RES 17-06

M E M O R A N D U M

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DATE: June 5, 2002

SUBJECT: Final Land Use Coverage for SFWMM 2000 Update

This document describes the effort to update the South Florida Water Management Model (SFWMM) land use to represent the year 2000 for each 2-mile by 2-mile model grid cell. The final 2000 land use map is shown in Figure 1.

An effort was made to use the most recent or most accurate data. Since no detailed, uniform map of vegetation exists for the entire SFWMM area several data sources were used to create a land use "supermap" at a fine resolution. Data sources are shown in Figure 3 and the land use "supermap" GIS coverage, intended to be used by other modelers, is available at \\modserv1a\hsm_data2\hsmgis\covs\base\landuse_2000.

After completion of the final 2000 land use map, the 1988 land use previously used for SFWMM calibration (1979-1989 period) was remapped using the same land use classes as the 2000 land use map. The revised 1988 land use map is shown in Figure 2. A comparison of the new codes and the old codes can be found in Table 1. Helicopter flights were taken to do a visual check of the natural areas and photographs are included to illustrate the new classification scheme.

This document describes the sources of data and why they were selected, then provides information on the correspondence between the former land use classes as used in SFWMM v3.5 and the 2000 land use classes documented here (SFWMM 2000). A description of each land use class is provided with emphasis on hydrological differences between classes. Values for overland flow resistance coefficients and evapotranspiration (ET) parameters are provided as starting values for the SFWMM 2000 calibration/verification effort. Some comments on these coefficients and parameters document how they were obtained and suggest how they could be changed during calibration and verification.

KT/JB

cc: Luis Cadavid
Randy Van Zee
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Carl Fitz
Chris McVoy
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Ken Rutchey
Les Vilchek

