Florida Statewide Agricultural Irrigation Demand (FSAID)

PO No. POEC1121

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Florida Statewide Agricultural Irrigation Demand (FSAID) – Final Report

Corrigendum to FSAID_II_Final_Report_The_Balmoral_Group_2150701.pdf

1. **Table 20. Potential Irrigation Conservation and Total Irrigation Demand, 2020 to 2035**

   Replace table 20 with the table below.

Table 20. Potential Irrigation Conservation and Total Irrigation Demand, 2020 to 2035

WMD	2020		2025		2030		2035	
	MGD	Conservation MGD	MGD	Conservation MGD	MGD	Conservation MGD	MGD	Conservation MGD
NWFWMD	47	2	52	5	55	7	59	10
SFWMD	779	38	795	79	900	121	979	166
SJRWMD	201	10	197	20	210	28	223	38
SRWMD	118	6	128	13	140	19	151	26
SWFWMD	518	25	506	50	574	77	611	104
Florida, totals; excluding EAA	**1,663**	**82**	**1,678**	**166**	**1,878**	**253**	**2,023**	**343**

Note: Excluding EAA, and potential irrigation conservation estimates. Based on FRIS trend of declining ratio of irrigation water applied to irrigated acres. Unless otherwise specified, water use estimates are in MGD for an average year

2. **Table A-5. Forecasted Irrigated and Agricultural Land in Acres, 2015-2035**

   Replace table A-5 with the table below.

Table A- 5. Forecasted Irrigated and Agricultural Land in Acres, 2015-2035

COUNTY	Forecasted Irrigated and Agriculture Land in Acres									
	2015		2020		2025		2030		2035	
	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag
Alachua	15,264	118,494	16,339	118,310	17,152	118,149	17,900	118,292	18,665	118,421
Baker	283	15,342	335	15,358	340	15,373	368	15,386	405	15,374
Bay	1,148	11,001	826	9,960	630	9,912	346	9,870	53	9,908
Bradford	1,030	22,841	1,133	22,544	1,133	22,286	1,133	22,059	1,133	22,263
Brevard	17,661	136,179	16,288	135,165	15,045	134,282	13,716	133,502	12,379	134,204
Broward	1,698	17,323	1,698	15,926	1,698	14,794	1,698	13,856	1,698	14,699
Calhoun	3,360	36,811	2,778	36,480	2,092	36,192	1,510	35,939	984	36,167
Charlotte	25,166	186,549	25,305	184,430	25,327	182,592	26,258	180,973	26,313	182,431
Citrus	1,486	34,870	1,309	33,017	1,181	31,475	952	30,163	765	31,342
Clay	775	51,914	1,114	49,538	1,422	47,546	1,602	45,841	1,977	47,374
Collier	75,220	233,325	80,696	213,362	81,372	197,279	84,018	183,989	86,669	195,919
Columbia	5,011	57,615	8,082	57,356	10,831	57,129	13,577	56,928	16,479	57,109
De Soto	75,826	322,635	73,344	318,340	70,864	314,623	68,368	311,353	65,841	314,297
Dixie	6,744	23,296	6,274	22,931	5,244	22,615	4,454	22,338	3,957	22,588
Duval	1,287	18,501	1,009	17,840	776	17,280	527	16,796	260	17,231
Escambia	3,456	46,539	3,456	47,314	4,566	48,004	5,121	48,627	5,681	48,066
Flagler	10,906	34,287	9,153	32,546	7,487	31,618	5,818	30,815	4,167	31,537
Franklin	-	63	20	57	53	52	53	48	53	52
Gadsden	4,522	41,226	4,200	40,632	3,655	40,117	3,375	39,666	3,080	40,072
Gilchrist	13,379	63,016	13,877	62,723	14,141	62,468	14,536	62,242	14,949	62,446
Glades	61,662	339,870	89,622	356,771	125,596	372,269	156,499	386,625	190,542	373,668
Gulf	96	3,131	73	2,644	49	2,280	-	1,999	-	2,251
Hamilton	11,708	42,682	11,860	42,250	11,912	41,876	11,951	41,546	12,134	41,843
Hardee	48,963	310,390	46,640	308,252	44,294	306,391	41,911	304,744	39,457	306,227
Hendry	203,703	655,005	199,700	649,484	195,484	644,685	191,536	640,444	187,525	644,263
Hernando	2,659	63,494	3,564	63,083	4,683	62,726	5,689	62,409	6,690	62,694
Highlands	81,730	497,842	75,565	505,065	69,296	511,480	63,128	517,256	56,897	512,050
Hillsborough	35,619	161,810	32,607	158,600	29,548	155,841	26,528	153,425	23,513	155,600
Holmes	1,923	66,885	1,711	68,793	1,472	70,510	1,280	72,074	1,111	70,664
Indian River	58,518	186,839	57,606	184,429	56,350	182,344	55,049	180,508	54,095	182,161
Jackson	32,378	194,862	33,446	195,418	34,424	195,907	35,302	196,342	36,150	195,950
Jefferson	4,425	52,017	4,793	52,362	5,008	52,666	5,189	52,938	5,352	52,693
Lafayette	10,584	38,044	12,376	37,756	13,520	37,505	14,900	37,282	16,285	37,482
Lake	19,235	161,316	17,114	154,806	14,947	149,317	12,795	144,598	10,683	148,843
Lee	22,730	78,860	20,740	76,655	18,677	74,774	16,745	73,139	14,847	74,610
Leon	543	28,737	1,146	28,179	1,803	27,699	2,430	27,279	3,053	27,657
Levy	18,960	131,548	21,172	130,808	22,876	130,162	26,400	129,591	28,329	130,106
Liberty	31	3,824	41	3,824	63	3,825	85	3,825	139	3,825

