DRAFT BIOLOGICAL ASSESSMENT

COLLIER COUNTY
COMPREHENSIVE WATERSHED IMPROVEMENT PLAN
COLLIER COUNTY, FLORIDA

APPENDIX N: RED-COCKADED WOODPECKER IMPACT ASSESSMENT

Appendix N

Collier County Comprehensive Watershed Improvement Project (CWIP)

Project Effects: Red Cockaded Woodpecker (*Picoides borealis)* Habitat Hydrology

Introduction

Red-cockaded woodpecker (*Picoides borealis*)

The red-cockaded woodpecker (*Picoides borealis*) is a federally and State of Florida listed endangered species endemic to open, mature, and old growth pine ecosystems in the southeastern United States. Once common throughout the southeastern United States, the species has been extirpated from 6 of the 17 states where it previously occurred (USFWS 2003). Loss of habitat, particularly the old pines required for nesting and roosting, has been the primary cause of the species' decline. The current status of the species is described in the Red Cockaded Woodpecker Recovery Plan (USFWS 2003) and related documents. The RCW information provided in this section has been taken directly from USFWS (2003) and other referenced sources.

Red-cockaded woodpeckers are non-migratory, territorial. They live in cooperative breeding social units called groups. Such groups are typically comprised of a breeding pair and up to three helpers, which are usually males and most often offspring of the mated pair from previous years (Jackson 1994). Juvenile females disperse or are expulsed from the breeding groups. The red-cockaded woodpecker is long-lived for a bird its size; banded birds in the wild have reached 15 years of age, and a captive-reared bird was documented at 13 years (Jackson 1994). Because of the cooperative breeding system, red-cockaded woodpecker populations are unusually resistant to environmental and demographic variation, but highly sensitive to the spatial arrangement of habitat. The buffering effect of helpers against annual variation operates only when helpers can readily occupy breeding vacancies as they arise. Helpers do not disperse very far and typically occupy vacancies on their natal territory or a neighboring one. If groups are isolated in space, dispersal of helpers to neighboring territories is disrupted and the buffering effect of the helper class is lost. When this happens, populations become much less likely to persist through time. Also, the cooperative breeding system does not allow rapid natural growth of populations. Colonization of unoccupied habitat is an exceedingly slow process under natural conditions, because cavities take long periods of time to excavate and birds do not occupy habitat without cavities. As forests age and old pines become abundant, rates of natural cavity excavation and colonization may increase. Changes in hydrology in South Florida have resulted in the loss of pineland habitat (USFWS 2003). If a nesting habitat becomes damaged or degraded, residents may not likely disperse to other, more suitable, but distant habitat and human assisted relocation of individuals or pairs may be similarly unsuccessful (Kim Dryden, Personal Communication, 2019).

Red-cockaded woodpecker populations are widespread regionally but occupy small and disjunct areas in the south Florida region. Substantial clusters of red-cockaded woodpeckers occur in Three Lakes Wildlife Management Area (Osceola County), Avon Park Air Force Range (Highlands County), Cecil M. Webb Wildlife Management Area (Charlotte County), and Big Cypress National Preserve (Collier and Monroe Counties) with scattered small populations throughout the service area. There is no designated critical habitat for the red-cockaded woodpecker. USFWS (2004). The Picayune Strand State Forest (PSSF) project area is part of the consultation area for the species.

Project Description

The Collier County Watershed Improvement Project (CWIP) proposes to enhance hydrologic conditions in the natural area immediately east of Naples, FL between I-75 and US-41 (**Figure 1**). The project area was once part of a much larger watershed draining from the north. Urban development and construction of I-75 cut off the northern third of the watershed. The runoff from that northern area was diverted into the Golden Gate Canal (GGC) as well as other ditches and drained to Naples Bay. The result was the dehydration of the area south of I-75, with attendant changes in vegetation communities due to changed hydrologic conditions. Collier County Collier County now proposes to return a portion of that diverted water to the project area. Due to other permitted water uses of the GGC flows, development within the project area for recreational and some residential/commercial uses, bordering urbanization, and the importance the habitat area for listed species, especially Red Cockaded Woodpecker and Florida Panther, Collier County proposes hydrologic restoration that will not impinge on other water uses or negatively impact developments bordering the project area.

The project will increase wet season hydration of approximately 9,000 acres west of Naples FL primarily in the western portion of the Picayune Strand State Forest (PSSF). Landscape boundaries of the hydration area include the I-75 corridor to the north, and city of Naples development to the west. To the south, the 6Ls Agricultural Area creates a boundary to project effects. To the east, the SFWMD CERP (Comprehensive Everglades Restoration Program) Picayune Strand Forest Restoration creates a hydrologic condition that the CWIP accounts for in evaluation of project effects in order to avoid negative hydrologic impacts.

Water withdrawn from the GGC during high flow periods will be diverted into a canal leading south to culverts under I-75 and then flow east within the I-75 stormwater canal on the south side of the highway for about a mile. A new canal running from that point south into the PSSF the project area includes water quality treatment in a linear flowway within a new canal, that terminates in a spreader ditch in the Picayune Strand State Forest (**Figure 1**). Flows will occur primarily during the wet season (May – October) but may also occur during high flow periods at other times of the year. Water reaching the south end of the project area will flow under US-41 and south into the tidal wetlands of Rookery Bay. The structures necessary to move water to the PSSF and additional structures are necessary to ensure the protection of private lands within the PSSF and residential development west of the 6L's agricultural area at the south end of the project. The project will impact about 60 acres of habitat within the USFWS RCW consultation Area, including about 35 acres of wetland (**Figure 1**).

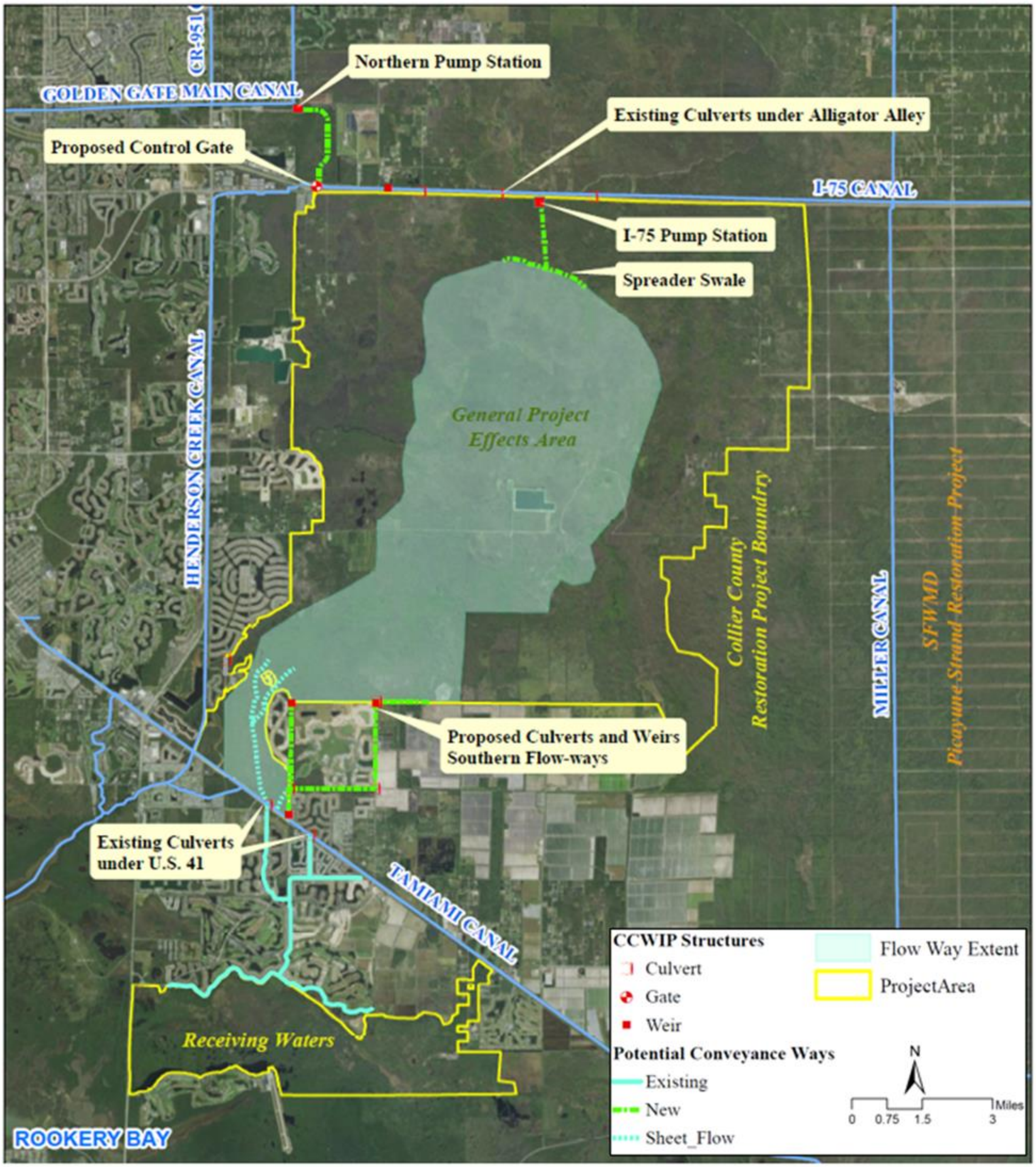

Figure 1. CWIP Restoration Project Overview

Project Area Conditions

The project evaluation area, about 22,000 acres, includes the western end of the Picayune Strand State Forest (PSSF) and other natural lands between the PSSF western boundary and the eastern edge of the Naples Florida development. The main effects of the project will occur in approximately 9,000 acres (**Figure 2**) identified as the Core Rehydration Area and Flowway Extent, dominated by four vegetation communities described by the Florida Land Use Cover and Classification Forms System (FLUCCS) as Cypress (FLUCCS 621), Cypress Pine Cabbage Palm (FLUCCS 624), Hydric Pine (FLUCCS 625), and Pine Flatwood (FLUCCS 411). Pine flatwoods are classified as uplands; the other dominant communities are wetlands. A similar community dominance occurs outside the 9,000-acre main effects area (**Figure 3, Figure 4, Table 1**). See **Permit Application Attachment 8** for detailed descriptions of project area community structure. Ten-year hydrologic simulations suggest that only minor and negligible hydrologic changes will occur outside the core rehydration area and flowway extent. Existing RCW habitat occurs almost entirely outside the main project effects area.

Red Cockaded Woodpecker (RCW) Core Foraging Areas in the Project Area

Two areas of multiple RCW nests occur within the project evaluation area (**Figure 5**; 2019 data provided by Jessica Spickler, Florida Fish and Wildlife Conservation Commission - FFWCC). Habitat quality of the Cluster area 1, in the northwest corner of the project evaluation area, was badly damaged by recent wildfires. While it is unclear whether the area will remain viable RCW habitat, it currently includes numerous nests and may recover in the long-term. Cluster area 2, much less impacted by wildfires of the past several years, is now the primary area of RCW nests in the project area. Cluster 2 extends to the east beyond the project evaluation area, into the Comprehensive Everglades Restoration Project (CERP) Picayune Strand Restoration Project (PSRP) effect area. Vegetation in the two RCW clusters as defined by the polygon comprised of all ½ mile core foraging areas is dominated by Cypress (FLUCCS 621 24%), Cypress Pine Cabbage Palm (FLUCCS 624 – 37%), Hydric Pine (FLUCCS 625, 18%), and Pine Flatwood (FLUCCS 411 17%), but includes a few small patches of other communities as well (**Figure 3** and **Figure 4**).

Analysis Focus and Objectives

A goal of the CWIP is to enhance hydrologic characteristics of the project area without negatively impacting habitats of listed species that use the area. Project RCW habitat effects assessment focuses on hydrologic changes within RCW habitat. The area used for the RCW habitat assessment, based on United States Fish and Wildlife Service (USFWS) and FFWCC data and recommendations, uses FLUCCS habitat polygons as the spatial footprint for assessment of effects. Results of project simulations defined for each selected vegetation polygon provides the data for assessment of change.

No comprehensive RCW habitat assessment has been conducted in the project area. However, the USFWS and FFWCC have extensive experience managing RCW and RCW habitat in this area. USFWS (Kim Dryden, personal communication 2019) recommended the use of a ½ mile radius core foraging area (CFA) around each nest as the assessment area basis. USFWS (2003) foraging habitat guidelines recommend all foraging habitat considered in an assessment be within 0.8 km (about ½ mile) of a cluster (i.e., the aggregation of active and inactive cavity trees defended by a single RCW group). The resulting polygon defining the edge of combined individual polygons and the project assessment area boundaries defined the focus area for RCW habitat effect evaluation; two CFA clusters resulted (**Figure 5**). Note that while the CFA clusters extend to the east, the CWIP has responsibility for hydrologic conditions only to the boundaries shown in **Figure 5**, which provides the CFA Area 2 shape shown.

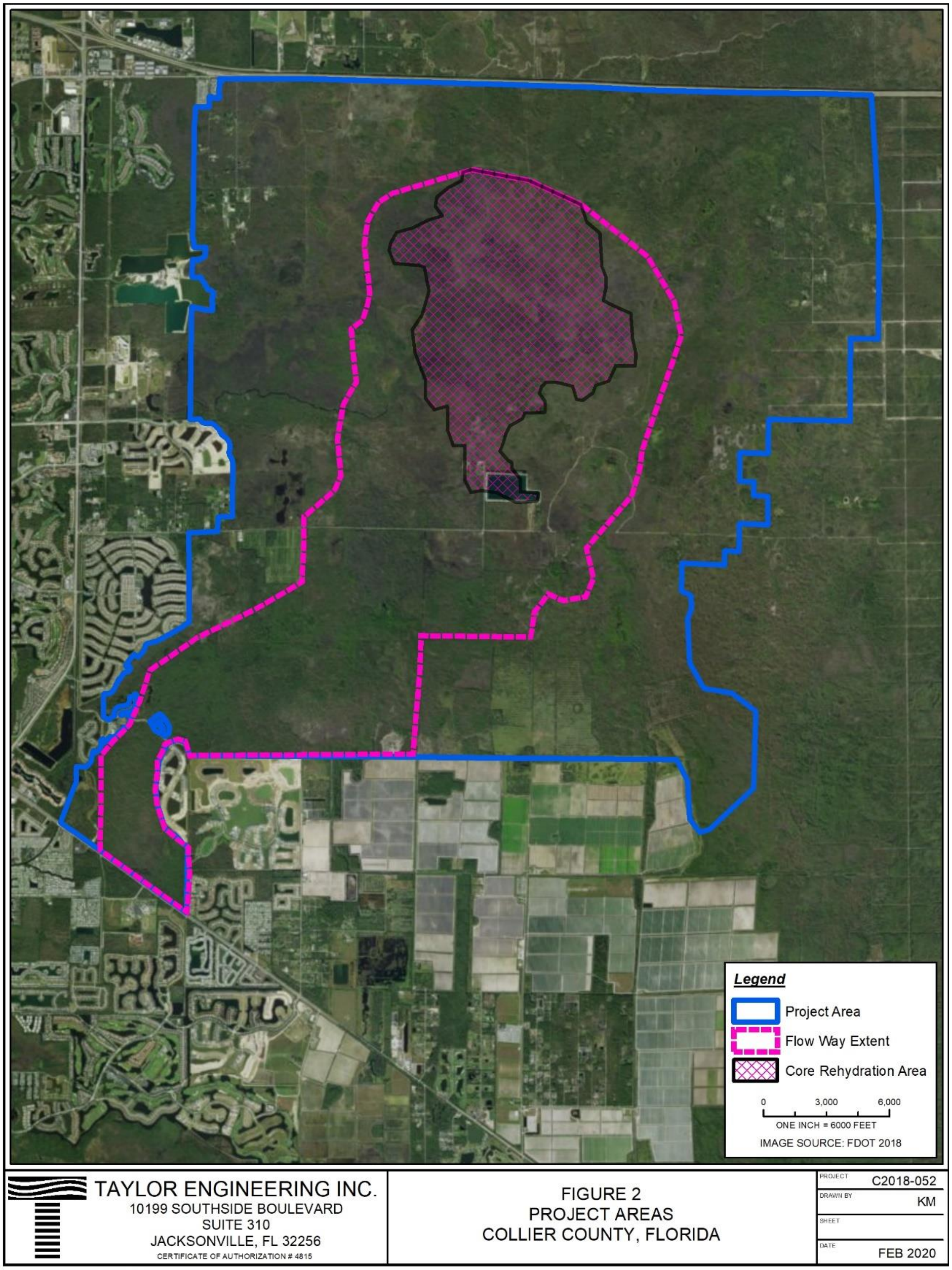

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Figure 2. CWIP Core Rehydration Area and Flowway Extent, about 9,000 acres.

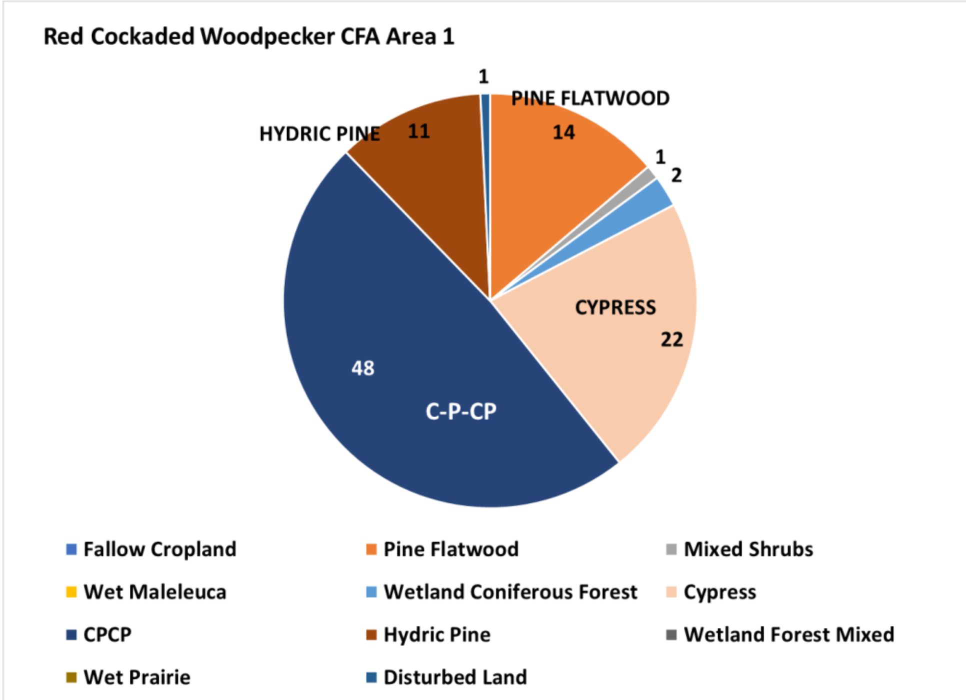

Figure 3. Percent Composition of communities within CFA Area 1

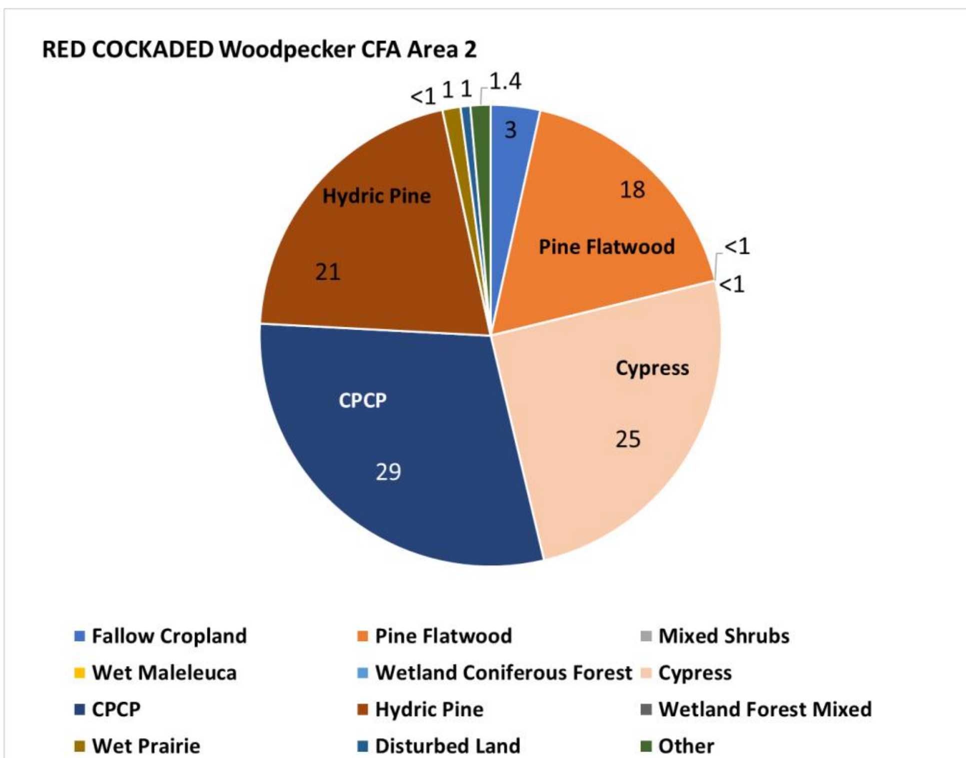

Figure 4. Percent Composition of Natural Communities within CFA Area 2

The CFA is a surrogate for the actual behavior of the species around a nest. The birds key on vegetation community conditions with a primary foraging area estimated to extend about a ½ mile from the nest within desirable habitats. RCW use of desirable vegetation communities may likely extend beyond the ½ mile CFA. Nesting cluster expansion also may occur in desirable areas immediately adjacent to the estimated CFA. Based on review of available technical literature on the species, Garabedian (2017) concluded that "there has been little empirical support for the foraging habitat thresholds included in the USFWS recovery plan as quantitative targets for RCW conservation". That research also summarized literature indicating variable habitat use and dispersal distances based on population densities and habitat qualities. Based on his own research, Garabedian (2017) concluded that while his research generally confirmed the 0.8 km (0.5 mile) foraging location boundaries, average RCW home ranges and forage areas were larger under low density population conditions than medium and high density population conditions and that foraging areas were not necessarily centered on cavity trees or clusters. Based on those research conclusions, the characteristics of the simulation data, and the highly dissected and heterogenous vegetation communities within the general project area and CFA clusters, we chose to assess complete vegetation community shapefiles. These shapefiles (**Figure 5, Table 1**) extend through the CFA cluster boundaries, testing the effects of project hydrology on CFA habitat areas and adjacent areas which may be important to the species' life functions.