Figure 1. South Florida Water Management Model 2000 Land Use

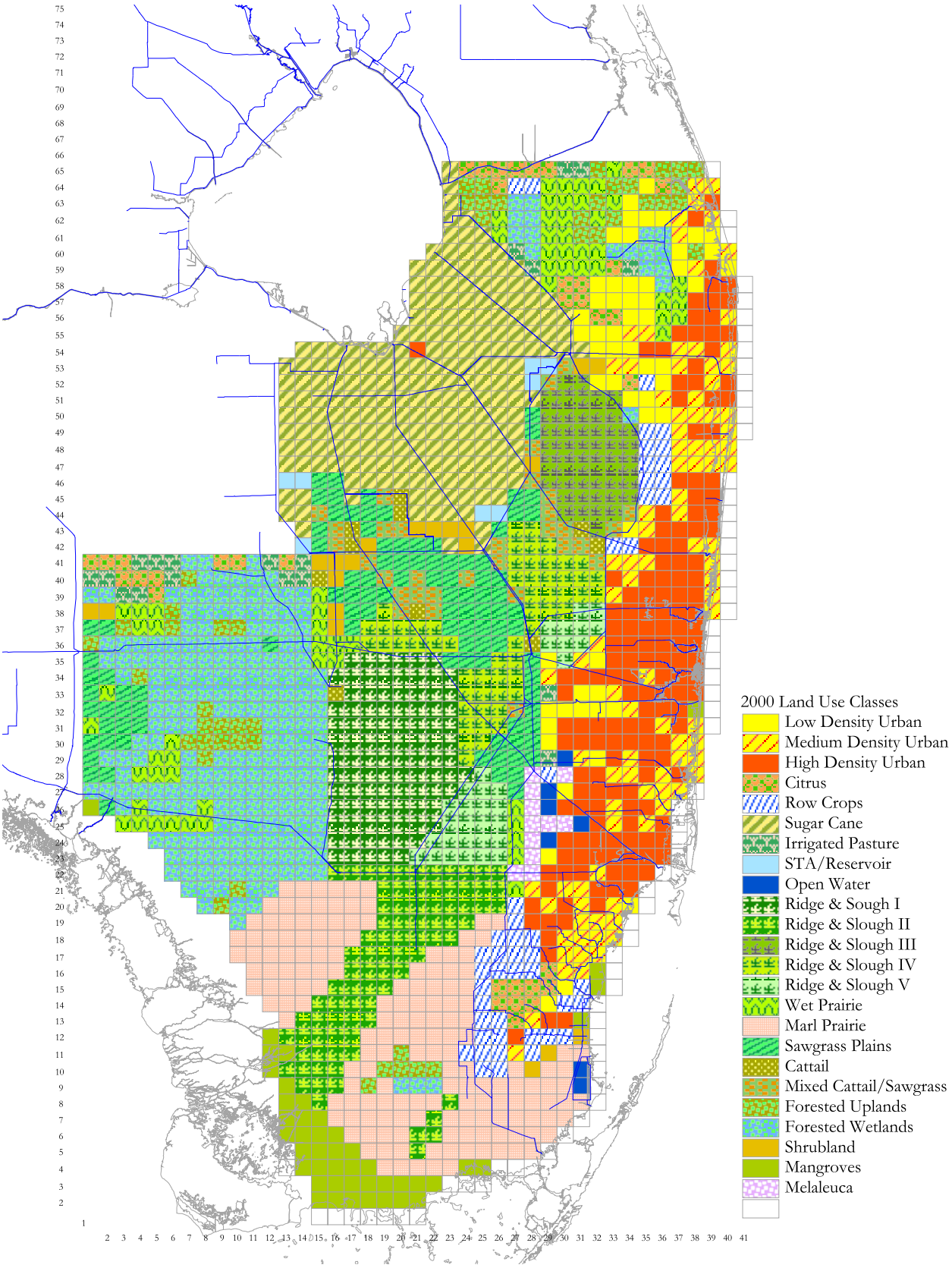
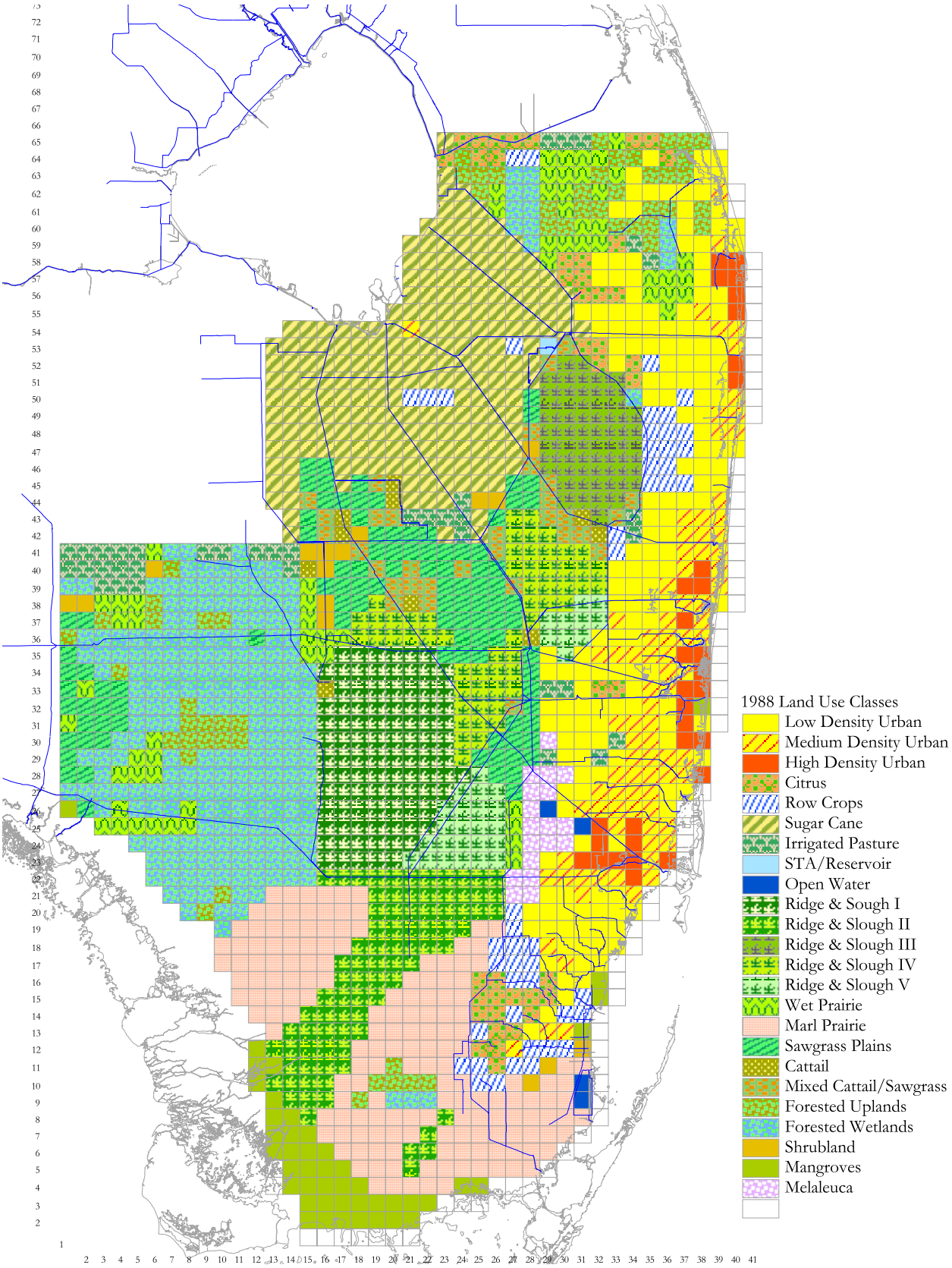


