TAYLOR ENGINEERING, INC.

Collier County Belle Meade Flowway Restoration: Vegetation Community Hydrology

Landscape Conditions and Modeled Hydrology

Existing and With Project Simulations

Collier County

Belle Meade Flowway Restoration

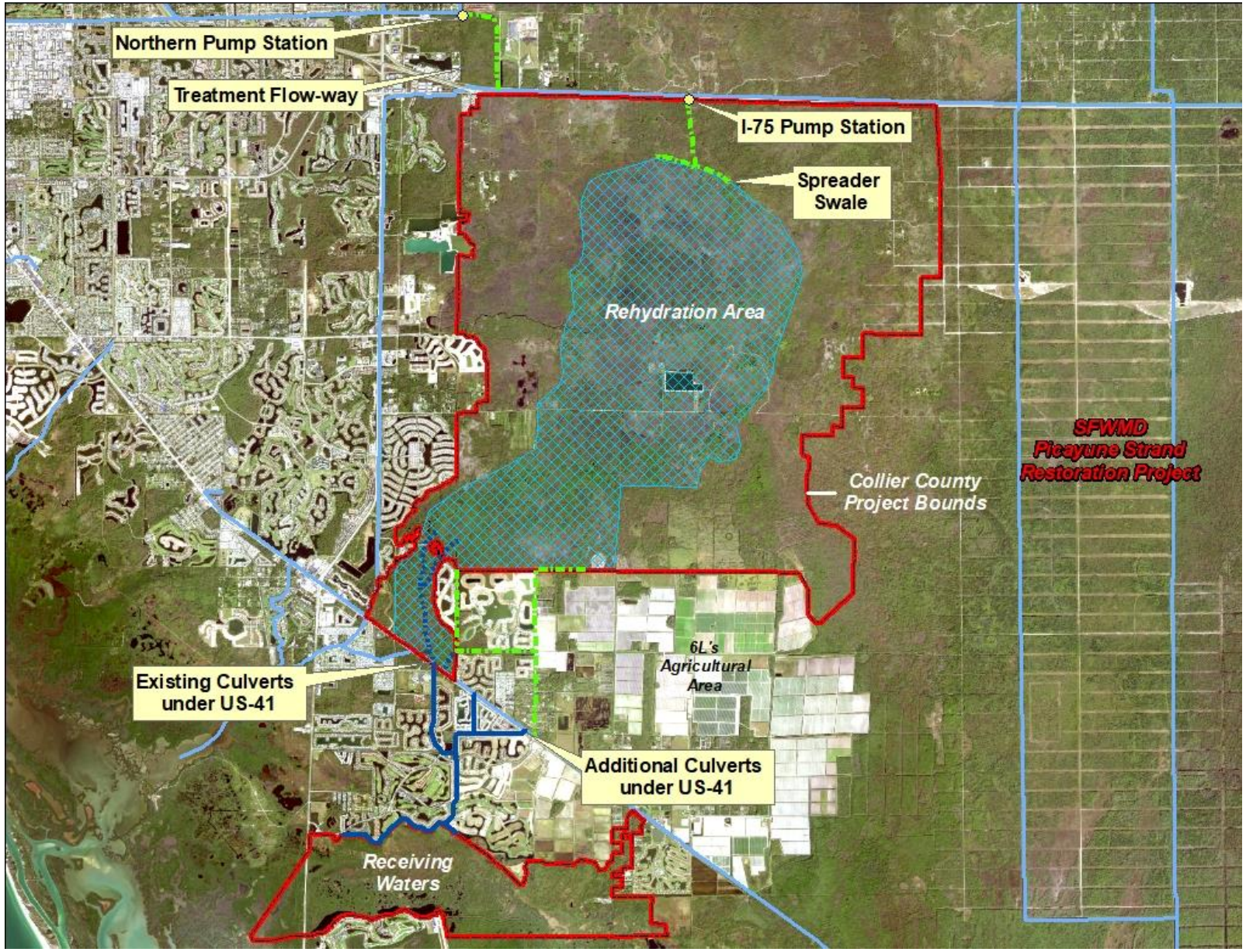
- Restores natural hydrology to about 9,000 acres of Picayune Strand State Forest
  - ✓ minimal changes to flora and fauna
  - ✓ Reduces potential for forest fires
- Avoids/minimizes Impacts to RCW Habitat
- Increases wet season flows to Rookery Bay
- Decreases wet season flows to Naples Bay
- Project includes extensive monitoring system to support effective adaptive management

Collier County

Project Components

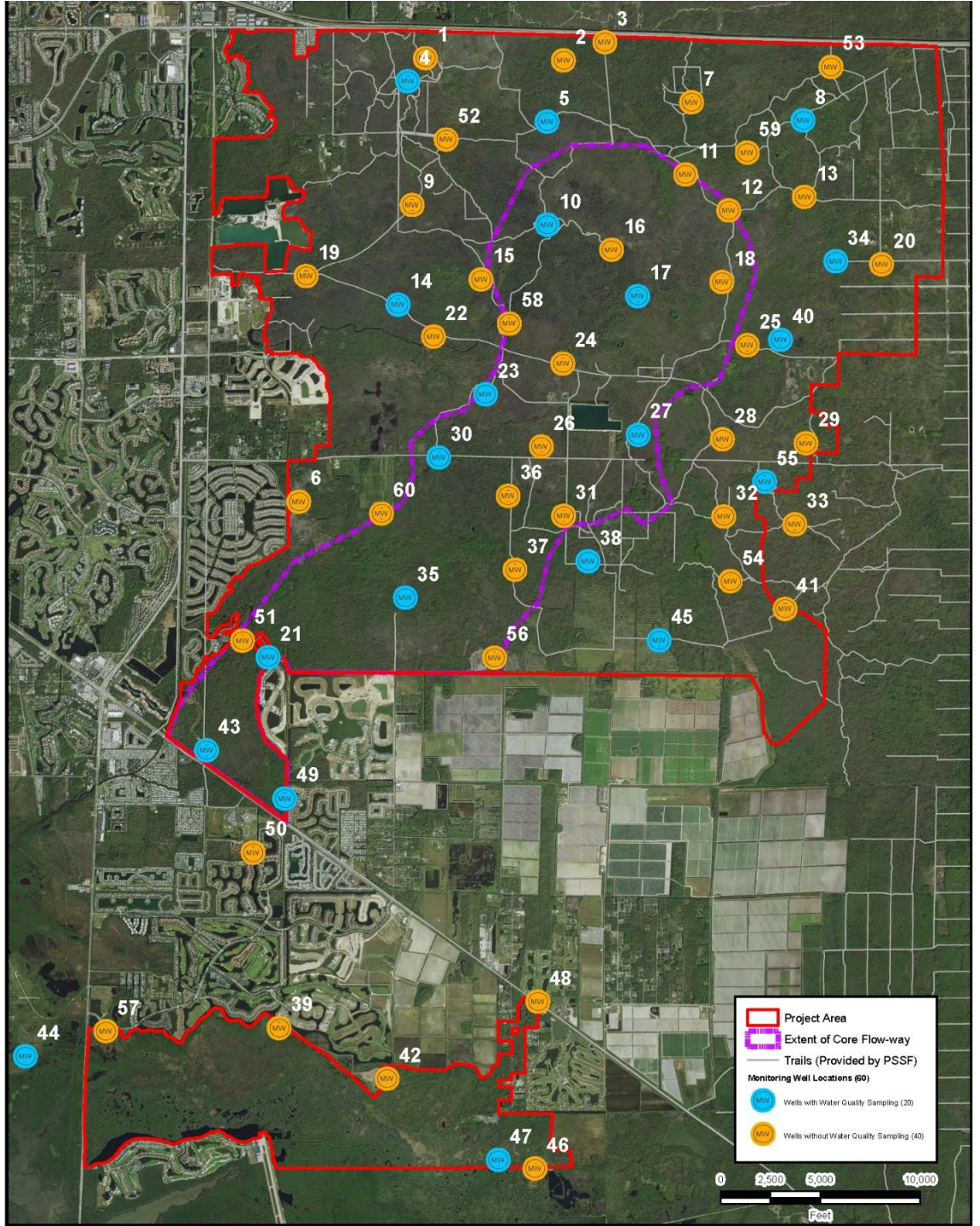
- Pump Station at Golden Gate Canal
- Water Pretreatment Area
- Supply Channel and Spreader ditch
- Improvements to move water South of US 41
- Pumps allow operational flexibility

- **Total Project Area North of US-41:** 22,114 acres
  - Core Rehydration Area: 2,390 acres
  - Remaining Flowway Extent: 6,538 acres
  - Receiving Water Area South of US-41**:** 2,390 acres



Monitoring Network

- 60 Monitoring Locations
  - 60 Groundwater and Surface Water Monitoring Wells
  - 60 Vegetation Transects
  - 30 Water Quality Sampling Stations
- Effectively tracks project performance
- Provides database for effective adaptive management



Analysis Approach

- **Model Existing and 'with Project' Hydrology**
- **Develop FLUCCS-Based Vegetation Community GIS Database**
- **Calculate and Compare Existing and With Project Hydrology by Vegetation Polygon and Project Assessment Areas**

Model Domain

Modeled Area

- 171,287 acres = 268 square miles

Model Boundaries

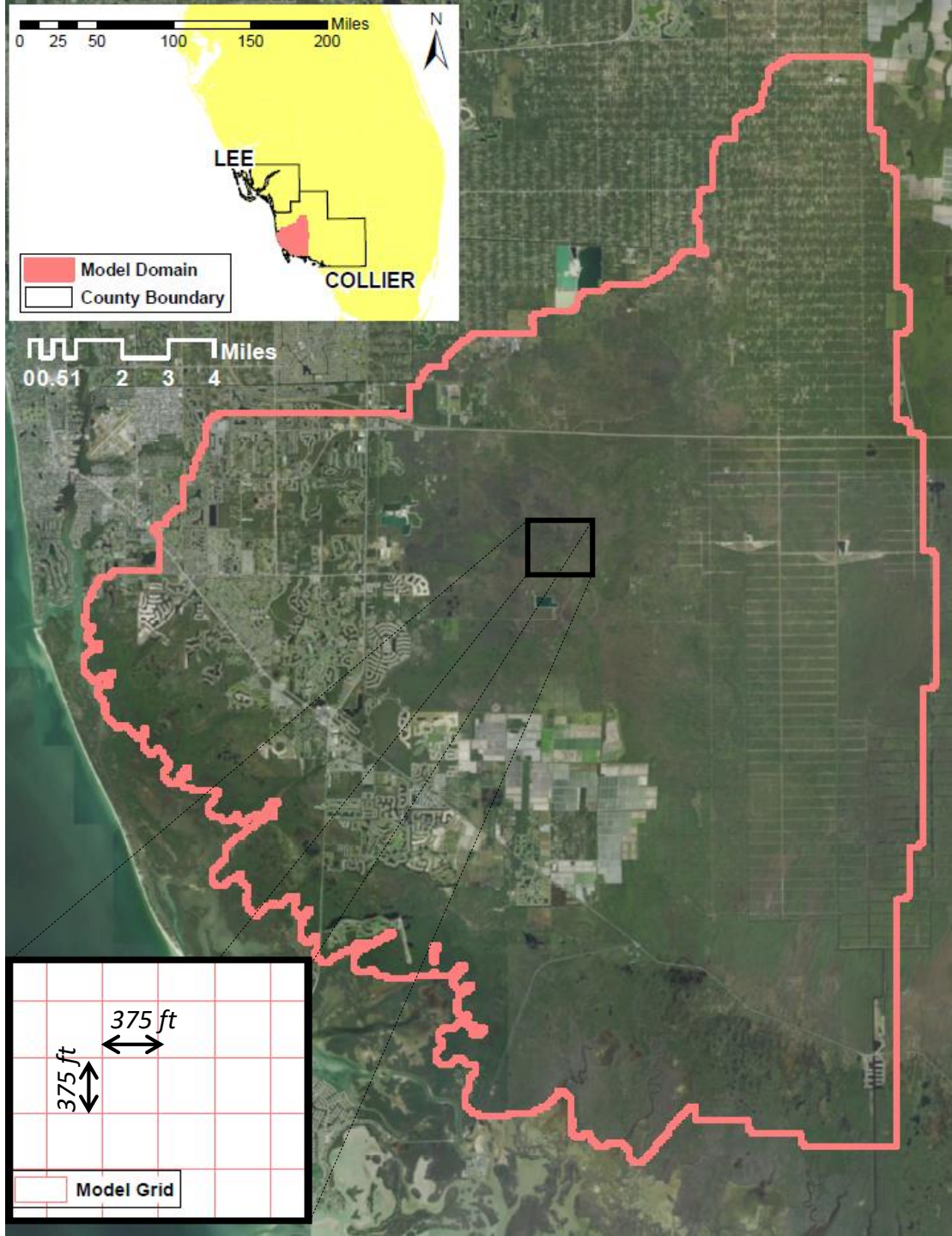
- ~ 3.3 miles east of Everglades Blvd.
- ~ 4.3 miles west of Collier Blvd.
- ~ 8.2 miles north of Alligator Alley
- ~ 7.8 miles south of CR 92 parallel to the coast

Grid Size

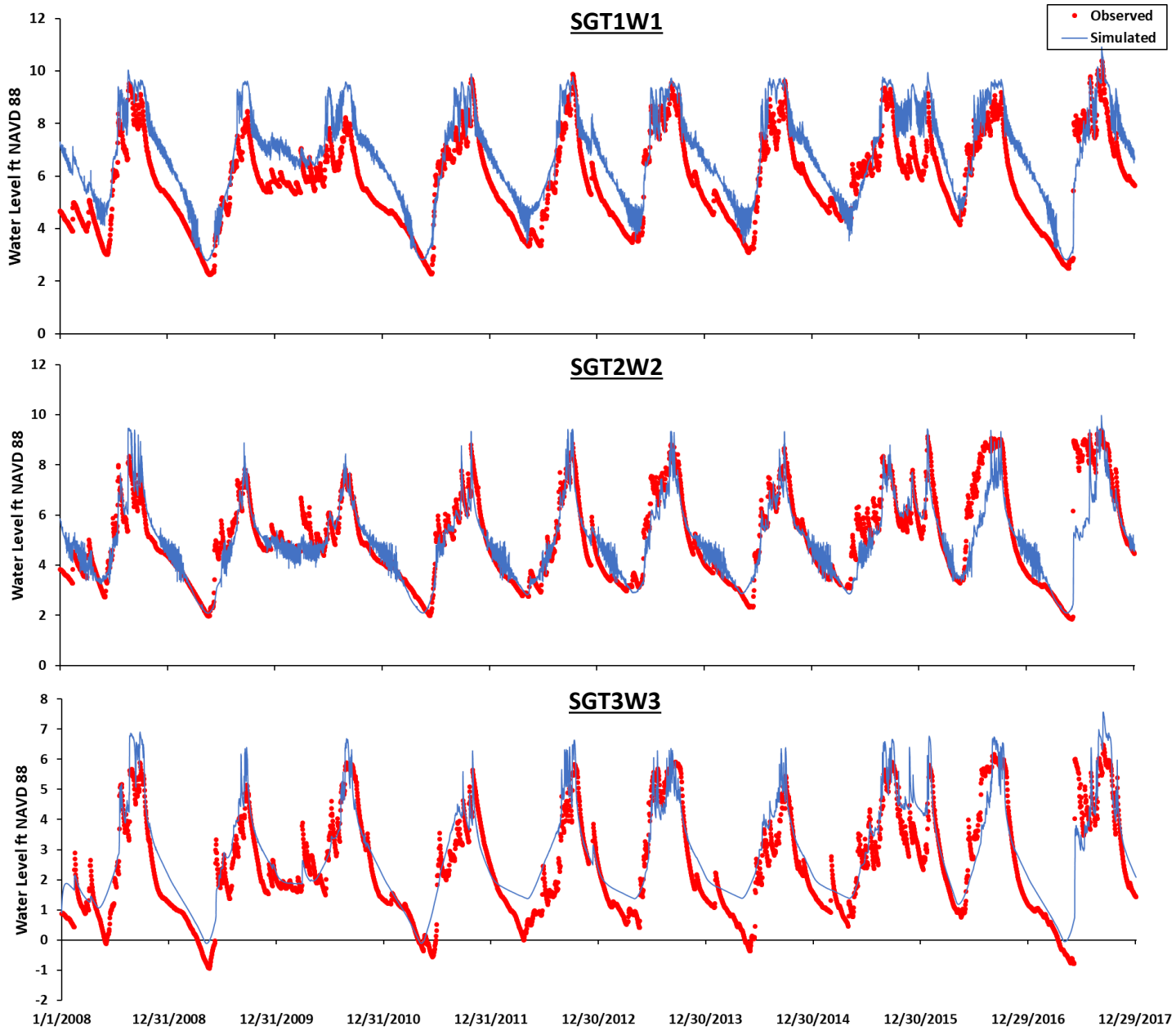
- 375 ft X 375 ft

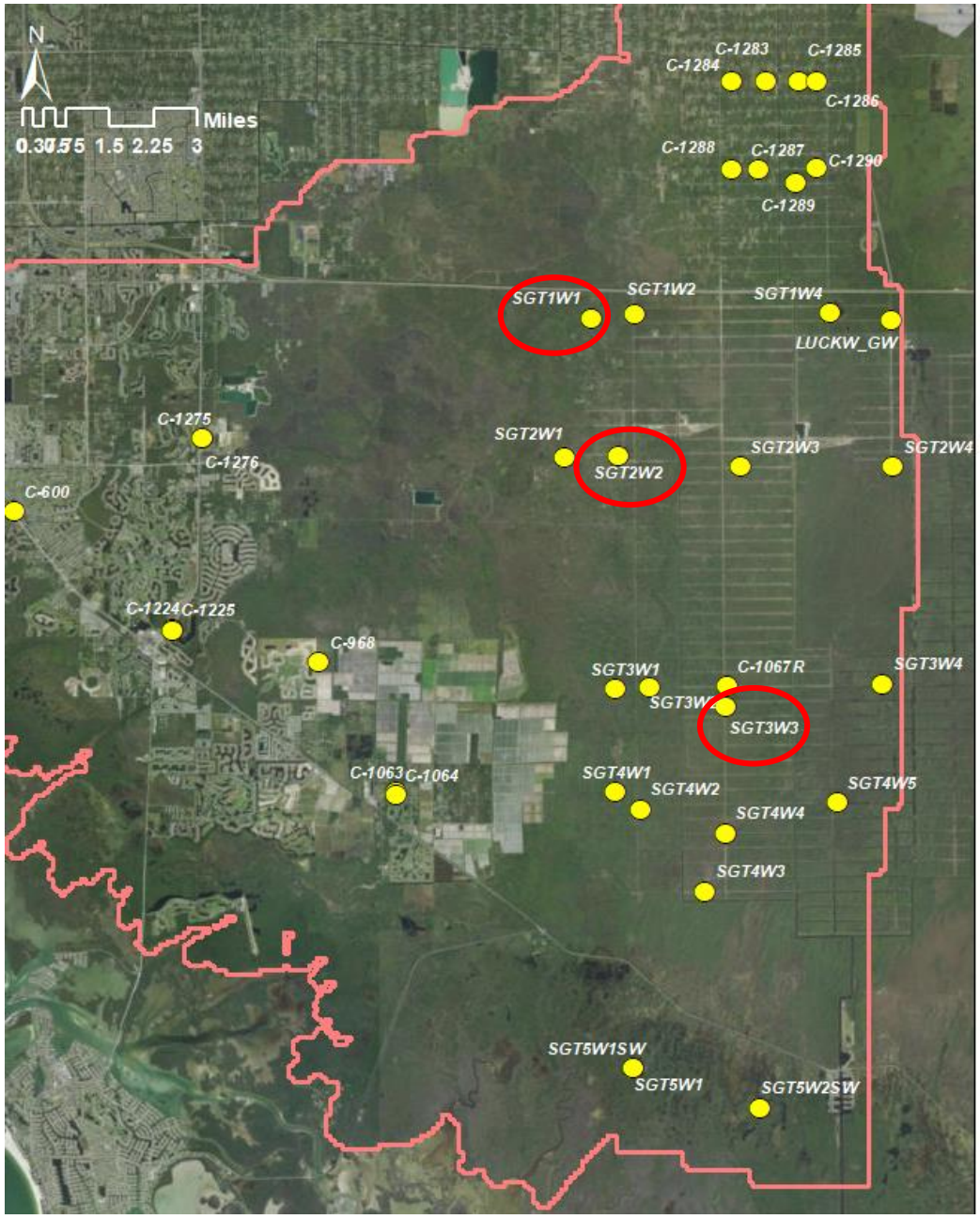
Simulation Period

- 10 years: 1/1/2008 to 12/31/2017
- Includes multiple dry and wet years, including 2017 Irma



Model Calibration – Groundwater Levels





Model Scenarios

- Current Conditions
- Current Conditions plus PSRP
  - Includes pump stations on Miller, Faka Union Canals, tieback levee, filling canals, etc.
  - Includes latest HEC-RAS modeled incarnation of Southwest Protection Feature
  - Coordinated closely with USACE / IMC modelers
- Current Conditions plus CWIP (no PSRP)
- Current Conditions plus PSRP and CWIP

CCWIP Pumping Scheme

100 cfs

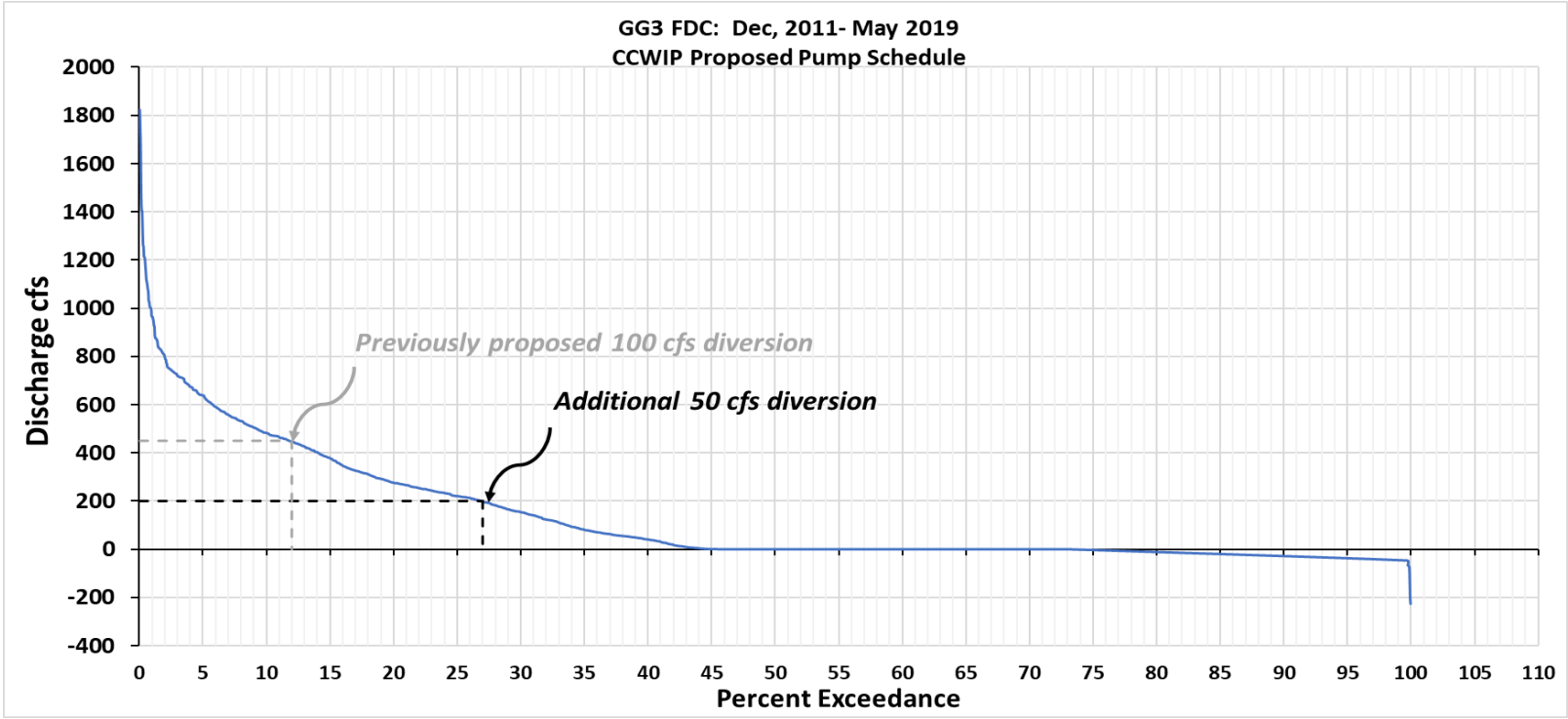
- When canal discharge is higher than 450 cfs at GG-3
- Diverted on ~ 56 days/year