Table 1. Characteristics of Vegetation Communities Used for Analysis of Project Hydrologic Effects on RCW Core Foraging Area Clusters

	Acres				
Cluster	**Cypress**	**C-P-CP***	**Hydric Pine**	**Pine Flatwood**	**Total**
1	189	1746	37	0	1971
2	853	329	378	332	1892

*C-P-CP = Cypress-Pine-Cabbage Palm

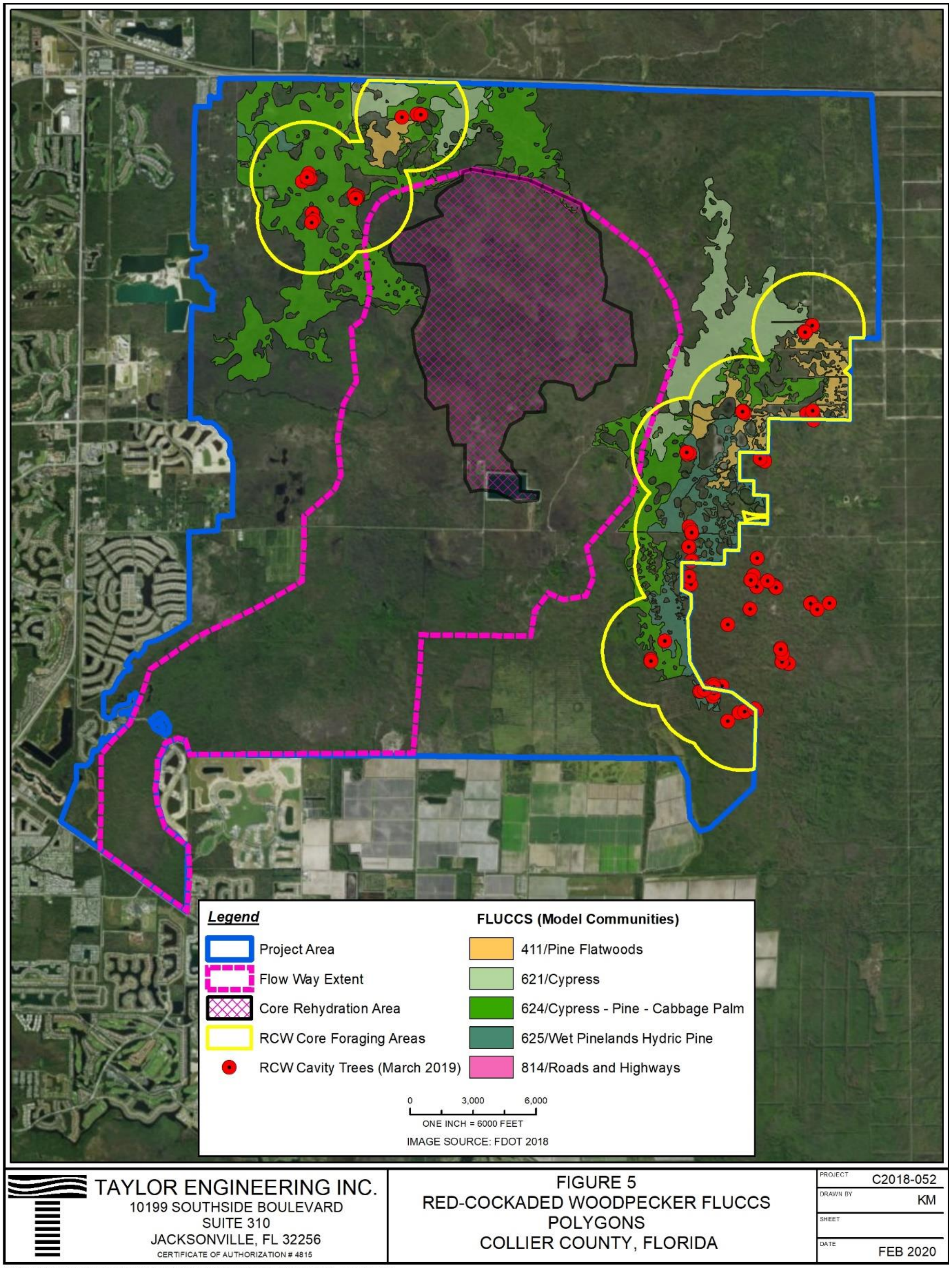

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Figure 5. RCW Habitat Area: Large Polygons Used for Vegetation Hydrology Effects Analysis

Methods

Hydrologic Simulation and FLUCCS Vegetation Shapefile Creation

Ten-year hydrologic simulation methods and development of FLUCCS shapefile maps used in this analysis are briefly summarized **Sub-Appendix 1**. As explained there, shapefiles >32.3 acres in size were used to assess existing and with project to best characterized community hydrology for each of the dominant FLUCCS vegetation types.

Definition of Vegetation Shapefile Hydrology

The hydrologic simulations results were estimated for each vegetation shape by weighting the hydrologic values in the grid cells intersecting each shape by the fraction of the shape associated with each intersecting grid cell (**Sub-Appendix 2**). Each hydrologic model grid cell had an area of 3.23 acres.

Within the landscape, vegetation patches express the elevation and related hydrology at those locations. Smaller vegetation patches within larger, dominant vegetation communities are associated with surface elevations that are small in area but sufficiently uniform to allow development of a community associated with a different hydrology than the surrounding community or communities. The hydrology of the many small vegetation patches (**Table 2**) could likely be misrepresented by the weighting scheme used to calculate shape hydrology (**Sub-Appendix 2**). Since reducing the simulation model cell size to accommodate small shapes (many an acre or less) was infeasible due to the related increase in computational time, vegetation patches over 32.3 acres (large patches) were selected to represent expected hydrology for each of vegetation communities, regardless of patch size. These large patches were most likely to include all or most of multiple grid cells for calculation of vegetation shapefile hydrologic values. The hydrologic values obtained using this subset of the data were considered representative of all patches of a community type. Note that about 2,000 acres of the project evaluation area are accounted for by various other land uses including disturbed lands, mines, open waters, development, etc.

Table 2. Area Relationships of Dominant Natural Community Patches in the Project Area

Vegetation Community	Total Area (acres)	n	Patches >32.3 acres	% of Area > 32.3 acres	n
Hydric Pine (FLUCCS 625)	2,253	381	1,034	46%	13
Cypress-Pine Cabbage Palm (FLUCCS 624)	7,472	222	6,878	92%	26
Cypress (FLUCCS 621)	7,156	242	6,183	86%	23
Wet Coniferous Forest (FLUCCS 620)	1,102	13	402	83%	5
Pine Flatwoods (FLUCCS 411)	2,619	397	1,473	56%	12
Totals	20,602	1,255	15,970	78%	79

Vegetation Community Hydrology Standards

Duever (2004) identified average hydrologic ranges for FLUCCS codes 411 (Pine Flatwood), 625 (Hydric Pine), 621 (Cypress), and 620 (Wet Coniferous Forest) for the PSRP project. The averages were based on several years of hydrologic data collected from locations east of the project area and existing technical literature (**Table 3**). FLUCCS code 624 (Cypress-Pine-Cabbage Palm) was not included in that analysis, due to the lack of that community in the locations where measurements were collected. Duever (personal communication 2019) associated hydrology of Cypress Pine Cabbage Palm (C-P-CP), a dominant community in the CWIP project area with that of hydric pine, based on the presence of hydric pine in that (FLUCCS 625) vegetation association (**Table 3**). Wet Coniferous Forest was assumed to have hydrology comparable to Cypress.

Table 3. Duever-Estimated Community Hydrology

Hydrologic Statistic	Pine Flatwood	Hydric Pine	C-P-CP*	Cypress
Hydroperiod (months)	0 - 1	1 - 2	1 - 2	6 - 8
Average Wet Season Depth (inches)	0 - 2	2 - 6	2 - 6	18 - 24
Average Annual Dry Season Water Table (inches)	-46	-30	-30	-16
1 in 10 yr. low water depth (inches)	-76	-60	-60	-46

*C-P-CP = Cypress-Pine-Cabbage Palm

The elevation data for large vegetation polygons in the project area (**Figure 6**), calculated for shapefiles greater than 32.3 acres indicated that cypress-pine cabbage palm (C-P-CP) community typically occurred at a lower landscape elevation than hydric pine; and is thus likely to include hydrologic conditions more aligned with cypress than with hydric pine. The analysis uses the hydric pine standard for C-P-CP hydrology display purposes but focuses on the elevation and hydrologic data for this community when reaching conclusions regarding project impacts.

Hydrologic Assessment Methods

Three approaches were used to assess whether the project was likely to negatively impact RCW habitat hydrology, assuming negative hydrologic impacts would result in similar vegetation community effects. Existing and with project simulation results were tested by vegetation community shapefile in the following ways:

1. Differences between existing condition and with-project hydrologic indicator levels (average amount of change)
2. Comparison of large vegetation shapefile existing and with project hydrologic indicator values to Duever's expected average hydrologic conditions for those indicators
3. Comparison of stage duration curves for existing and with project conditions of specific hydrologic simulation grid cells within and without of the RCW CFA clusters.

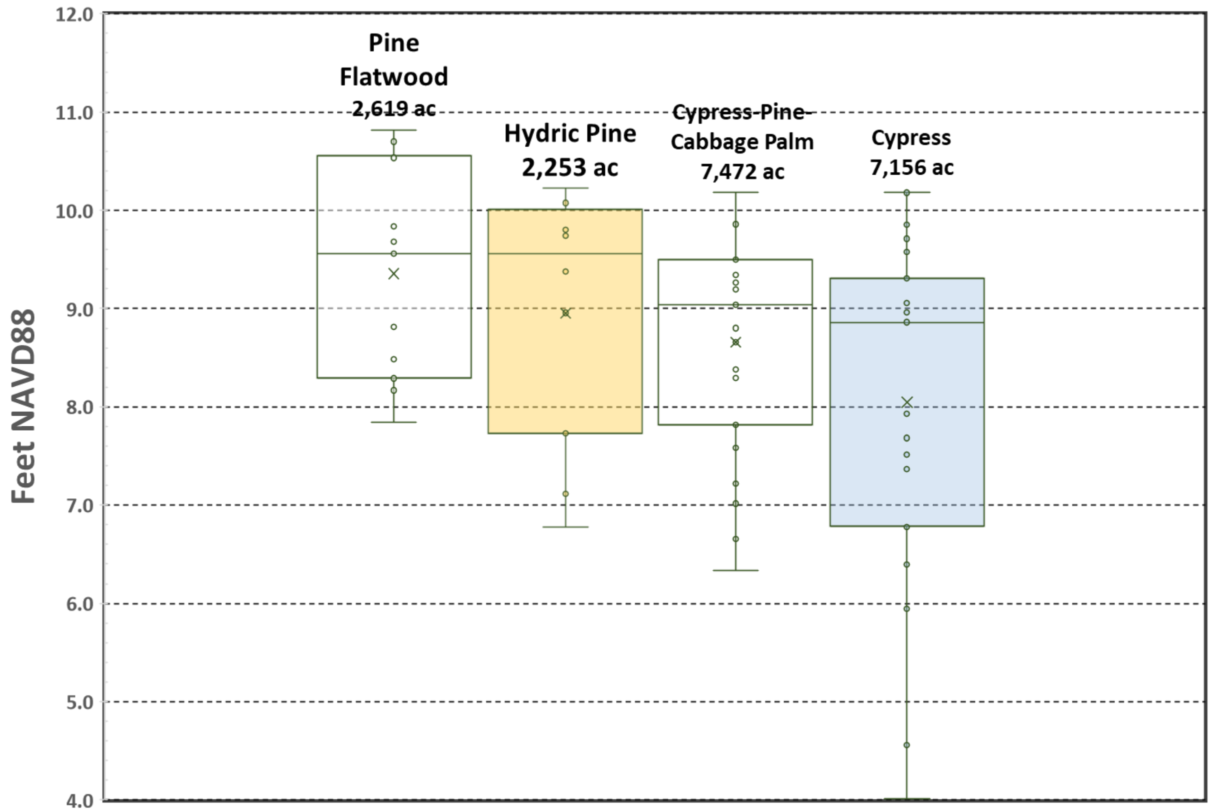

Figure 6: Box and Whisker Plot Summary of Elevation Characteristics of Large Vegetation Patches. The "Whiskers" display the interquartile range for each dataset

Results

Vegetation Shapefile Hydrology Compared to Duever (2004) Estimated Average Hydrology

Duever (2004, Duever, Personal Communication 2019) estimated average community hydrology was compared to simulation-estimated hydrology for RCW habitat shapefiles as defined above. **Table 4** provides the hydrologic statistics for each area. **Table 5** summarized the numeric differences in existing and with project hydrology by community type for hydroperiod, wet season water elevation, and dry season water table elevation.

The summarized simulation results suggest that

1. Existing and with project conditions are consistent with or drier than Deuver estimates, assuming the C-P-CP community has hydrology conditions closer to Cypress than Hydric Pine.
2. Hydroperiods show clear existing and with-project differences; C-P-CP shows the greatest change between existing and with project conditions, as might be expected if the landscape placement of that community was more like Cypress than Hydric Pine. Average wet season depths are consistent with landscape elevation differences.

3. All dry season water table elevations are below Duever average values. Average dry season depths are very similar, with only small differences between vegetation communities.
4. All communities experience the same dry season 1 in 10-year minimum depths; this is not surprising, as once water elevations recede well below the zone of most active vegetation uptake, hydrology is much less affected by the vegetation.
5. Considering by vegetation community and together as a habitat area, average differences between existing and with project conditions are small; not indicative of large hydrologic shifts that could imply major vegetation changes.

Table 4. Comparison of RCW Habitat Hydroperiod, Wet Season Water Elevation, and Dry Season Water Table Elevation Differences for Existing and With-Project Conditions

	Cluster 1			Cluster 2			
	Cypress	**C-P-CP**	**Hydric Pine**	**Cypress**	**C-P-CP**	**Hydric Pine**	**Pine Flatwood**
Hydroperiod (months)	0.2	1.7	0.3	0.4	3.0	2.1	1.3
Dry Season (inches Below Ground)	-38.6	-33.6	-42.3	-45.6	-28.8	-34.9	-39.9
Minimum Dry Season (inches Below Ground)	-80.5	-79.5	-86.4	-89.0	-74.7	-80.8	-86.4
Wet Season (inches Above Ground	0.0	0.3	0.0	0.0	1.4	0.4	0.1
Hydroperiod (months)	0.3	2.2	0.4	0.6	3.4	2.8	1.6
Dry Season (inches Below Ground)	-37.7	-32.2	-41.7	-44.5	-23.4	-32.6	-38.7
Minimum Dry Season (inches Below Ground)	-80.2	-79.3	-86.1	-88.8	-74.5	-80.6	-86.3
Wet Season (inches Above Ground)	0.0	0.8	0.0	0.1	2.9	1.4	0.3

*C-P-CP = Cypress-Pine-Cabbage Palm

Table 5. Differences Between Existing and With-Project Condition Hydrologic Indicator Values

RCW Area 1 Differences				
Vegetation Community	**Hydroperiod (months)**	**Dry Season (inches)**	**Minimum Dry Season (inches)**	**Wet Season (inches)**
Cypress	0.04	0.93	0.26	0.01
C-P-CP	0.46	1.43	0.25	0.49
Hydric Pine	0.03	0.69	0.33	0.00
RCW Area 2 Differences				
Vegetation Community	**Hydroperiod Differences (months)**	**Dry Season (inches)**	**Minimum Dry Season (inches)**	**Wet Season (inches)**
Cypress	0.12	1.07	0.22	0.08
C-P-CP	0.36	5.45	0.19	1.45
Hydric Pine	0.61	2.21	0.12	0.92
Pine Flatwood	0.33	1.17	0.11	0.16

As seen in **Figures 7-9**, the hydrologic indicator values in both RCW assessment areas remain within or below the Duever values. These polygons are in general the least influenced by the project. See the analysis of vegetation hydrology (**Permit Application Attachment 8**) for comparison.

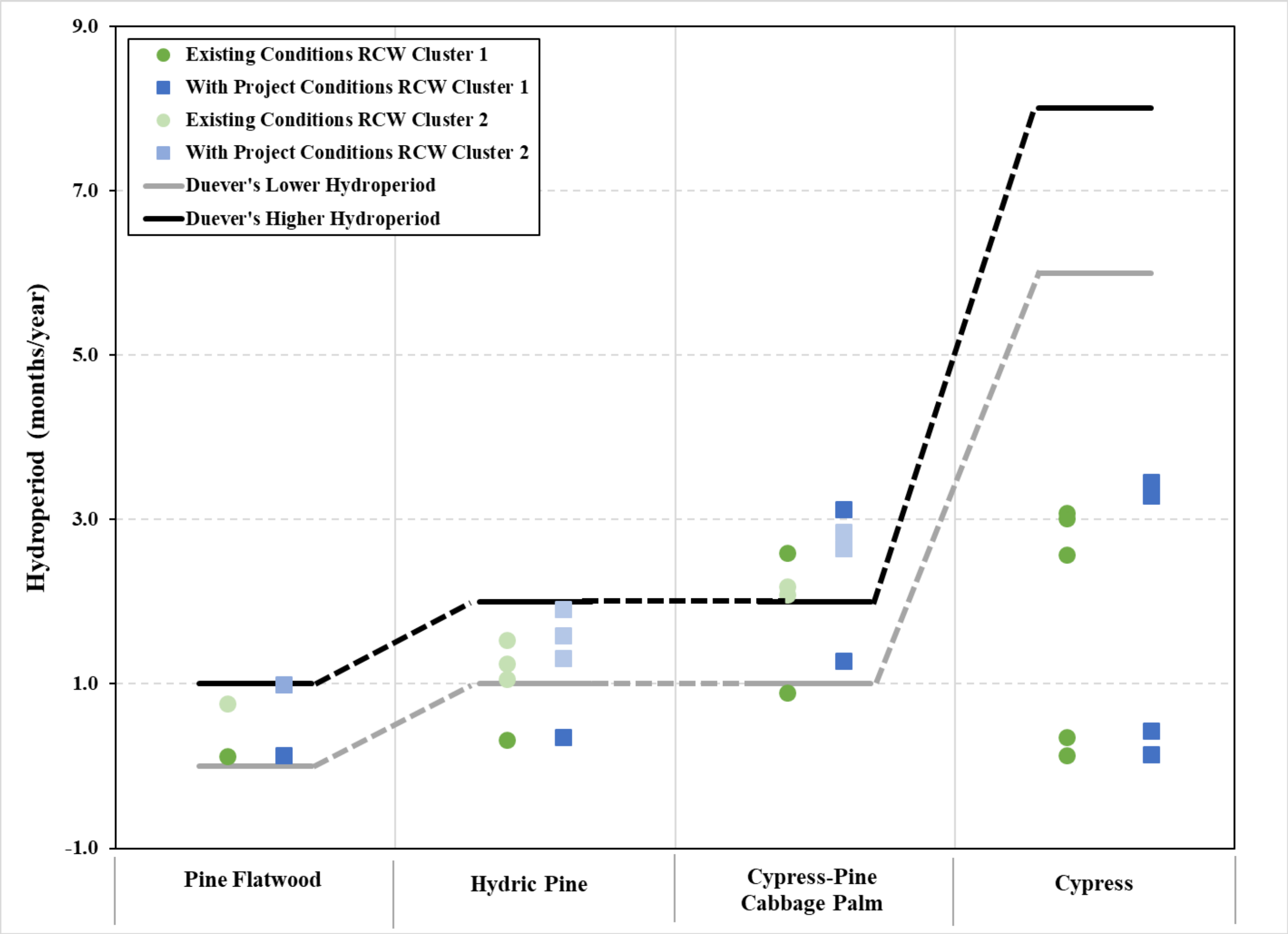

Figure 7. Duever (2004) Estimated Average FLUCCS Community and RCW Habitat Shapefile Hydroperiod, Existing and With-Project Conditions by RCW Area