Figure 2. South Florida Water Management Model 1988 Land Use



Sources and Classification Method

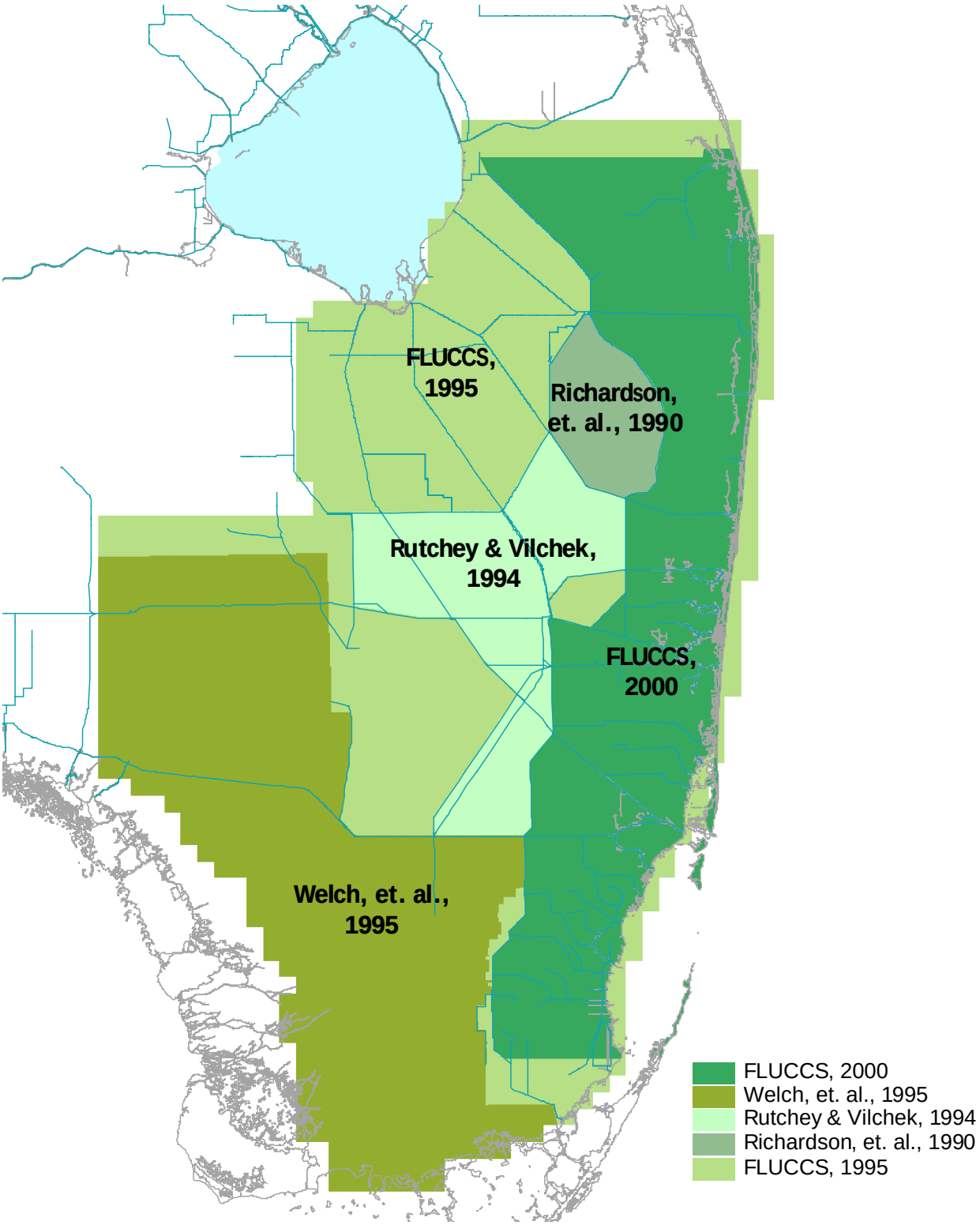
Since the FLUCCS data did not include detailed vegetation mapping it was decided that alternate data sources be used for the natural areas (Figure 3). The data sources used for the natural areas were taken from the best available information following personal communication with Carl Fitz, Ken Rutchey and Les Vilchek. A GIS coverage was made containing all of these sources and then overlaid with the SFWMM model grid in order to come up with a majority land use type for each grid cell. Checks were undertaken to see what each grid cell's former and new land use codes were and a visual check against 2000 satellite imagery was done. Professional judgment was used in areas where the majority from the land use data did not match its signature from the satellite imagery.