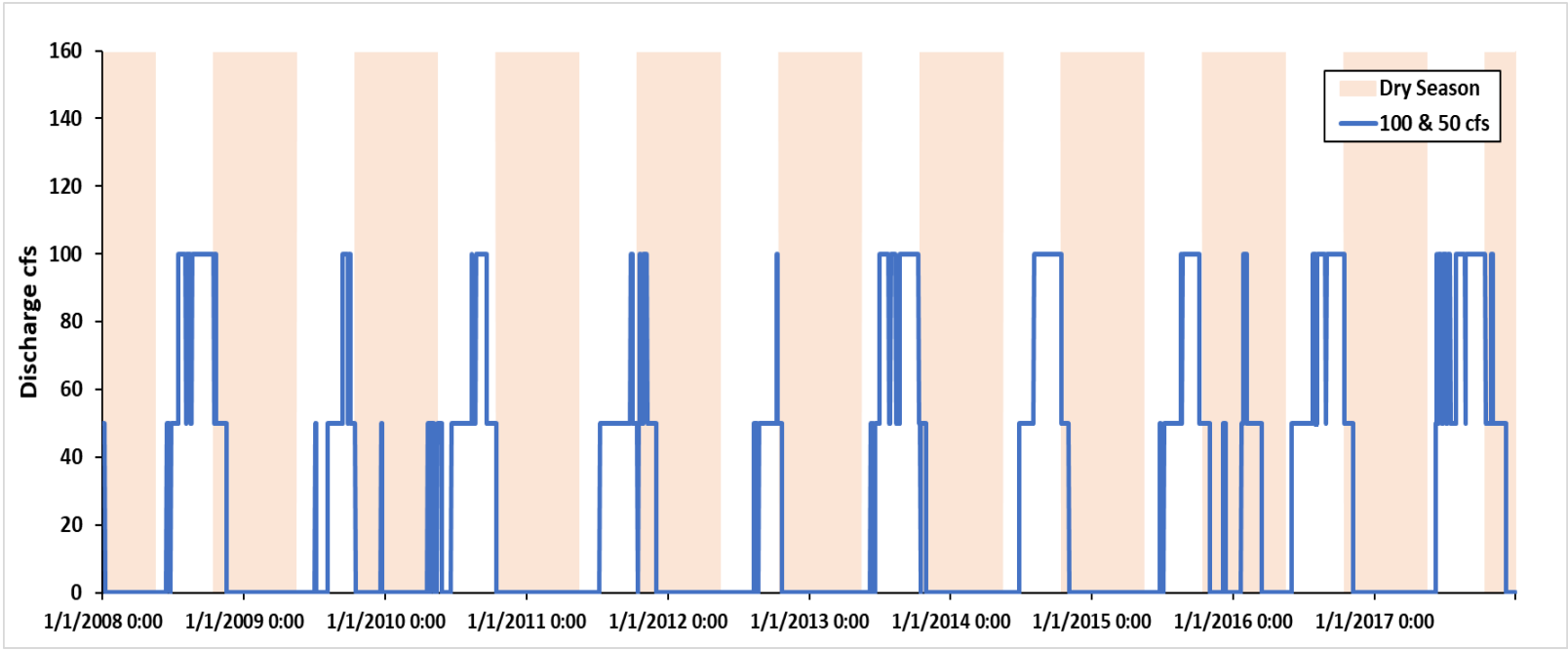
50 cfs

- When canal flow is higher than 200 cfs at GG-3 but less than 450 cfs
- Diverted on ~ 83 days/year

Total Pumping days

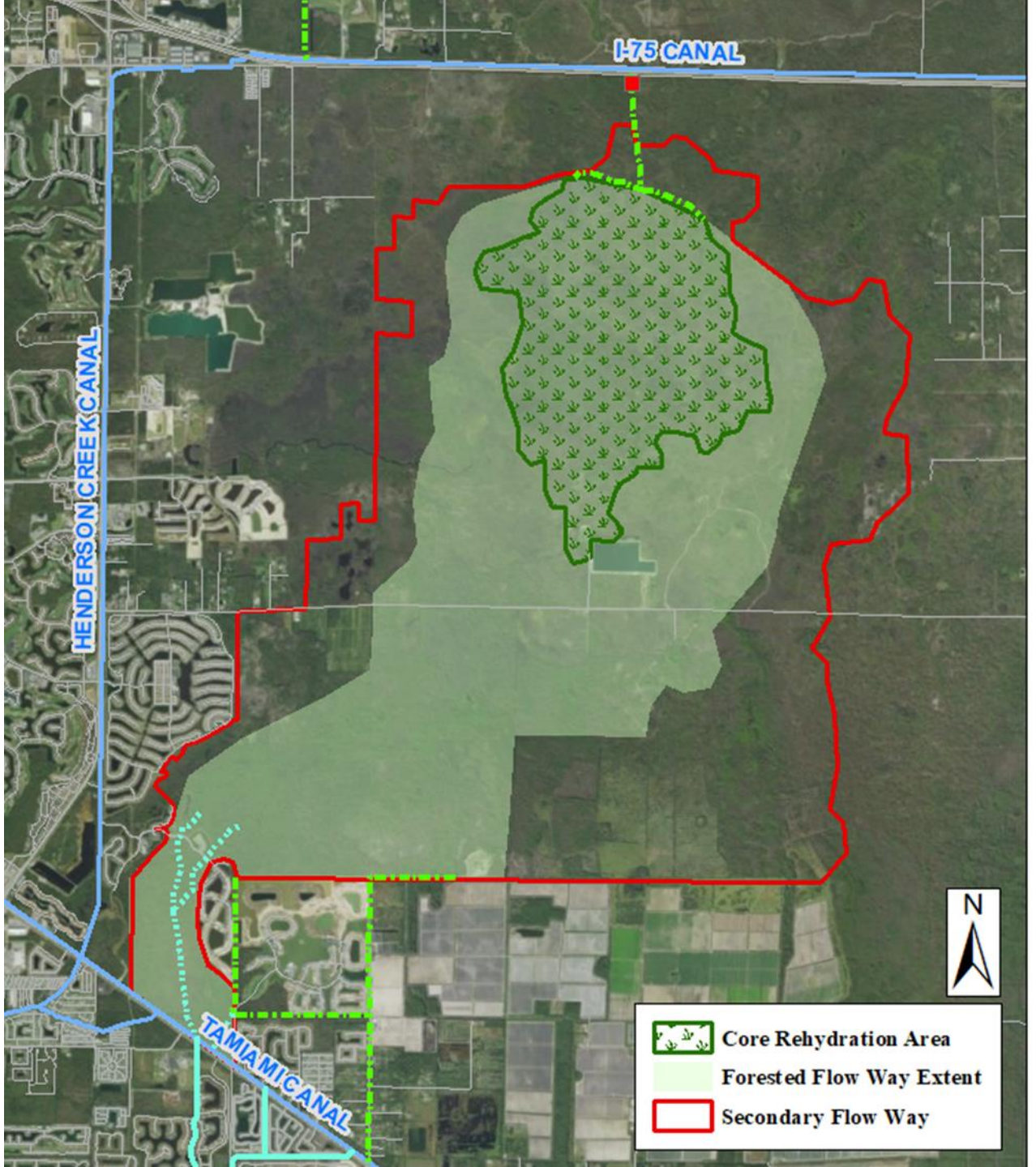
- ~ 139 days/year





Expected Surface Water Level Changes

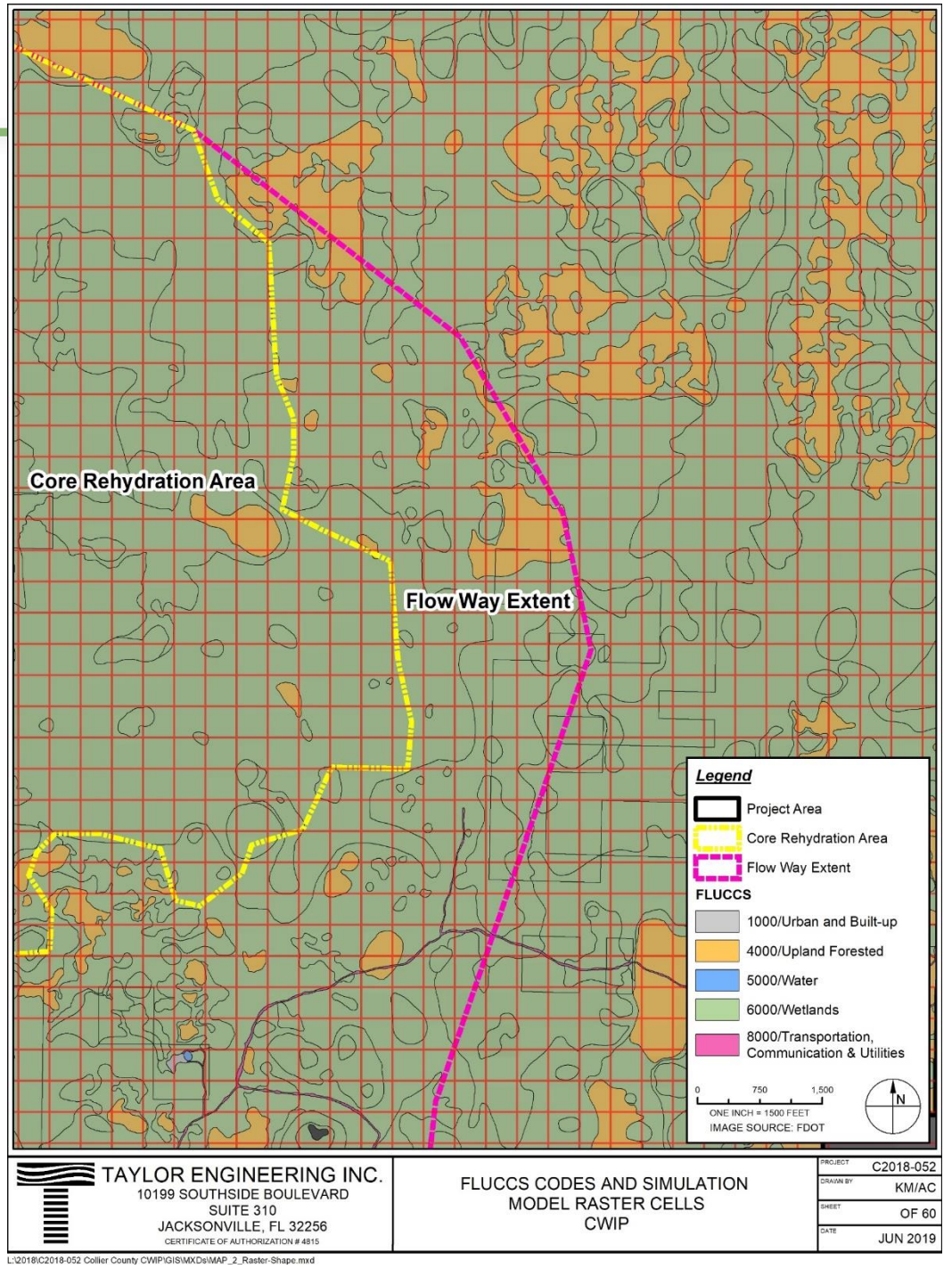
- Inside Core Rehydration Area:
  - 2-8 inches of additional standing water
  - Duration extended to ~10 months per year
- Outside Core Rehydration Area but in Primary Flow-Way:
  - Generally less than 2 inches additional standing water
  - ~1-2 months per year increase in duration
- Outside Primary Flow-Way but inside secondary Flow-Way:
  - Less than 1 inch increase
  - Less than 1 month increase in duration



Vegetation Community Analysis

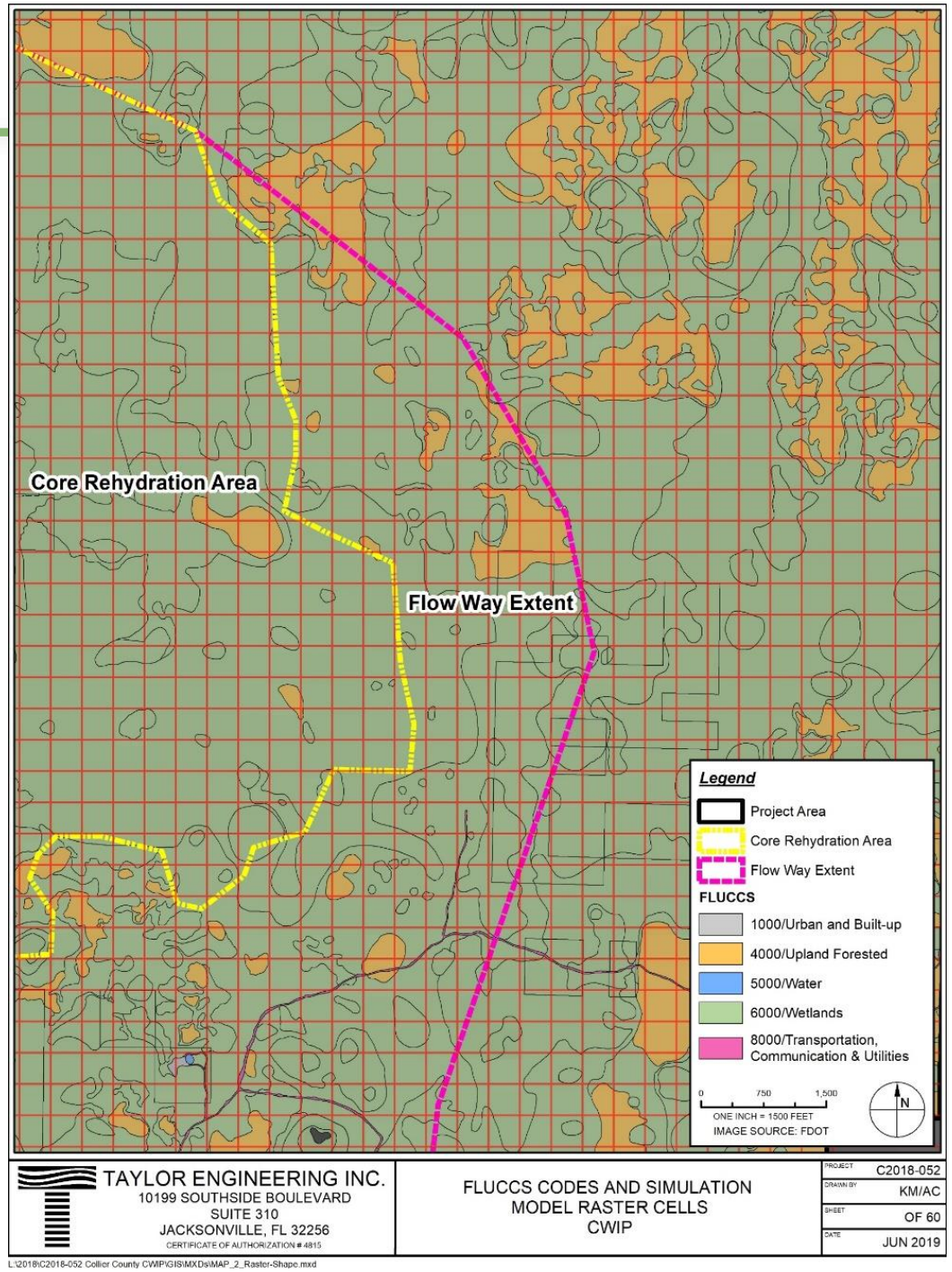
Vegetation Community Data:

- Merged FNAI & FLUCCS Datasets
  - All Data Converted to FLUCCS Codes (SFWMD and Duever Crosswalks)
    - Picayune Strand State Forest FNAI, 2016-2017 (released 2018)
    - SFWMD FLUCCS for Collier County, 2016 (released 2018)
  - Field Verification of GIS Mapping
    - FNAI data (2017)
    - Collier County (2019)
  - Vegetation Polygons identified by Assessment Area
    - Some Polygons split along Assessment Area boundaries
  - Field Verification FNAI 2017, Collier County 2019



Vegetation Community Analysis Overview

- **Vegetation Polygons > 32.3 acres used in hydrologic characterizations**
  - Hydrologic simulation grid cell size: 3.23 acres
    - Each cell includes one hydrologic simulation calculation point
    - Grid size may affect accuracy of data associated with small vegetation polygons
    - Therefore, polygons > 32.3 acres used to define community hydrology
    - Polygons >32.3 acres cover 15,394 acres north of US-41
- **Hydrologic Calculations for a Polygon**
  - Each hydrologic simulation grid cell intersecting a polygon provided one value
  - Calculations for a vegetation polygon statistics:
    - weighted the data in each grid cell by its percent area contribution to the polygon
    - Averaged the weighted contributions to provide a polygon-level hydrologic statistic
  - Summary values of each vegetation type and each project area zone calculated as medians
    - Non-parametric values do not assume any underlying data distribution



Vegetation Community Analysis Overview

➢Vegetation Polygon Hydrologic Statistics

- Hydroperiod (months/year) – period of water above land surface
- Dry Season October 15 – May 15
  - Median Water elevation (inches) with respect to ground elevation
  - Dry Season 1 in 10-year minimum value
- Wet Season May 16 – October 14
  - Median Water elevation (inches) with respect to ground elevation

➢Median Statistical Values compared to Duever Hydrologic Ranges

Project Assessment Areas

Core Rehydration Area

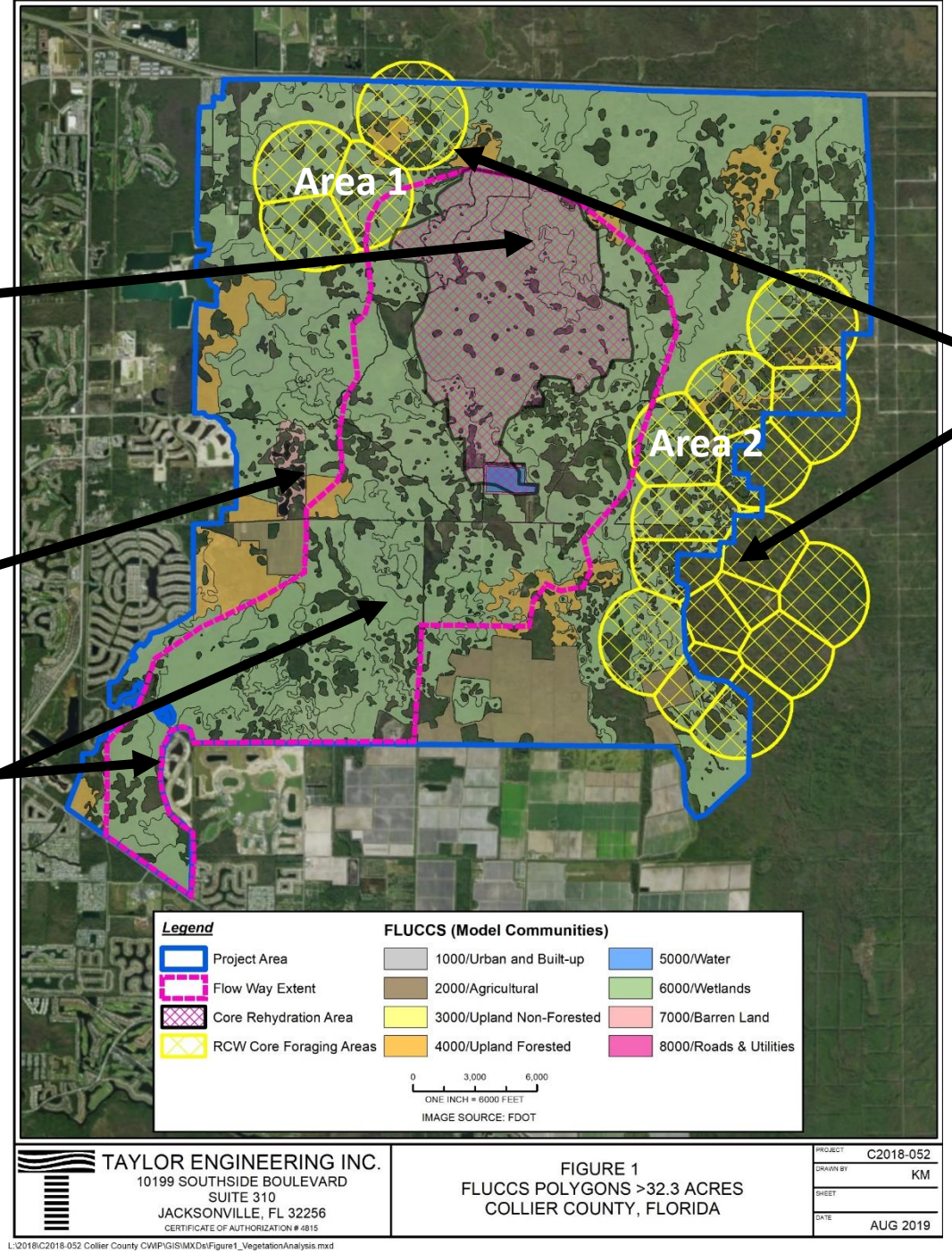
2,390 acres

Areas Outside Flowway Extent

13,056 acres

Flowway Extent

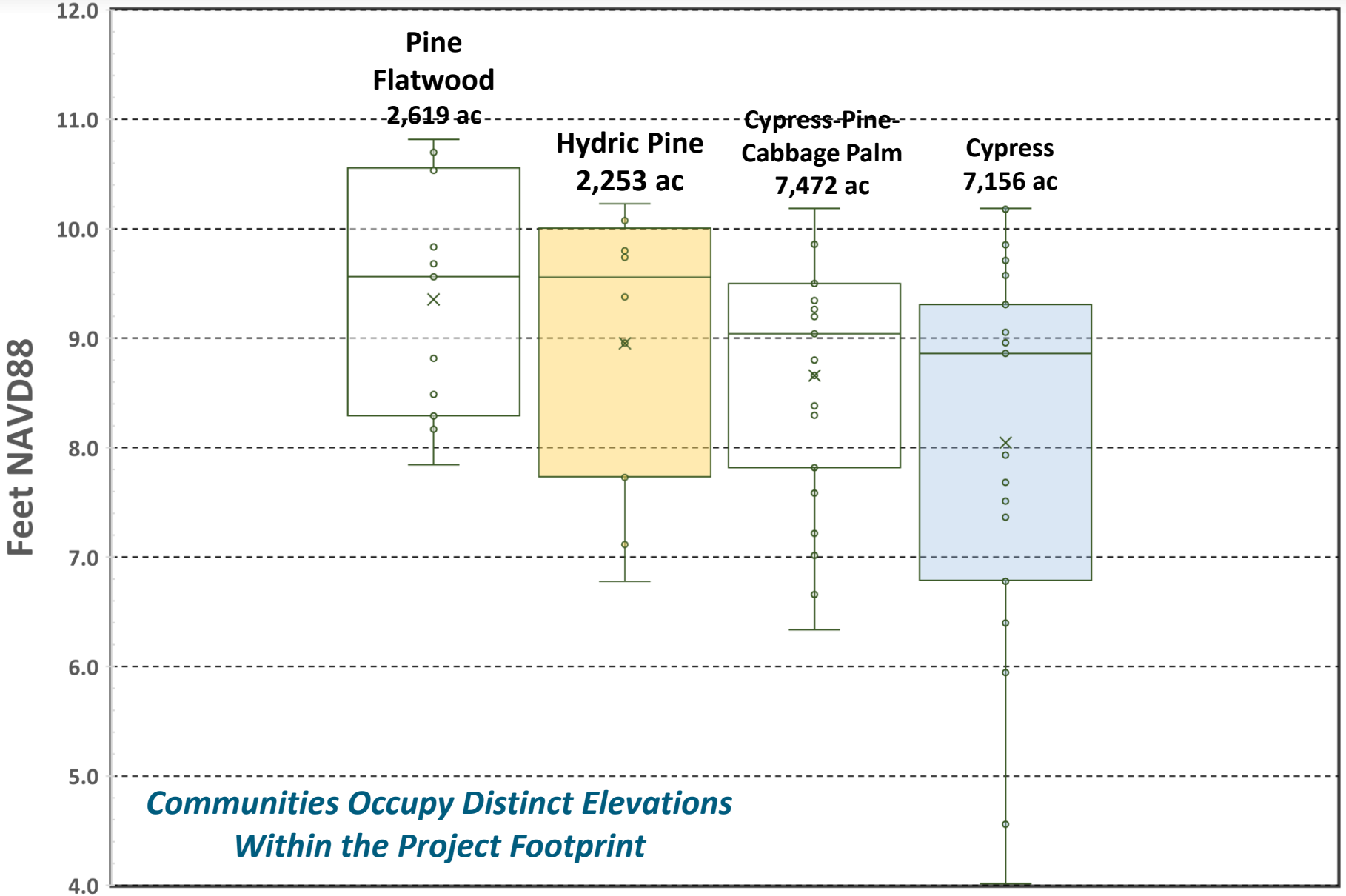
6,538 acres



Red Cockaded Woodpecker Core Foraging Area (within CWIP Project Area)