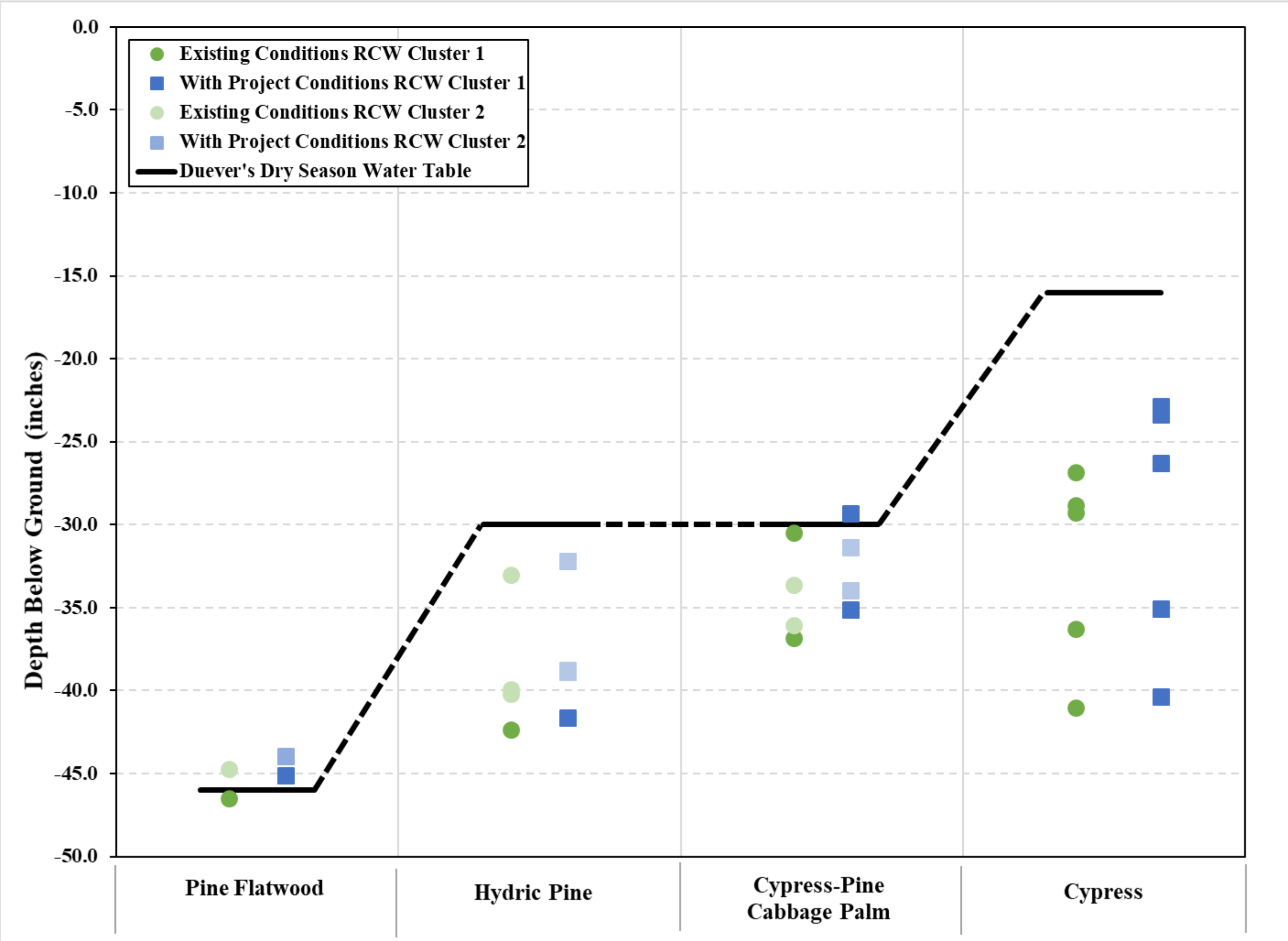

Figure 8. Duever (2004) Estimated Average FLUCCS Community and RCW Habitat Shapefile Dry Season Median Water Elevations, Existing and With-Project Conditions by Cluster

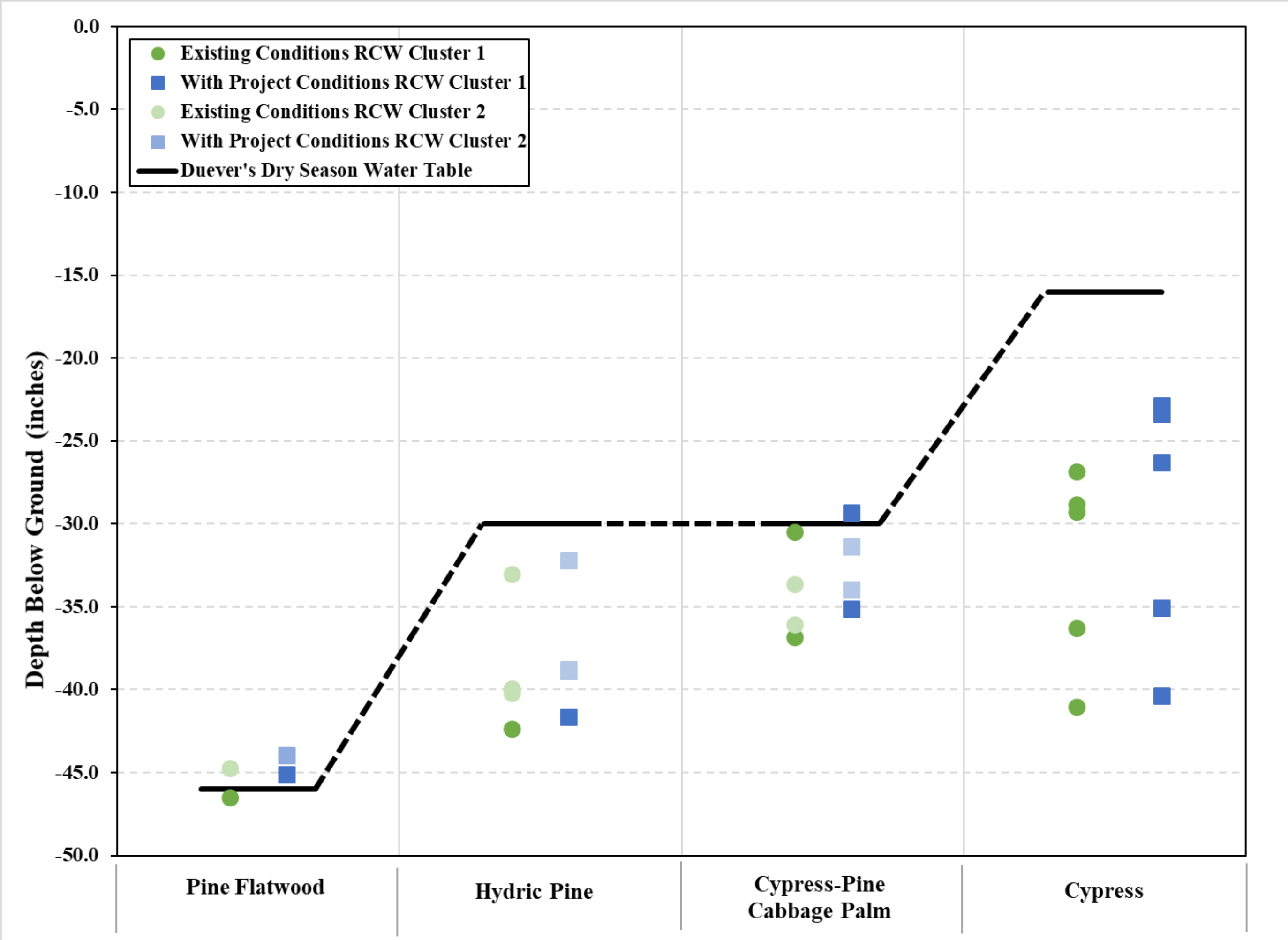

Figure 9. Duever (2004) Estimated Average FLUCCS Community and RCW Habitat Shapefile Wet Season Median Water Elevations, Existing and With-Project Conditions by Cluster

Stage Duration Curve Comparisons

Stage-duration curves provide another way to summarize project-related hydrologic changes. Model outputs of the combined groundwater-surface water model used to simulate project hydrology over a 10-year period were used to produce the stage duration curves for 21 locations within the project assessment area.

Locations for assessment were selected to assess the effects of the CWIP project alone and in conjunction with a fully functional Comprehensive Everglades Restoration Program Picayune Strand Restoration Project (PSRP) immediately east of the CWIP project area with a focus on those vegetation communities most commonly used by RCW or identified by USFWS and Florida Forestry Service as potential RCW habitat (**Figure 10**). At each location, the simulation results from a single hydrologic simulation cell (3.2 acres) wholly contained within one vegetation type was selected for analysis

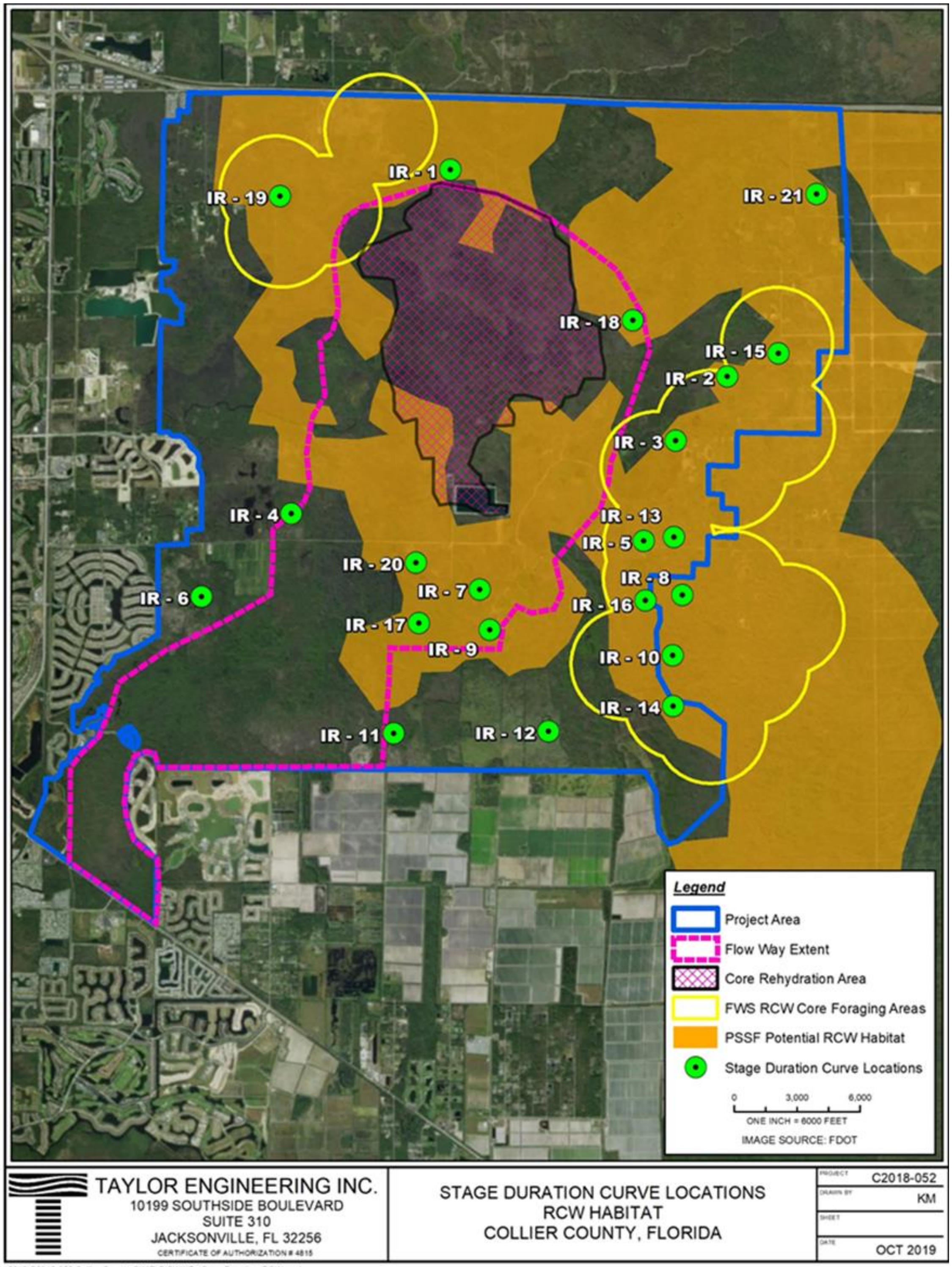

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Figure 10. Stage Duration Curve Locations and RCW Habitat Areas

Stage duration curves (**Sub-Appendix 3**) were plotted and the plot data used to calculate related hydrologic statistics including hydroperiod (the period when the water table exceeded the ground elevation, average water depth during that time, average water table elevation during the SFWMD-defined wet season (May 15 – October 15) and dry season (October 16 – May 14) water elevations. Statistics were calculated for existing and with project conditions for single simulation grid cells within the dominant communities (**Table 6**), with findings for hydroperiod and dry season elevations summarized in **Table 7**. The average water table elevations are always below the ground elevation because the calculated hydroperiods are always much shorter than the SFWMD wet and dry season periods (5 and 7 months long, respectively) and even during the wet season the water elevations above the ground surface do not offset the below-ground depths of the water table during the rest of the wet season. We calculated the average water elevation for the period that the water was above the ground surface to provide another dataset for comparison to the Duever average values for the PSRP wetland communities; the actual "wet season" period used for those calculations was not clearly defined.

The data indicate that for those simulation grid cells, the average values almost always fell below or within the Duever (2004) expected average values Since soil water table elevations are strongly influenced by site-specific soil conditions it is not surprising the data show some variability; there does not appear to be sufficient variability to suggest any pattern of exceedences of the Denver averages; in fact most of the data are less than the Duever estimates. The exceptions to this general conclusion, locations IR-6 and IR-7, mapped as pine flatwood and cypress pine cabbage palm communities. At an elevation of 7.8 ft NAVD88, IR-6 lies well below the pine flatwood community and within the Hydric Pine and Cypress-Pine-Cabbage Palm elevations. (**Sub-Appendix 3, Figure A3-5**). Since the vegetation communities at the select locations were not verified by direct observation; it is very possible that the community at IR-6 is identified incorrectly identified. IR-7 lies at the same elevation as IR-6 and while Duever (Personal Communication 2019) identified Cypress-Pine-Cabbage Palm communities as likely having hydrologic characteristics similar to Hydric Pine, the data collected for this project suggest that the C-P-CP community in the project area occurs in landscape elevations more typical of Cypress. Therefore, these anomalies do not suggest that the project may produce extreme hydrologic conditions in general for those communities; almost all the rest of the data suggest the opposite; that in fact the project has only a minor effect within the area of primary hydrologic change, and inconsequential hydrologic effects outside that area, where the current RCW colonies are located and where the habitat suggests that future colonies may develop or be developed as part of the RCW Recovery Plan actions.

Hydrologic average values were not calculated for stage duration curves of combined CWIP and PSRP simulations shown in in several figures in **Sub-Appendix 3**. it is clear from the presented figures and data that the combined project water elevations are as inconsequential to the RCW habitat as are the effects of the CWIP alone. The adjacent PSRP proposes rehydration of about 55,000 acres of the former Golden Gate Estates, drained for development that was never built. One objective of the CWIP project is to avoid negative hydrologic changes on the eastern project border when added to hydrologic changes created by the PSRP; that project is already in progress, although not yet complete. With-Project PSRP hydrologic simulations results provided by the South Florida Water Management District added to results at the same locations from the CWIP hydrologic simulations estimated the combined projects' changes.

Table 6. Average Hydrologic Values for 21 locations within the Project Assessment Area for Existing and With Project Simulations.

						Water Table Depths From Soil Surface			
Location ID*	FLUCCS ID	Hydrologic Condition	Simulation Hydroperiod (months)	Duever Hydroperiod (months)	Simulation Hydroperiod Average Water Depth Above Surface (Inches)	Average Simulated Wet Season Water Depth (inches)	Duever Average Wet Season Water Depth (inches)	Dry Season Average Water Table depth (inches)	Duever Average Dry Season Depth (inches)
IR-1	411	Existing	0.0	0 - 1	0.17	-36	0 - 2	-45	-46
		With-Project	0.1		0.11	-30		-41	
IR-2	624	Existing	2.4	1 - 2	0.32	-24	1 - 2	-36	-30
		With-Project	2.6		0.38	-23		-34	
IR-3	411	Existing	0.0	0 - 1	0.04 (one value)	-41	0 - 2	-51	-46
		With-Project	0.0		0.06 (one value)	-39		-49	
IR-4	411	Existing	0.0	0 - 1	0.14	-30	0 - 2	-37	-46
		With-Project	0.0		0.14	-29		-35	
IR-5	625	Existing	1.2	1 - 2	0.24	-30	0 - 1	-41	-30
		With-Project	1.9		0.3	-28		-39	
IR-6	411	Existing	2.2	0 - 1	0.2	-25	0 - 2	-32	-46
		With-Project	2.5		0.24	-24		-31	
IR-7	624	Existing	3.7	1 - 2	0.26	-18	1 - 2	-27	-30
		With-Project	4.3		0.55	-17		-24	
IR-8	624	Existing	1.4	1 - 2	0.11	-28	1 - 2	-39	-30
		With-Project	1.7		0.13	-27		-37	

						Water Table Depths From Soil Surface			
Location ID*	**FLUCCS ID**	**Hydrologic Condition**	**Simulation Hydroperiod (months)**	**Duever Hydroperiod (months)**	**Simulation Hydroperiod Average Water Depth Above Surface (Inches)**	**Average Simulated Wet Season Water Depth (inches)**	**Duever Average Wet Season Water Depth (inches)**	**Dry Season Average Water Table depth (inches)**	**Duever Average Dry Season Depth (inches)**
IR-9	624	Existing	0.2	1 - 2	0.11	-30	1 - 2	-39	-30
		With-Project	0.6		0.1	-28		-37	
IR-10	624	Existing	1.1	1 - 2	0.06	-26	1 - 2	-37	-30
		With-Project	1.4		0.075	-26		-36	
IR-11	621	Existing	3.7	6 - 8	0.54	-13	18 - 24	-27	-16
		With-Project	4.0		1.25	-11		-24	
IR-13	625	Existing	1.0	1 - 2	0.14	-33	2 - 6	-44	-30
		With-Project	1.3		0.14	-32		-43	
IR-14	625	Existing	0.6	1 - 2	0.14	-25	2 - 6	-36	-30
		With-Project	0.8		0.14	-24		-36	
IR-15	411	Existing	0.0	0 - 1	0.09	-37	0 - 2	-50	-46
		With-Project	0.0		0.07	-37		-50	
IR-16	411	Existing	0.5	0 - 1	0.06	-28	0 - 2	-38	-46
		With-Project	0.7		0.07	-27		-37	
IR-17	625	Existing	1.0	1 - 2	0.14	-27	2 - 6	-36	-30
		With-Project	2.5		0.19	-24		-33	
IR-18	411	Existing	0.1	0 - 1	0.11	-31	0 - 2	-41	-46

						Water Table Depths From Soil Surface			
Location ID*	FLUCCS ID	Hydrologic Condition	Simulation Hydroperiod (months)	Duever Hydroperiod (months)	Simulation Hydroperiod Average Water Depth Above Surface (Inches)	Average Simulated Wet Season Water Depth (inches)	Duever Average Wet Season Water Depth (inches)	Dry Season Average Water Table depth (inches)	Duever Average Dry Season Depth (inches)
		With-Project	0.1		0.09	-29		-38	
IR-19	411	Existing	0.0	0 - 1	0.03 (one value)	-41	0 - 2	-49	-46
		With-Project	0.0		0.03 (one value)	-39		-48	
IR-20	411	Existing	0.1	0 - 1	0.15	-29	0 - 2	-37	-46
		With-Project	0.4		0.11	-26		-34	
IR-21	625	Existing	0.0	1 - 2	0.03 (one value)	-42	2 - 6	-55	-30
		With-Project	0.0		0.03 (one value)	-42		-55	
IR-12**	fallow cropland	Existing	1.7	na	0.45	-24	na	-37	na
		With-Project	2.8		0.6	-22		-35	

* See Figure

** Duever (2004) did not provide average hydrologic values for this FLUCCS code.

Stage-Duration curves of existing and with project hydrologic simulations included:

- 10 locations within Pine Flatwood
- 5 locations within Hydric Pine
- 4 locations within Cypress Pine Cabbage Palm
- 1 location within cypress
- 1 one location in fallow cropland (just north of the 6L's area)

The hydrologic simulation data for each curve was extracted from a single simulation model cell within the vegetation community type shown in the figure.

Existing and with-Project stage duration curves were compared to Duever (2004) expected hydroperiod and dry season water table elevations at 21 sites in the CWIP project area. Six figures (IR-2, IR-3, IR-8, IR-10, IR-13, and IR-15) include simulated effects of the Everglades PSRP project to the east of the CWIP in addition to the existing and with project condition simulation results.

Pine Flatwoods (FLUCCS 411)

Pine flatwood is a mesic upland community that has the greatest potential as high-quality RCW habitat. With one exception, (IR-6) the existing and with project conditions were very similar. At IR -6, hydroperiod increased, but with very shallow water depths. Dry season water table elevations did not change significantly.