A draft 2000 land use map from the interpretation of the data sources and satellite imagery described above was verified by helicopter overflight. Different classifications in the natural areas and parts of the Everglades Agricultural Area were checked and adjusted following the inspection flight.

Revision of the 1988 land use map was undertaken by starting with the 2000 land use map, it was assumed that natural areas in 2000 were also natural areas with the same land use type in 1988. Urban and agricultural areas in the SFWMM v3.5 1988 land use and the SFWMM 2000 land use update were checked against each other. Where cells were designated as agricultural in the original 1988 map, and as urban in the 2000 map, they were set as agricultural in the revised 1988 map. A check for urban cells was also performed. In this check the SFWMM v3.5 1988 land use was used as a guide in determining the updated 1988 land use values. Since the SFWMM v3.5 did not include the Medium Density Urban category this had to be fit into the new scheme. Following is a table of the urban land use categories:

SFWMM v3.5 1988 Land Use	SFWMM 2000 Land Use	SFWMM Updated 1988 Land Use
High Density Urban	Low Density Urban	Low Density Urban
High Density Urban	Medium Density Urban	Medium Density Urban
High Density Urban	High Density Urban	High Density Urban
Low Density Urban	Low Density Urban	Low Density Urban
Low Density Urban	Medium Density Urban	Low Density Urban
Low Density Urban	High Density Urban	Medium Density Urban

Figure 3. South Florida Water Management Model 2000 Land Use Data Sources



Landscape Classification Crosswalk

The correspondence between the SFWMM v3.5 land use classes and those for the SFWMM 2000 are shown in Table 1. Where possible the Basic Land Unit (BLU) numbers were kept the same as in SFWMM v3.5 to minimize changes and possible confusion. The Marsh category used in SFWMM v3.5 is no longer used and urban areas are further subdivided to include a Medium Density Urban class which takes over the BLU number 3 from Marsh. The Ridge and Slough (R&S) landscape is divided into 5 subclasses. BLU 17 is used for R&S I to be consistent with SFWMM v3.5, while R&S II through R&S V are given new BLU numbers 21 through 24.

Table 1. Land Use Crosswalk from SFWMM v3.5 to SFWMM 2000

	SFWMM v3.5		SFWMM 2000	
Land Use	BLU	Type/Description	BLU	Type/Description
Urban	1	Low density	1	Low Density
	11	High Density	3	Medium Density
			11	High Density
Agricul-ture	2	Citrus	2	Citrus
	7	Row (or truck) Crops	7	Row (or truck) Crops
	8	Sugar Cane	8	Sugar Cane
	9	Irrigated Pasture	9	Irrigated Pasture
Rangeland	6	Shrubland	6	Shrubland
Wetland	18	Marl Prairie	18	Marl Prairie
	17	Modified Ridge & Slough I	17	Ridge & Slough I
	21	Modified Ridge & Slough II	21	Ridge & Slough II
	17	Modified Ridge & Slough I	22	Ridge & Slough III
			23	Ridge & Slough IV
			24	Ridge & Slough V
	4	Sawgrass Plains	4	Sawgrass Plains
	15	Cattail	15	Cattail
	19	Mix Cattail / Sawgrass	19	Mix Cattail / Sawgrass
	5	Wet Prairie	5	Wet Prairie
	3	Marsh		
	10	Stormwater Treatment Area	10	Stormwater Treatment Area
Forest	12	Forested Wetland	12	Forested Wetland
	22	Cypress Prairie		
	16	Forested Uplands	16	Forested Uplands
	13	Mangroves	13	Mangroves
	14	Melaleuca	14	Melaleuca
Water	20	Open Water	20	Open Water

Land Use or Landscape Description

Urban

High Density Urban
Areas with greater than 50% impervious cover. They comprise industrial sites, shopping centers with large paved areas and high density residential areas.

Figure 4. Example of High Density Urban Land Use.

Medium Density Urban
Areas with 25-50% impervious cover. Comprise predominantly medium density residential areas

Figure 5. Example of Medium Density Urban Land Use.

Low Density Urban
Areas with less than 25% impervious cover. Includes golf courses, small holdings and agricultural areas where the area under agriculture was not dominant over the 4 sq. mile cell.