- RCW Core Foraging Area 1: 1,429 acres
- RCW Core Foraging Area 2: 2,563 acres

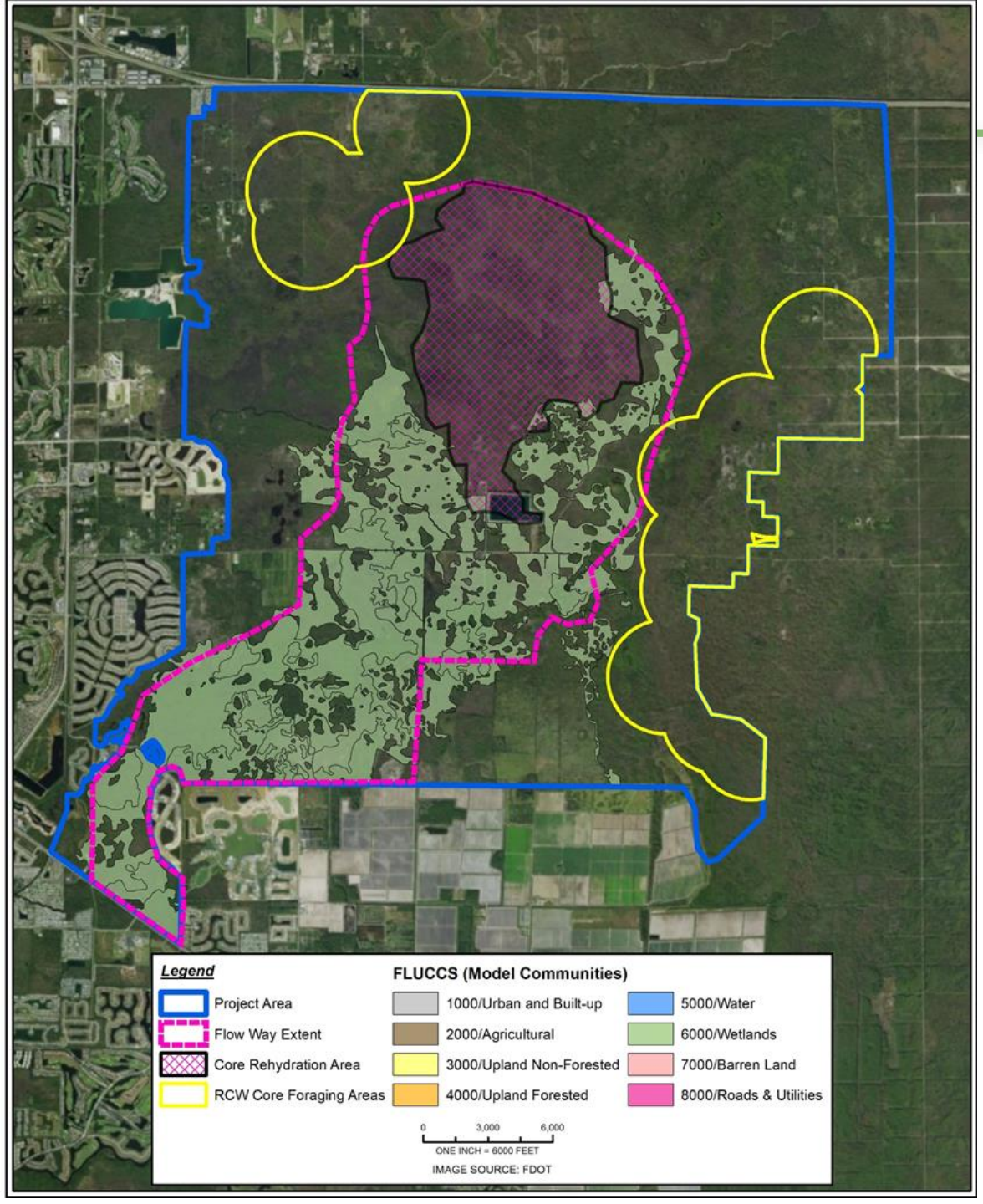
FLUCCS Dominant Community Elevation Data (Feet NAVD 88)



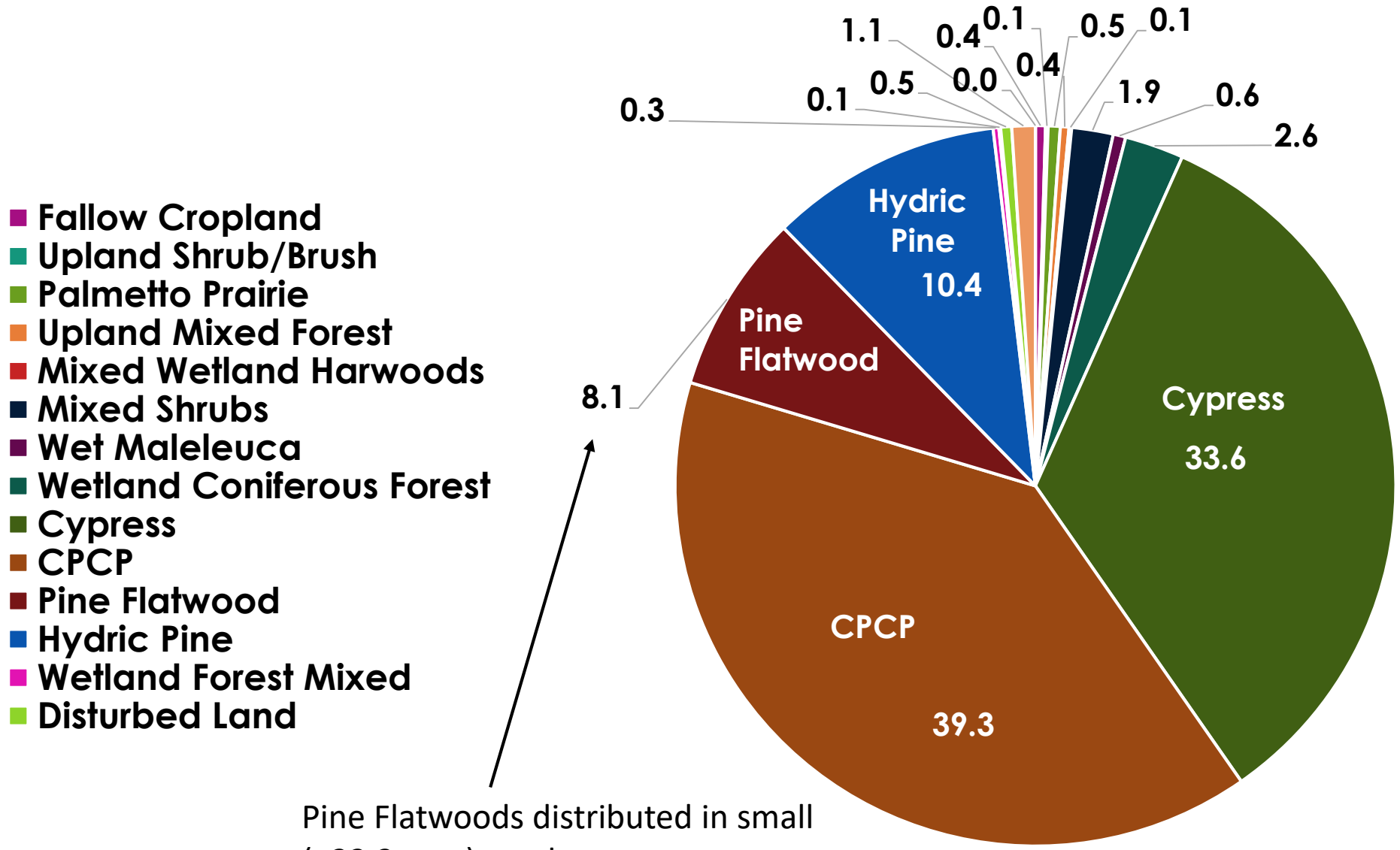
Hydrologic Statistics: Vegetation Community Median Values and Duever's Hydrologic Ranges

	Pine Flatwood		Hydric Pine		Cypress-Pine Cabbage Palm		Cypress	
Statistic	**Existing**	**With Project**	**Existing**	**With Project**	**Existing**	**With Project**	**Existing**	**With Project**
Hydroperiod (months/Year)	0.55	0.81	0.77	1.31	2.26	3.10	2.74	3.81
Duever average	*≤ 1*		*1 - 2*				*6 - 8*	
Dry season Median Depth (inches)	-40.40	-30.27	-39.08	-32.61	-32.32	0.02	-28.82	-20.24
Duever Dry Season Average (inches)	*-46*		*-30.0*				*-16*	
Dry Season Minimum depth (inches)	-86.56	-79.57	-83.50	-81.68	-79.16	-25.46	-74.74	-67.43
Duever Dry Season Minimum (inches	*-76*		*-60*				*-46*	
Wet Season depth (inches)	0.07	0.26	0.04	0.14	0.45	0.9	1.40	3.94
Duever Wet Season Average (inches)	*≤ 2*		*2 - 6*				*6 - 8*	

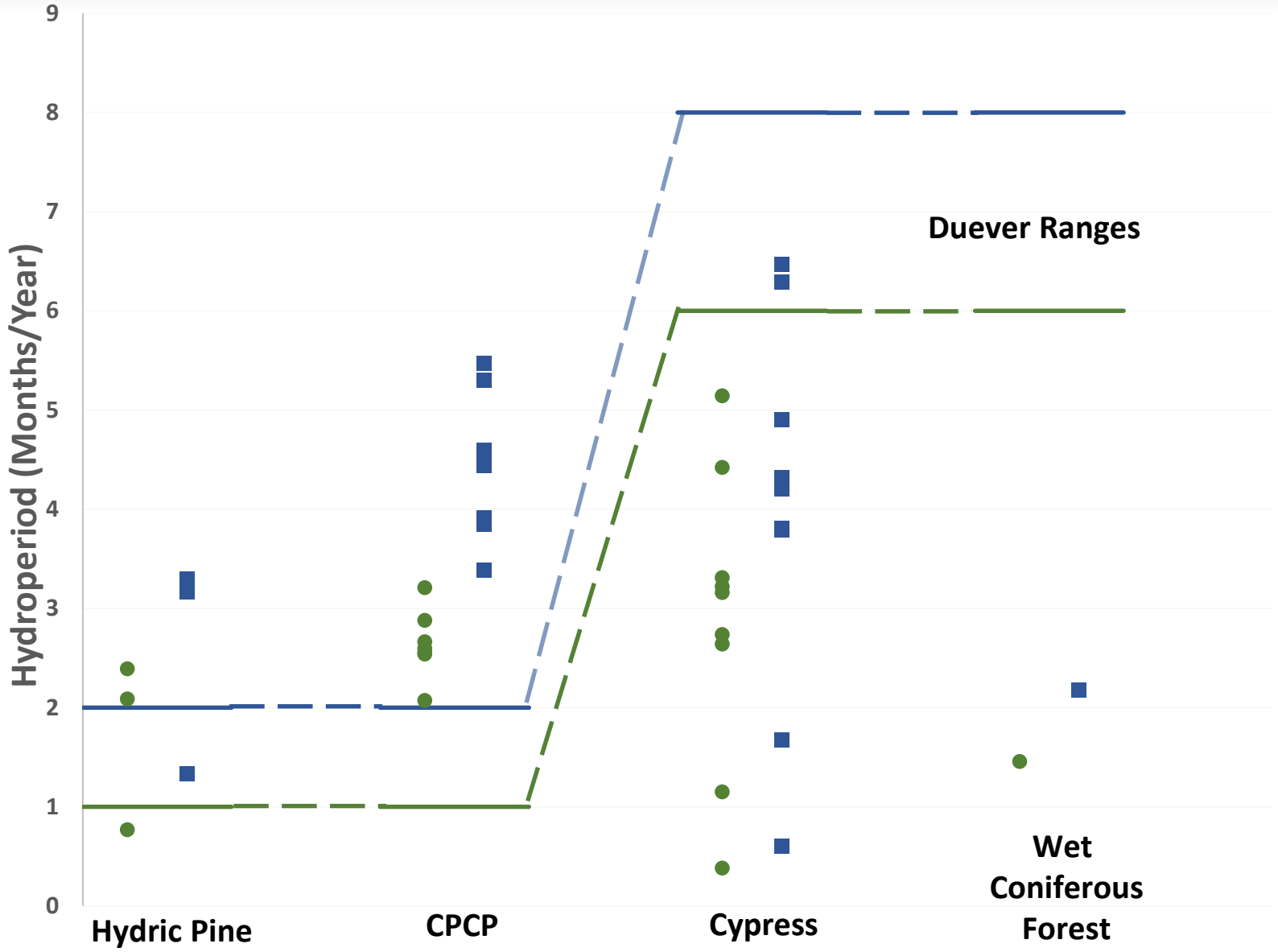
Flowway Extent



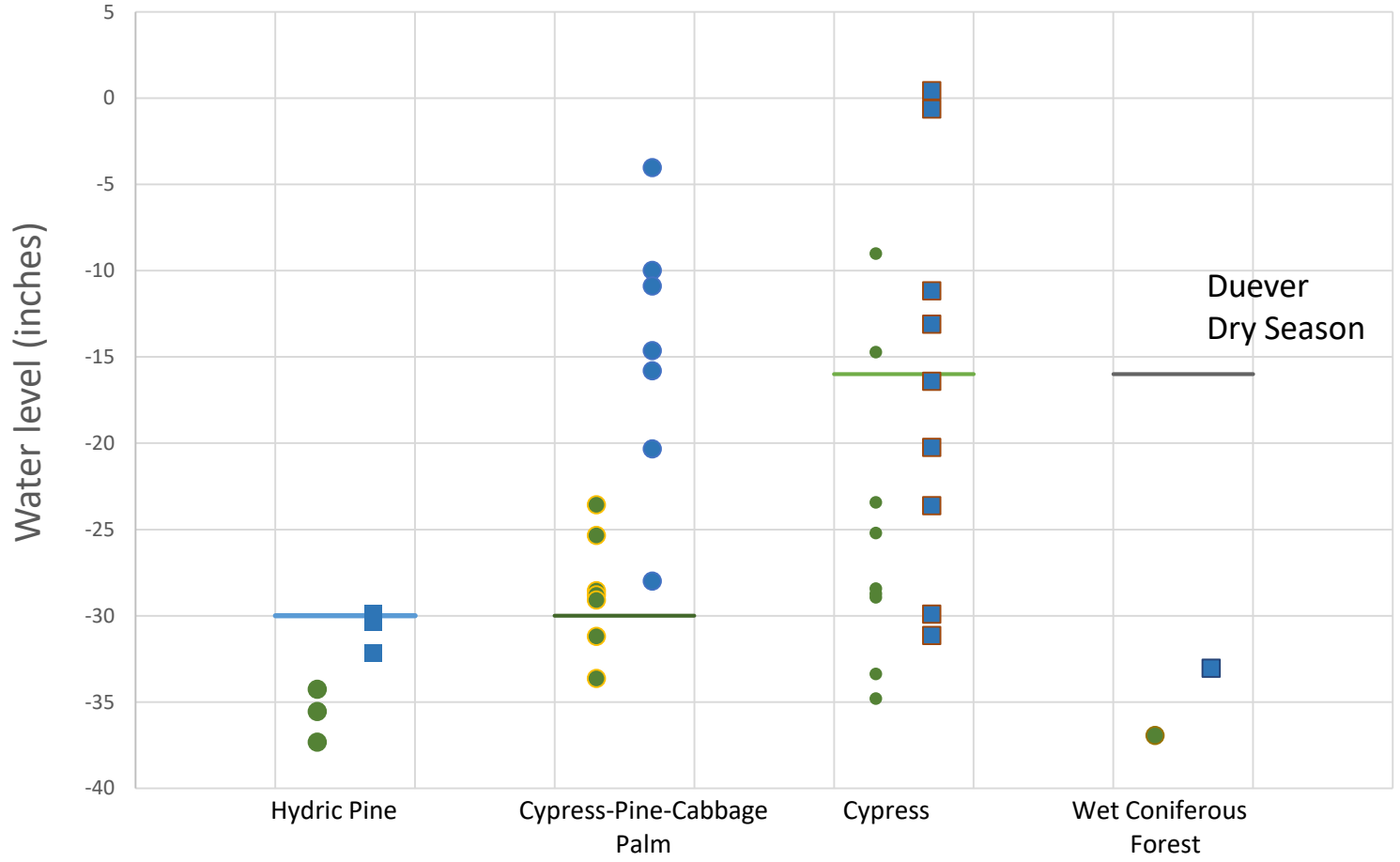
Flowway Extent Percent Vegetation Cover (Total Area = 6,538 acres)