Hydric Pine (FLUCCS 625)

The Hydric Pine community is slightly lower in the landscape than Pine Flatwood, but simulations comparisons revealed very little difference between scenarios

Cypress-Pine- Cabbage Palm (C-P-CP; FLUCCS 624)

Duever (Personal Communication) recommended using Hydric Pine hydrology to asses project changes for the C-P-CP community, as he did not report hydrologic measures for this community in Duever (2004). Site IR-2 was reflective of more typical hydrologic conditions for C-P-CP in the larger project area: both scenarios exceeded Hydric Pine hydroperiod targets. With project the locations showed a higher dry-season water table elevation, although still not greatly exceeding the hydric pine average dry season water table. Other C-P-CP locations had similar dry season water table elevations but shorter, shallower hydroperiods. Note that locations considered in the stage duration curves were identified to consider potential effects on RCW habitat. Hydrologic simulation results for large patches of C-P-CP within the CWIP identified hydrologic conditions more like Cypress than Hydric Pine in several locations. A more complete comparison considering Cypress hydrology as well as Hydric Pine is provided elsewhere

Cypress (FLUCCS 621)

A single Cypress location was assessed and found to be drier than expected in both existing and with project scenarios.

Fallow Cropland (FLUCCS 281)

The site falls within the hydric pine hydrologic indicator ranges.

Table 7. Summary of Stage-Duration Curve Existing and With Project Comparisons for hydroperiod and dry season water table elevations

Station ID	FLUCCS code	FLUCCS Name	Hydroperiod Change with Project	Dry season water table elevation Change with Project
IR-1	411	Pine Flatwood	No difference between existing and with-project hydroperiods of a few days / year	Existing conditions fall below Duever target 5 months per year. With-project decreases elevations below Duever target to 3.2 months / year)
IR-2*	624	Cypress-Pine-Cabbage Palm	All conditions exceed Duever C-P-CP hydroperiod existing condition by about 2.5 months. With-project-with-PSRP extends hydroperiod to about 3.5 months	Scenarios range within one month. Existing conditions: 6.5 months/year below Duever target. With-project-with-PSRP conditions below Duever elevation 5.5 months / year
IR-3*	411	Pine Flatwood	Existing and with-project within Duever hydroperiod range (0-1 month)	Scenarios differ by as much as one month. Existing condition elevations below Duever target 6 months per year. With-project-with-PSRP conditions below Duever elevation 5 months / year
IR-4	411	Pine Flatwood	Slight difference between existing and with-project hydroperiods of a few days/yr.	Existing and with-project elevations below Duever dry-season elevations for 4 and 3.5 months/yr.
IR-5	625	Hydric Pine	All scenarios fall within Duever ranges	Existing and With-Project dry-season elevations below Duever target for 7.5 and 7 months / year
IR-6	411	Pine Flatwood	Existing condition 2.5 months/ yr. With-project increases hydroperiod to about 3 months.	No difference between existing and with-project conditions - 2.5 months / yr. below Duever dry-season elevation estimate
IR-7	624	Cypress-Pine-Cabbage Palm	Existing and with-project conditions exceed Duever range. Existing condition 3.5 months/yr.; with-project almost 5 months/yr.	Existing elevations deeper than Duever estimate 2 months per year. With-project elevations are deeper 1.5 months /yr.
IR-8*[1]	624	Cypress-Pine-Cabbage Palm	All scenarios within Duever ranges. Very little difference among scenarios.	All scenarios almost identical; deeper than Duever elevation about 7 months / year
IR-9	411	Pine Flatwood	Minimal change; both scenarios within Deuver hydroperiod range (0-1 month/yr)	Existing and with-project elevations differ by about ½ month; 4 and 3.5 months below Duever dry-season elevation estimate.

Station ID	FLUCCS code	FLUCCS Name	Hydroperiod Change with Project	Dry season water table elevation Change with Project
IR-10*[1]	624	Cypress-Pine-Cabbage Palm	Scenarios almost identical; about 1.5 months/yr	Scenarios almost identical; deeper than Deuver dry-season elevation 7 – 6 months / yr.
IR-11	621	Cypress	Existing condition hydroperiod 7.5 months. With-project increased 0.5 months. Both well below Duever hydroperiod range	Both scenarios have water tables lower than Duever dry season average about 8 months / year in
IR-12	261	Fallow Cropland	Existing hydroperiod 2 months With-project hydroperiod extended to 3 months/yr. both scenarios are within hydric pine hydroperiod range	Existing and with-project elevations below Duever estimate differ by ½ month: Dry-season water table lower than -30 inches is 7 months; with-project 6.5 months
IR-13*	625	Hydric Pine	Scenarios hydroperiods range 1-1.5 months/yr: at lower end of Duever hydric pine estimate	Dry-season elevations very similar; Water table lower than Duever dry season estimate for about 8 months/yr in existing and 7.5 months/yr in with-project conditions.
IR-14	625	Hydric Pine	Both scenarios have hydroperiods about 1 month/yr: the Duever minimum hydric pine hydroperiod	Scenarios identical: Water table lower than Duever value 6.5 months/yr.
IR-15*	411	Pine Flatwood	All scenarios have hydroperiod a few days per year or less.	Existing condition dry season elevations deeper than Duever average about 5.5 months/yr. Wit- project-with-PSRP project elevations below Duever about 4 months / year.
IR-16	411	Pine Flatwood	Little difference between scenarios with hydroperiods 1 month/yr or less.	Very little difference between scenarios: Existing condition 4.5 months lower than Duever elevation. With-project 4 months
IR-17	625	Hydric Pine	One-month existing condition hydroperiod (minimum Duever hydroperiod); with-project hydroperiod nearly 3 months/yr, 1 month longer than Duever max hydroperiod.	Existing condition dry season elevations deeper than Duever average 6.5 months/yr. With-project causes a 1-month decrease (to 5.5 months) in elevations deeper than Duever average

Station ID	FLUCCS code	FLUCCS Name	Hydroperiod Change with Project	Dry season water table elevation Change with Project
IR-18	411	Pine Flatwood	Scenarios very similar with flooded conditions a few days/ yr.	Existing condition elevations deeper than Duever dry-season average 5 months/yr. With project elevations deeper 2 months/yr.
IR-19	411	Pine Flatwood	No change - hydroperiod 1 day or less /yr.	Existing condition 5.5 months/ yr below Duever dry-season average. With-project 4 months per year below Duever target elevation.
IR-20	411	Pine Flatwood	Both existing and with-project hydroperiods less than 1/2 month/year	Existing condition elevation below Duever dry season average about 3.5 months/yr; with-project condition decreases to about 2.5 months/yr.
IR-21	411	Hydric Pine	No difference between existing and with project conditions: zero-day hydroperiods	No difference between existing and with project conditions: about 6.5 months/yr. deeper than Duever target elevation

*indicates that the curves in the figure include the existing condition, the with-project condition, the existing condition with the PSPR, and with project / with PSRP

[1]Location outside the CWIP to the east (within the Everglades PSRP)

Monitoring and Adaptive Management Plans

Monitoring Plan

Collier County has defined a monitoring plan, installed a monitoring system, and is currently collecting background information from that system.

The basic monitoring system is described in **Permit Application Attachment 2: Project Overview** and related appendices and shown in **Figure 11**. Sixty shallow wells were installed to a target depth of approximately four (4) feet below grade surface or until refusal occurred. Hobo MX2001 water level loggers were installed to record water depths at four (4) hour intervals and is downloaded quarterly. Water quality data is collected during each download event at 20 of the wells (**Figure 11**)**.** At each well location, beginning with well installation in the late spring and summer of 2019, transect and plot vegetation data, along with site photographs are recorded annually. The vegetation sampling plan includes groundcover, mid-story, and canopy species measurements to allow understanding of both short-term and long-term vegetation community responses and allow consideration of conditions important to key plant and animal species. The pre-construction data collection period will provide the baseline information that will allow validation of the hydrologic simulation model and if appropriate modification of the model parameters to best simulate the existing conditions. During project operation, the collected data will support validation of the model (with modifications if appropriate) and allow adaptive management to provide the long-term best project execution of the project.

While the hydrologic response is rapid, the vegetation response will occur over a period of years. The baseline and operation period annual data will be compared for change beginning after a full year of operation and collection of the first annual operating period vegetation data.

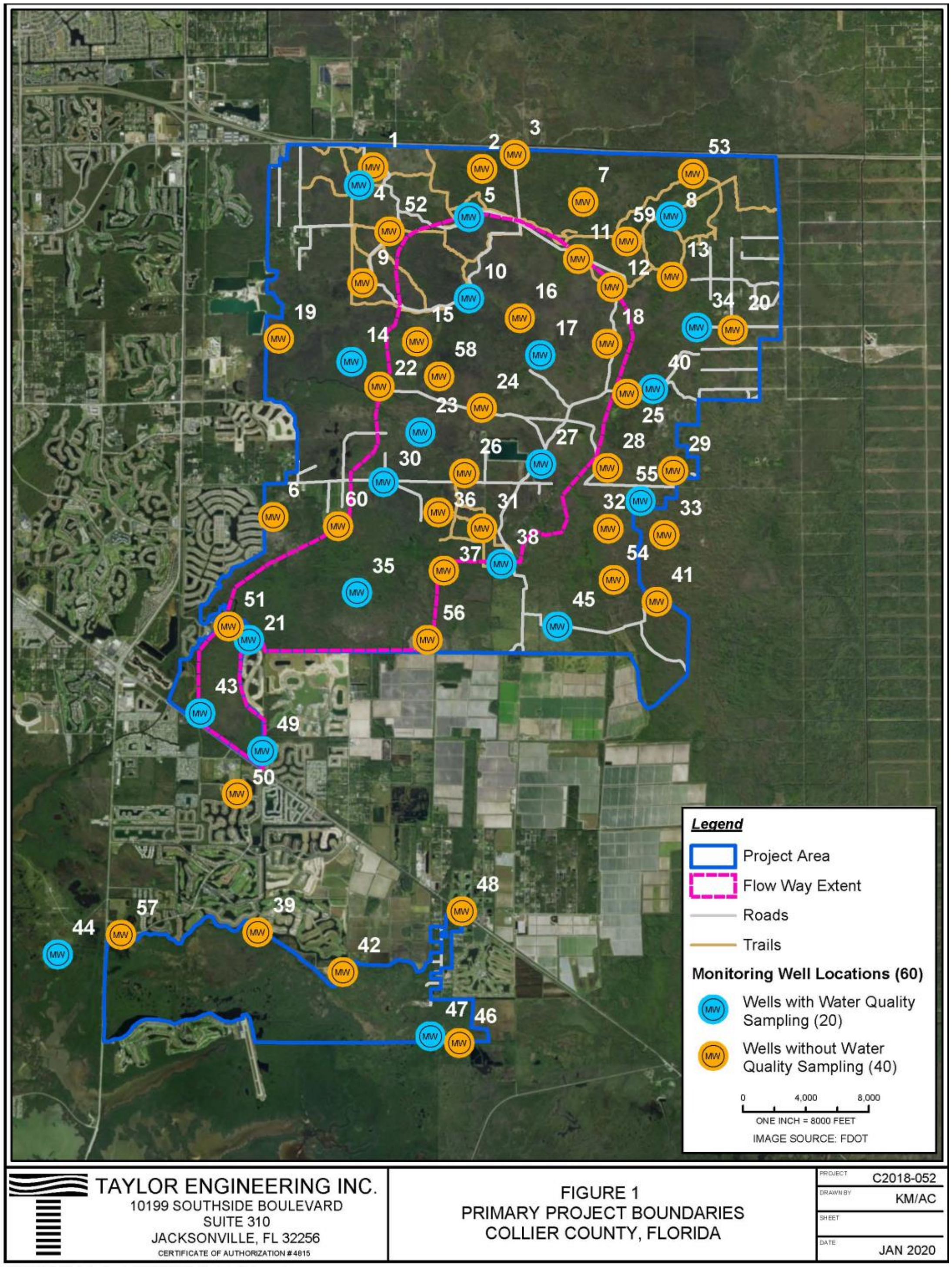


Figure 11. CWIP Hydrologic, Water Quality, and Vegetation Monitoring Stations

Adaptive Management Plan

Introduction

The CWIP project has the goals of enhancing hydrologic conditions in the PSSF project area and decreasing freshwater flows to Naples Bay, without creating significant environmental impacts. The operational plan for withdrawing water from Golden Gate Canal and discharging it into the PSSF provides the basis to achieve the project goals. However, the operational plans are based on model results; once the project begins operating and data from the monitoring system are collected and analyzed, those plans can be adjusted to refine the operations to better meet the goals. This approach is the heart of the adaptive management plan for the CWIP.

For the CWIP, adaptive management intends to improve project operations to better meet project goals: to improve habitats in general (Picayune Strand State Forest, Naples Bay, and Rookery Bay wetlands) and habitat for listed and managed species, to protect and enhance human activity (e.g., recreation in the state forest), and to protect existing infrastructure. While led by Collier County, other project stakeholders, with key roles in conceiving, developing, and implementing the project have a significant role in the adaptive management process. Those stakeholders include at least the following: Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, Florida Forestry Service, Rookery Bay National Estuarine Research Reserve, South Florida Water Management District, US Fish and Wildlife Service, and United States Army Corps of Engineers, and the citizens of the state of Florida.

Short Term and Long-Term Adaptive Management Plan

Collier County has divided the adaptive management process into short-term and long-term actions. Using the monitoring data, Collier County will alter short-term and long-term operational plans to enhance the project performance. The current plans, based on hydrologic simulations, identify pump activation and pumping rates based on GGC flow rates. The plans also call for shutting down the pumps when high rainfall is forecast or high water levels in the CWIP effect area are observed that may result in negative impacts to infrastructure (see **Permit Application Attachment 13 Operational & Management Plans** and a summary description in **Permit Application Attachment 2 Project Overview**). The monitoring data will allow evaluation of the performance the project using the GGC flow values and allow the county to identify changes to those plans to maintain or enhance target hydrologic conditions without impacting development (roads, houses, private property, etc.). It may be possible to assess the effects of short-term operations as soon as one full quarter of data collection after the operational events occur. This will mainly involve storm-associated shutdown values; longer term datasets (at least a year period) will be necessary to begin to assess overall project performance and identify any long-term pumping changes.

The current plans will be provisionally revised as the environmental data that reflect the results of the operational plans are analyzed. Some decisions may be made quickly, for instance if the storm-related pump shutdown is assessed to have been planned to occur too close to the expected event. Longer-term, as annual operational data become available, Collier County will be able to assess and adjust the seasonal operations.

As soon as sufficient data are available to assess the effects of short-term events (e.g. hurricanes or droughts) Collier County will assess whether the operational plan was appropriate and effective. As necessary, the county will identify necessary changes in the operation plans for better project performance and inform the project stakeholders of any recommended changes. As necessary, the county will hold workshops to present the data and change recommendations.

Once the project begins operating, Collier County will hold an annual Adaptive management Plan Review with key stakeholders to present analysis of project performance and obtain consensus for significant changes to the operational plans. The county will release an annual project report and hold annual technical workshops to present the prior year project performance, compare of predicted and actual project performance, and obtain consensus on desirable changes to the operational plan.

Red-Cockaded Woodpecker Habitat Adaptive Management Plan Component

The Red-Cockaded Woodpecker (RCW) population in the project area is a very important natural resource to which the project cannot cause adverse impacts. Benefits to the population by improving the habitat of that species is not a project goal but would certainly be appreciated by the county and all the project stakeholders. Beneficial vegetation changes would probably not be measurable for a number of years. However, hydrologic data can provide evidence of impact avoidance on an annual basis. Therefore, annual evaluation of hydroperiod and water elevation data and vegetation transect data from each well location will provide a basis for assessment of project performance and allow development of recommendations to ensure continued avoidance of impacts to RCW. Changes to the monitoring plans based on the monitoring RCW area hydrologic monitoring results will be considered annually. The expert RCW stakeholders (Florida Forestry Service, Florida Fish and Wildlife Conservation Commission, and the US Fish and Wildlife Service) will form a subgroup focused on project performance considering the RCW. The analysis results may also support the goals and objectives of the agencies responsible for RCW recovery.

Adaptive Management Plan Summary

The Collier County CWIP Adaptive Management Plan includes the following components

- Intensive hydrologic, water quality, and vegetation community data collection and analysis.
- Ongoing review and analysis as needed to assess the performance of key short-term operational and identify immediately necessary plan changes.
- Annual assessment of project performance compared to predicted performance, project objectives, and project goals.
- Based on short-term and long-term performance, adjustment of the operation plans to provide best possible project performance.
- Ongoing informal and annual formal coordination with key stakeholders to maintain their understanding of the project performance and consensus for necessary and beneficial changes to project operations.
- The annual project performance evaluation will include a separate evaluation focus on the Red Cockaded Woodpecker habitat hydrology, based on the baseline RCW habitat hydrology assessment provided as part of the project permit package. A stakeholder expert group will work with Collier County on this evaluation and any recommendations for changes to better ensure RCW habitat impact avoidance.

Summary

The combined analyses strongly suggest the proposed CWIP project will not negatively impact RCW habitat. Slightly wetter hydrologic conditions may in fact benefit the area, at least to the extent that it may help reduce the frequency and intensity of wildfires. Collier County has developed an intensive monitoring program now collecting baseline data and has an adaptive management plan to consult and coordinate with the agency stakeholders to ensure that the project is operated to enhance the Picayune Strand State Forest and avoid impacts to the RCW.

References

Duever, Michael. 2004. Southwest Florida Pre-Development Vegetation Map. Appendix B in: Zahina John G., Winifred Park Said, Rachelle Grein and Michael Duever 2007. Pre-Development Vegetation Communities of Southern Florida. Technical Publication HESM-02. South Florida Water Management District, West Palm Beach FL. June 2007.

Duever, 2019. Personal Communication May 2019.

Garabedian, James Edward. 2017. Population-density Mediated Resource Partitioning by Foraging Red-cockaded Woodpeckers. A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy Fisheries, Wildlife, and Conservation Biology. Raleigh, North Carolina. Accessed December 2019 at: https://repository.lib.ncsu.edu/bitstream/handle/1840.20/33645/etd.pdf?sequence=1

Jackson, J.A. 1994. Red-cockaded Woodpecker. Pages 1–20 in A. Poole and F.B. Gill, eds. The Birds of North America, no. 85. The Academy of Natural Sciences, Philadelphia; The American Ornithologists' Union, Washington, D.C.

USFWS (U.S. Fish and Wildlife Service). 2003. Red-cockaded woodpecker (*Picoides borealis*) recovery plan: second revision. Atlanta, Georgia: U.S. Department of Interior, Fish and Wildlife Service. Accessed December 2019 at: https://catalog.data.gov/dataset/2003-recovery-plan-for-the-red-cockaded-woodpecker-picoides-borealis-second-revision

USFWS 2004 South Florida Ecological Services Office 1 DRAFT July 12, 2004 Species Conservation Guidelines South Florida Red-cockaded Woodpecker. https://www.fws.gov/verobeach/BirdsPDFs/200407SlopesCompleteRedCockadedWoodpecker.pdf

Sub-Appendix 1.

Definition of Vegetation Community Shapefiles

Florida Land Use/Cover Classification System - Florida Natural Areas Inventory Crosswalk

Vegetation Community Shapefile Creation and Data Summary

Definition of Vegetation Community Shapefiles

The 10-year hydrologic simulation results used in this assessment were the product of a combined surface groundwater continuous simulation model. The model used a 375 ft x 375 ft (3.23 acre) grid as the basis for reporting simulation results. Each grid cell produced one simulation value for each day of the simulation period. Daily grid cell results for SFWMD-defined wet season (DATE _ DATE) and dry season (DATE _ DATE), and hydroperiod (days when the water level was above the ground surface for the cell) were averaged over the 10 year simulation period to provide the data for the analysis.

A shapefile depicting the vegetation communities within the project area was created by merging the most recently created Picayune Strand State Forest (PSSF) Florida Natural Areas Inventory (FNAI) shapefile provided by the Florida Forest Service (FFS 2018), the South Florida Water Management District (SFWMD) Land Cover Land Use 2014 – 2016 shapefile (SFWMD 2018), and FLUCCS vegetation communities delineated within outparcels of the PSSF using aerial imagery and vegetation community signatures and polygon definitions from defined polygons on outparcel boundaries.

The PSSF FNAI shapefile defines vegetation communities only within the boundaries of the PSSF and as such does not include any information for the private outparcels within the forest bounds (**Figure 1**). These outparcels range in size from 0.25 acres to 525 acres. In order to create a seamless shapefile for the project area, the communities within these boundaries were delineated within ESRI's ArcMap® version 10.5.1 (ESRI 2016) using 2018 aerial imagery for Collier County provided through the Florida Department of Transportation (FDOT) Aerial Photo LookUp System (FDOT 2018). The vegetation communities within the outparcels were attributed using the FNAI classification scheme (FNAI 2010), tied into the PSSF FNAI shapefile, and attributed using the FNAI classification scheme. The data were clipped to the project area. The PSSF vegetation communities were tied into the SFWMD Land Cover 2016 shapefile (**Figure 3**). However, as the vegetation communities within the SFWMD shapefile were attributed using the Florida Land Cover Classification System (FLUCCS) (FLUCCS 2018) rather than FNAI, a crosswalk was used to attribute each of the shapefiles using both FLUCCS and FNAI classification systems. This crosswalk was created using the Habitat Classification and Field Reconnaissance table provided by the Florida Fish and Wildlife Conservation Commission (FWC 2018), adjusted to include all the communities defined within the project area. As the PSSF FNAI data (and subsequently the outparcel data) were delineated at a finer scale than the SFWMD FLUCCS data, the data were merged using the FNAI information. Along the boundaries of the PSSF, vegetation communities were again delineated using the FDOT imagery in order to tie the PSSF FNAI shapefile to the SFWMD shapefile. Once these communities were tied together, a seamless shapefile was created that maintained both the FNAI and FLUCCS information, as well as source information for each of the communities.