Figure 6. Example of Low Density Urban Land Use.

Wetlands

Ridge and Slough
The dominant vegetation in the natural areas of the remnant Everglades consists of sawgrass ridges interspersed with open water sloughs. Ridges vary from consisting only of sawgrass to ridges with shrub cover or tree islands. The sloughs vary from being open water to being completely covered by water lilies. Periphyton occurs to varying degrees in some sloughs. In places the sloughs are filled in, to varying degrees with sawgrass and other species (e.g. *Eleocharis*, McVoy and Park 1997). Sloughs are highly directional in places (WCA-3A) and tend to have non-directional characteristics in other places (WCA-1). The Ridge and Slough landscape currently found in the Everglades represents a modified form of the original Ridge and Slough landscape that occupied much of the Everglades prior to water management actions over the last century. In this classification the Ridge and Slough landscape is divided into five categories representing different degrees of modification of the original Ridge and Slough landscape, each with different hydrologic properties of resistance to flow and evapotranspiration.

Ridge and Slough I (R&SI)
This landscape closely represents the current understanding (pers comm., McVoy, Heisler, Rutchey) of what the original Ridge and Slough landscape looked like. It consists of linear directional sawgrass ridges interspersed with predominantly open water sloughs (Figure 7). This subclass of Ridge and Slough has lower resistance to flow than other Ridge and Slough subclasses because it has more open water, with less water lilies, little to no invasion of the sloughs with sawgrass and other species and little periphyton. The Ridge and Slough I landscape is found in WCA-3A south of Alligator Alley and southwest of the Miami Canal.

Ridge and Slough II (R&SII)
Ridge and Slough II is comprised of directional sawgrass with open water sloughs that have been partly filled in with sparse sawgrass and other species increasing resistance to flow. Periphyton (benthic mats) are more present in the Ridge and Slough II landscape than in R&SI. Periphyton growth on submerged stems of the emergent vegetation in the sloughs increases flow resistance. The Ridge and Slough II landscape is found in Shark River Slough and Taylor Slough.

Ridge and Slough III (R&SIII)
Ridge and Slough III is predominantly non-directional consisting of circular and irregular shaped sawgrass ridges interspersed with open water sloughs (Figure 8). Shrubs and trees are present on many of the ridges. In places water lilies are present in the sloughs. Ridge and Slough III is found in WCA-1. Resistance to flow is expected to be higher than R&SII because of its lack of directionality.

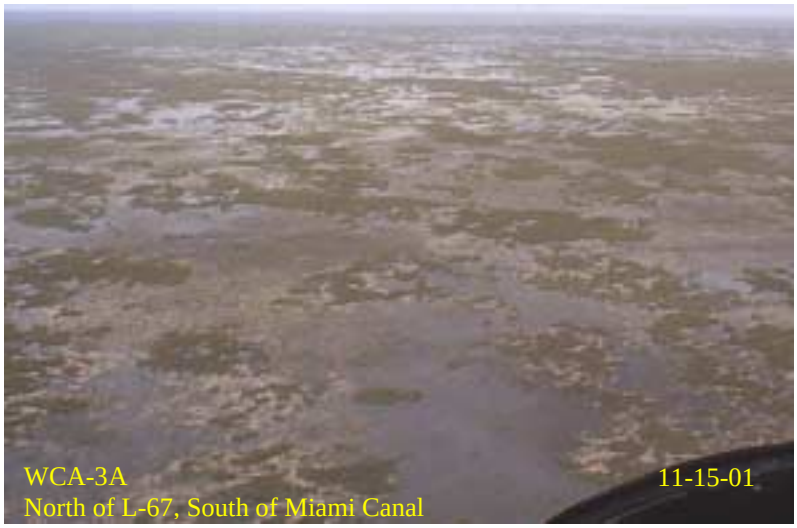
Ridge and Slough IV (R&SIV)
Ridge and Slough IV consists of non-directional to slightly directional sawgrass ridges with little evidence of shrubs or tree islands. Open water sloughs often have water lilies or periphyton in them (Figure 9). Areas of Ridge and Slough IV include central and southern WCA-2A and parts of WCA-3A north of Alligator Alley and southeast of the Miami Canal / Alligator Alley intersection. Ridge and Slough IV resistance to flow is expected to be less than that of Ridge and Slough III and close to that of Ridge and Slough II. It is kept as a separate subclass from Ridge and Slough II (found in Everglades National Park) to facilitate model calibration.