Flowway Extent Median Hydroperiod

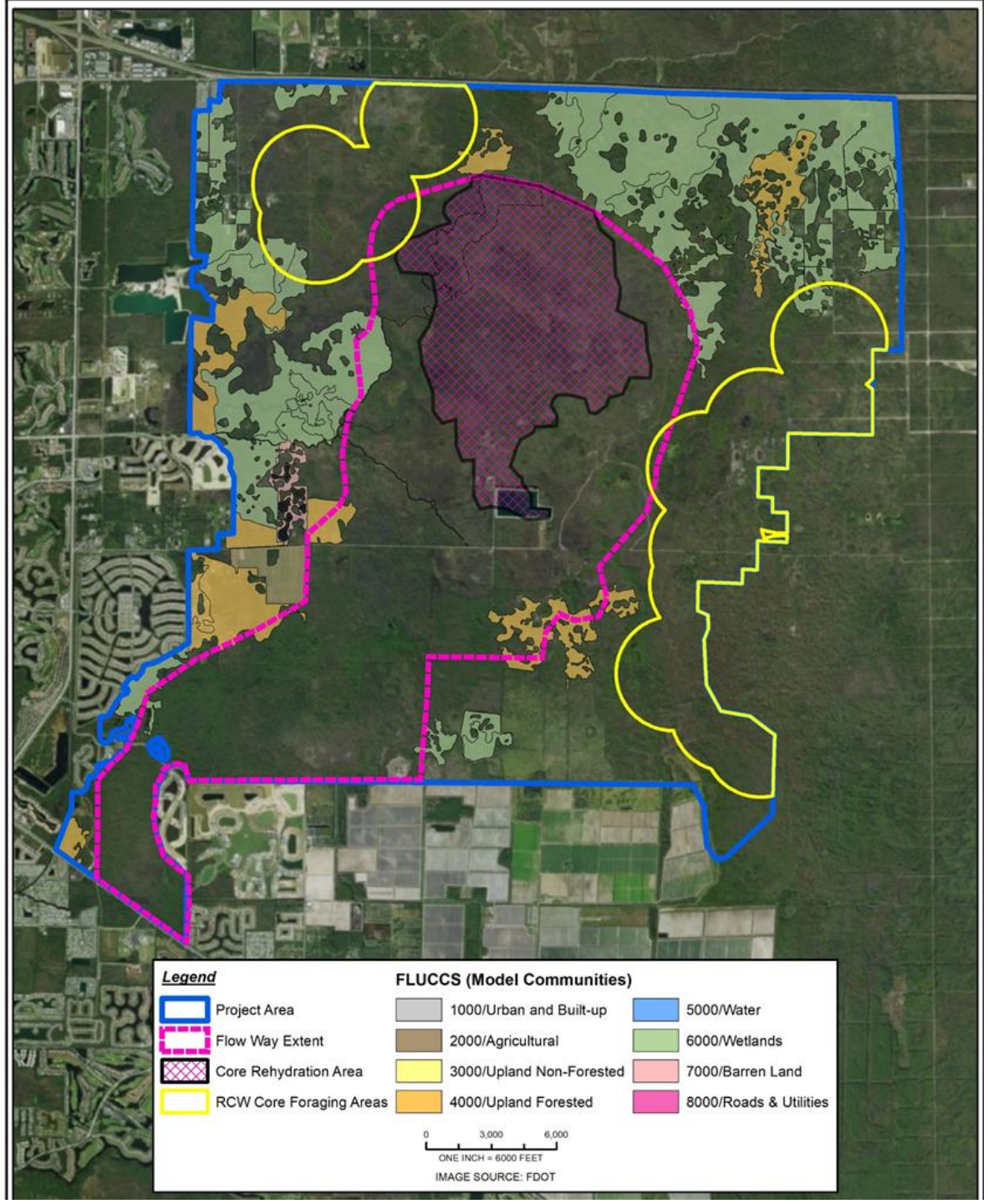


Flowway Extent Dry Season Median Water Elevations



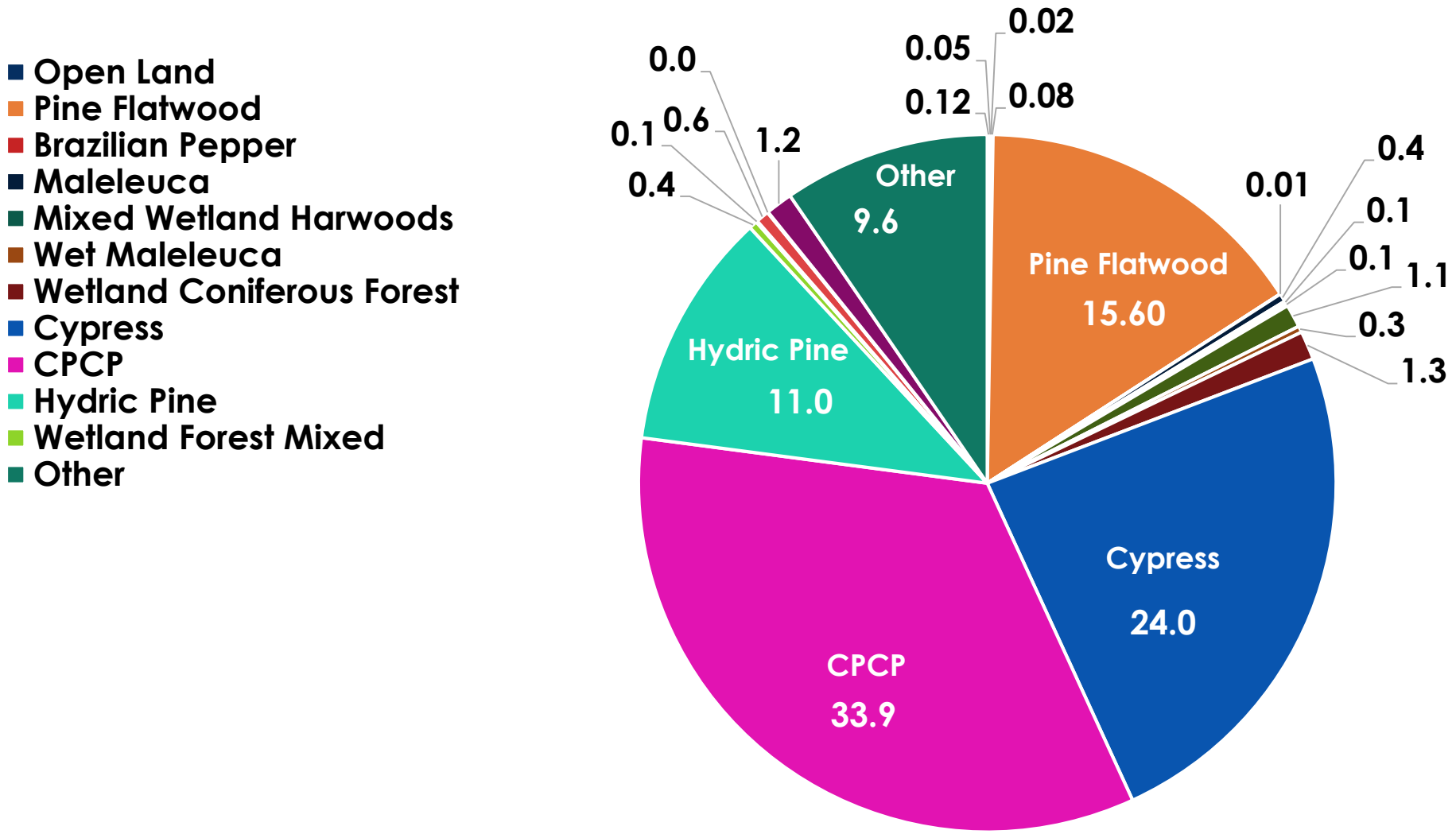
‘Other’ Assessment Areas

- Areas Outside the Flowway and RCW zones

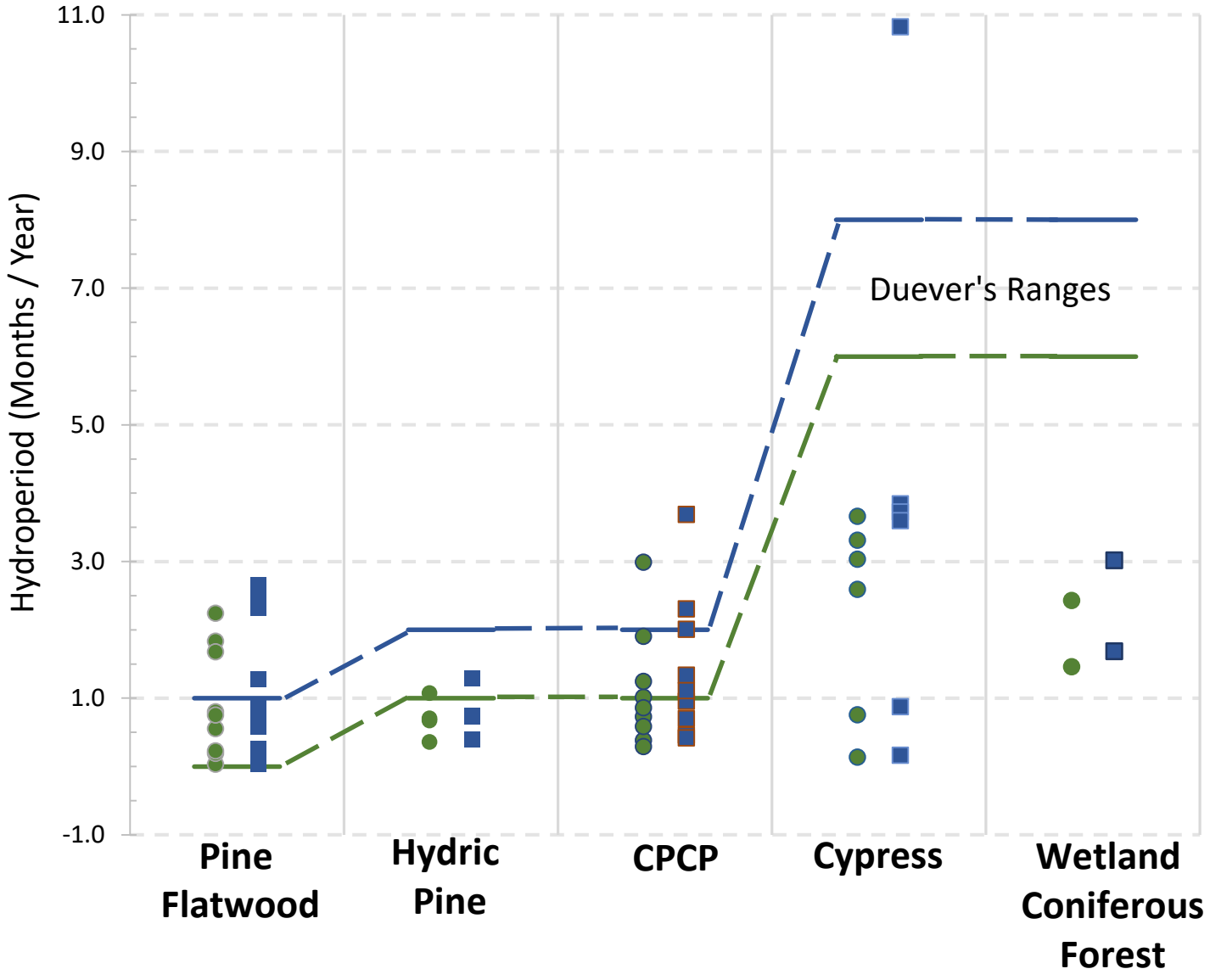


Other Communities Percent Vegetation Cover

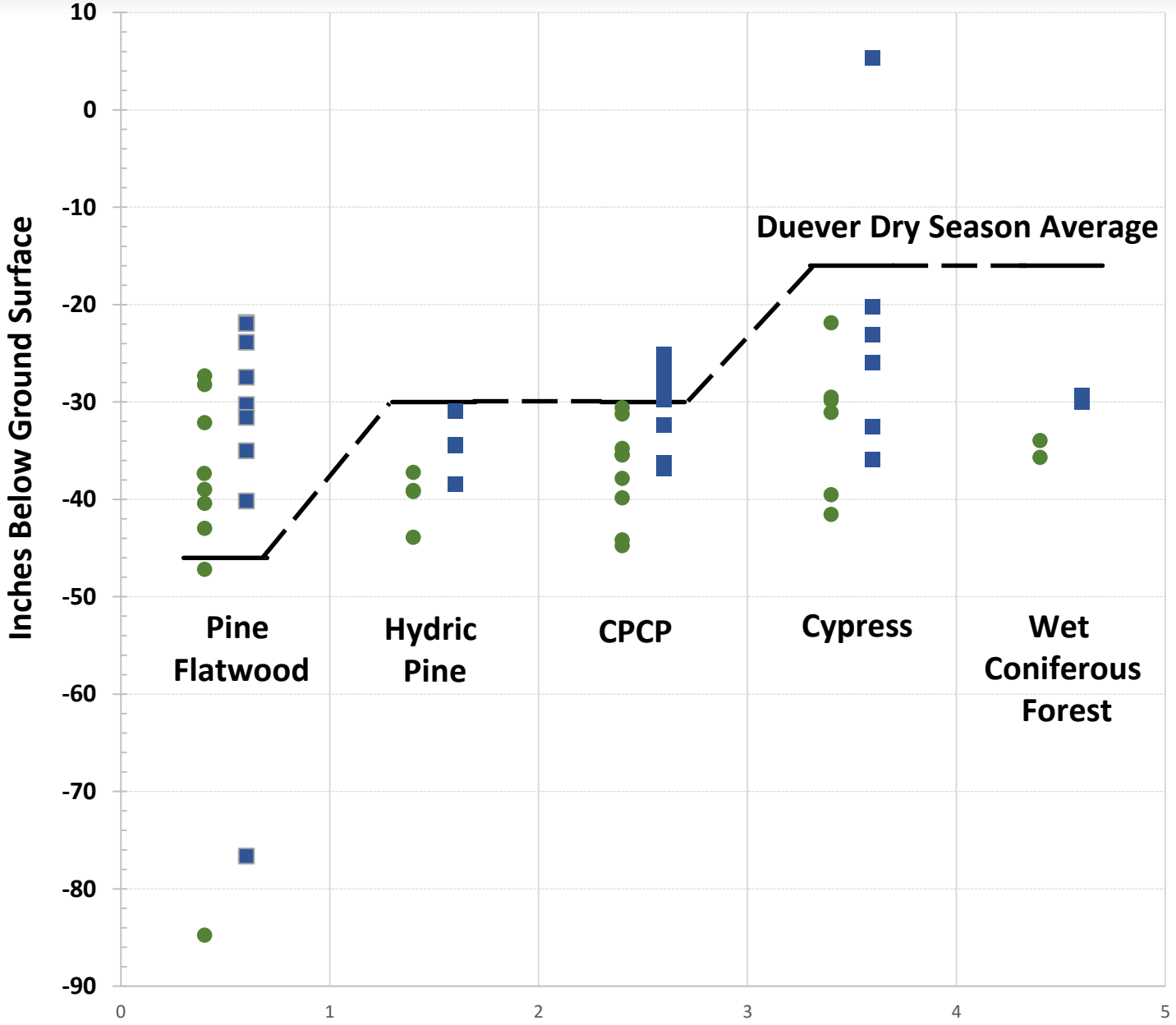
(Total Area = 11,878 acres)



Other Areas Hydroperiod Comparison



Other Areas Dry Season Median Water Elevation

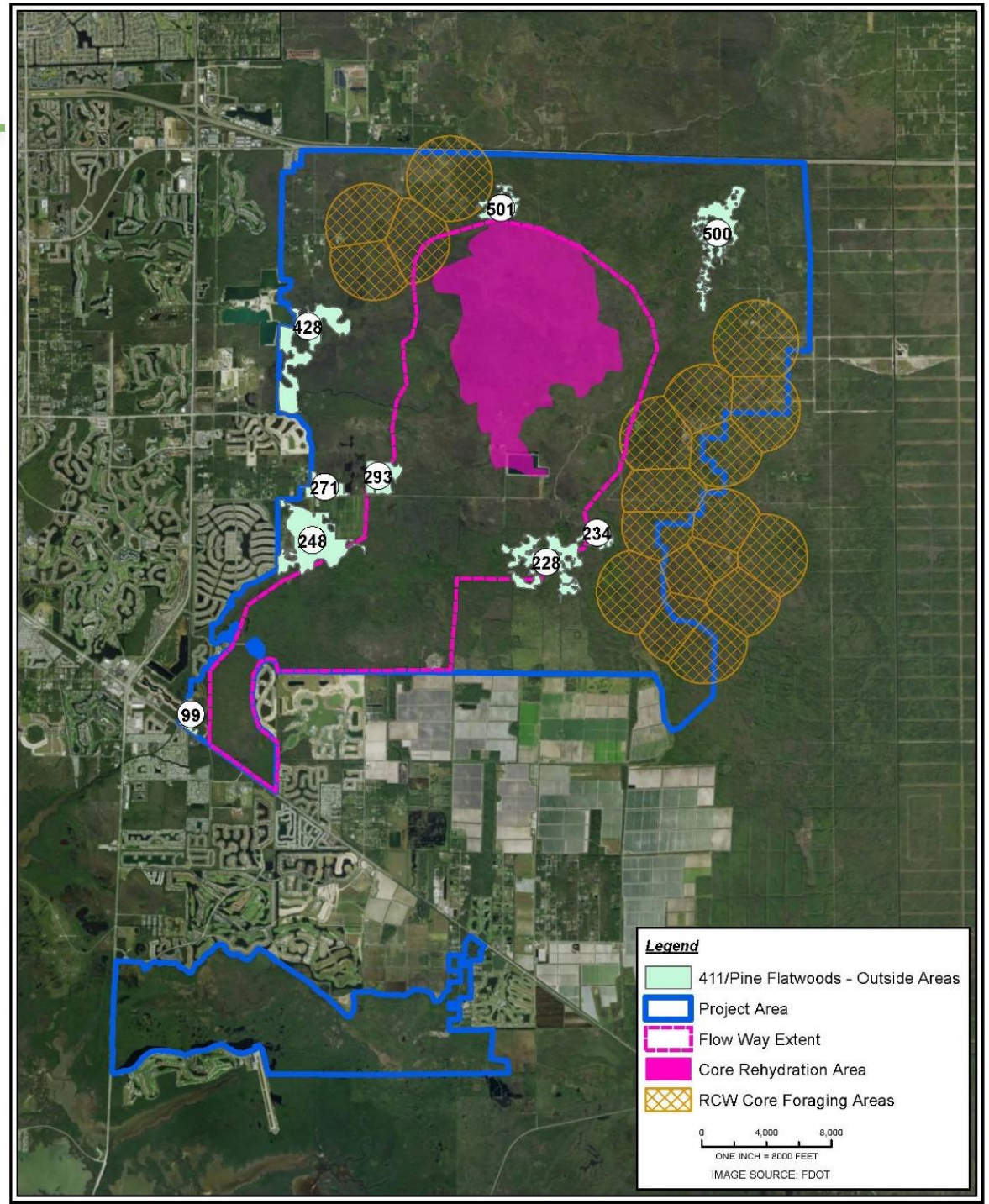


Other Areas – Pine Flatwoods

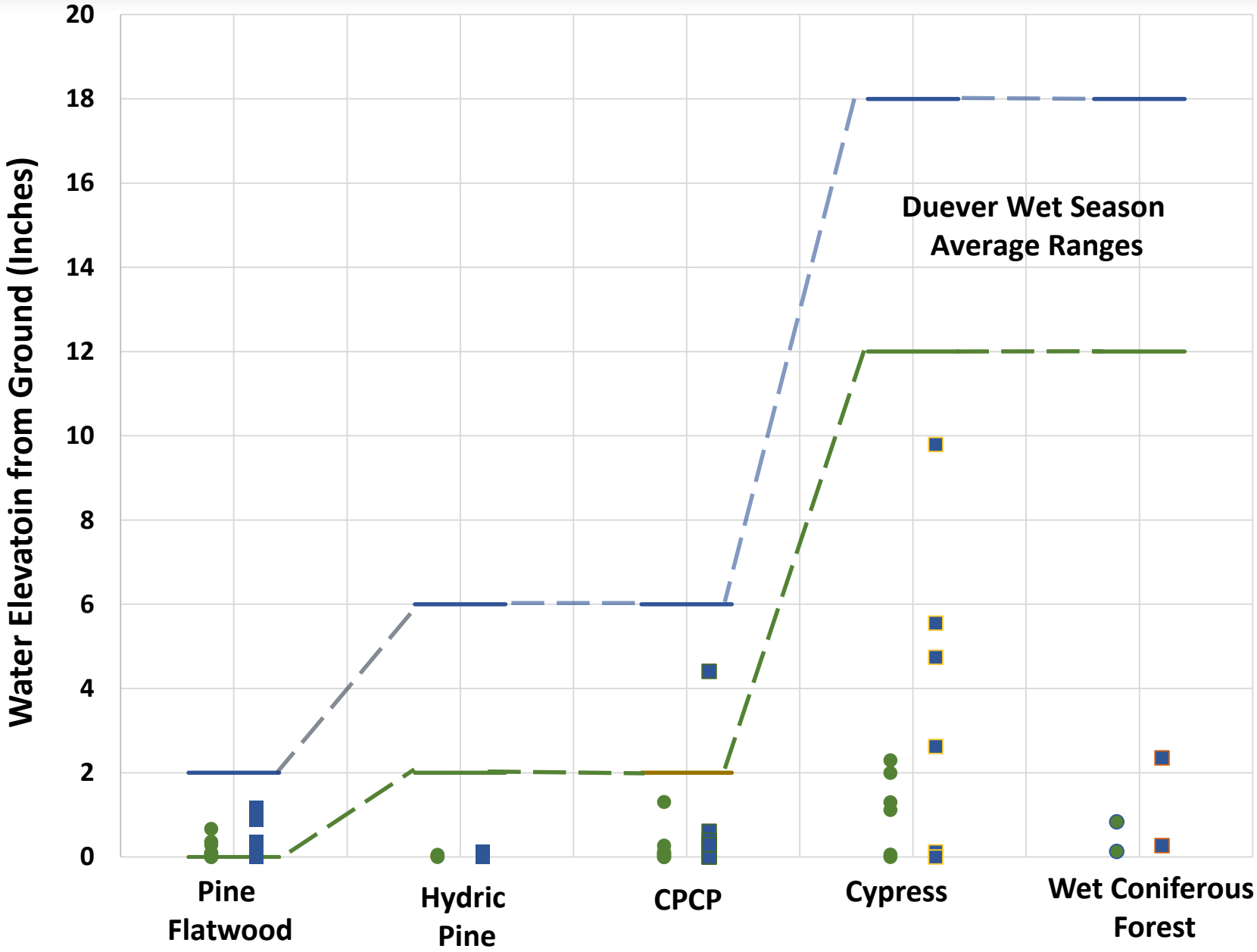
			Existing Conditions			With Project Condition		
ID	Area	Elevation	Hydroperiod	Dry Season Median	Wet Season Median	Hydroperiod	Dry Season Median	Wet Season Median
248	249.24	7.84	1.83	-32.13	0.36	2.32	-27.46	0.88
271	59.68	8.17	2.24	-28.21	0.67	2.65	-23.86	1.17
99	41.51	8.29	0.03	-84.75	0.00	0.03	-76.63	0.00
293	82.22	8.29	1.68	-27.33	0.29	2.43	-21.85	1.00
228	180.47	8.49	0.80	-37.35	0.09	1.28	-30.27	0.36
234	35.84	8.81	0.55	-38.98	0.10	0.81	-31.58	0.31
428	225.46	9.68	0.75	-40.40	0.07	0.85	-35.00	0.13
501	60.66	10.58	0.23	-42.97	0.02	0.57	-21.95	0.26
500	167.08	10.70	0.19	-47.18	0.00	0.26	-40.16	0.02

Correlations with Elevation of Polygon

HP	dry season	wet season	HP	dry season	wet season
-0.84	-0.88	-0.72	-0.86	-0.43	-0.80



Other Areas Wet Season Median Water Elevations

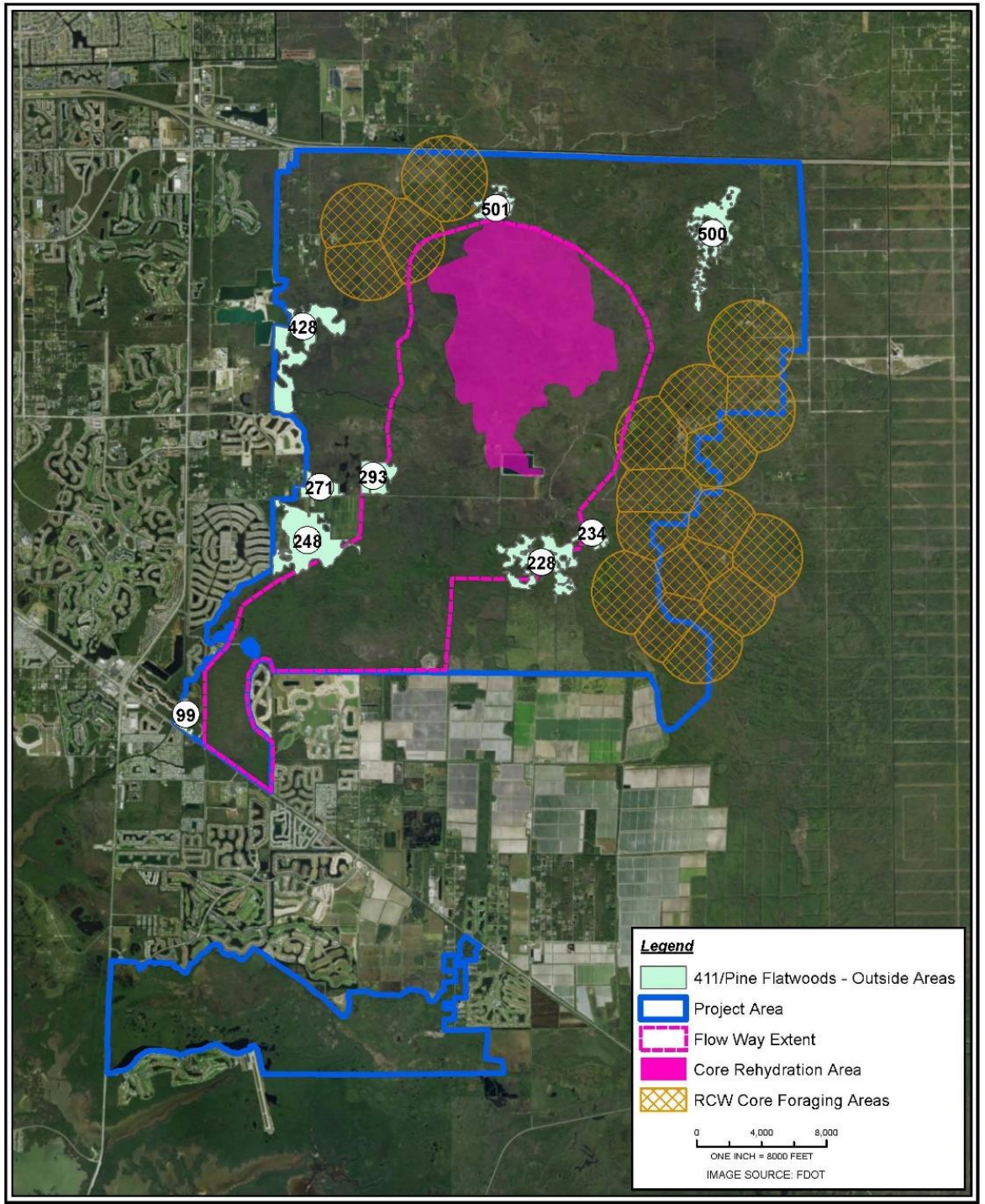


Other Areas – Pine Flatwoods Patches

			Existing Conditions			With Project Condition		
ID	Area	Elevation	Hydroperiod	Dry Season Median	Wet Season Median	Hydroperiod	Dry Season Median	Wet Season Median
248	249.24	7.84	1.83	-32.13	0.36	2.32	-27.46	0.88
271	59.68	8.17	2.24	-28.21	0.67	2.65	-23.86	1.17
99	41.51	8.29	0.03	-84.75	0.00	0.03	-76.63	0.00
293	82.22	8.29	1.68	-27.33	0.29	2.43	-21.85	1.00
228	180.47	8.49	0.80	-37.35	0.09	1.28	-30.27	0.36
234	35.84	8.81	0.55	-38.98	0.10	0.81	-31.58	0.31
428	225.46	9.68	0.75	-40.40	0.07	0.85	-35.00	0.13
501	60.66	10.58	0.23	-42.97	0.02	0.57	-21.95	0.26
500	167.08	10.70	0.19	-47.18	0.00	0.26	-40.16	0.02

Correlations with Elevation

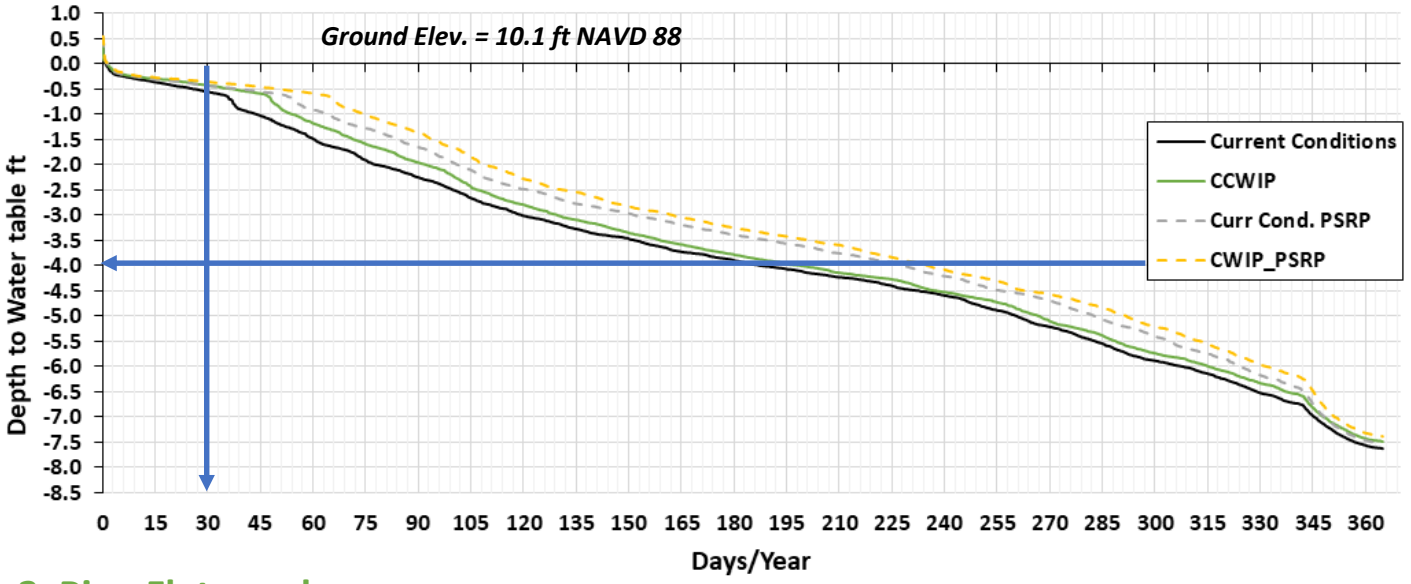
Existing			With Project		
HP	Dry Season	wet season	HP	Dry Season	wet season
-0.64	**-0.10**	**-0.59**	**-0.63**	**0.08**	**-0.62**