For analysis purposes, the FLUCCS-FNAI shapefile created for the project area was dissolved using the FLUCCS information in order to create a shapefile with slightly coarser detail and fewer very small shapefiles. These resulting shapefiles defined the vegetation community used in the analyses.

REFERENCES

FDOT 2018 – Florida Department of Transportation (FDOT), 2018. COL 2018. Flight 6438. Resolution 0.5 ft. Acquired 12/1/2017 - 12/11/2017. Prepared by GIS Office, FDOT, Tallahassee, FL. Obtained September 2018 from https://fdotewp1.dot.state.fl.us/AerialPhotoLookUpSystem/.

FLUCCS 2018 – Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Florida Land Cover Classification System*. Prepared by Robert Kawula & Jennylyn Redner, Center for Spatial Analysis, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

FNAI 2010 – Florida Natural Areas Inventory (FNAI), 2010. *Guide to the natural communities of Florida: 2010 edition*. Florida Natural Areas Inventory, Tallahassee, FL.

FWC 2018– Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Habitat Classification and Field Reconnaissance*. Prepared by Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Accessed September 2018 at: http://fwcg.myfwc.com/index_files/textonly/slide12.html

Florida Land Use/Cover Classification System - Florida Natural Areas Inventory Crosswalk

The Collier County Comprehensive Watershed Improvement Plan (CWIP) project area had vegetation community GIS information available in two different formats. As the vegetation communities within the existing shapefiles were attributed using two different classification systems, a crosswalk was used to attribute each of the shapefiles using both FLUCCS (Florida Land Use Cover Classification System) and FNAI (Florida Natural Areas Inventory) classification systems. The FLUCCS, developed by the Florida Fish and Wildlife Conservation Commission (FWC), incorporated classifications currently used by the Florida Fish and Wildlife Conservation Commission (FWC), Florida Natural Areas Inventory (FNAI), and Florida's water management districts (WMD) (FLUCCS 2018). It includes all categories of land use, including, but not limited to natural communities. The FNAI Classification System was developed by the Florida Natural Areas Inventory (FNAI) and categorizes the original, natural biological associations of Florida (FNAI 2010). A Natural Community is defined as a distinct and recurring assemblage of populations of plants, animals, fungi, and microorganisms naturally associated with each other and their physical environment (FNAI 2010). The crosswalk used for the majority of the communities in this project area (**Table 1**) was created using the Habitat Classification and Field Reconnaissance table provided by the Florida Fish and Wildlife Conservation Commission (FWC 2018), adjusted to include all of the communities defined within the project area. As the FNAI delineates vegetation communities in finer detail than FLUCCS, we found it necessary to create an additional crosswalk (**Table 2**) to use on case-by-case basis for certain community types in an effort to maintain more FNAI dataset detail for dominant FLUCCS codes in the project area.

REFERENCES

FNAI 2010 – Florida Natural Areas Inventory (FNAI), 2010. *Guide to the natural communities of Florida: 2010 edition*. Florida Natural Areas Inventory, Tallahassee, FL.

FLUCCS 2018 – Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Florida Land Cover Classification System*. Prepared by Robert Kawula & Jennylyn Redner, Center for Spatial Analysis, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

FWC 2018– Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Habitat Classification and Field Reconnaissance*. Prepared by Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Accessed September 2018 at: http://fwcg.myfwc.com/index_files/textonly/slide12.html

Table 1: Standard FLUCCS – FNAI Crosswalk

FLUCCS Code	FLUCCS Name	FNAI
1180	Rural Residential	Developed
1210	Fixed Single-Family Units	Developed
1290	Medium Density Under Construction	Developed
1320	Mobile Home Units	Developed
1330	Multiple Dwelling Units, Low Rise	Developed
1390	High Density Under Construction	Developed
1400	Commercial & Services	Developed
1700	Institutional	Developed
1900	Open Land	Clearing
2230	Other Groves	Agriculture
2230	Other Groves	Agriculture
2610	Fallow Cropland	Abandoned Field/Abandoned Pasture
2610	Fallow Cropland	Abandoned Field/Abandoned Pasture
3100	Herbaceous (Dry Prairie)	Dry Prairie
3200	Upland Shrub and Brushland	Dry Prairie
3210	Palmetto Prairies	Dry Prairie
4110	Pine Flatwoods	Mesic Flatwoods
4340	Upland Mixed Coniferous/Hardwood	Upland Mixed Coniferous Hardwood
5120	Channelized Waterways, Canals	Canal/Ditch
5300	Reservoirs	Artificial Pond
5300	Reservoirs	Inland Ponds and Sloughs
5300	Reservoirs	Swamp Lake
6120	Mangrove Swamp	Mangrove Swamp
6170	Mixed Wetland Hardwoods	Hydric Hammock
6191	Wet Melaleuca	Invasive Exotic Monoculture
6200	Wetland Coniferous Forests	Wet Flatwoods
6215	Cypress- Domes/Heads	Dome Swamp
6216	Cypress - Mixed Hardwoods	Strand Swamp
6250	Wet Pineland Hydric Pine	Wet Flatwoods
6300	Wetland Forested Mixed	Floodplain Swamp
6300	Wetland Forested Mixed	Mesic Hammock
6410	Freshwater Marshes / Graminoid Prairie - Marsh	Marl Prairie
6410	Freshwater/Graminoid Prairie – Marsh	Wet Prairie
6420	Saltwater Marshes / Halophytic Herbaceous Prairie	Salt Marsh
7400	Disturbed Land (Except Artificial Ponds and Roads)	Clearing
7400	Disturbed Land	Spoil Area
7400	Disturbed Land	Clearing
8140	Roads and Highways	Road

Table 2: Alternate FLUCCS – FNAI Crosswalk

FNAI	FNAI Subtype	FLUCCS Code	FLUCCS Name
Wet Flatwoods	Mixed Cypress/Pine/Palm	6240	Cypress-Pine-Cabbage Palm
	NOT Mixed Cypress/Pine/Palm	6172	Wet Pinelands Hydric Pine
Hydric Hammock	Wet Flatwoods	6250	Wet Pinelands Hydric Pine
	NOT Wet Flatwoods	6172	Mixed Shrubs
Dome Swamp	Palm	6240	Cypress - Pine - Cabbage Palm
	NOT Palm	6210	Cypress
Wet Prairie	Mixed Cypress/Pine/Palm	6240	Cypress-Pine-Cabbage Palm
	NOT Mixed Cypress/Pine/Palm	6430	Wet Prairie
Developed	CASE BY CASE	8140 /1400 / 1180	Roads and Highways / Commercial and Services / Rural Residential

Vegetation Community Shapefile Creation and Data Summary

Vegetation Community Shapefile Creation

Source Data

Table 1: Source Data

Source Data	Reference	Description
Picayune Strand State Forest (PSSF) Florida Natural Areas Inventory (FNAI)	FFS 2018	Florida Forest Service (FFS) Historic Natural Community Mapping Project: This is a polygon file that delineates natural communities on FFS managed lands as identified by FNAI staff during field surveys. Most polygons have associated natural community point data that describes the ecological condition within the polygons.
South Florida Water Management District (SFWMD) Land Cover Land Use 2014 – 2016	SFWMD 2018	This data set serves as documentation of land cover and land use (LCLU) within the South Florida Water Management District as it existed in 2014-16. Land Cover Land Use data was updated from 2008-09 LCLU by photo-interpretation from 2014-16 aerial photography and classified using the SFWMD modified FLUCCS classification system. Features were interpreted from the county-based aerial photography (4 in - 2 ft pixel). The features were updated on screen from the 2008-09 vector data. Horizontal accuracy of the data corresponds to the positional accuracy of the county aerial photography. The minimum mapping unit for classification was 0.5 acres for wetlands and 5 acres for uplands.
Collier County 2018 Aerial Imagery	FDOT 2018	Provided through the Florida Department of Transportation (FDOT) Aerial Photo LookUp System. Flight: 6438. Resolution: 0.5 ft. Acquired: 12/1/2017 - 12/11/2017.

Tools

Table 2: Processing Tools Provided within ESRI's ArcMap (ESRI 2016)

Tool Name	Toolbox	Description
ERASE	Analysis	Creates a feature class by overlaying the Input Features with the polygons of the Erase Features. Only those portions of the input features falling outside the erase features outside boundaries are copied to the output feature class.
CLIP	Analysis	Extracts input features that overlay the clip features.
DISSOLVE	Data Management	Aggregates features based on specified attributes.

Process Steps

1. Using the outline of the PSSF FNAI shapefile, a new shapefile was made containing the areas within the outparcels of the State Forest using the ERASE tool.
2. Using the FDOT 2018 imagery as a reference, vegetation communities were delineated within the outparcels by cutting each outparcel polygon into different shapes depicting the outline of the different vegetation signatures using a CINTIQ® 22HD Interactive Pen Display Tablet (WACOM Technology Corporation). Map scale was set between 1:500 to 1,500.
3. Polygons within the outparcel shapefile were attributed using the FNAI classification system (FNAI 2010) by using the corresponding vegetation signatures within PSSF FNAI shapefiles.
4. The PSSF FNAI shapefile, Outparcel shapefile, and SFWMD shapefile were each clipped to the project boundary using the CLIP tool.
5. The PSSF FNAI shapefile and Outparcel shapefile were erased from the clipped SFWMD shapefile using the ERASE tool.
6. The crosswalk described above was used to attribute each of the shapefiles with the corresponding FLUCCS or FNAI information.
7. Using the FNAI attribute information, the data were merged together. Along the boundaries of the PSSF, vegetation communities were again delineated according the vegetation signatures using the FDOT imagery in order to tie the PSSF FNAI shapefile to the SFWMD shapefile via a CINTIQ® 22HD Interactive Pen Display Tablet (WACOM Technology Corporation).
8. Any new shapes were attributed with both FNAI and FLUCCS information.
9. A seamless shapefile was then created that maintained both the FNAI and FLUCCS information, as well as source information for each of the communities by merging the PSSF FNAI shapefile, Outparcel shapefile, and SFWMD shapefile (including the edits described in step 7).
10. After a single shapefile was created for all the information, the data were aggregated based on FLUCCS Information, FNAI Information, and Source Information using the DISSOLVE tool.
11. Topology was run on the dissolved shapefile to identify any gaps or overlapping data. Any errors identified were fixed. This shapefile (Final_FLUCCS_FNAI) was then uploaded into the Collier Watershed Improvement Plan GIS database for submittal to the County following project completion.
12. For analyses purposes only, an additional shapefile (FLUCCS_Only_ForAnalyses) was created that aggregated the polygons based only on FLUCCS information using the DISSOLVE tool. This was done in order to create a slightly coarser dataset that would be more appropriate for use with the hydrologic data information.

Vegetation Community Data Summary

Project Area

Table 3: FLUCCS Acreages

FLUCCS	Acreage
113/Mixed Units, Fixed and Mobile Home Units	3.36
118/Rural Residential	81.51
121/Fixed Single Family Units	4.27
122/Mobile Home Units	1.30
123/Mixed Units, Fixed and Mobile Home Units	1.20
129/Medium Density Under Construction	3.06
132/Mobile Home Units	0.09
133/Multiple Dwelling Units, Low Rise	2.27
139/High Density Under Construction	36.16
1423/Junk Yards	14.72
162/Sand and Gravel Pits	2.60
182/Golf Course	0.60
190/Open Land	15.40
211/Improved Pastures	0.88
223/Other Groves	143.98
232/Poultry Feeding Operations	14.56
251/Horse Farms	10.44
261/Fallow Cropland	831.21
310/Herbaceous (Dry Prairie)	6.38
320/Upland Shrub and Brushland	16.35
321/Palmetto Prairies	46.44
411/Pine Flatwoods	2619.09
422/Brazilian Pepper	0.92
424/Melaleuca	50.29
434/Upland Mixed Coniferous / Hardwood	45.43
512/Channelized Waterways, Canals	38.49
520/Lakes	4.23
530/Reservoirs	103.31
542/Embayments Not Opening Directly to Gulf or Ocean	153.33
612/Mangrove Swamp	1451.30
617/Mixed Wetland Hardwoods	94.93
6172/Mixed Shrubs	545.94
6191/Wet Melaleuca	99.86
620/Wetland Coniferous Forests	387.07
621/Cypress	7155.85
624/Cypress - Pine - Cabbage Palm	7471.77

FLUCCS	Acreage
625/Wet Pinelands Hydric Pine	2253.52
630/Wetland Forested Mixed	233.52
641/Freshwater Marshes / Graminoid Prairie - Marsh	93.62
642/Saltwater Marshes / Halophytic Herbaceous Prairie	527.75
643/Wet Prairie	101.23
644/Emergent Aquatic Vegetation	4.69
740/Disturbed Land	224.24
811/Airports	0.41
814/Roads and Highways	154.20
834/Sewage Treatment	1.09
TOTAL	25052.88

Table 4: FNAI Acreages

FNAI	Acreage
Abandoned Field/Abandoned Pasture	823.24
Agriculture	159.42
Artificial Pond	103.31
Basin Marsh	79.29
Basin Swamp	68.64
Canal/Ditch	38.49
Clearing	239.64
Developed	163.08
Dome Swamp	674.05
Dry Prairie	54.19
Floodplain Swamp	187.44
Hydric Hammock	492.94
Inland Ponds and Sloughs	153.33
Mangrove Swamp	1451.30
Marl Prairie	98.32
Mesic Flatwoods	2676.79
Mesic Hammock	46.99
Road	162.18
Strand Swamp	6659.41
Swamp Lake	4.23
Tidal Marsh	527.75
Upland Hardwood Forest	45.43
Wet Flatwoods	10042.18
Wet Prairie	101.23
TOTAL	25052.88

Data described in this appendix were created and processed using ArcGIS® software by Esri (Version 10.5.1). ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright© Esri.

References

FDOT 2018 – Florida Department of Transportation (FDOT), 2018. COL 2018. Flight 6438. Resolution 0.5 ft. Acquired 12/1/2017 - 12/11/2017. Prepared by GIS Office, FDOT, Tallahassee, FL. Obtained September 2018 from https://fdotewp1.dot.state.fl.us/AerialPhotoLookUpSystem/.

FFS 2018 – Florida Forest Service, 2018. *Picayune Strand State Forest (PSSF) Historic Natural Community Mapping Project*. Prepared by the Florida Natural Areas Inventory Staff, Tallahassee, FL.

ESRI 2016 – Environmental Systems Research Institute (ESRI), 2016. *ArcGIS. Version 10.5.1.* Environmental Systems Research Institute, Inc., Redlands, CA.

FNAI 2010 – Florida Natural Areas Inventory (FNAI), 2010. *Guide to the natural communities of Florida: 2010 edition*. Florida Natural Areas Inventory, Tallahassee, FL.

FLUCCS 2018 – Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Florida Land Cover Classification System*. Prepared by Robert Kawula & Jennylyn Redner, Center for Spatial Analysis, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

SFWMD 2018 – South Florida Water Management District (SFWMD), 2018. *SFWMD Land Cover Land Use 2014 – 2016.* South Florida Water Management District, West Palm Beach, FL. Obtained November 2018 at: https://geo-sfwmd.hub.arcgis.com/datasets/sfwmd-land-cover-land-use-2014-2016.

Sub-Appendix 2

Calculation of Weighted Average Hydrologic Statistics

<u>Calculation of Weighted Average Hydrologic Statistics</u>

Weighted hydrologic statistic for each shape within a FLUCCS codes:

$$H_{swn} = H_{cn} * (A_w / Ac)$$

$$\text{mean } H_{sw} = (\sum H_{swn})/n$$

Where

- s = a hydrologic statistic - hydroperiod, wet season annual average depth, dry season annual average depth, dry season 1/10-year annual average lowest depth
- H_{swn} = area-weighted cell hydrologic statistic value
- H_{cn}= raster cell hydrologic statistic value
- A_w = area of cell within intersecting veg polygon
- A_c = area of cell

Hydrologic statistic mean for each FLUCCS code:

$$H_{sfi} = (\sum(H_{wnix}) (A_{ix} / \sum A_{ix}))/n_i$$

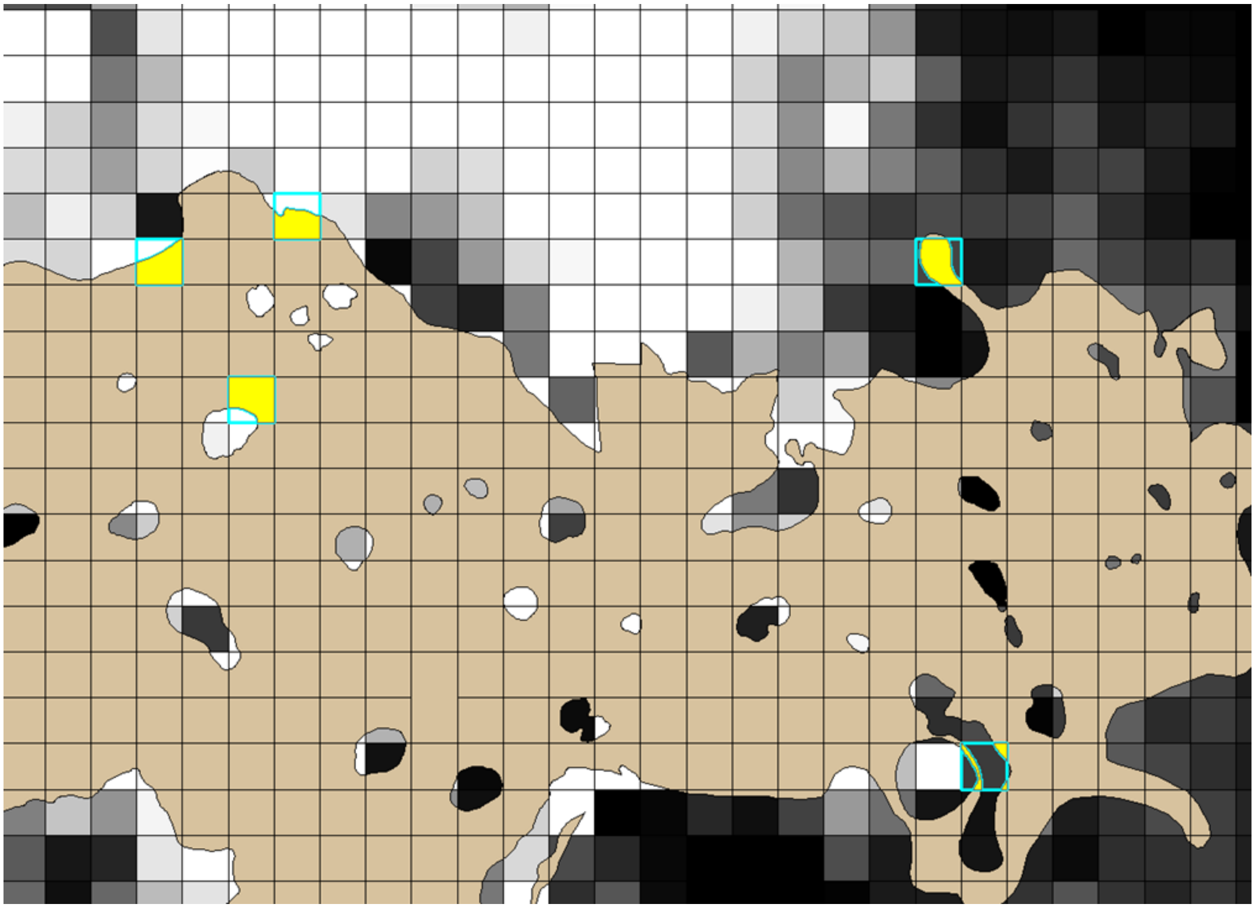
Where:

- H_{sfi} = The hydrologic statistic average value for FLUCCS code i
- s = a hydrologic statistic –
- H_{wnix} = A hydrologic statistic value wn for one shape x of FLUCCS code i
- A_{ix} = area of FLUCCS code i shape x
- n_i = number of shapes for FLUCCS code i

For different multiple polygon areas (e.g. for Red Cockaded Woodpecker core foraging areas - CFA) the same general equations would apply to a calculation of the weighted hydrologic statistics for each FLUCCS shape intersecting a CFA, each FLUCCS code, and CFA mean hydrologic statistics.

<u>Polygon Example (and see Figure below)</u>

- The cell with red borders (full cell) has the average overland depth of 9.0 inches.
- After intersection with cypress polygon, only about 71.9% of the cell falls in the cypress polygon (yellow colored segment). Hence, the area weighted average overland depth for the cypress cell comes out to be 6.5 inches (71.9% of 9.0 inches).
- I have shown some other bordering cells following the same methodology.
- Whereas, the cells that fall 100 % within the cypress polygons will retain the raster values.