Ridge and Slough V (R&SV)
Ridge and Slough V consists of Ridge and Slough vegetation that has been considerably modified by in filling of sloughs with sawgrass and other wet prairie species (Figure 10). Resistance to flow is higher than the other Ridge & Slough subclasses and slightly less than that of the sawgrass plains. The impounded areas of WCA-2B and WCA-3B fall into this subclass.

Figure 7. Examples of Ridge and Slough I Landscape.

Figure 8. Examples of Ridge and Slough III Landscape.

Figure 9. Examples of Ridge and Slough IV Landscape.



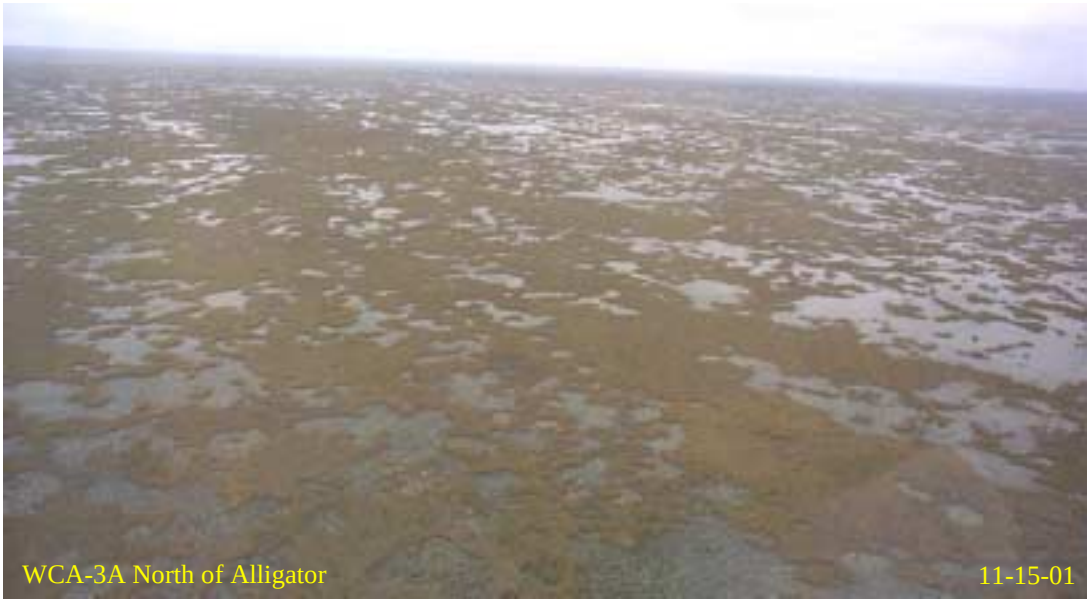


Figure 10. Examples of Ridge and Slough V Landscape.

Marl Prairie

Marl Prairies comprise relatively (compared to Ridge and Slough landscapes) sparse, low stature sawgrass on marl soils. There are open water sloughs with no prominent directional pattern. The Marl Prairie landscape was defined by intersecting model grid cells with predominantly sawgrass vegetation with marl soils. The resulting Marl Prairies correspond closely with those defined by McVoy and Park (1997) who observed a distinct separation between the Marl Prairies and the Ridge and Slough landscape. Resistance to flow in the Marl Prairies is expected to be lower than in the Ridge and Slough landscapes because of the relatively sparse sawgrass.

Wet Prairie

This landscape is found in depressions among flatwoods and pastures and at the edges of cypress domes and marshes. In this classification wet prairie is a grassy landscape mixed with shallow open water. However, this landscape is not derived from Ridge & Slough. The dominant vegetation of wet prairies include wiregrass, spike rush, muhly grass, beak rush, cordgrass, maidencane, and St. John's wort.

Sawgrass Plains

Consist of continuous or nearly continuous areas of medium to dense sawgrass *(Cladium jamaicense)*. In some places there are breaks in the sawgrass due to open water. Where sawgrass sloughs from a Ridge & Slough landscape have almost completely filled in, such as in northern WCA-3B, the landscape is classified as sawgrass plains.

Figure 11. Example of Sawgrass Plain Landscape.

Cattail
Cattail (*Typha* spp.) is the dominant vegetation. Usually this occurs in patches within the sawgrass plains.

Mixed Cattail / Sawgrass
This is a mixture of cattail patches in sawgrass. Four-square-mile grid cells that contain greater than 20% cattail and greater than 20% sawgrass were assumed to fit into this category.

Figure 12. Example of Mixed Cattail / Sawgrass Landscape.