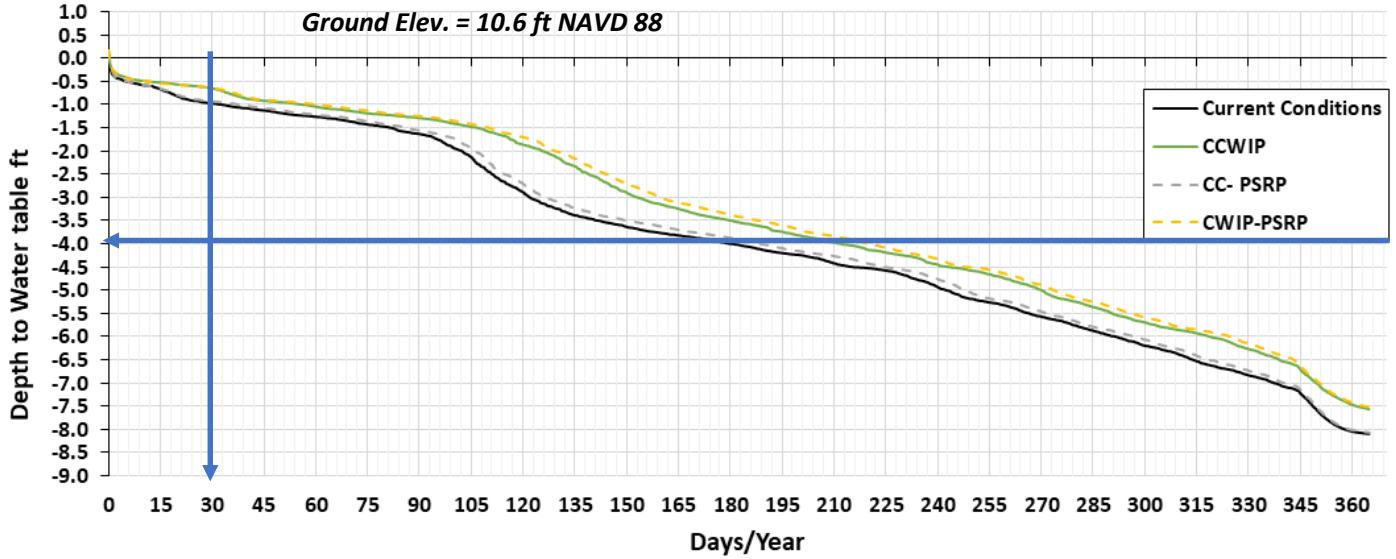
Stage-Duration Curves – Current and CWIP Conditions

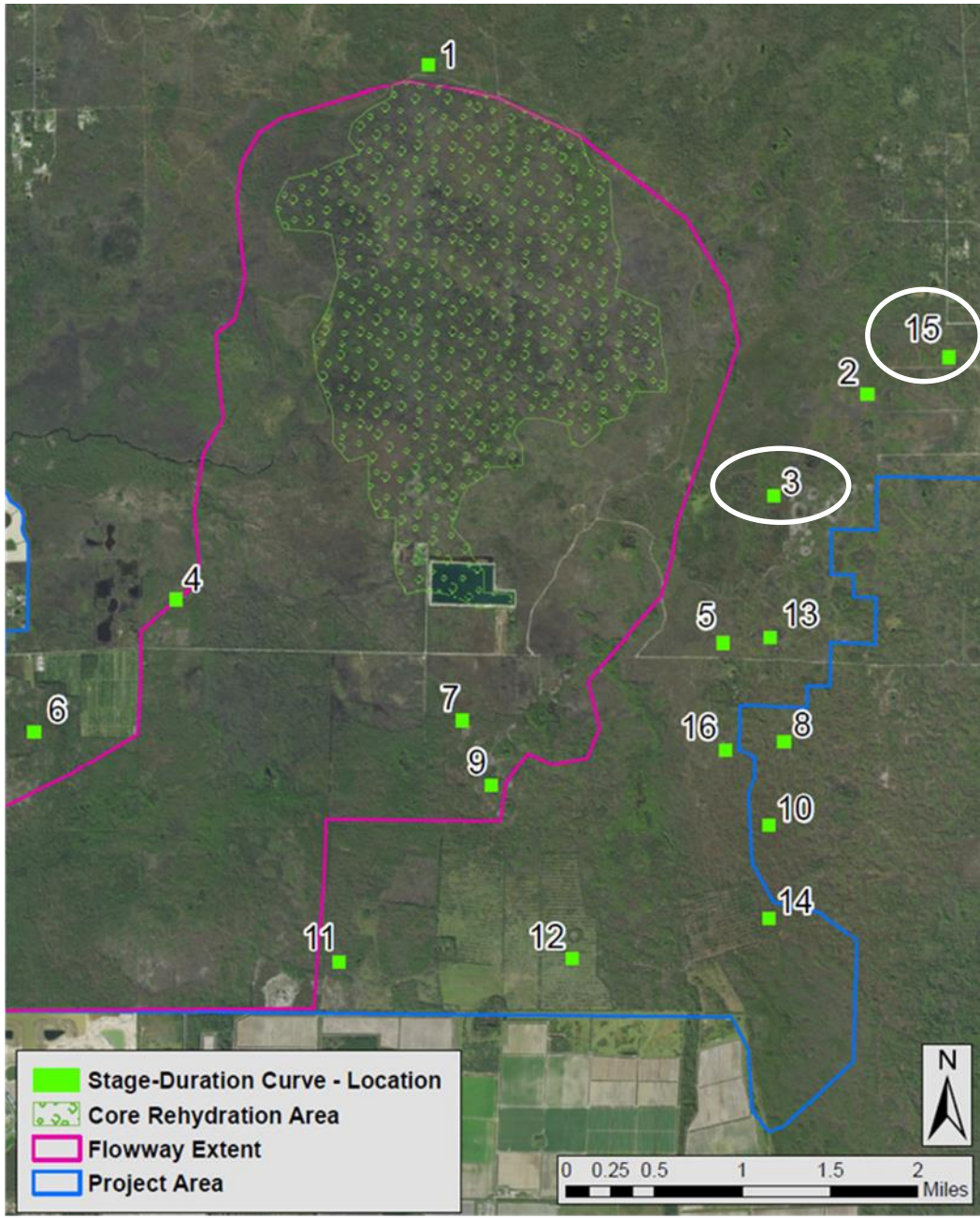
15 : Pine Flatwoods (ID=500)

Ground elevation of 1 grid cell



3 Pine Flatwoods

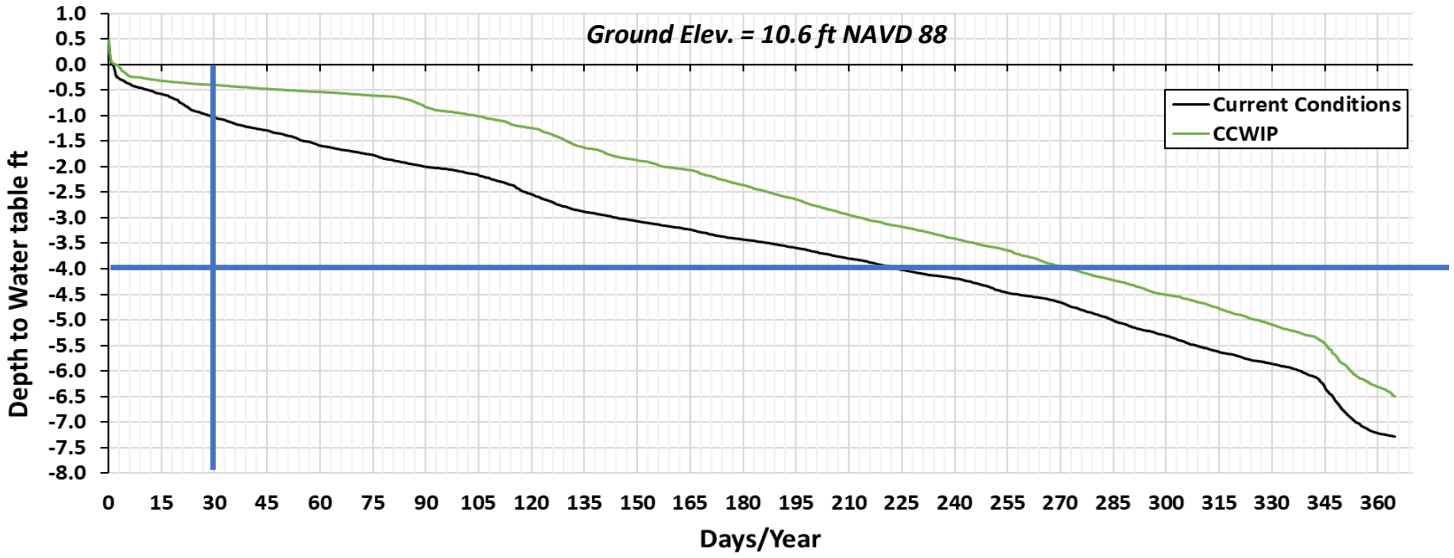




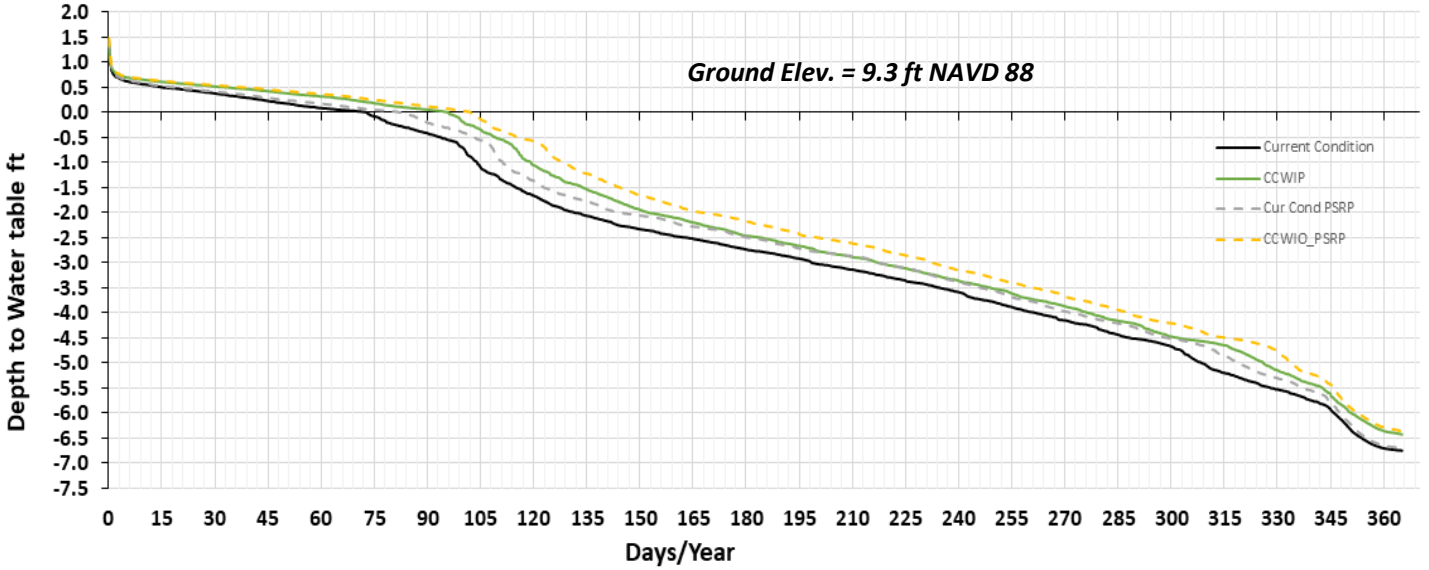
Stage-Duration Curves: Current Conditions and CWIP

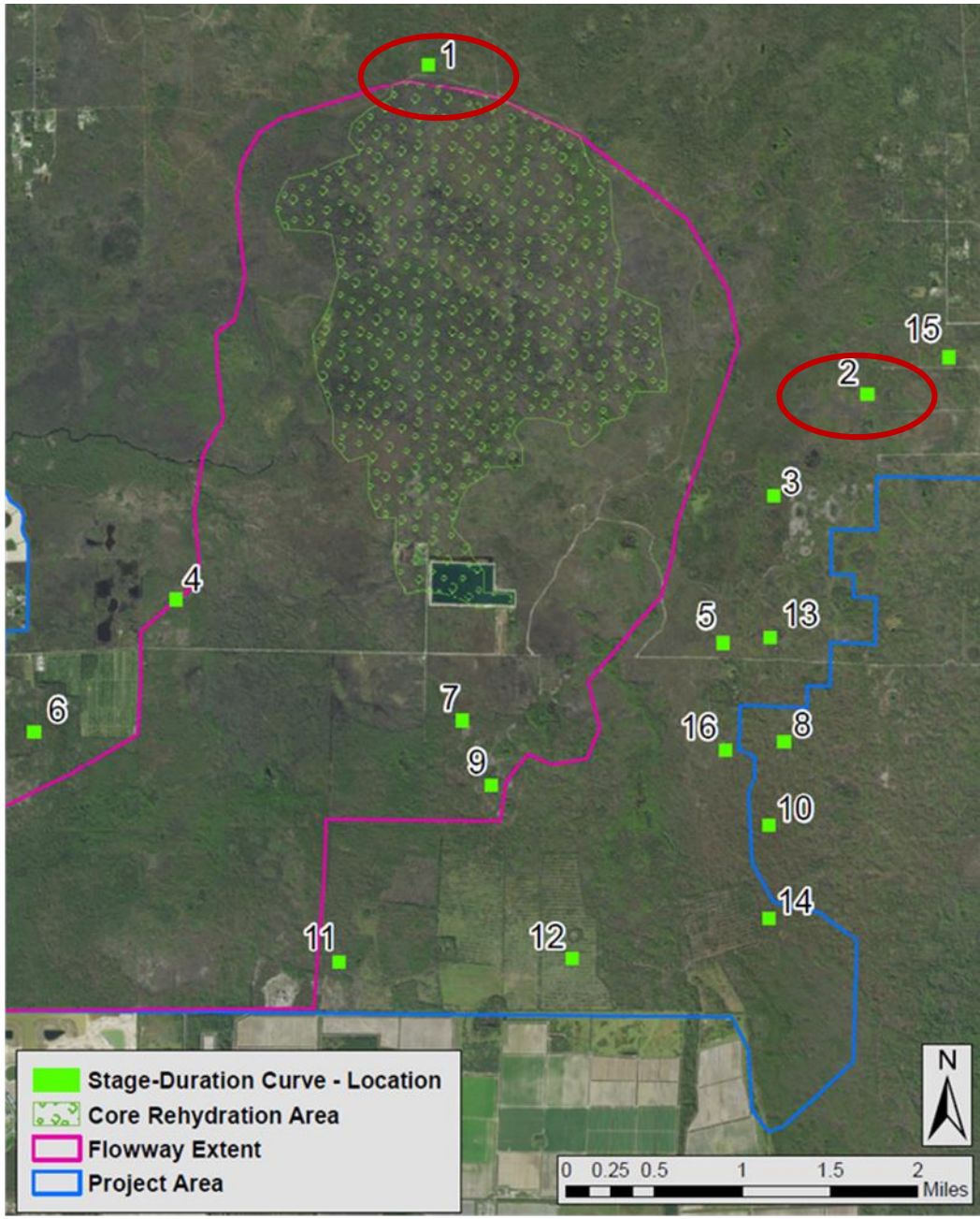
Ground elevation of 1 grid cell

1: Pine Flatwoods (ID= 501)



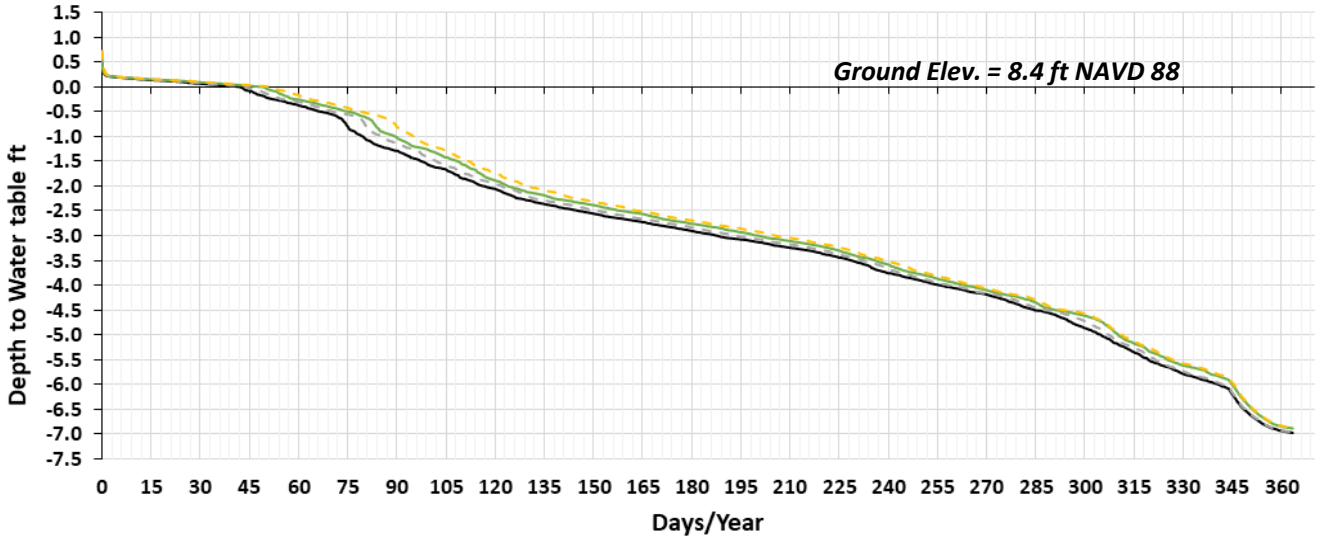
2: Cypress Pine Cabbage Palm



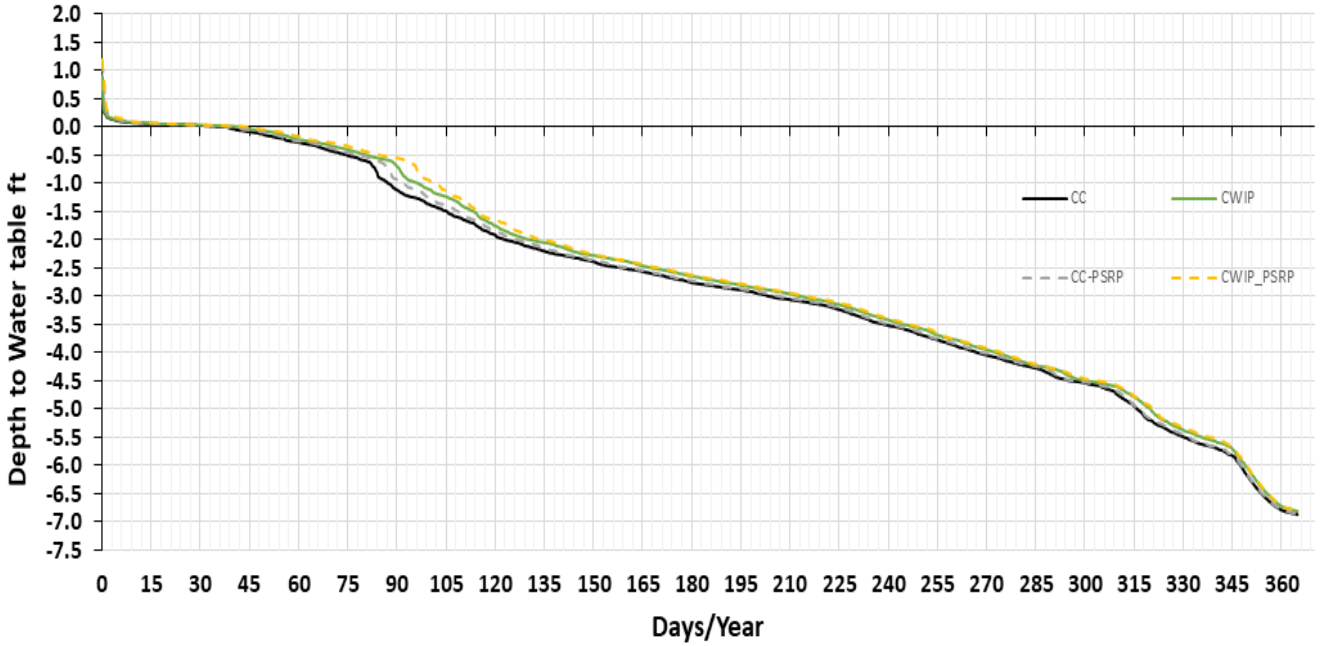


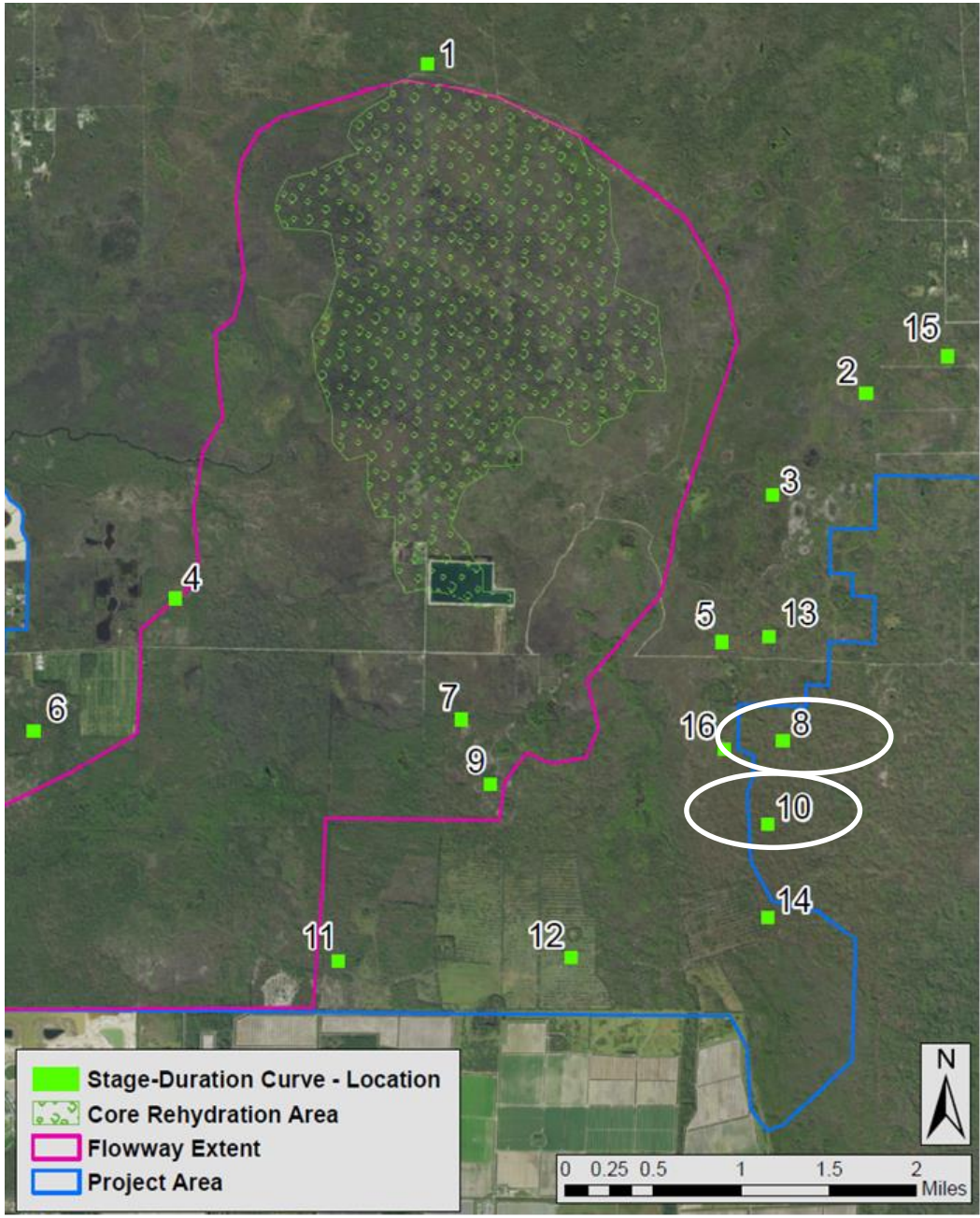
Stage-Duration Curves – Current and CWIP Conditions