Sub-Appendix 3

Stage Duration Curves

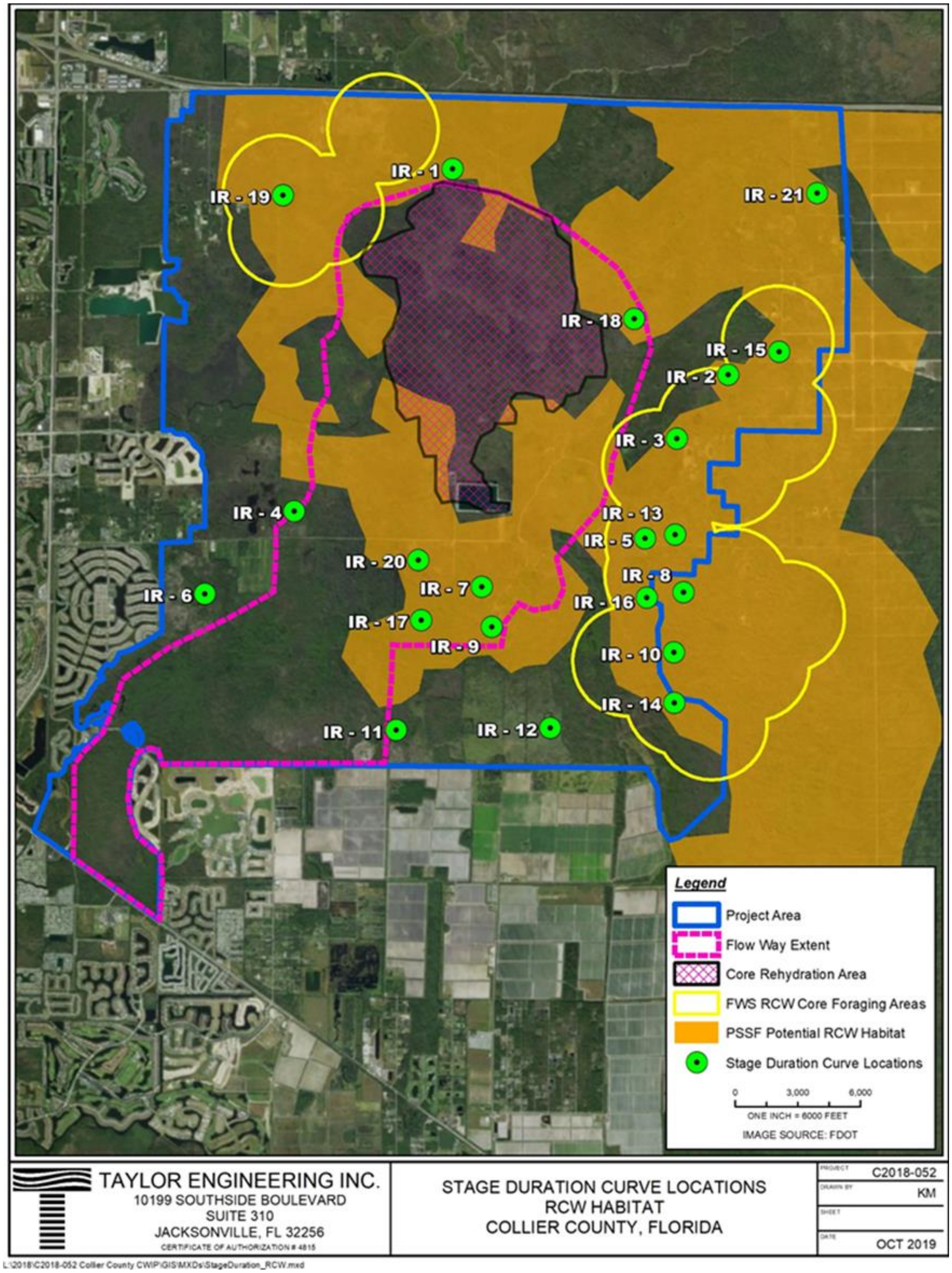
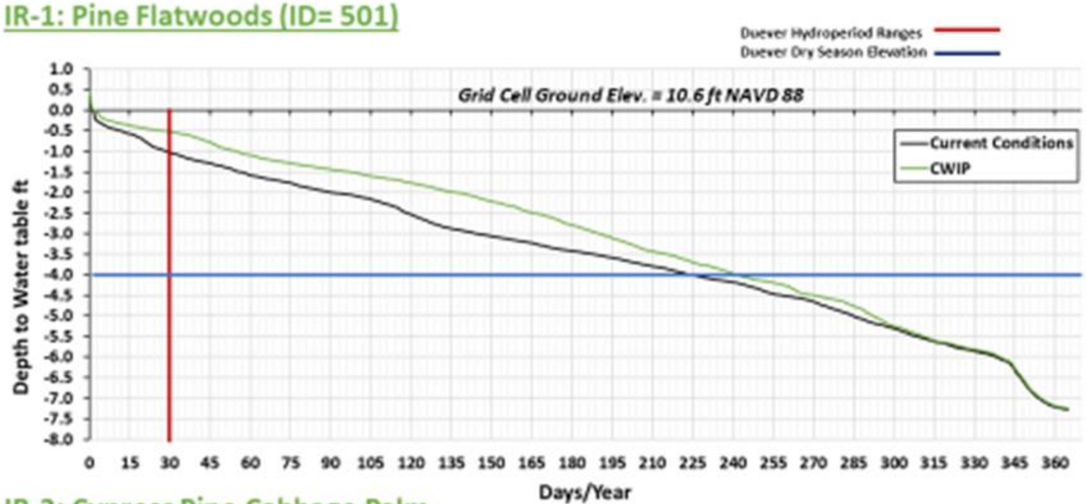


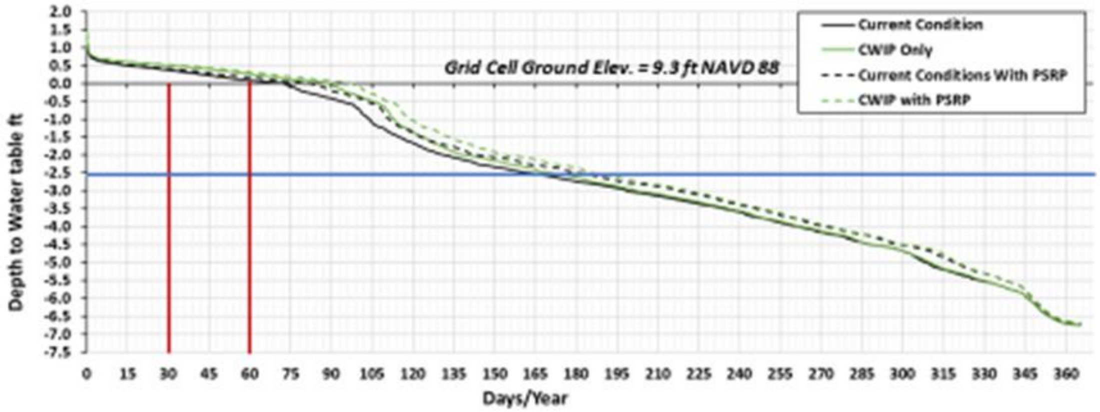
Figure A5-1. Stage Duration Curve Locations and RCW Habitat Areas

Stage-Duration Curves: Current Conditions and CWIP

IR-1: Pine Flatwoods (ID= 501)



IR-2: Cypress Pine Cabbage Palm



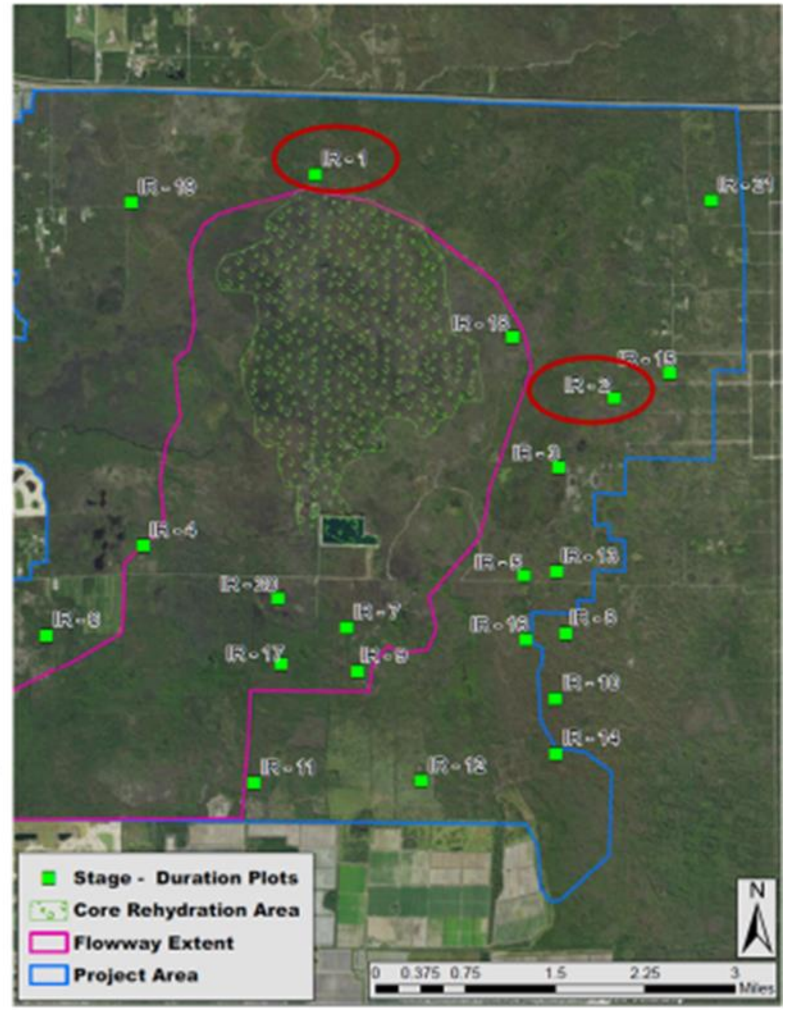
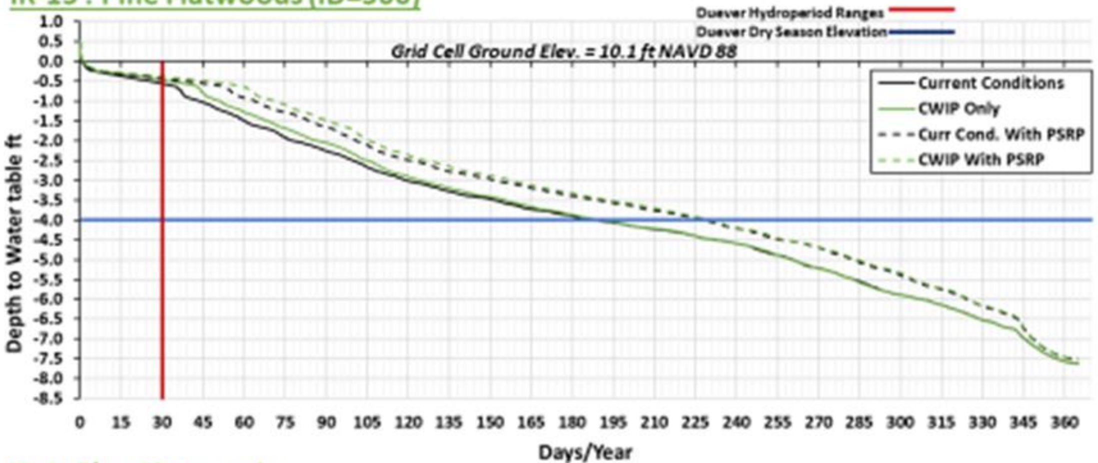


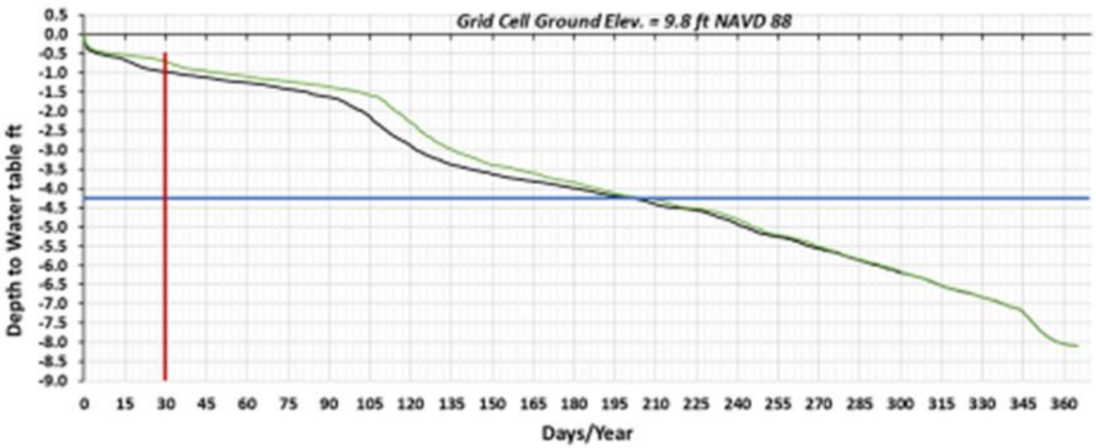
Figure A3-2

Stage-Duration Curves – Current and CWIP Conditions

IR-15 : Pine Flatwoods (ID=500)



IR-3 Pine Flatwoods



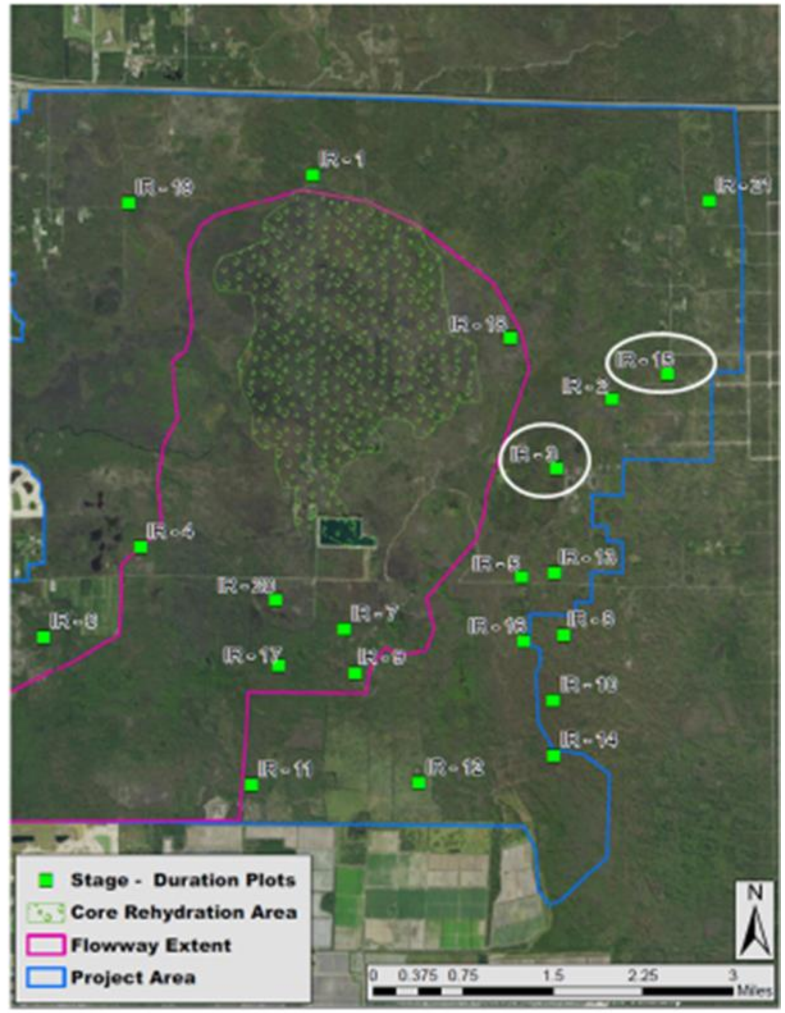
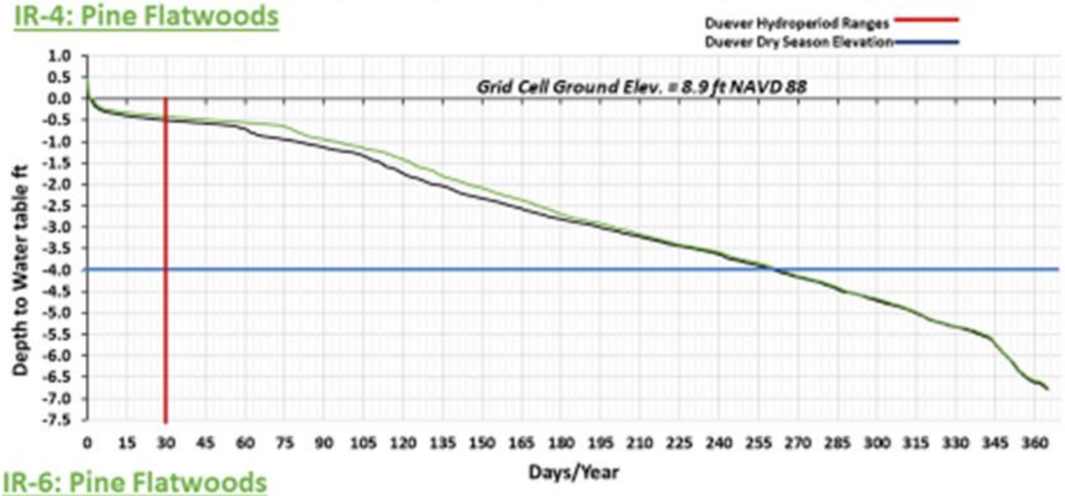


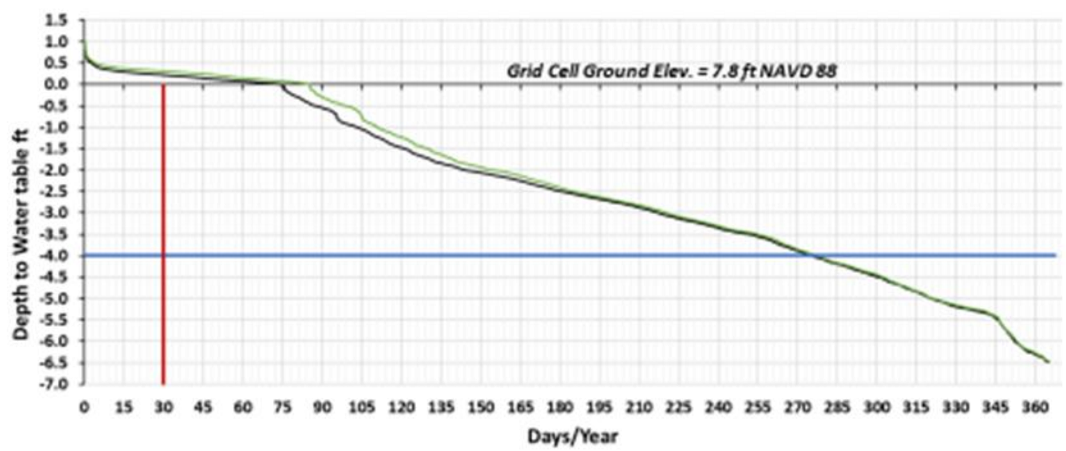
Figure A5-3

Stage-Duration Curves – Current and CWIP Conditions

IR-4: Pine Flatwoods



IR-6: Pine Flatwoods



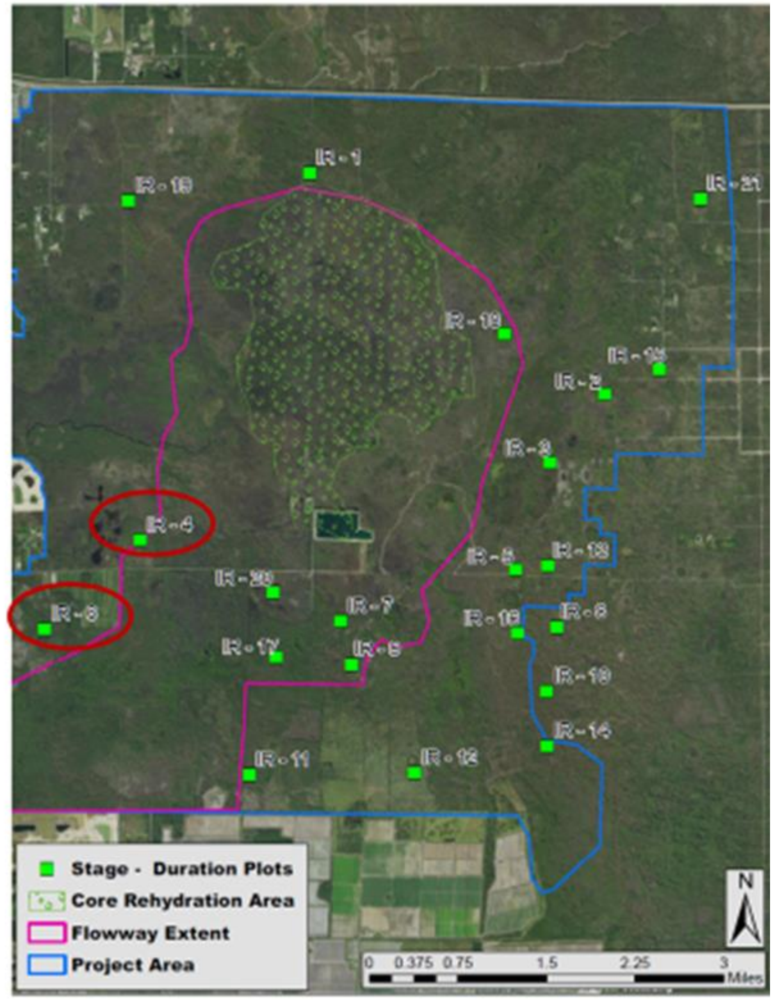
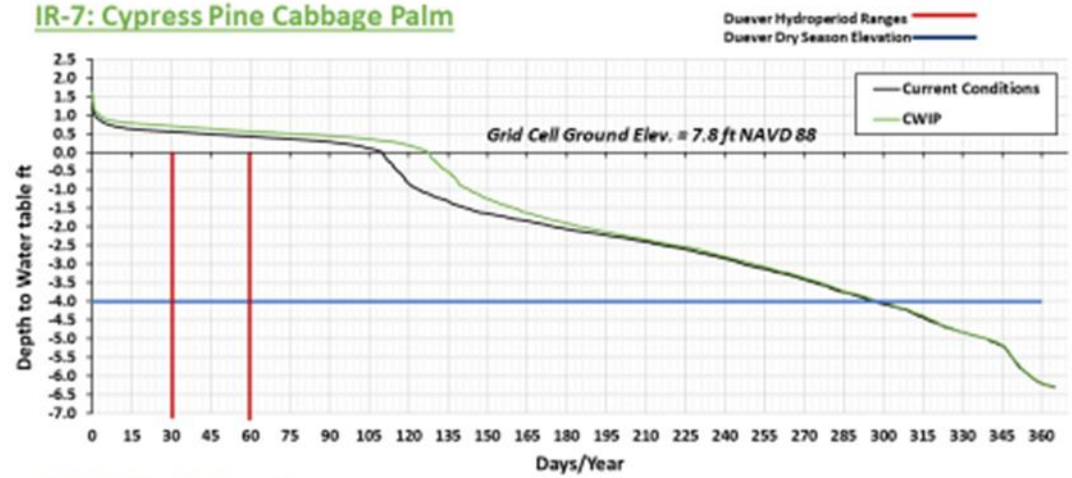