Table A- 5. Forecasted Irrigated and Agricultural Land in Acres, 2015-2035 (Continued)

COUNTY	Forecasted Irrigated and Agricultural Land in Acres									
	2015		2020		2025		2030		2035	
	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag
Madison	18,156	87,303	19,459	88,241	21,227	89,070	22,768	89,815	24,310	89,144
Manatee	62,352	220,149	64,243	212,760	66,236	206,489	67,446	201,065	68,713	205,945
Marion	14,004	250,756	16,838	249,521	23,180	248,444	27,866	247,489	32,513	248,349
Martin	40,806	193,172	40,249	185,769	39,837	179,515	39,399	174,128	39,007	178,974
MiamiDade	36,018	78,373	36,558	77,855	37,585	77,404	38,311	77,004	39,030	77,364
Monroe	-	5	5	7	5	8	5	9	5	8
Nassau	824	21,017	603	20,484	8	20,029	-	19,632	-	19,989
Okaloosa	1,059	30,012	686	30,041	339	30,067	109	30,090	-	30,070
Okeechobee	24,159	359,782	21,883	361,491	19,489	362,996	17,550	364,340	15,143	363,129
Orange	7,036	122,330	7,119	120,821	7,327	119,513	7,479	118,362	7,697	119,399
Osceola	25,009	545,279	27,687	532,432	28,878	521,424	31,138	511,821	33,042	520,464
Palm Beach	428,615	526,830	428,635	515,581	428,662	505,921	429,047	497,478	429,080	505,077
Pasco	12,688	130,959	11,820	127,262	10,946	124,108	10,027	121,368	9,164	123,834
Pinellas	17	1,355	14	1,167	12	1,024	-	912	-	1,012
Polk	92,422	435,384	90,957	431,410	89,448	427,958	88,064	424,909	86,690	427,654
Putnam	11,943	64,301	10,548	62,213	9,198	60,440	7,856	58,904	6,487	60,285
Santa Rosa	3,570	71,710	3,943	72,014	7,351	72,282	8,108	72,521	10,751	72,305
Sarasota	6,855	89,882	6,692	83,867	6,563	78,928	6,419	74,778	6,250	78,506
Seminole	1,784	30,322	1,547	28,082	1,320	26,255	1,099	24,730	697	26,100
StJohns	24,050	40,814	22,989	39,422	22,175	38,241	21,262	37,220	20,433	38,139
StLucie	59,895	257,193	56,258	245,529	52,899	235,743	49,376	227,364	45,925	234,899
Sumter	4,051	133,259	3,415	128,623	2,806	124,693	2,180	121,297	1,550	124,352
Suwannee	30,657	130,531	32,125	130,737	35,345	130,919	37,714	131,080	40,091	130,935
Taylor	398	20,608	738	19,338	766	18,289	863	17,404	968	18,200
Union	1,241	18,920	1,165	18,498	1,050	18,135	990	17,819	927	18,104
Volusia	10,369	64,103	10,849	60,415	11,049	57,358	11,292	54,769	11,536	57,096
Wakulla	123	4,622	130	4,850	213	5,058	257	5,251	282	5,077
Walton	1,336	49,180	1,249	50,127	1,040	50,971	849	51,735	662	51,047
Washington	1,187	41,585	1,437	41,223	1,724	40,908	1,964	40,630	2,195	40,880
TOTAL	1,800,312	8,508,719	1,816,852	8,392,784	1,841,693	8,298,237	1,862,185	8,218,629	1,885,453	8,290,423