8 Cypress-Pine- Cabbage Palm



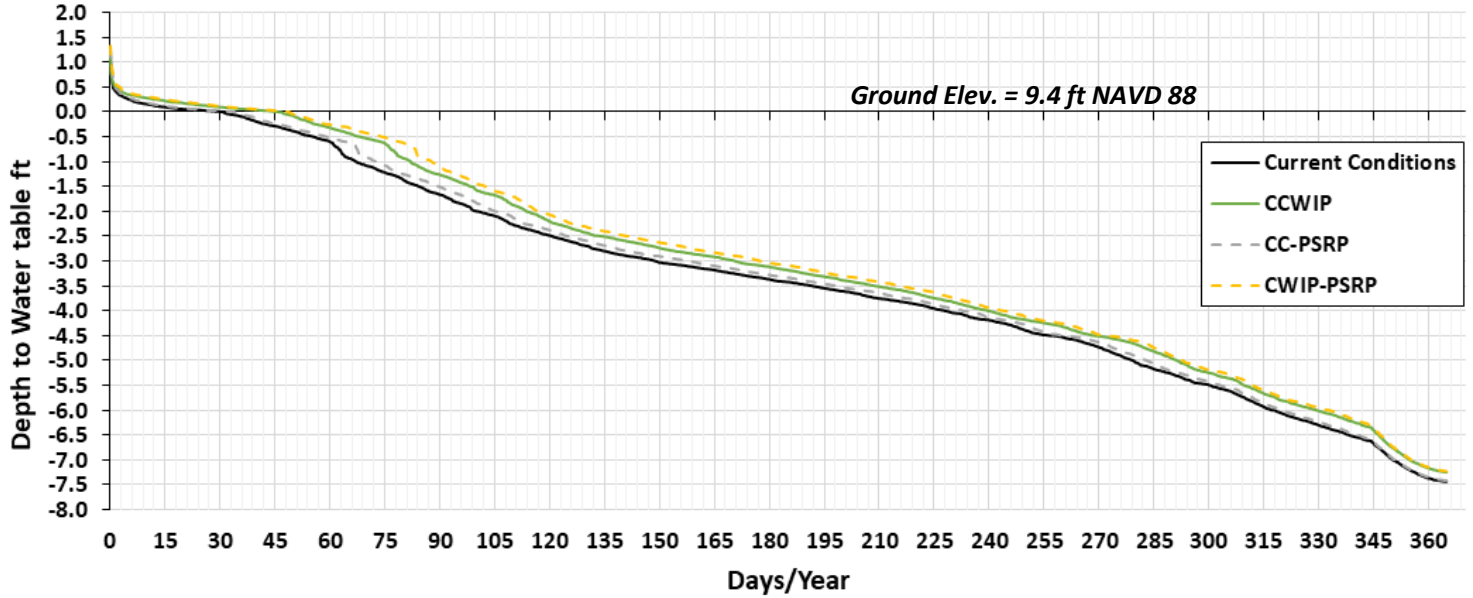
10 Cypress-Pine- Cabbage Palm



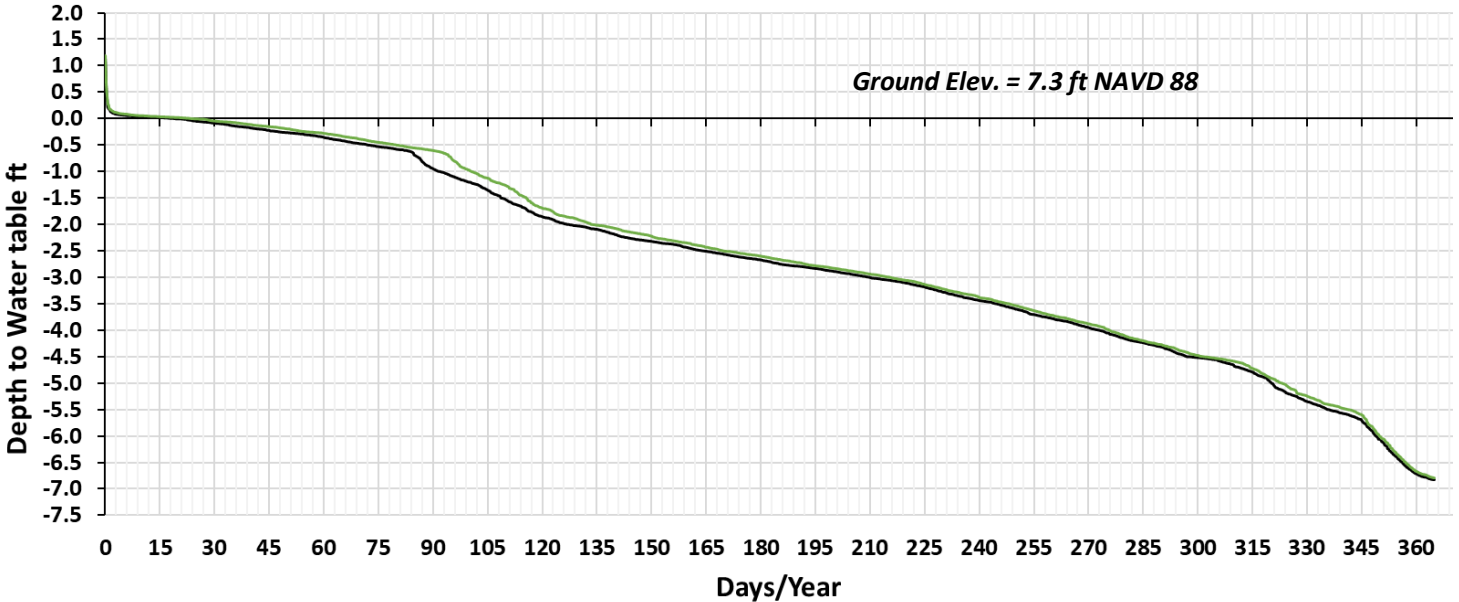


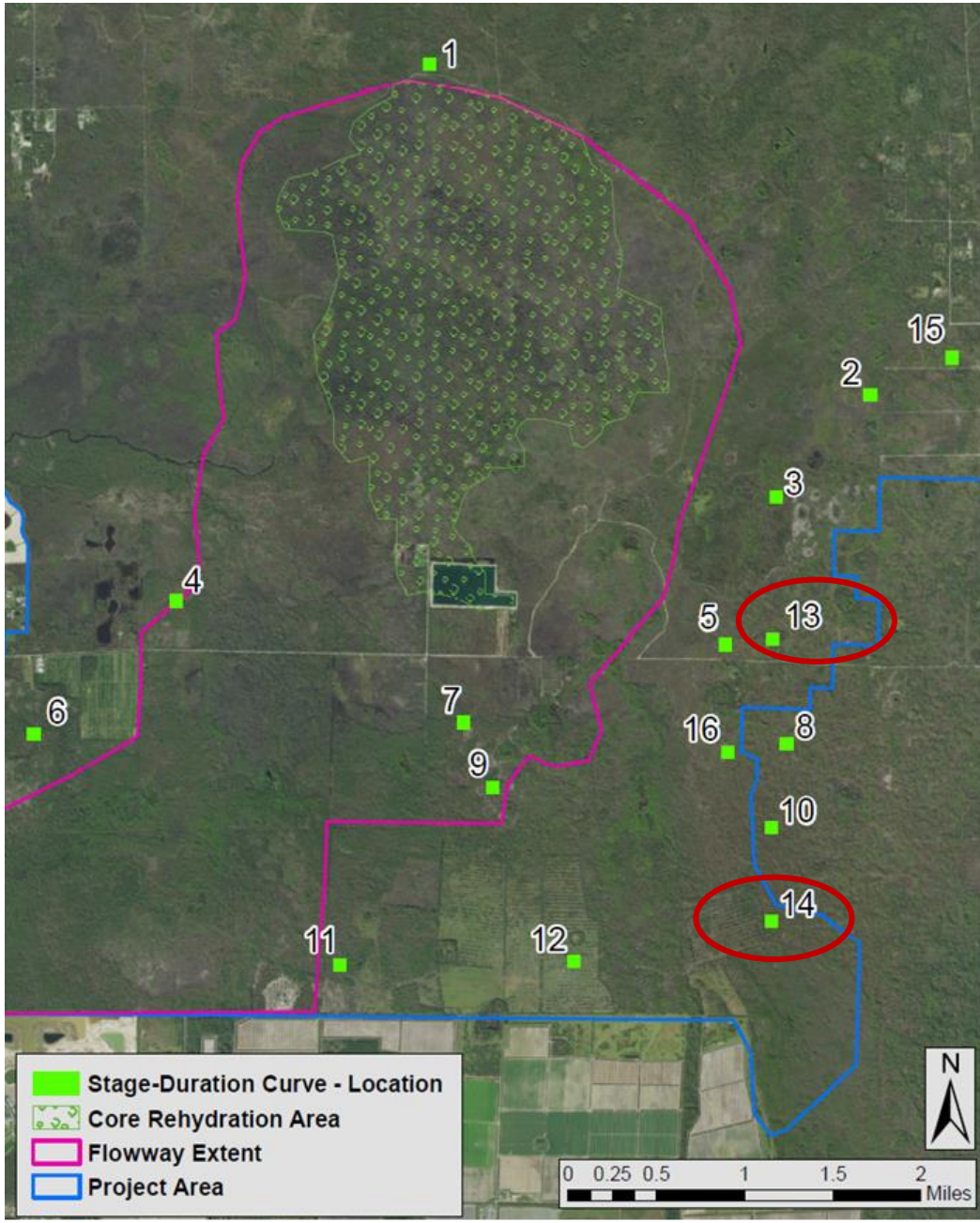
Water Table Depths (ft) – Current Conditions and CWIP

13 : Hydric Pine



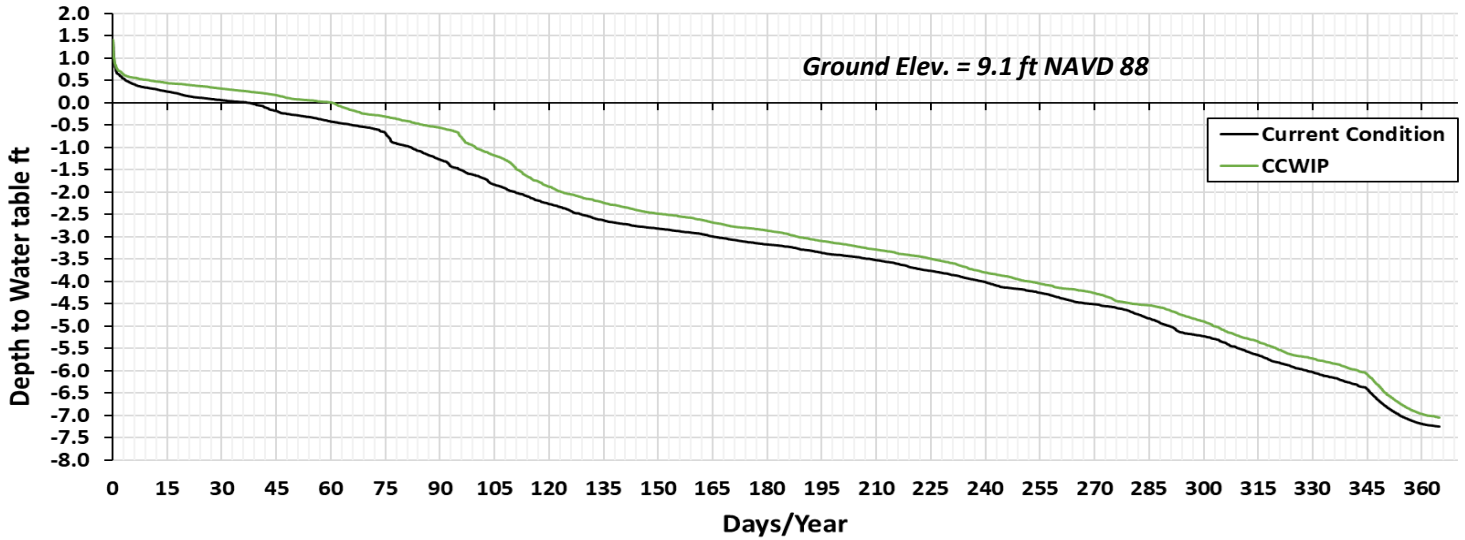
14 : Hydric Pine



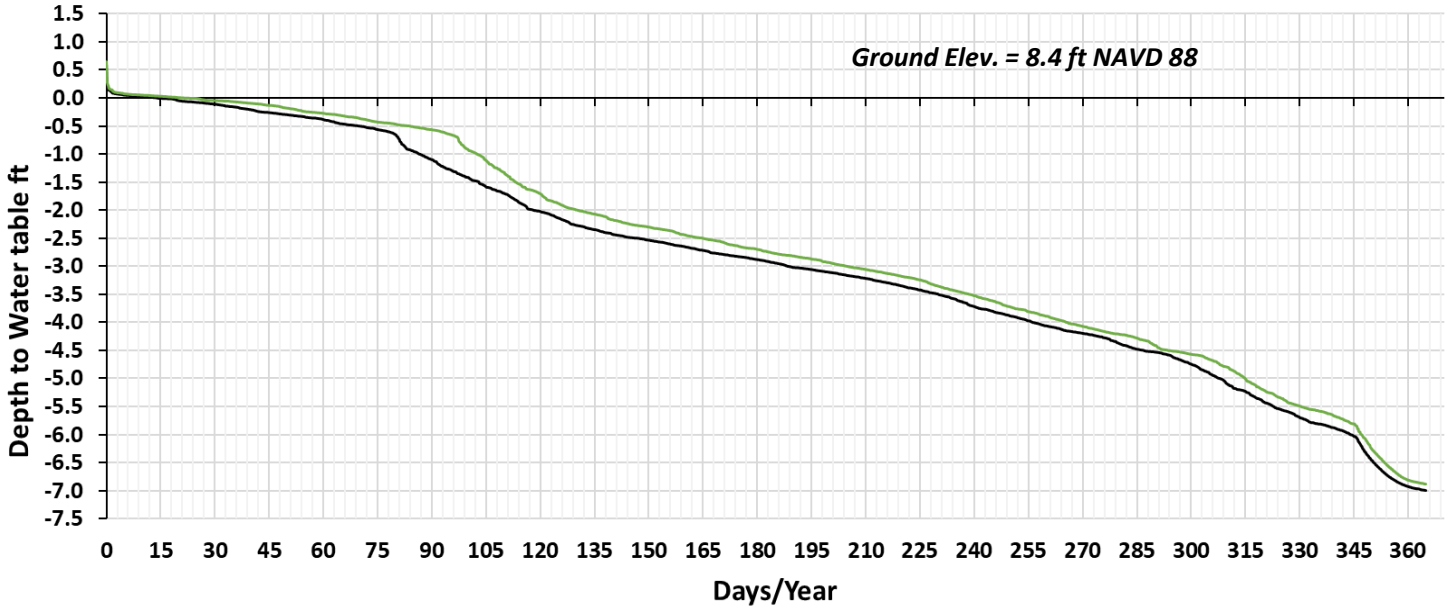


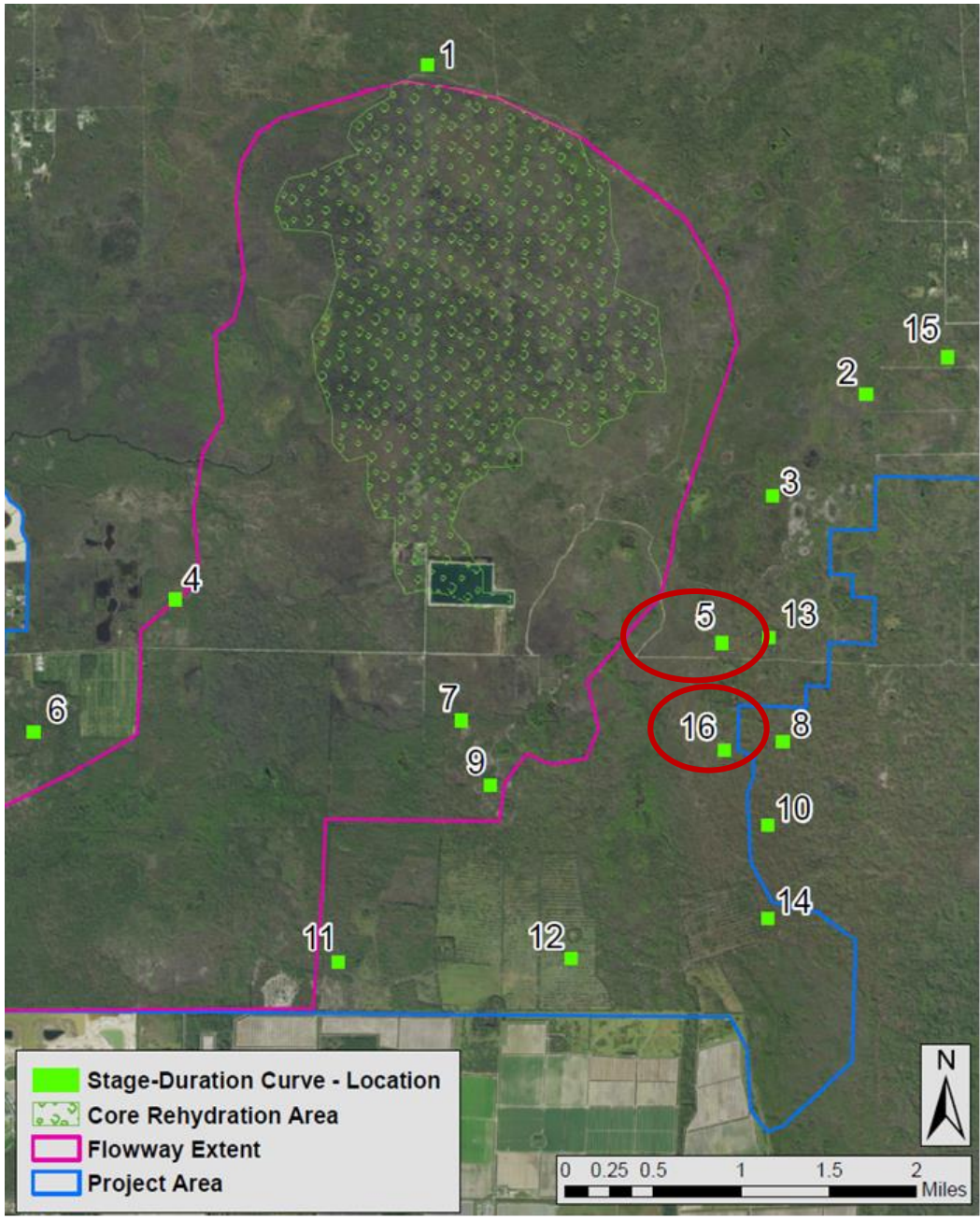
Water Table Depths (ft) in IR – Current Conditions and CWIP