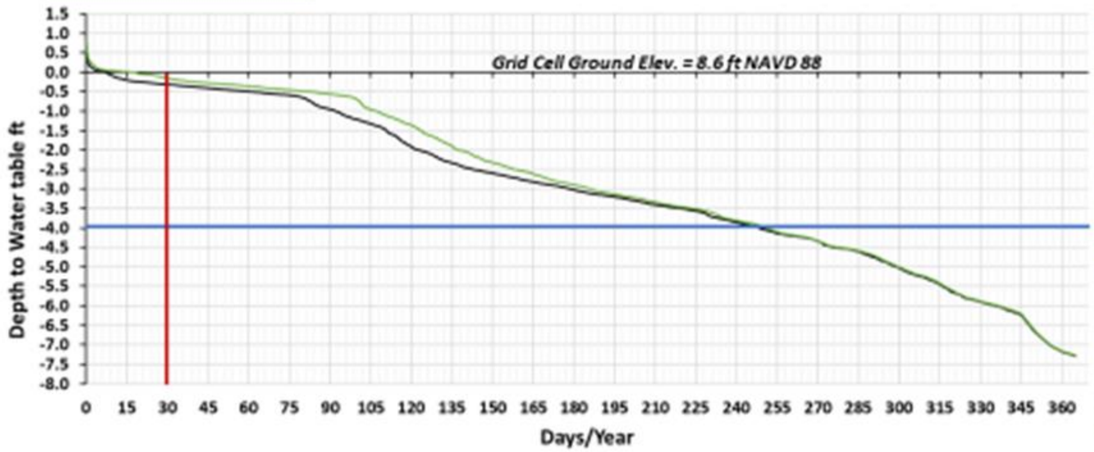
Figure A3-4

Stage Duration Curves – Current Conditions and CWIP

IR-7: Cypress Pine Cabbage Palm



IR-9: Pine Flatwoods



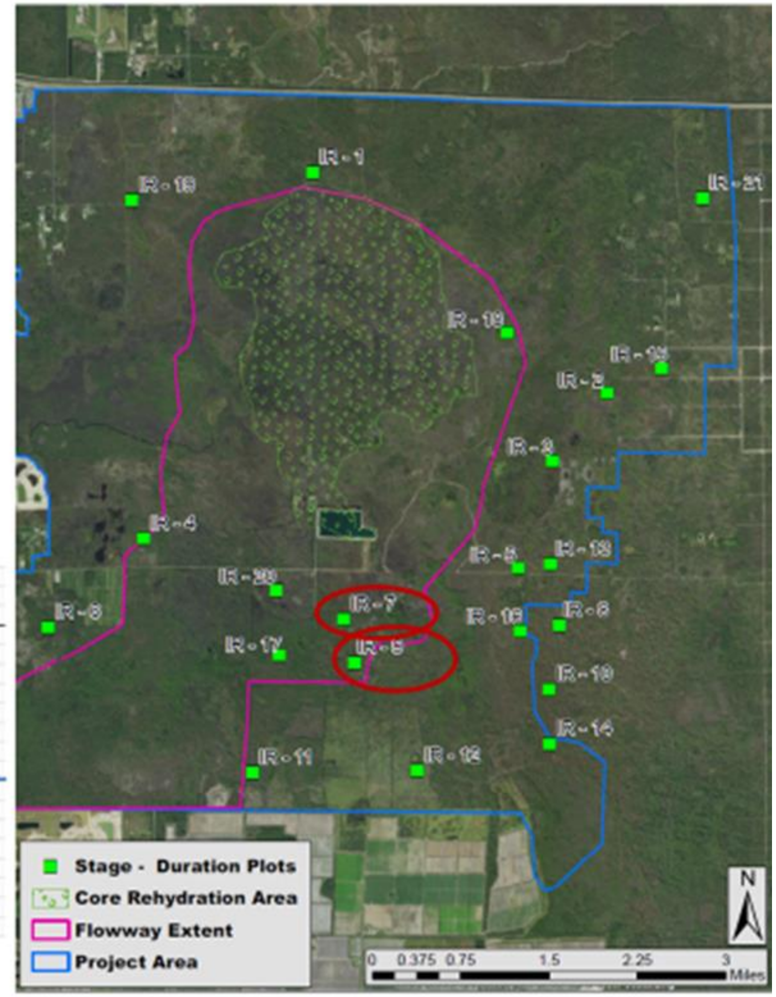
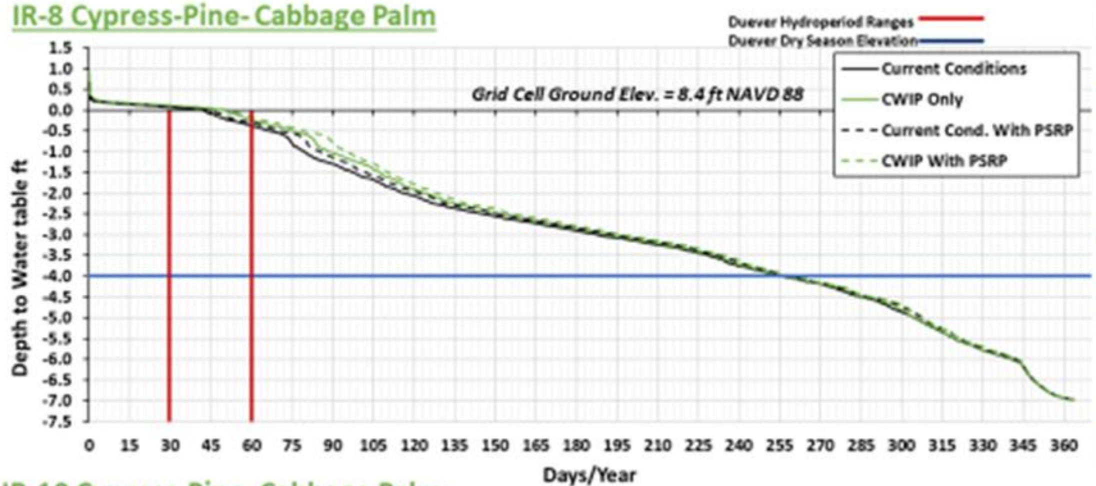


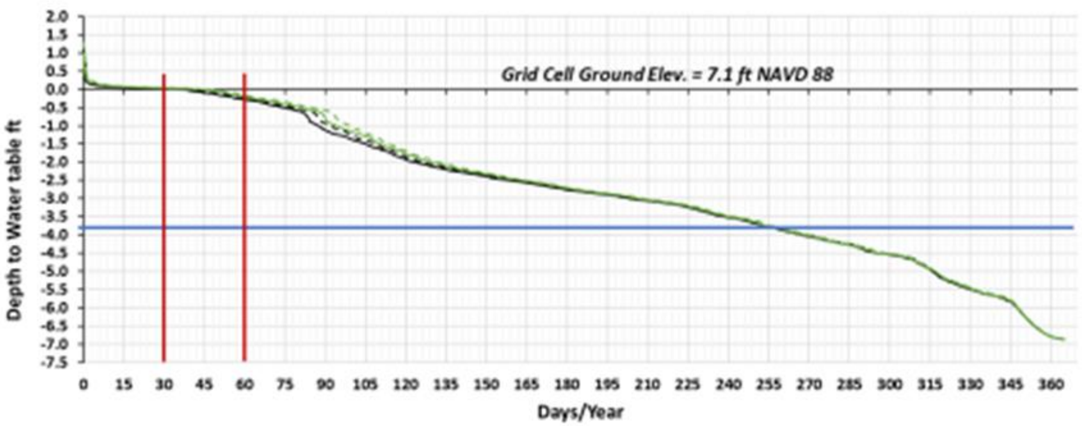
Figure A3-5

Stage-Duration Curves – Current and CWIP Conditions

IR-8 Cypress-Pine- Cabbage Palm



IR-10 Cypress-Pine- Cabbage Palm



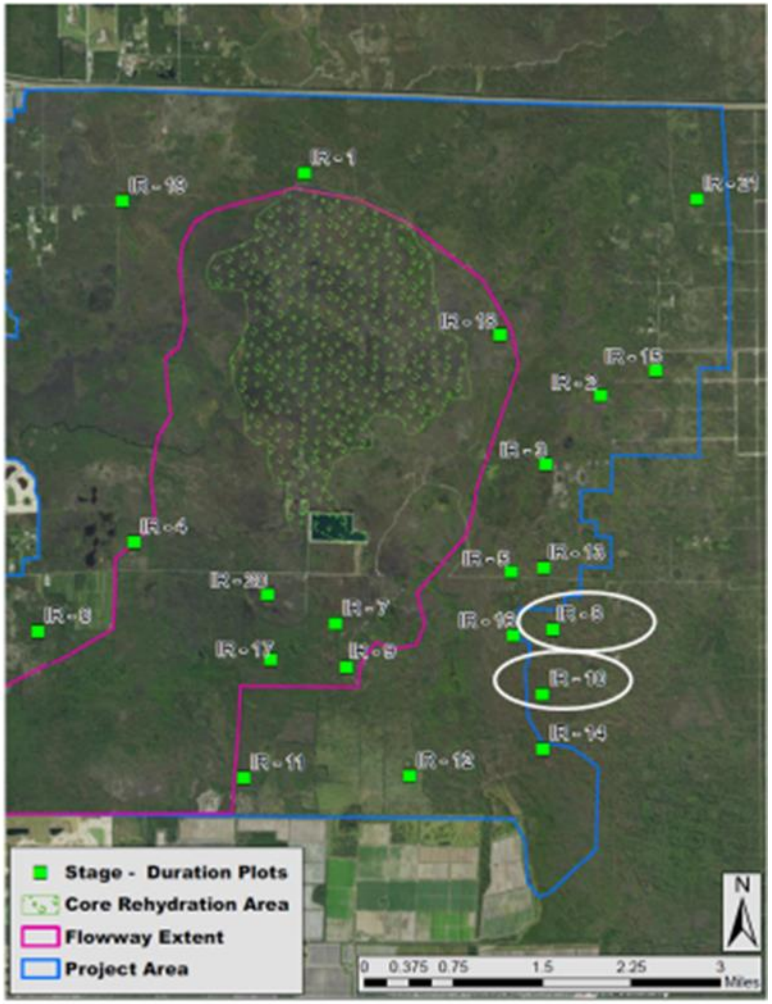


Figure A3-6

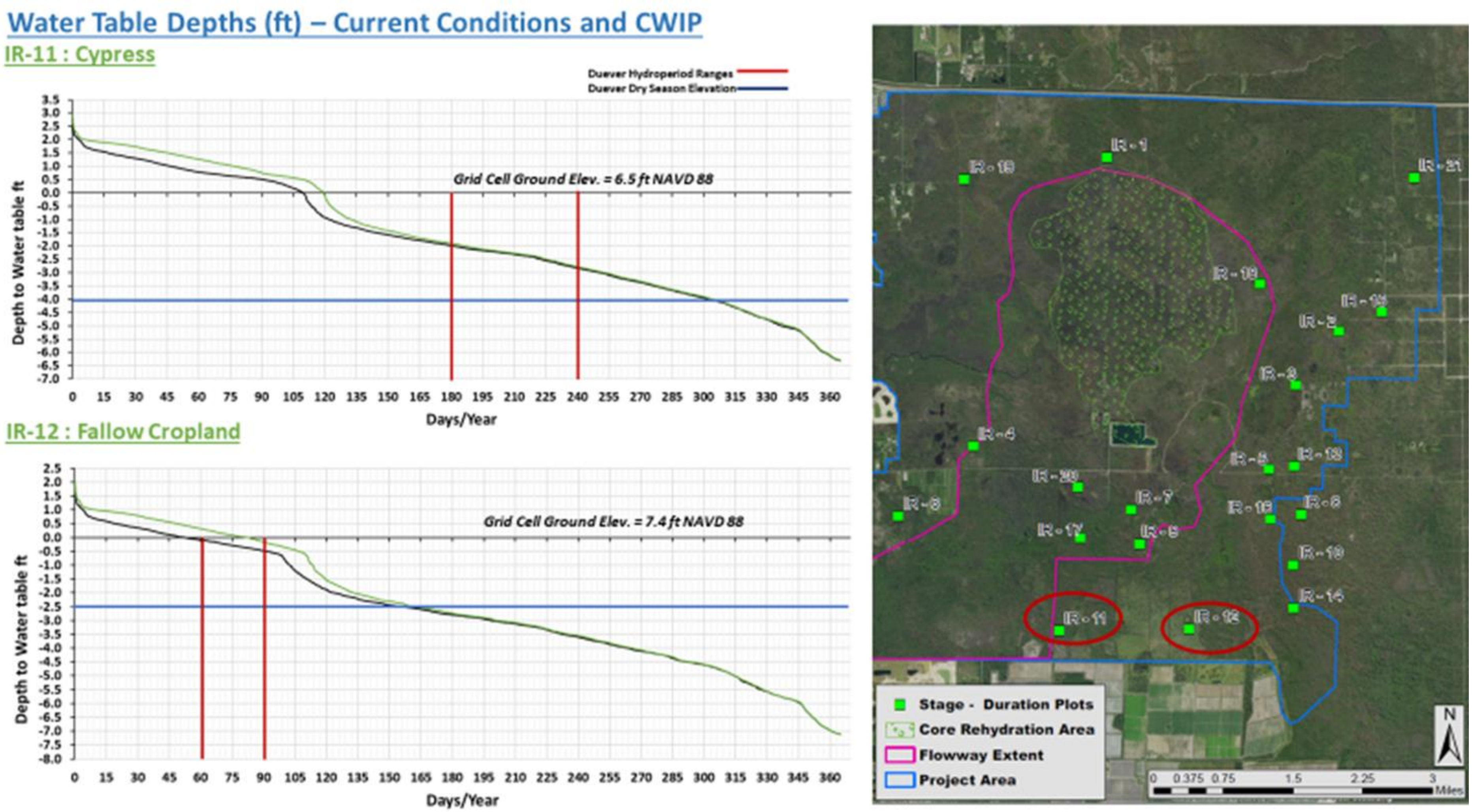
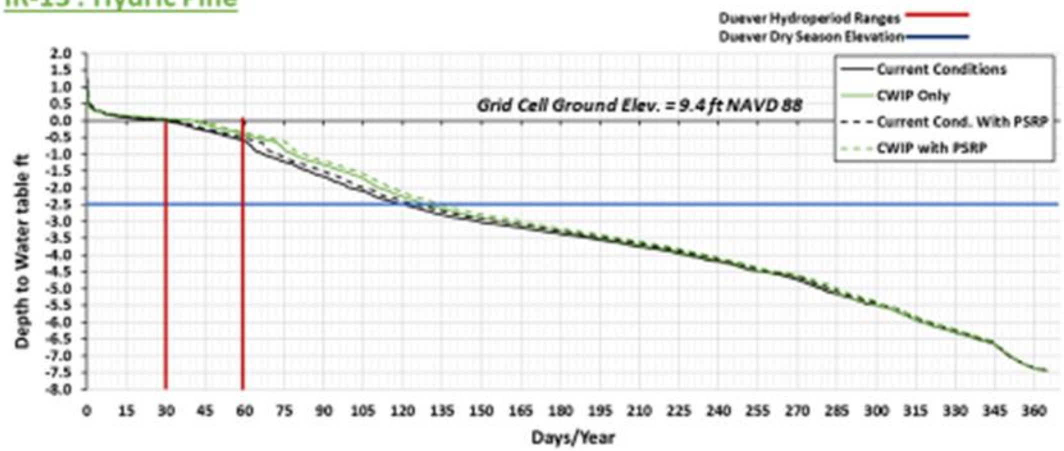

Water Table Depths (ft) – Current Conditions and CWIP
IR-11 : Cypress
Duever Hydroperiod Ranges
Duever Dry Season Elevation
Grid Cell Ground Elev. = 6.5 ft NAVD 88
Depth to Water table ft
Days/Year
IR-12 : Fallow Cropland
Grid Cell Ground Elev. = 7.4 ft NAVD 88
Depth to Water table ft
Days/Year
IR-11
IR-12
Stage - Duration Plots
Core Rehydration Area
Flowway Extent
Project Area
N
0 0.375 0.75 1.5 2.25 3
Miles

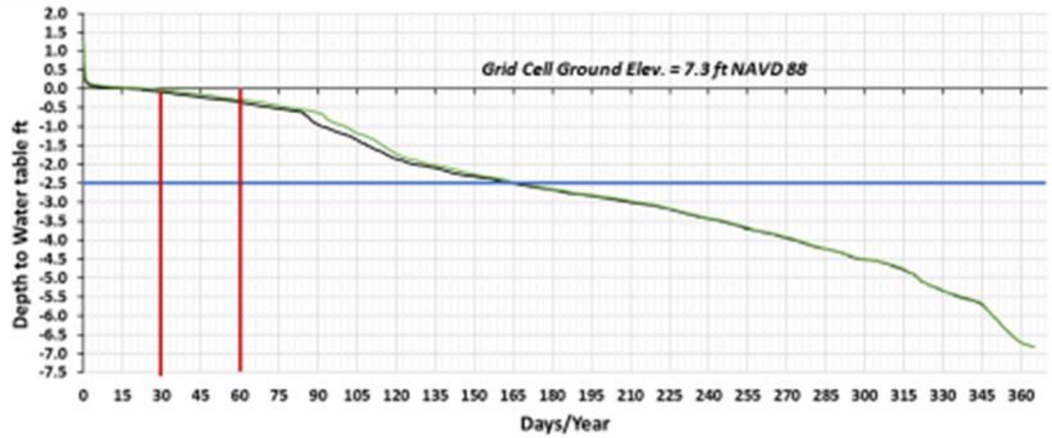
Figure A3-7

Stage – Duration Curves: Current Conditions and CWIP

IR-13 : Hydric Pine



IR-14 : Hydric Pine



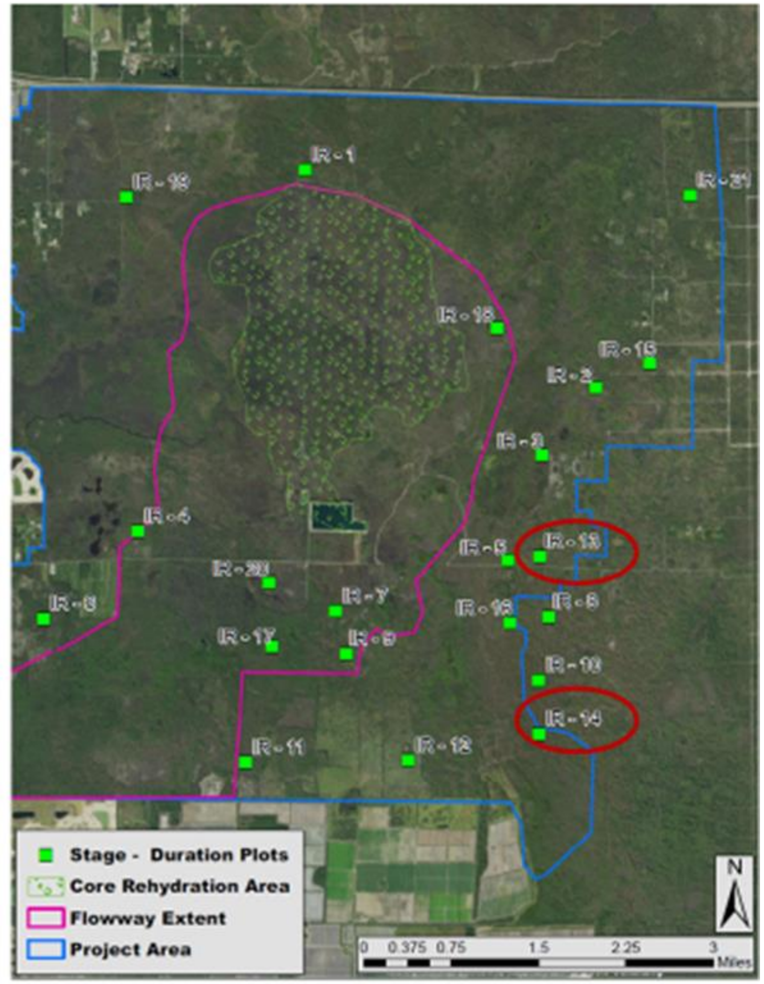
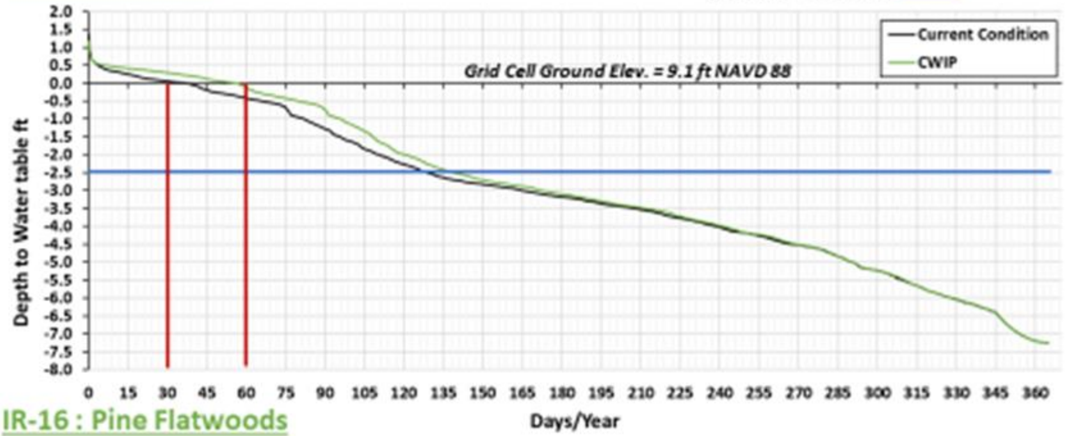


