summary Of Annual Phosphorus Inputs To Trout Lake

Source	Annual Input (kg/yr)	Percent Of Total
Direct Precipitation	22.3	0.4
Runoff	624	10.2
<u>Lake Inflow</u>		
Pine Meadows	14.7	0.2
Umatilla	42.0	0.6
Whitcomb	7.9	0.1
Blanchester	21.5	0.4
Andrews	4.6	0.1
Serpentine	18.4	0.3
Clear	3.2	0.1
Willie	2.8	< 0.1
Additional Inputs	5366	87.6
TOTALS:	6127	100.0

Features of the Trout Lake Drainage Basin



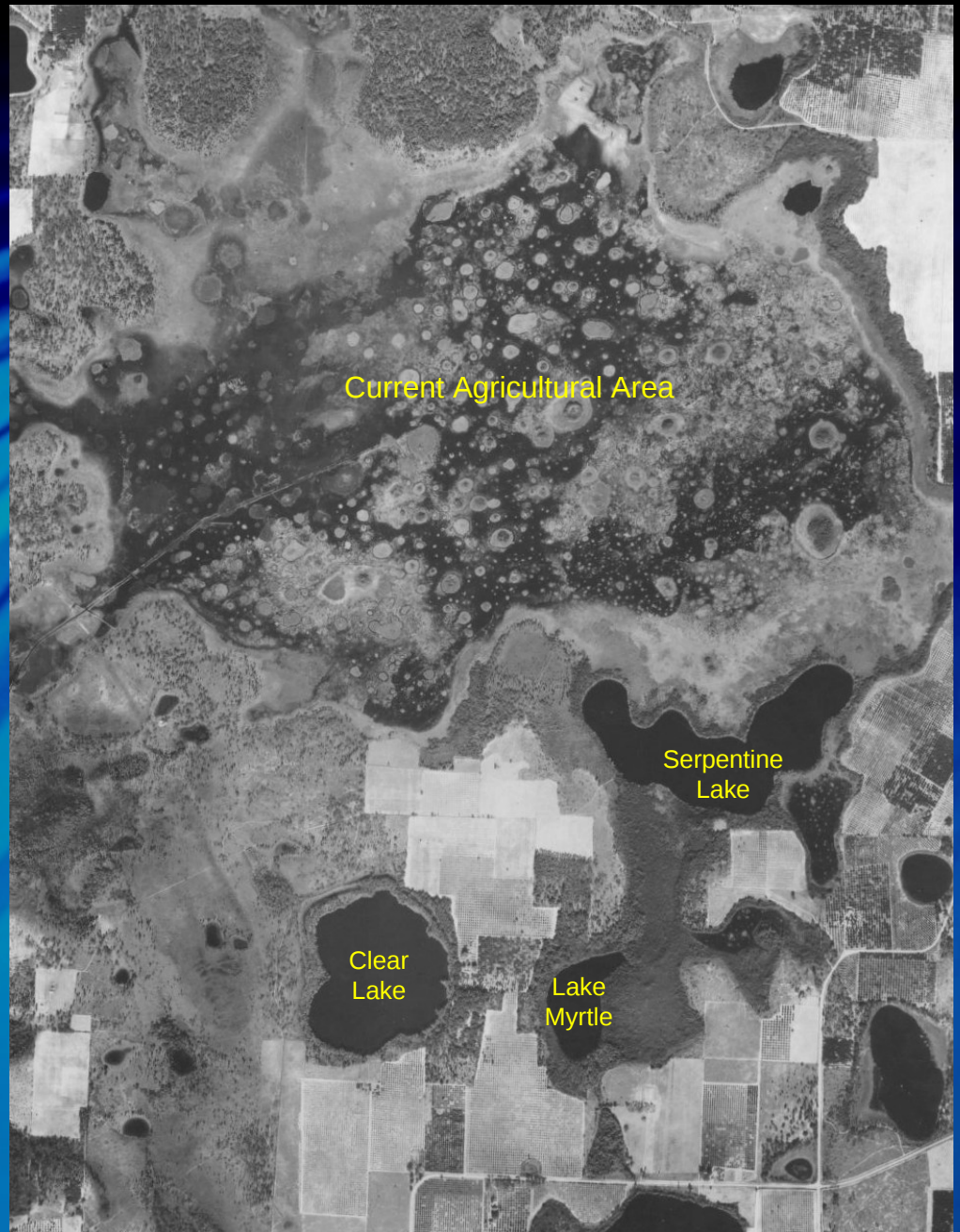
Water Quality Monitoring Sites in the Trout Lake Drainage Basin



Infrared Photography of the Trout Lake Drainage Basin



Photograph of the Hick's Ditch Area During 1953



Wastewater Treatment Facilities in the Trout Lake Drainage Basin



Golf Course Area in the Trout Lake Drainage Basin



Preliminary Findings

- The sources of elevated phosphorus loadings and poor water quality characteristics in Lake Trout originate within the Lake Trout watershed
- Contributions of phosphorus from interconnected waterbodies are minimal
- Potential sources of additional phosphorus include:
 - Agricultural areas
 - Wastewater treatment plant effluent
 - Golf course
 - Wetlands
- Additional water quality monitoring may be necessary to identify the source of these loadings

The background of the slide is a dark blue gradient with flowing, wavy lines in lighter shades of blue, creating a sense of movement and depth.

Questions/Comments?