5: Hydric Pine -



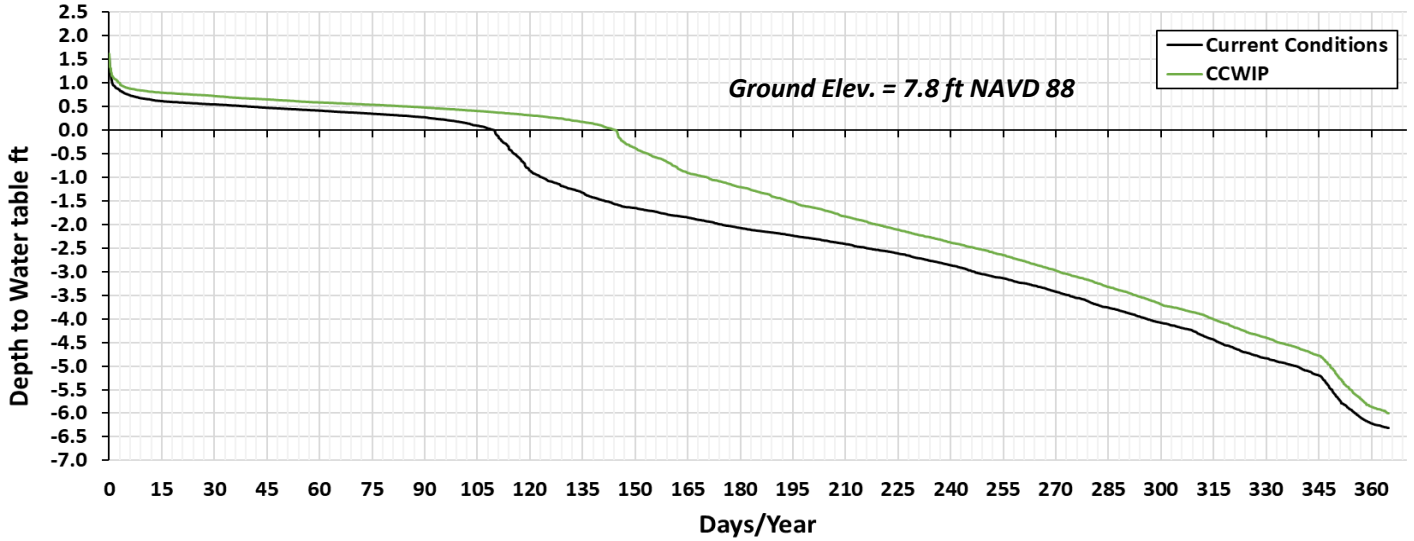
16 : Pine Flatwoods



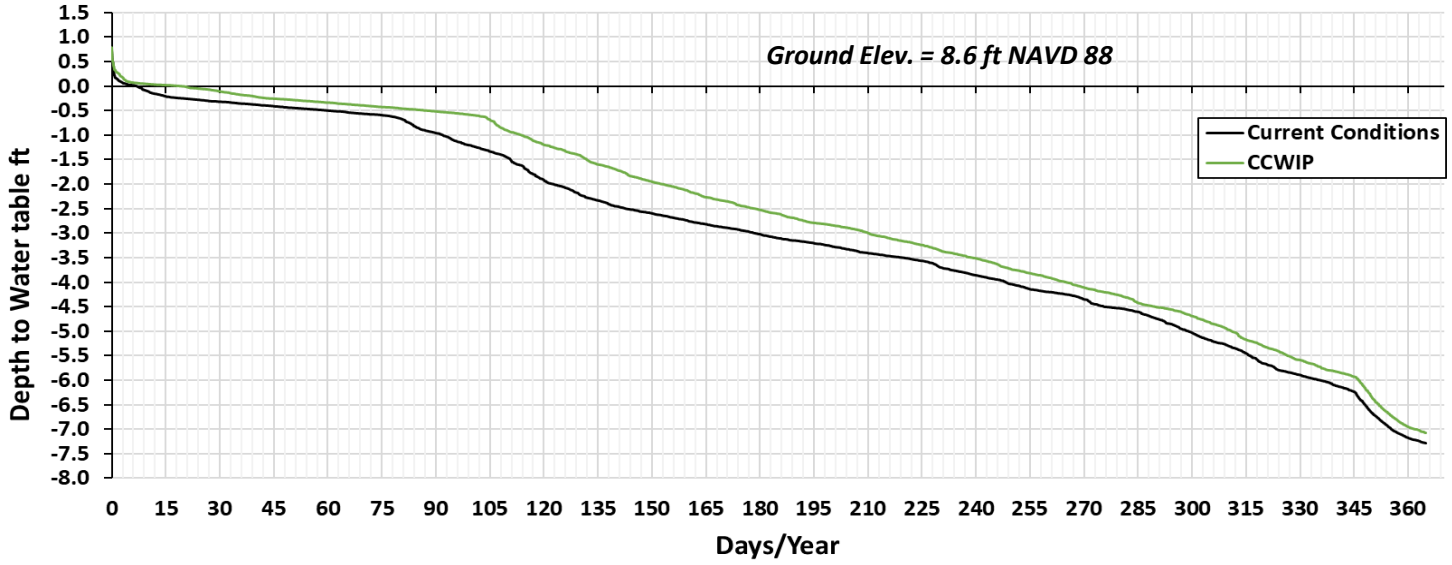


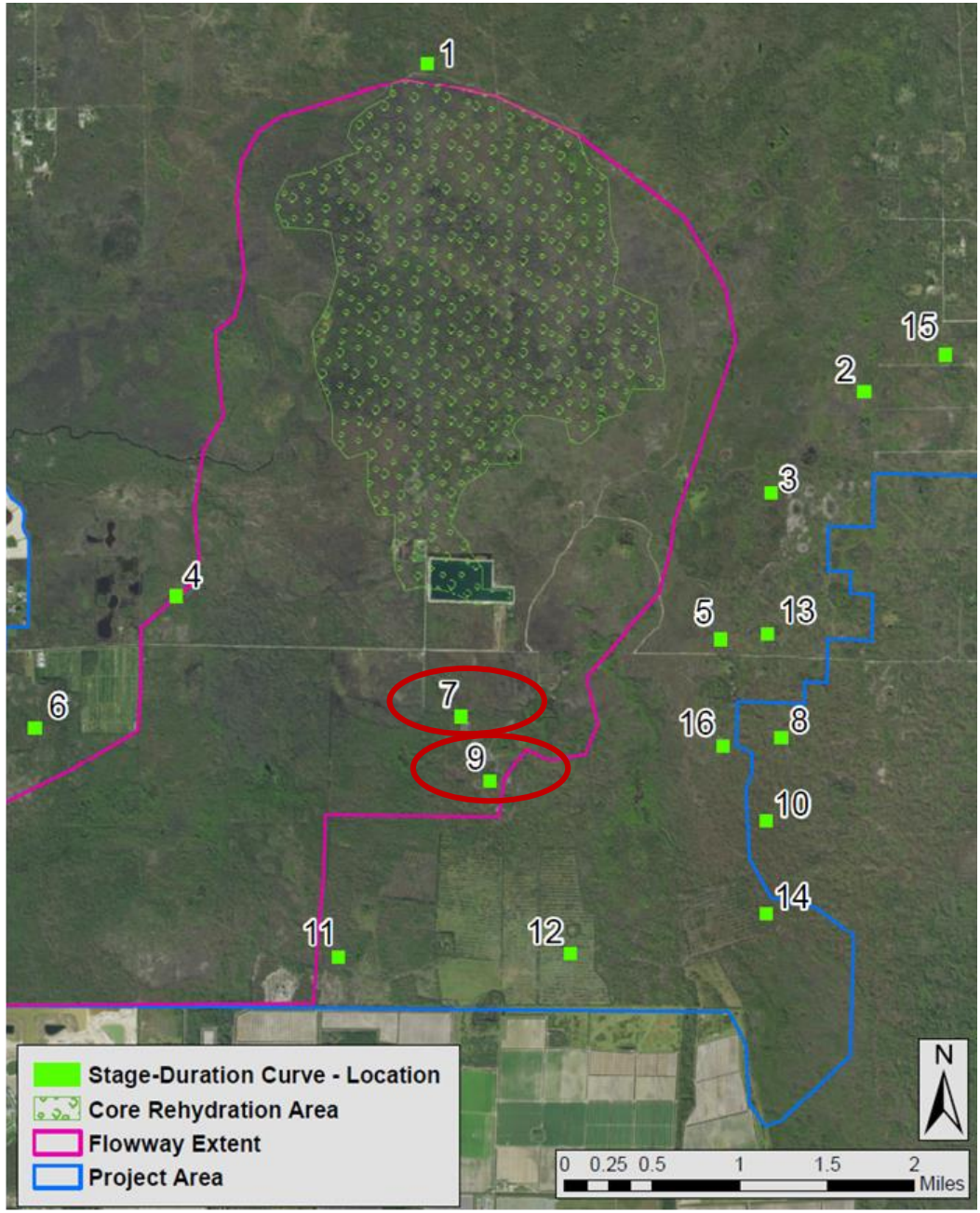
Water Table Depths (ft) – Current Conditions and CWIP

7: Cypress Pine Cabbage Palm



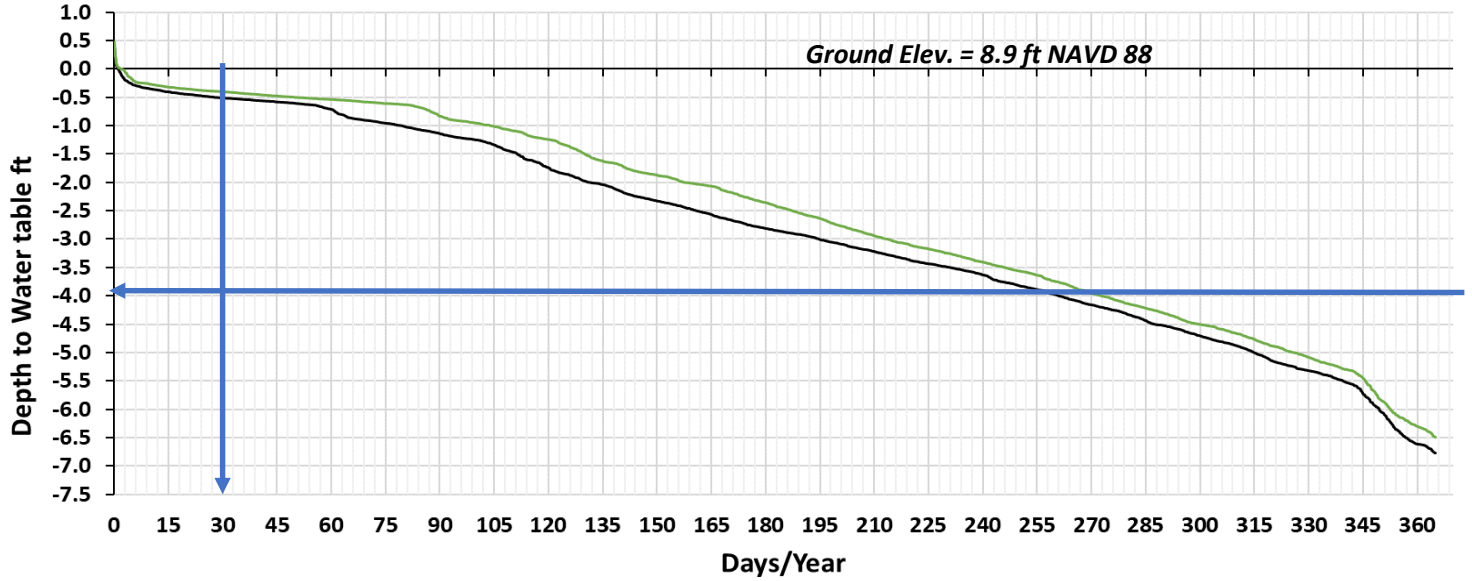
9: Pine Flatwoods



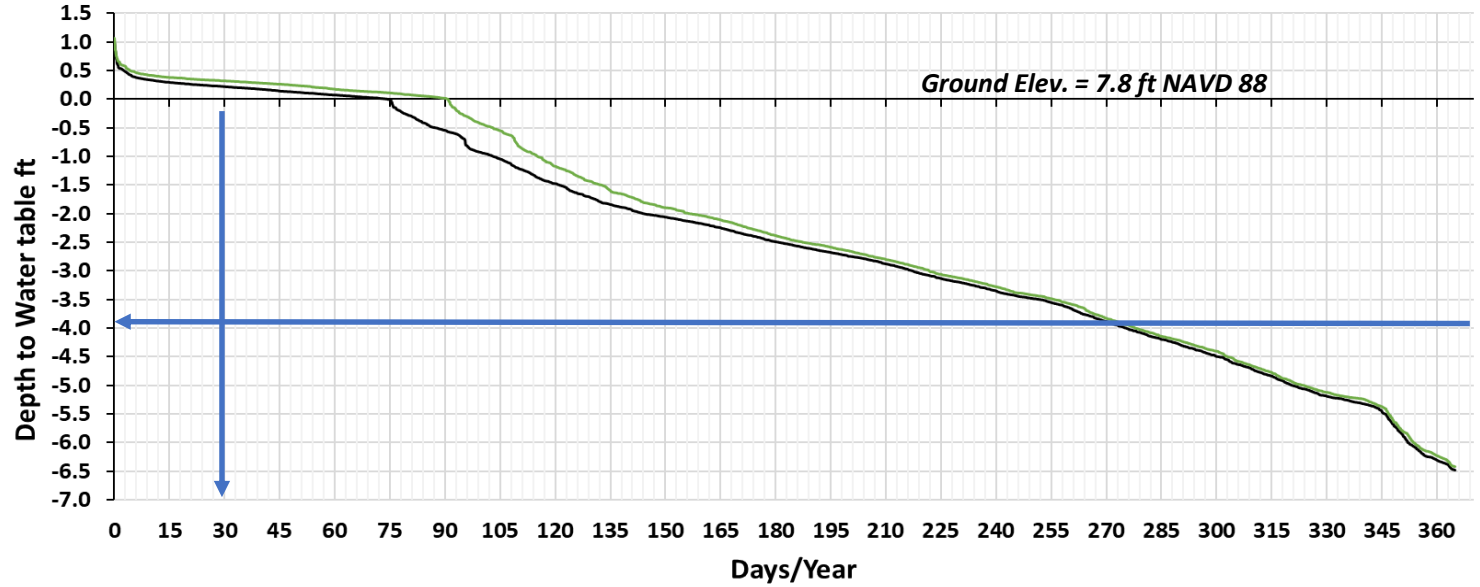


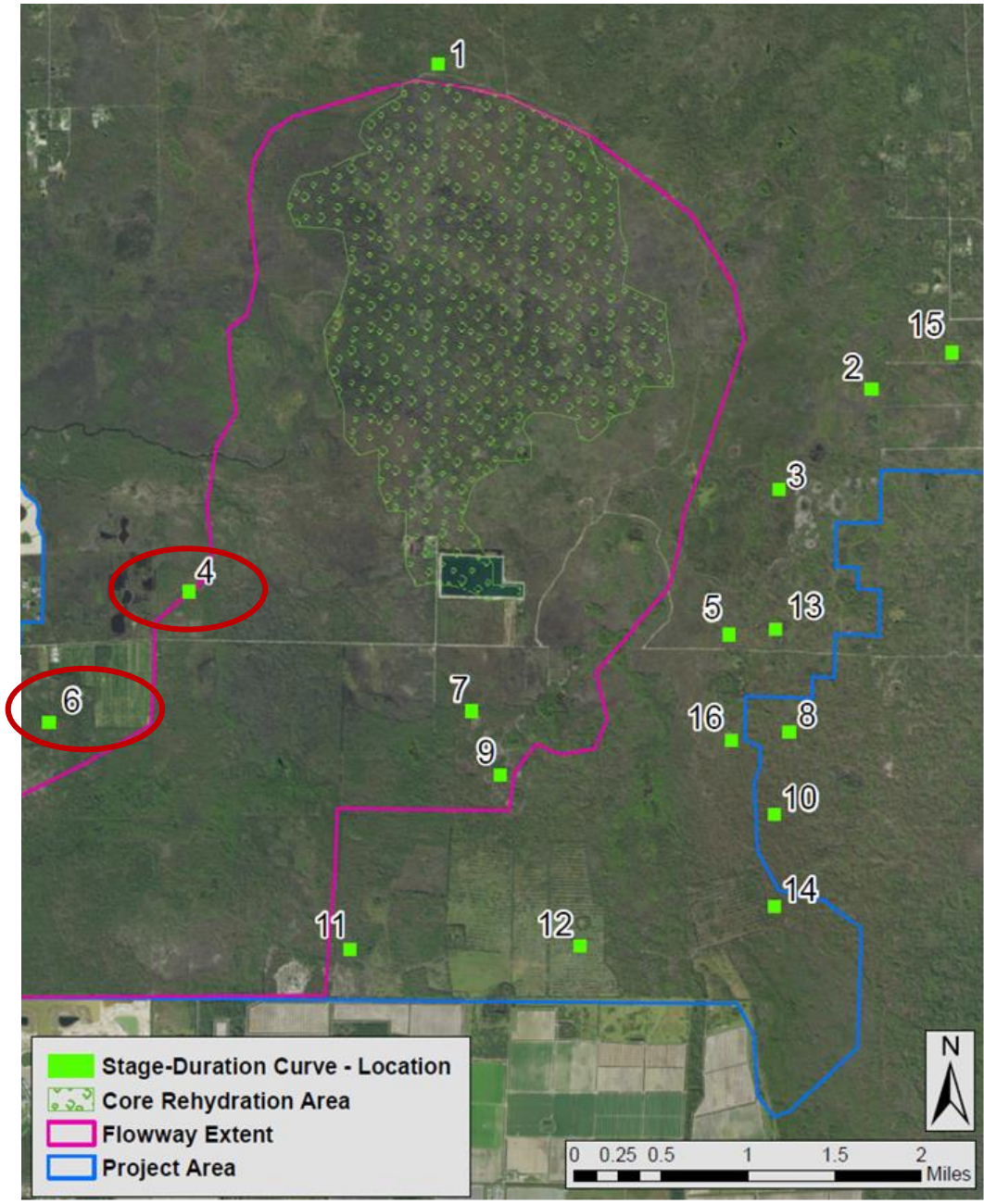
Stage-Duration Curves – Current and CWIP Conditions

4: Pine Flatwoods

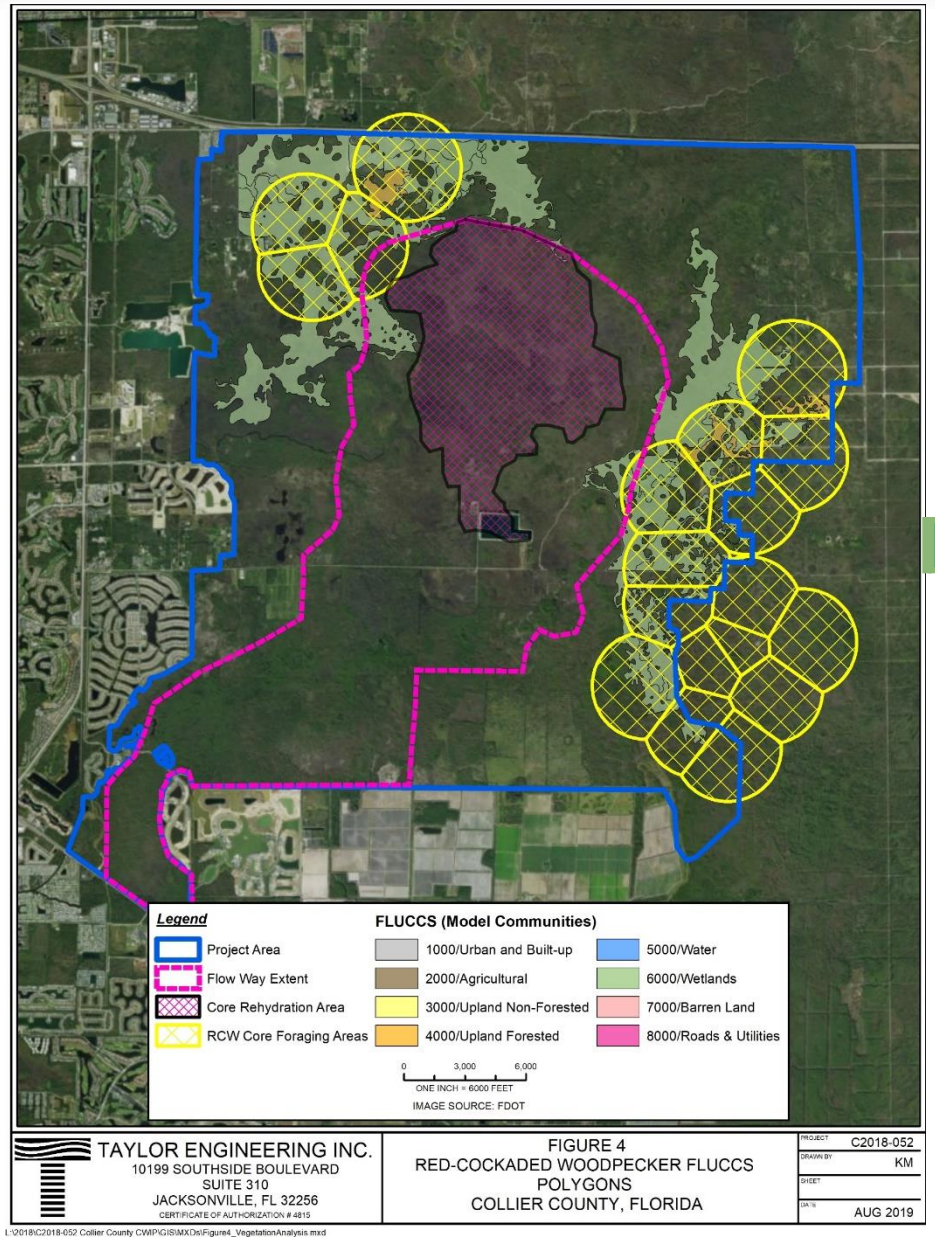


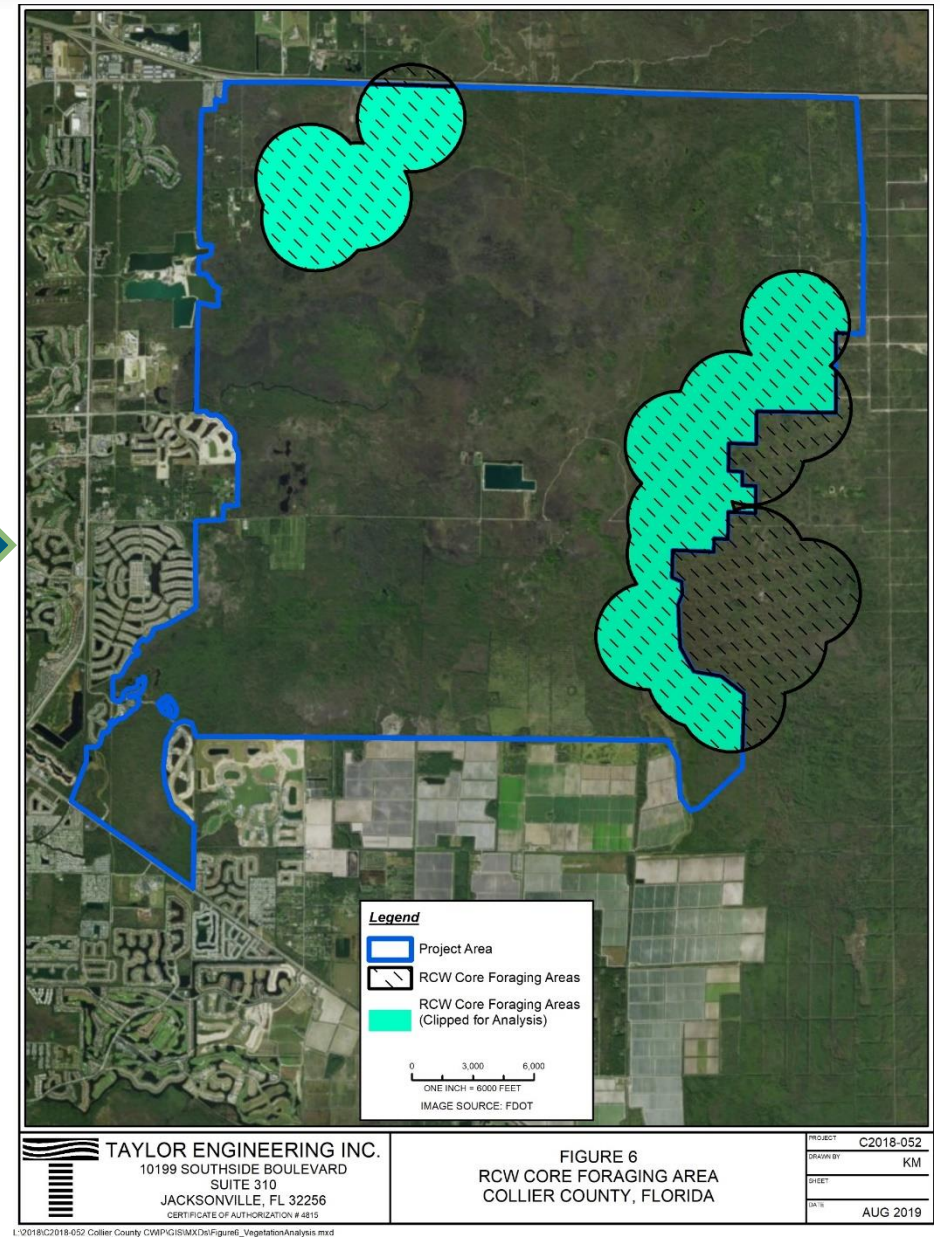
6: Pine Flatwoods





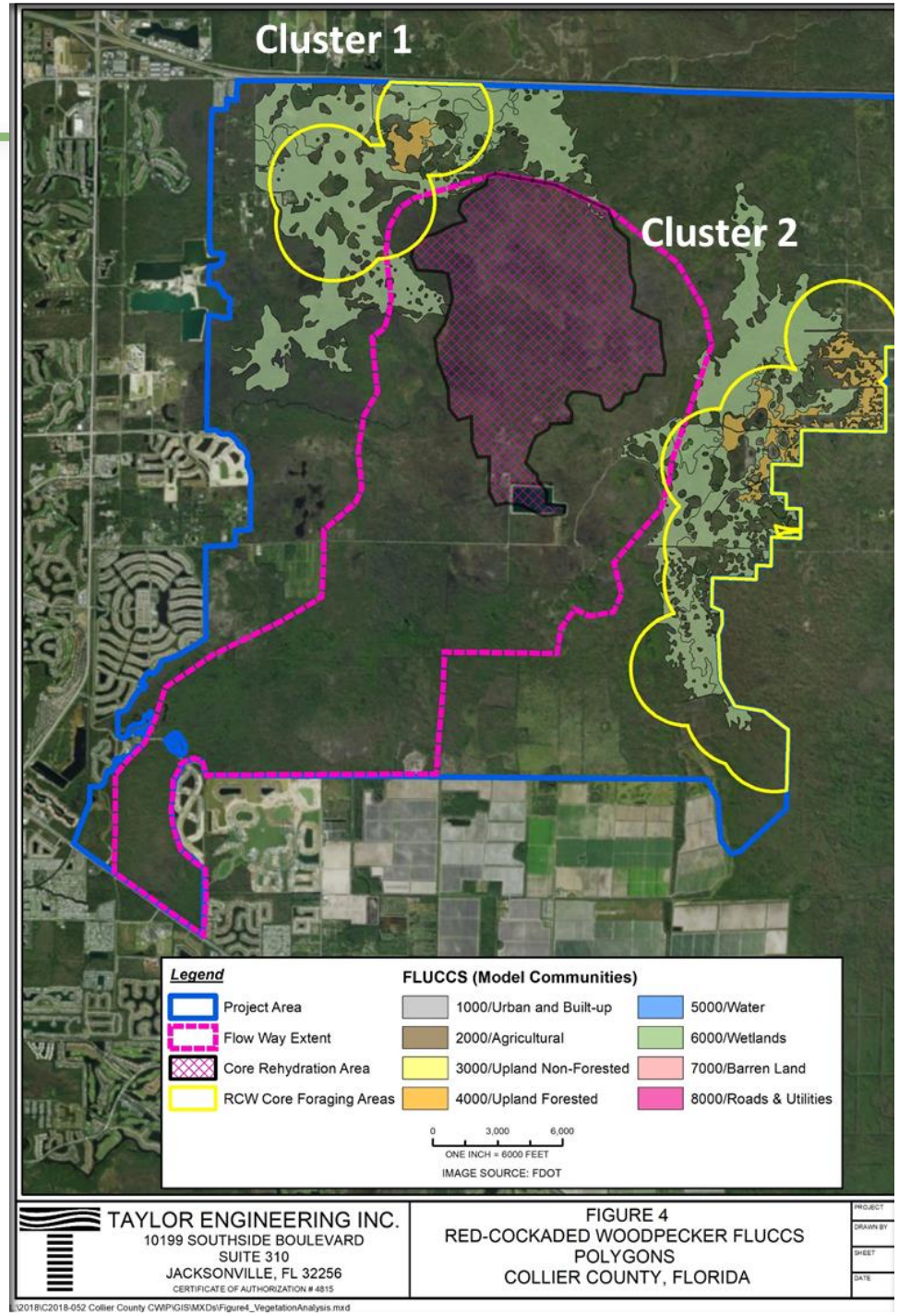
RCW Core Foraging Areas Clipped to Project Boundaries