Source: USDA, National Agricultural Statistics Service (historical acreage); TBG Work Product (projected acreages)

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List of Abbreviations

AADF – Average Annual Daily Flow

AGMOD – The Agricultural Water Use Model (used by SWFWMD)

AFSIRS – Agricultural Field Scale Irrigation Requirements Simulation

AHPS – Advanced Hydrologic Prediction Service

ALG – Agricultural Lands Geodatabase

AWC – Available Water Content

AWS – Actual Water Savings

CDL – USDA Cropland Data Layer

CUP – Consumptive Use Permit

EAA – Everglades Agricultural Area

ET – Evapotranspiration

FAPRI – The Food and Agricultural Policy Research Institute

FLUCCS – Florida Land Use and Cover Classification System

FRIS – Farm and Ranch Irrigation Survey

GIS– Geographic Information System

GOES – Geostationary Operational Environmental Satellite

ILG – Irrigated Lands Geodatabase

IQR – Interquartile Range, as in a Tukey Box plot

MG – Millions of Gallons

MGD – Millions of Gallons per day

MIL – Mobile Irrigation Lab

NAIP – National Agricultural Imagery Program

NASS – National Agricultural Statistics Service

NRCS – Natural Resources Conservation Service

SSURGO – Soil Survey Geographic database

UF-IFAS – The University of Florida's Institute of Food and Agricultural Sciences

USGS – U.S. Geological Survey

USDA – United States Department of Agriculture

WMDs – Water Management Districts

Acknowledgments

The participation of the following individuals is acknowledged for their data-collection and tabulation efforts or for their technical input and support: Leigh Brooks, Ken Friedman, Angela Chelette, and Christina Coger at NWFWMD; Tammy Bader at SJRWMD; Cynthia Gefvert and Ian R. Miller, at SFWMD; Jay Yingling at SWFWMD; Tommy Kiger, Megan Wetherington and Dale Jenkins at SRWMD.

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Executive Summary

The Florida Department of Agriculture and Consumer Services (FDACS) is charged with developing estimates of statewide agricultural water use demand[1]. Prior to the statutory requirement for FDACS to prepare projections, Florida's five water management districts prepared estimates independently. The estimates herein have been provided to the Water Management Districts (WMDs) for consideration in development of their respective water supply plans.

Over the past twenty-five years, U.S. researchers have noted agricultural irrigation practices in western states shifting eastward; more intensive agricultural irrigation has accompanied a decline in overall agricultural land. At the same time, adoption of increasingly efficient technology has slowed the increase in total water use from rates seen in prior decades. Responses to market conditions, including land use constraints, urbanization pressures and energy costs, are reflected in the crop mix and irrigation decisions made by Florida producers. The estimates provided herein incorporate these economic factors in addition to traditional engineering and climatic factors. Water use data for more than 2,000 Florida farms throughout the state was used to estimate the historical effects of location, irrigation equipment, crop mix (including the decision to multi-crop where applicable), crop prices, and climate conditions on overall irrigation quantities over a five year period. Long-term crop price projections prepared by USDA (United States Department of Agriculture) were then applied to average climate conditions to simulate farmer response to future market conditions, including expanding or reducing irrigated acreage and/or shifting future crop mix.

In 2015, about 21% of Florida's 8.5 million acres of agricultural land are irrigated, or 1.8 million acres compared with about 20% of 8.6 million acres in 2010. Overall, the estimates project a net increase of approximately 85,000 acres of irrigated acreage over the next twenty years. Water use is projected to increase approximately 17% to 2,491 Million Gallons per Day (MGD) by 2035[2]. Projections for the state as a whole are provided in **Table 1** and on the website: **www.fsaid2.com**.