Stormwater Treatment Area (STA)
STA's comprise large, constructed, treatment wetlands designed to serve as biological filters to reduce the phosphorous concentration in agricultural runoff entering the Everglades Protection Area. Vegetation varies by STA, and consists mainly of cattail, mixed marsh and submerged aquatic vegetation (SAV) communities.

Forest

Forested Wetlands
Cypress swamps, hardwood and wetter species forming a mosaic of pine flatwoods and depressed wetlands.

Forested Uplands
Pinelands on higher sands. Also areas of former mosaic of pine flatwoods and depressed wetlands that have been overdried by artificial drainage.

Mangrove
A coastal landscape containing red, white or black mangrove. May extend inland such as in the southern and southwestern Everglades. Permanently to regularly flooded by tidal waters.

Melaleuca
Exotic species (*Melaleuca quinquenervia*) forming monotypic stands that dominate the landscape. Exists in upland and lower areas which have experienced prolonged inundation.

Shrubland
Includes areas where trees are not present. Shrubs are the dominant vegetation which may include: Brazilian pepper, wax myrtle and saw palmetto. This is an upland community which rarely experiences inundation.

Figure 13. Example of Shrubland Landscape.

Open Water
Open water bodies such as lakes, canals or deep excavated reservoirs are included in this category.

Overland Flow Resistance Coefficients and ET parameters

Starting values for overland flow resistance coefficients and ET parameters for use in SFWMM 2000 (Table 2) are the same as they were for SFWMM v3.5 except as follows.

The detention depth (DETEN) was close to 0.1 ft in all land use types in SFWMM v3.5 and there didn't appear to be justification for differentiating between DETEN values so they were set to 0.1 ft for all land use types in SFWMM 2000. The value of DETEN could potentially be increased for the forest landscapes during calibration.

Medium Density Urban
The values for the "A" coefficient used in the calculation of Manning's roughness "n", the depth to the bottom of the deep root zone (DDRZ) and vegetation coefficient (KVEG) for each month are assumed to be the average of the SFWMM v3.5 values for Low Density and High Density Urban.

Marl Prairie
"A" was increased slightly from the SFWMM v3.5 value of 0.565 to 0.6 as it was felt that this roughness was possibly a little low. The Marl Prairie coefficient "A" is lower than values of "A" for the Ridge and Slough landscapes which range from 0.7 to 1.0. Monthly ET coefficients for Marl Prairie were left the same as their SFWMM v3.5 values. It is however felt that these values could be lowered to values closer to those used for the Ridge and Slough landscapes. Opportunities to do so should be investigated during calibration.

Ridge and Slough Landscapes
The value for the "A" coefficient in Manning's "n" was set at 0.7 for R&S I, 0.8 for R&S II and R&S IV, 0.9 for R&S III and 1.0 for R&S V. This corresponds with differences in resistance to flow for each of these landscapes as described above. The SFWMM v3.5 values of KVEG (month) for Modified Ridge and Slough I were used for R&S I, Modified Ridge and Slough II for R&S II, R&S III and R&S IV. KVEG (month) values for R&S V were set to be the average of the SFWMM v3.5 values for Sawgrass Plains and Modified Ridge and Slough II. Open water ponding depths (OWPOND) for all the SFWMM 2000 Ridge and Slough landscapes were set to 4.0 ft, the same as that for Modified Ridge and Slough I in SFWMM v3.5. The depth to the deep root zone (DDRZ) for all the SFWMM 2000 Ridge and Slough landscapes were set to 3.0 ft, the same as that for Modified Ridge and Slough II in SFWMM v3.5.

Wet Prairie

Wet Prairie has often been used as a "catch-all" landscape class to cover a variety of wetland landscapes. In SFWMM v3.5 wet prairie described areas that were part of the pre-drainage Ridge and Slough Landscapes but that were not classified as either Modified Ridge and Slough I or II. For SFWMM 2000 Wet Prairie takes on a different meaning. It refers to wet marsh landscapes outside the original Ridge and Slough area, defined as Wet Prairie in the FLUCCS definition. Wet prairies are open marsh landscapes with not enough trees to be a forested wetland and insufficient sawgrass to be classified as sawgrass plains. Resistance to flow in wet prairies is assumed to be larger than in sawgrass plains. The same KVEG coefficients are used in SFWMM 2000 as were used in SFWMM v3.5 simply because this is still a "catch-all" classification and the SFWMM v3.5 seemed to be as good a starting value as any others.

Forested Landscapes

Open water ponding depths (OWPOND) for the Forested Uplands, Forested Wetlands and Melaleuca were set to 10 ft to more realistically reflect the height of this canopy although ponding to these depths is never expected to occur.

References

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Table 2. Overland Flow Coefficients and ET Parameters for SFWMM 2000.