RCW Core Foraging Areas

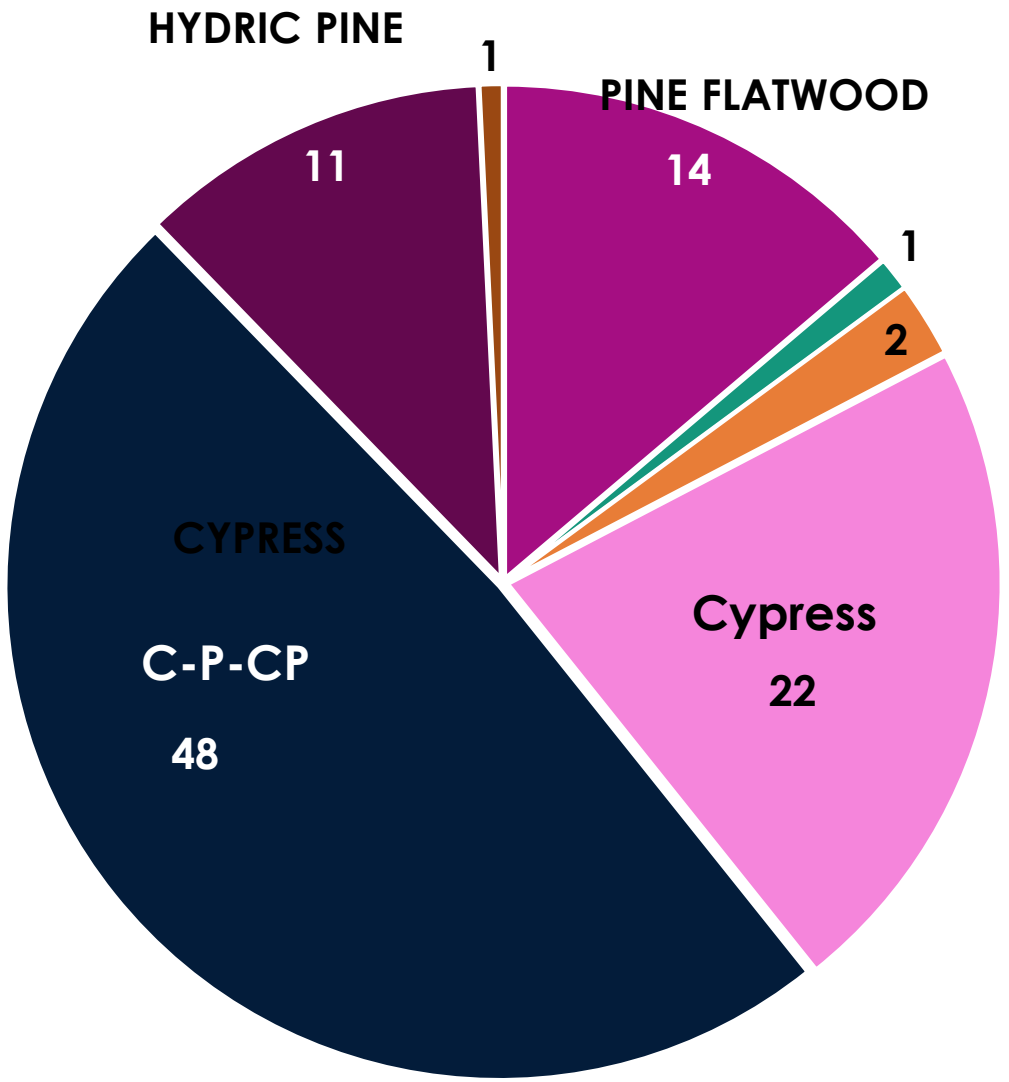
Land Use Description	Cluster 1 (acres)	Cluster 2 (acres)
Total Area	1429	2563
Dominant Vegetation Types	1290	2372
Percent Dominant Vegetation	94.7%	92.5%
Pine Flatwoods	186	451
Cypress	295	639
Cypress-Pine-Cabbage Palm	653	752
Hydric Pine	155	530



Red Cockaded Woodpecker CFA Area 1: Vegetation Percent Cover

(Total Area = 1429 acres)

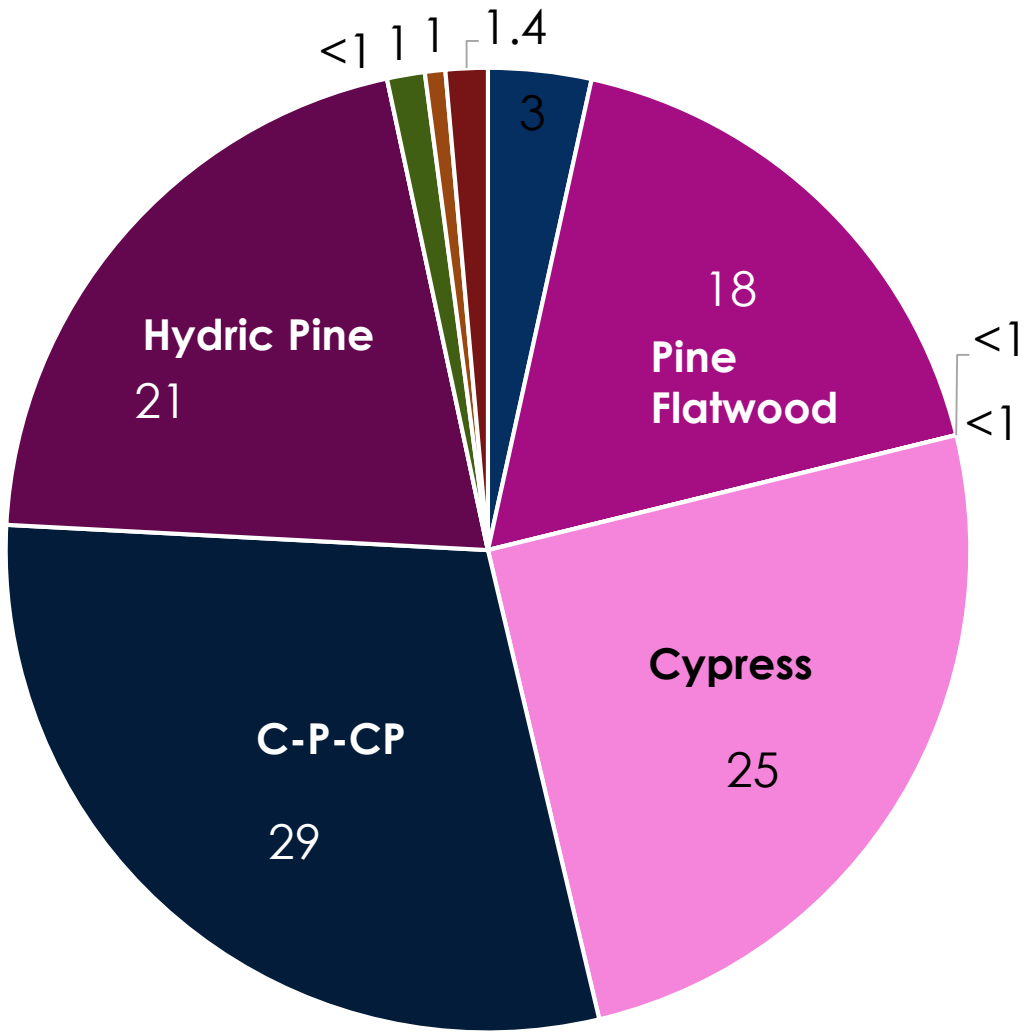
- Fallow Cropland
- Pine Flatwood
- Mixed Shrubs
- Wet Maleleuca
- Wetland Coniferous Forest
- Cypress
- CPCP
- Hydric Pine
- Wetland Forest Mixed
- Wet Prairie
- Disturbed Land



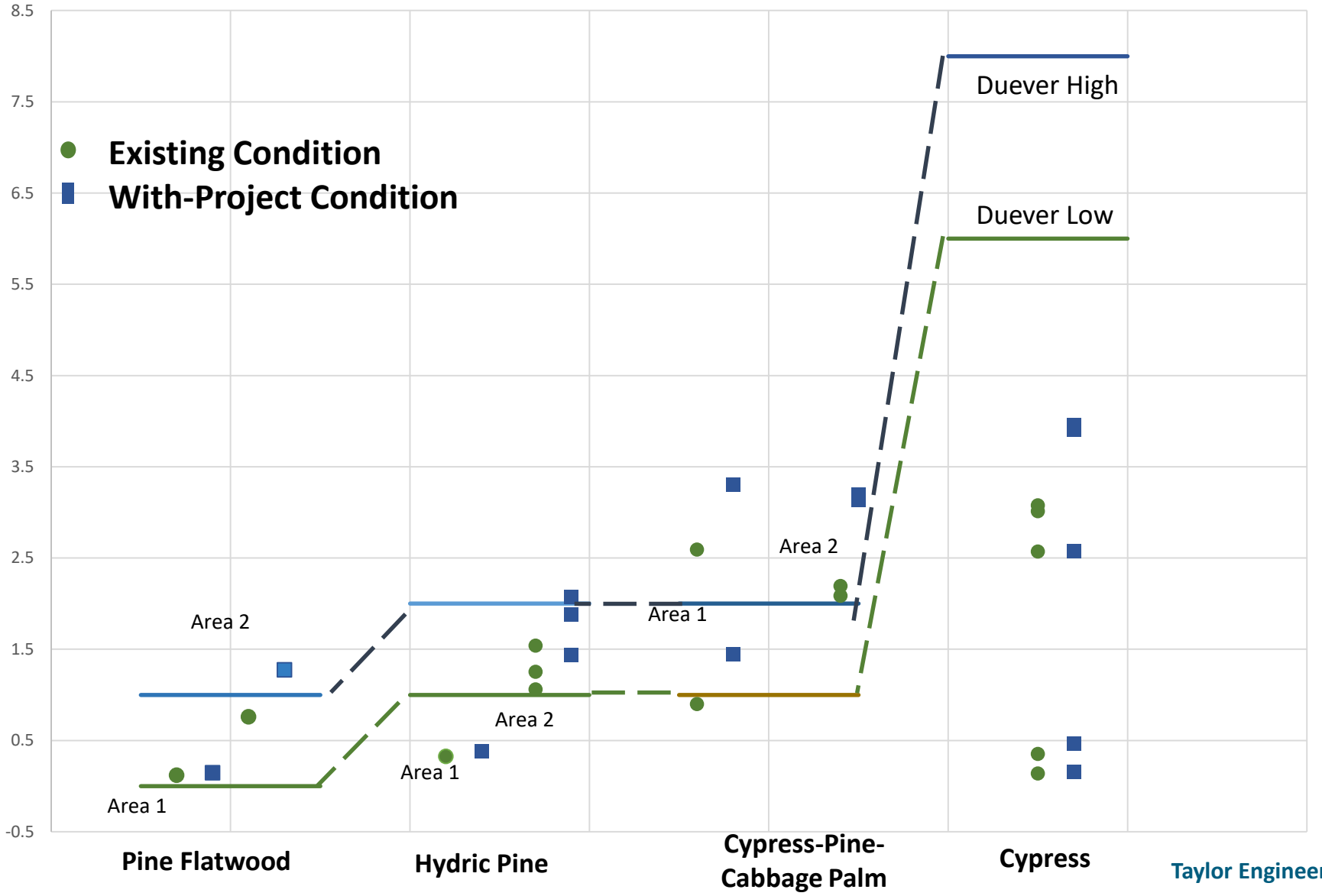
Red Cockaded Woodpecker CFA Area 2: Vegetation Percent Cover

(Total Area = 2563 acres)

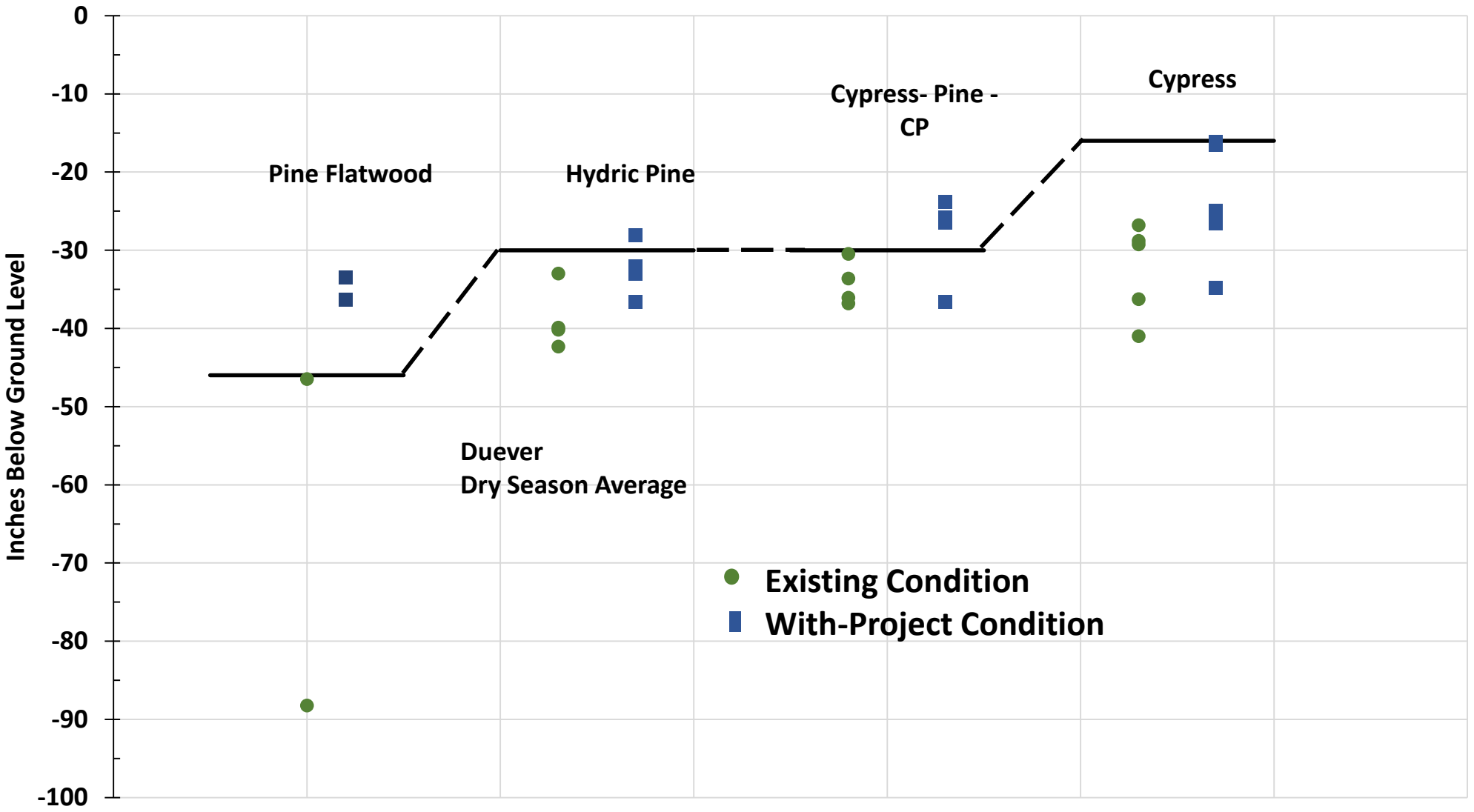
- Fallow Cropland
- Pine Flatwood
- Mixed Shrubs
- Wet Maleleuca
- Wetland Coniferous Forest
- Cypress
- CPCP
- Hydric Pine
- Wetland Forest Mixed
- Wet Prairie
- Disturbed Land
- Other



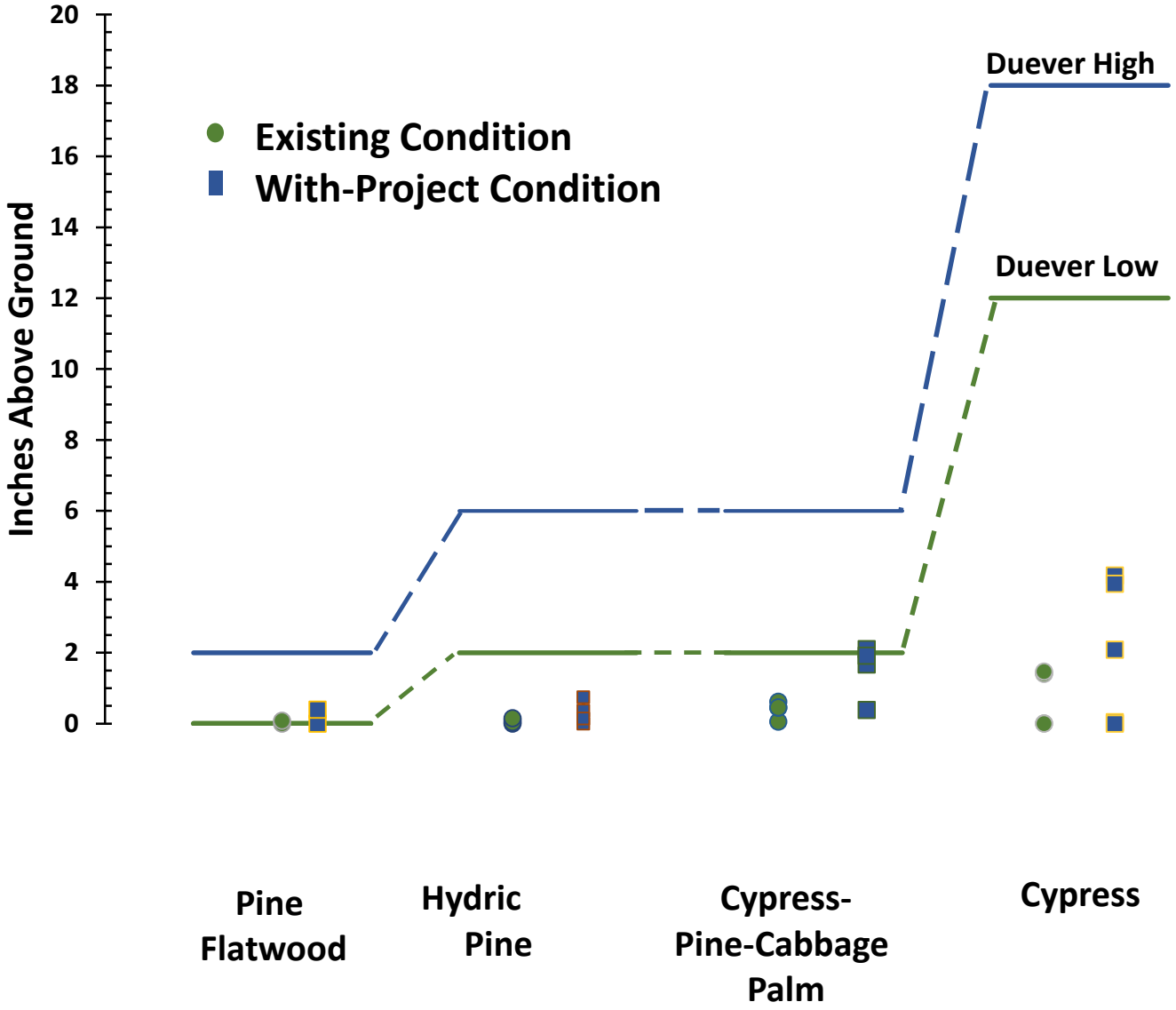
RCW Core Foraging Area Hydroperiods: Area 1, Area 2



RCW Core Foraging Areas Dry Season Median Water Elevation



RCW Area Shapefiles Wet Season Existing & With-Project Median Depths

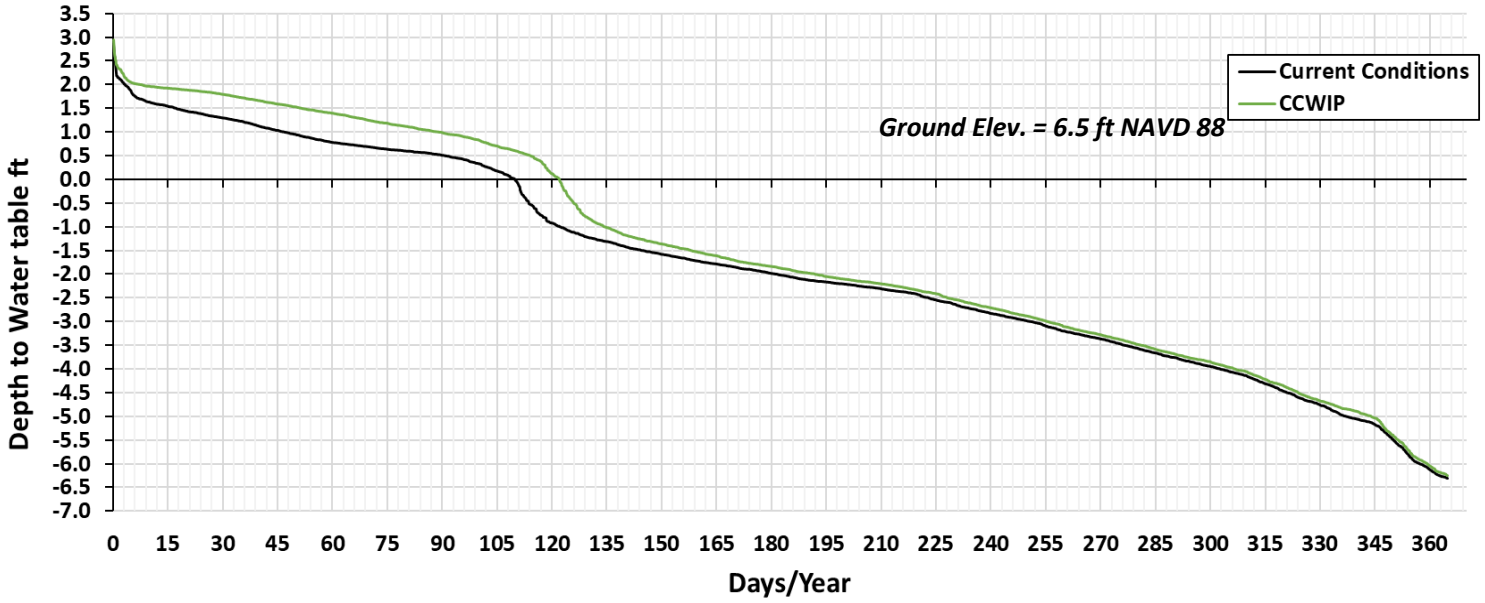


Conclusions

- **Project meets objectives of restoring hydrology within the Belle Meade Flow-Way**
- **Avoids/minimizes adverse impacts to listed species habitats**
- **Combined PSRP and CWIP changes along eastern project boundary are not expected to result in adverse hydrologic conditions**
- **Monitoring program tracks project performance**
- **Operational flexibility allows for adaptive management**

Water Table Depths (ft) – Current Conditions and CWIP

11 : Cypress



12 : Fallow Cropland