The increases are not distributed evenly throughout the state. The southern half of the state, which houses the greatest concentration of irrigated agriculture, is expected to experience the most impact from urbanization, with migration northward of more intensive agricultural practices. The northward migration, combined with revenue projections, results in the relative increases being amplified in the northern half of the state. Projections for each Water Management District are provided in **Table 2** (Water Use) and **Table 3** (Irrigated Acreage).

[1] Florida Statute 570.93. Department of Agriculture and Consumer Services; agricultural water conservation and agricultural water supply planning.

[2] The FSAID 2015 irrigation demand of 2,100 MGD represents a 19% decline compared to the FSAID 2010 irrigation water use estimate. This results from the EAA Sugarcane water use being held constant at 14.5" per year in the FSAID 2015 approach. Without this limitation (if modeled irrigation intensity for sugarcane were used), 2015 estimates would be 2,491 MGD, a 4% decline from 2010. Similarly, if the FSAID 2010 approach were adjusted with sugarcane irrigation intensity held constant, total water use would be 2,202 MGD, or 5% higher than the 2015 estimate. For purposes of comparison, the net increase to 2035 would then be 19%.

Table 1. Statewide Agricultural Water Use Estimates, 2015 - 2035

Statewide	2015	2020	2025	2030	2035	
Predominant Crop	Avg Year MGD	Avg Year MGD	Avg Year MGD	Avg Year MGD	Avg Year MGD	Dry Year MGD
Citrus	689	700	711	876	1,006	1,157
Fruit (Non-citrus)	51	51	50	52	52	60
Potatoes	40	41	45	197	221	254
Vegetables (Fresh Market)	337	340	348	232	232	267
Field Crops	92	90	87	86	84	97
Greenhouse/Nursery	119	119	124	126	125	144
Hay	106	98	95	91	87	100
Sod	84	80	77	78	79	90
Sugarcane	616	613	610	608	605	695
Total	2,132	2,132	2,146	2,346	2,491	2,865

Table 2. Agricultural Water Use Estimates by Water Management District, 2015 – 2035

WMD	2015	2020	2025	2030	2035	
	Avg Year MGD	Avg Year MGD	Avg Year MGD	Avg Year MGD	Avg Year MGD	Dry Year MGD
NWFWMD	46	47	52	55	59	67
SFWMD	1,237	1,248	1,263	1,369	1,448	1,665
SJRWMD	208	201	197	210	223	256
SRWMD	107	118	128	140	151	174
SWFWMD	534	518	506	574	611	703
Total	2,132	2,132	2,146	2,346	2,491	2,865

Table 3. Irrigated Agricultural Acreage Estimates by Water Management District, 2015 – 2035

WMD	2015	2020	2025	2030	2035	2015 - 2035	2015 - 2035
	Acres	Acres	Acres	Acres	Acres	Difference	% Difference
NWFWMD	56,829	57,374	61,879	63,260	66,713	9,883	17%
SFWMD	1,045,697	1,064,518	1,085,635	1,108,037	1,129,211	83,514	8%
SJRWMD	177,371	172,698	168,708	161,006	157,536	(19,835)	-11%
SRWMD	123,956	133,201	142,671	151,765	162,106	38,150	31%
SWFWMD	396,459	389,062	382,800	378,117	369,888	(26,571)	-7%
Total	1,800,312	1,816,852	1,841,693	1,862,185	1,885,453	85,142	5%

The effects of long-term price projections are appropriately viewed in the context of likely trends in agricultural practice. Pricing projection models predict an increase in irrigation for some crops, and a decrease for others, on a per unit basis. New crop mixes and technologies have emerged over the last twenty years and will continue to do so; the irrigation volumes projected herein should be viewed in that context. The new crop on any given field may not be the exact combination known today, but for a similar revenue trajectory, projected irrigation intensities are likely to displace some of the current crop mix combinations. A good example is the effect of greening on citrus production. Many scientists and producers expect that greening impacts will dissipate over the next three to five years. The projections of revenue for citrus crops indicate increases of citrus production in certain counties. If the greening impacts are not solved, transition to next most profitable crops is likely in areas without urbanization pressures. In this scenario, localized water use is likely to increase, based on the water use data for citrus and compatible crops.