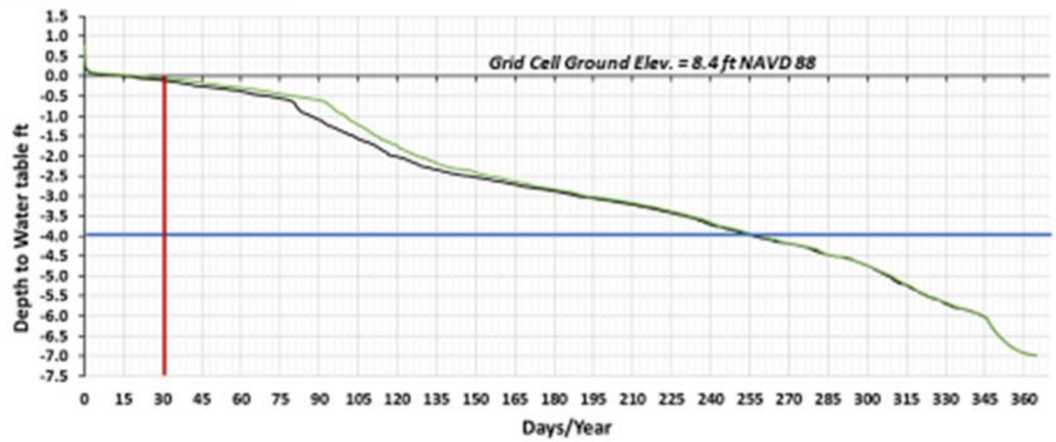
Figure A3-8

Stage Duration Curves – Current Conditions and CWIP

IR-5: Hydric Pine



IR-16 : Pine Flatwoods



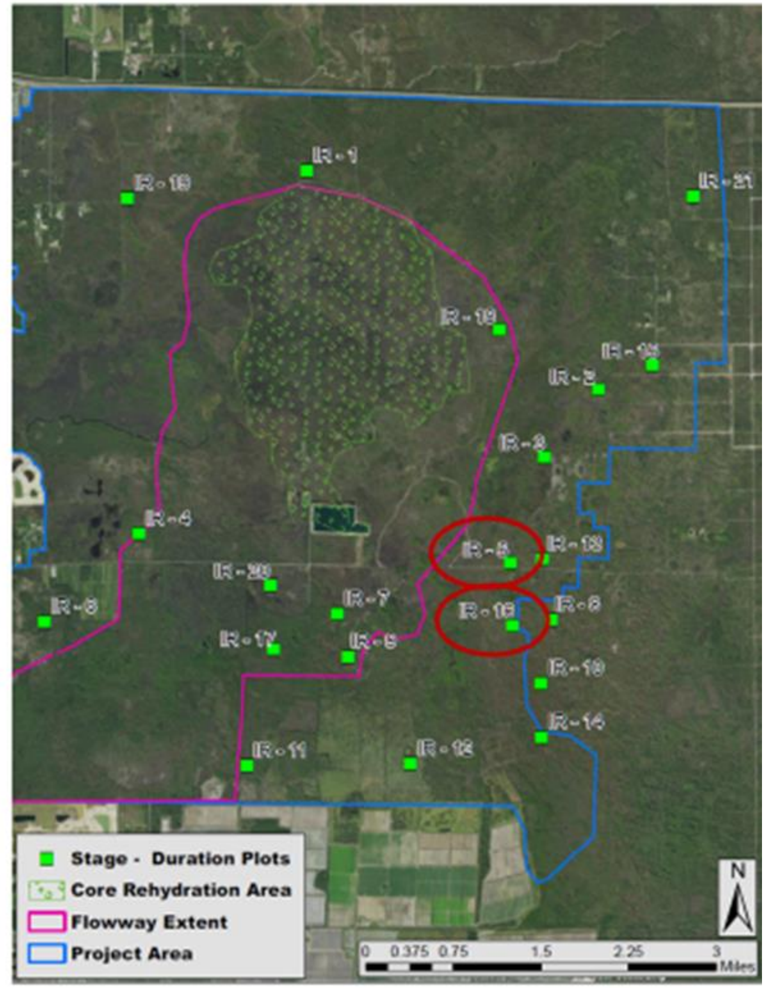
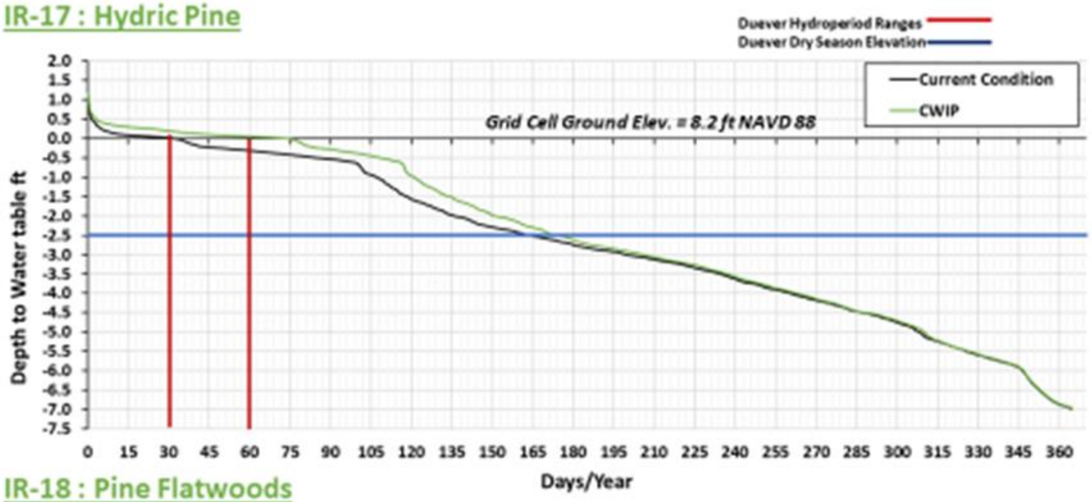


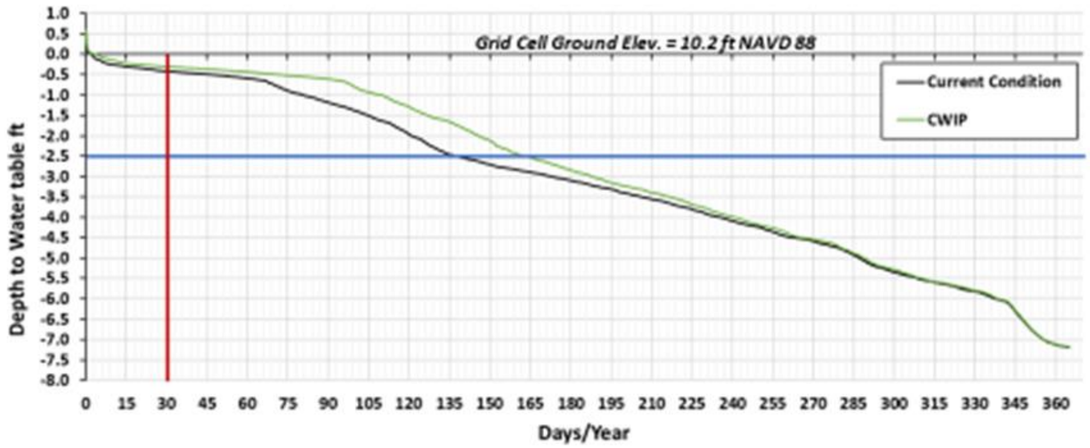
Figure A3-9

Stage Duration Curves – Current Conditions and CWIP

IR-17 : Hydric Pine



IR-18 : Pine Flatwoods



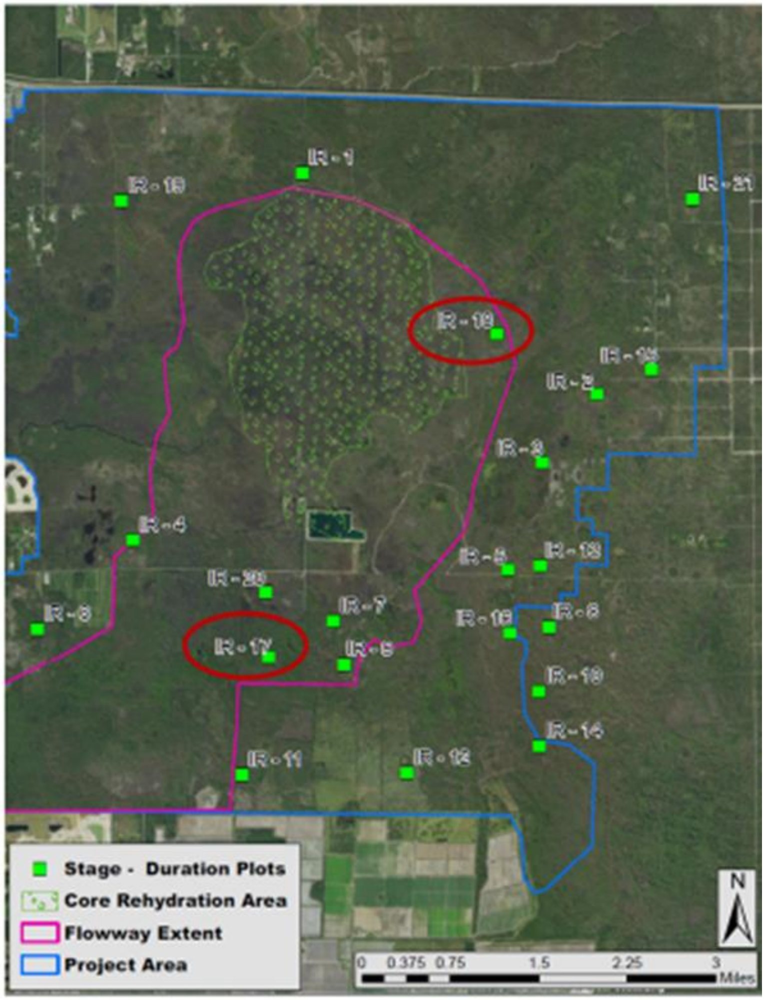
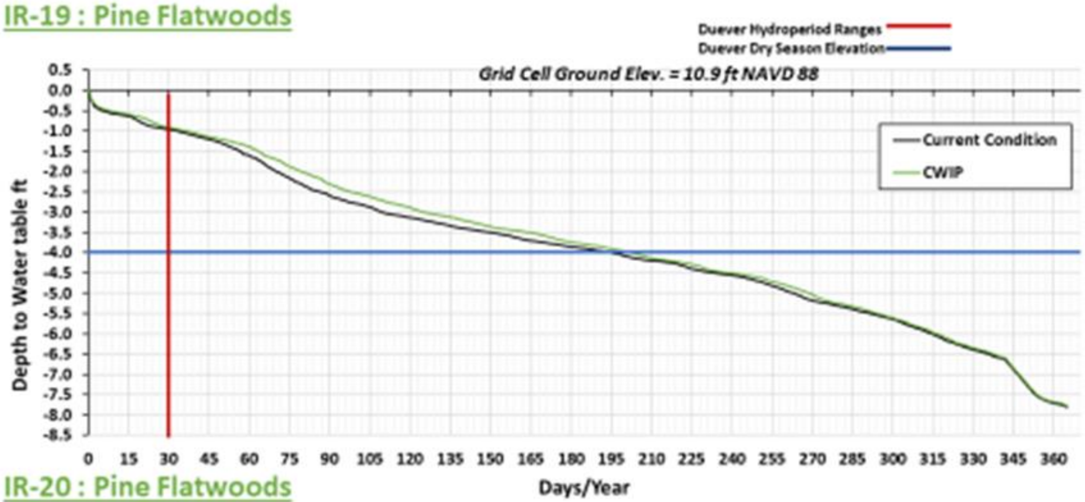


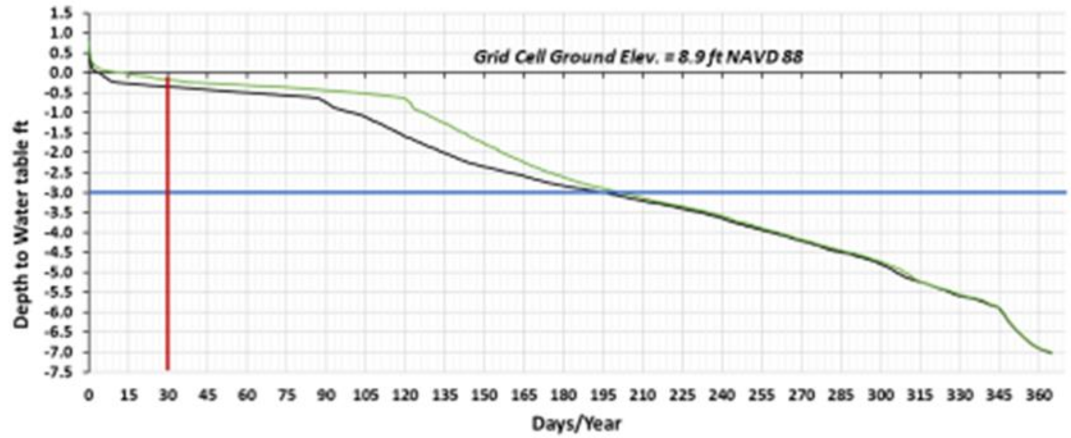
Figure A3-10

Stage Duration Curves – Current Conditions and CWIP

IR-19 : Pine Flatwoods



IR-20 : Pine Flatwoods



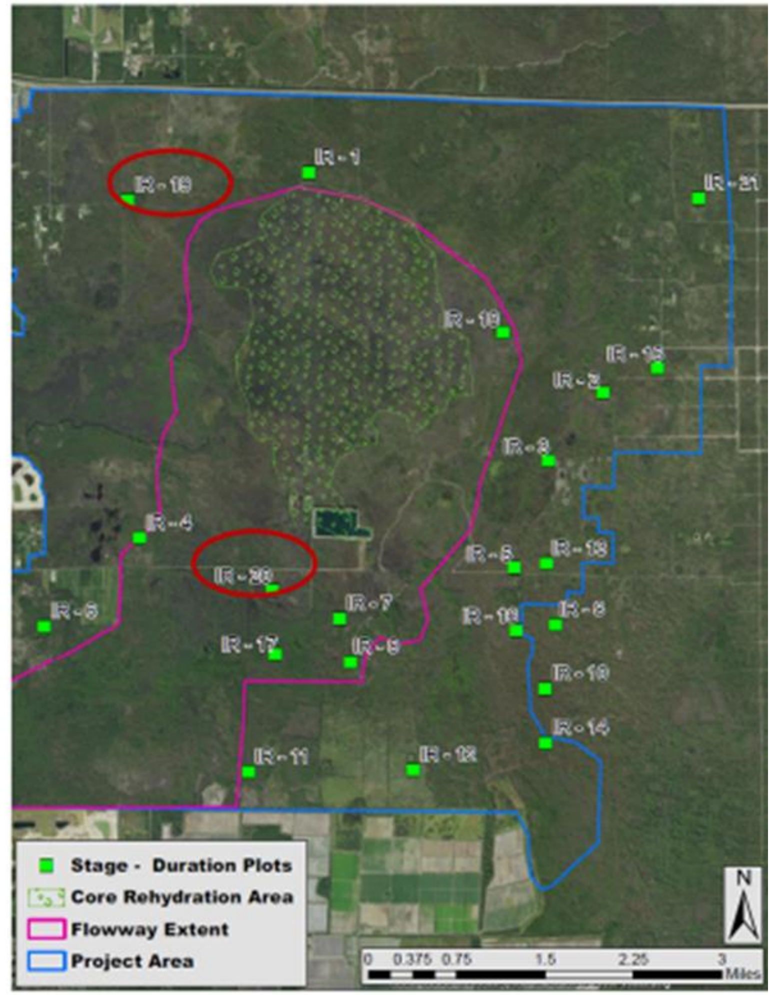
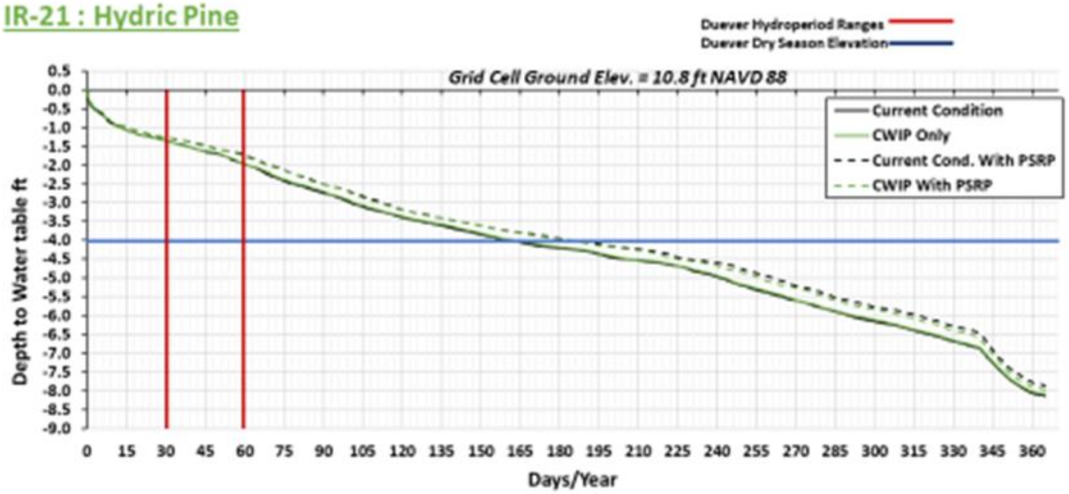


Figure A3-11

Stage Duration Curves – Current Conditions and CWIP

IR-21 : Hydric Pine



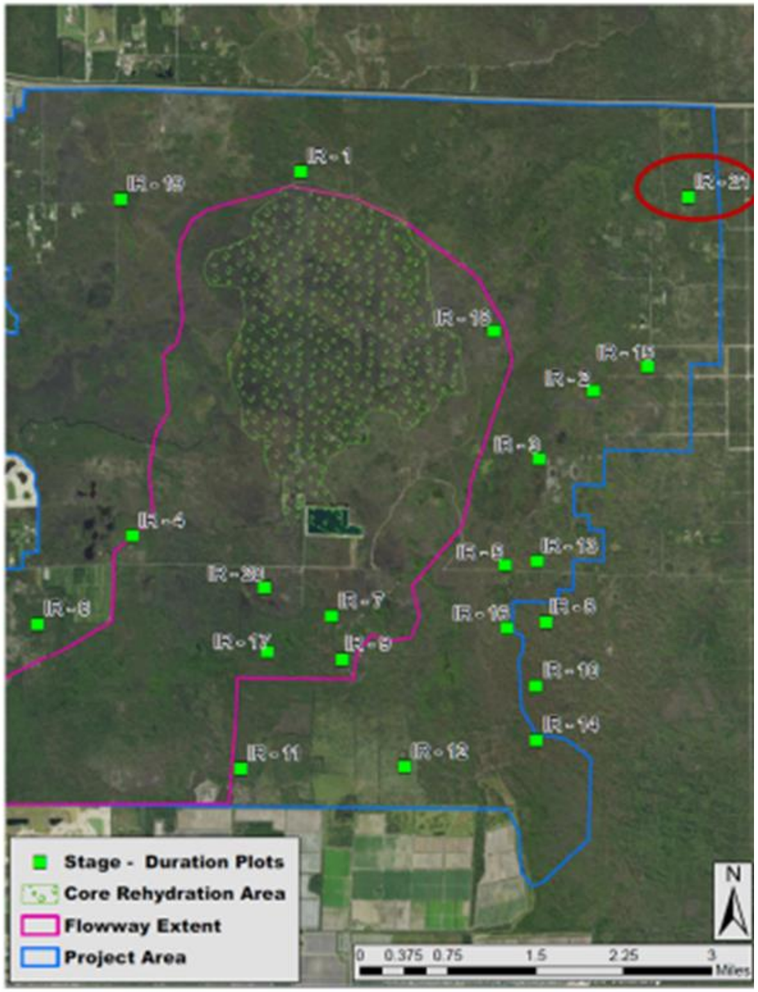


Figure A3-12