BLU	Land Use Type	Manning's n		OWPOND	DSRZ	DDRZ	Vegetation/Crop Coefficient (KVEG)											
		A	b	(ft)	(ft)	(ft)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Low Density Urban	0.200	0.00	1.0	1.0	2.0	.556	.502	.534	.542	.562	.562	.628	.706	.702	.686	.604	.552
3	Medium Density Urban	0.140	0.00	1.0	1.0	1.3	.460	.412	.443	.452	.467	.467	.511	.575	.562	.570	.503	.457
11	High Density Urban	0.080	0.00	1.0	1.0	1.5	.363	.321	.352	.361	.372	.372	.394	.443	.421	.453	.402	.361
2	Citrus	0.225	0.00	3.0	2.0	3.0	.701	.693	.610	.542	.661	.710	.744	.810	.822	.702	.723	.700
7	Row (or truck) Crops	0.225	0.00	1.0	1.5	3.0	.640	.690	.870	.950	.860	.660	.610	.660	.710	.870	.930	.880
8	Sugar Cane	0.225	0.00	3.0	1.5	3.8	.800	.600	.550	.800	.950	1.00	1.05	1.05	1.05	1.00	.950	.900
9	Irrigated Pasture	0.225	0.00	1.0	1.0	2.0	.650	.700	.750	.950	.950	.980	.980	.980	.940	.800	.870	.650
6	Shrubland	1.550	-0.77	3.0	0.0	7.0	.855	.802	.850	.875	.875	.871	.881	.901	.901	.882	.824	.811
18	Marl Prairie	0.600	-0.77	3.0	0.0	2.5	.893	.862	.905	.933	.933	.921	.957	.975	.970	.92	.941	.894
17	Ridge & Slough I	0.700	-0.77	4.0	0.0	3.0	.705	.692	.710	.715	.715	.710	.721	.740	.740	.715	.724	.701
21	Ridge & Slough II	0.800	-0.77	4.0	0.0	3.0	.775	.750	.800	.810	.820	.810	.820	.825	.825	.780	.790	.771
22	Ridge & Slough III	0.900	-0.77	4.0	0.0	3.0	.775	.750	.800	.810	.820	.810	.820	.825	.825	.780	.790	.771
23	Ridge & Slough IV	0.800	-0.77	4.0	0.0	3.0	.775	.750	.800	.810	.820	.810	.820	.825	.825	.780	.790	.771
24	Ridge & Slough V	1.000	-0.77	4.0	0.0	3.0	.795	.770	.815	.825	.836	.839	.851	.868	.868	.810	.793	.781
4	Sawgrass Plains	1.110	-0.77	5.0	0.0	4.0	.815	.790	.830	.840	.852	.868	.882	.910	.910	.840	.795	.790
15	Cattail	1.110	-0.77	5.0	0.0	3.0	.795	.770	.800	.810	.822	.838	.852	.894	.890	.830	.795	.787
19	Mix Cattail/Sawgrass	1.110	-0.77	5.0	0.0	3.0	.800	.790	.810	.820	.832	.848	.862	.904	.900	.835	.795	.788
5	Wet Prairie	1.200	-0.77	5.0	0.0	4.5	.742	.725	.760	.761	.765	.775	.791	.815	.815	.772	.764	.741
10	STA	1.350	-0.77	3.0	0.5	5.0	.852	.802	.85	.875	.883	.881	.901	.941	.952	.892	.824	.811
12	Forested Wetland	0.155	-0.77	10.0	0.0	8.0	.723	.702	.745	.750	.770	.760	.770	.790	.790	.740	.770	.735
16	Forested Uplands	0.850	0.00	10.0	0.0	4.0	.743	.722	.768	.773	.783	.784	.805	.820	.820	.760	.771	.754
13	Mangroves	0.950	-0.77	6.5	0.0	4.0	.791	.760	.830	.855	.882	.880	.882	.904	.900	.824	.803	.753
14	Melaleuca	0.350	-0.77	10.0	1.5	8.0	.800	.770	.850	.880	.910	.900	.910	.970	.970	.860	.880	.800
20	Water	0.010	0.00	0.0	0.0	0.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Notes: Manning's $n=A(h)^b$ where h is ponded depth
Detention Depth (DETEN) = 0.1 ft for all Land Use Types
KMAX = 1.1 ft for all Land Use Types
OWPOND is the minimum ponding depth above which ET for open-water is assumed.
DSRZ is the depth from the land surface to the bottom of the shallow root zone.
DDRZ is the depth from the land surface to the bottom of the deep root zone.