The water use estimates are gross of net recharge effects, and may be treated differently for water supply planning purposes than other types of water use. Further investigation into the effects of increased agricultural irrigation in various areas of the state may be warranted in this context. Long-term irrigation efficiencies imply that Florida has experienced an annual savings per acre of about 0.5% of current use, over the past twenty-five years, and this is expected to continue. Policies to significantly increase conservation practices are likely to require concerted and targeted incentive plans.

Finally, a number of factors present uncertainty in future projections for Florida agricultural irrigation demand. Citrus greening is the most obvious, but other significant factors include agricultural policy as it affects sugar tariffs, energy policy as it affects field crop prices, and environmental regulations pertaining to water quality. Peer review of the model and its outcomes was completed, including sensitivity to these issues[3]. Water use for citrus and sugarcane, which contribute the vast majority of forecast demand, are sensitive to risks that could result in overestimating associated demand beyond the next five years. However, a better dataset is not available to estimate the likelihood of this risk. With regards to policy changes, data to forecast these changes are not yet available, and further, these changes are not likely to affect the overall agricultural demand for water in Florida.

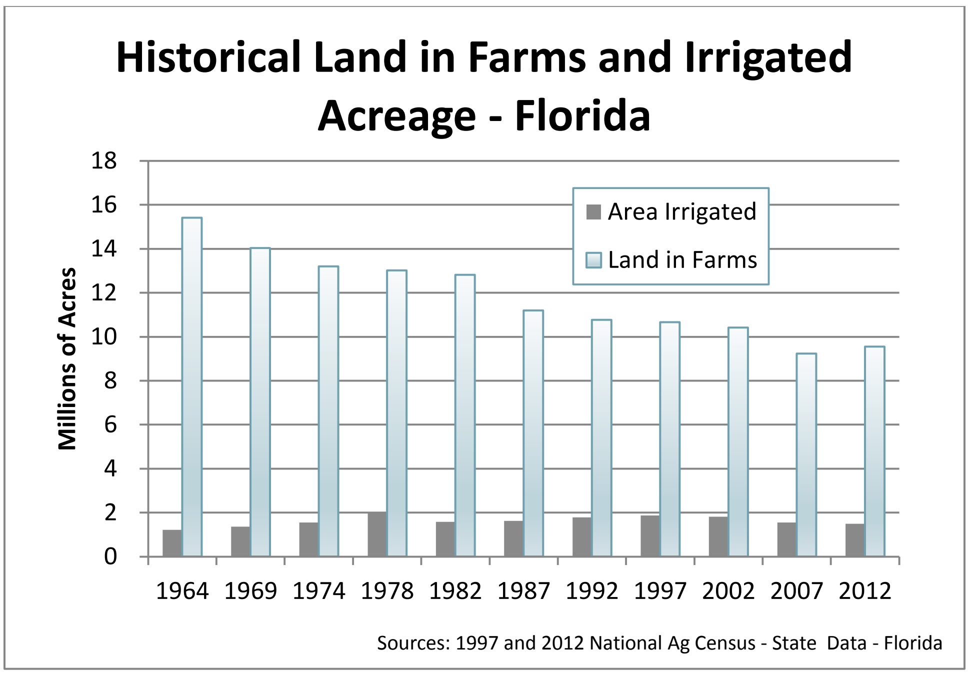
[3] Dr. Charles Moss, Professor and Research Coordinator of the Food and Resource Economics Department at the University of Florida. Florida Statewide Agricultural Irrigation Demand (FSAID): Review. 2015.

Introduction

The Florida Statewide Agricultural Irrigation Demand (FSAID) project began in 2013. Historically, Florida's five water management districts prepared estimates of agricultural water use as part of District water supply plans. The methodology, data, and underlying assumptions were distinct for each District, reflecting different agricultural and District practices.

The relationship between agricultural lands and water use had at times been assumed to be linear – as Districts saw declines in agricultural land, declines in corresponding water use were anticipated. According to the Ag Census data for Florida, 50 years ago there were approximately 15.4 million acres of land in farms; 8% of this land was irrigated (NASS, 1999). Over time there has been a steady decline in the land in farms, yet the irrigated acreage has generally increased (see **Figure 1**). As a result, the percentage of land in farms that is irrigated has roughly doubled.

Figure 1. Historical Land in Farms and Irrigated Acreage - Florida



Context

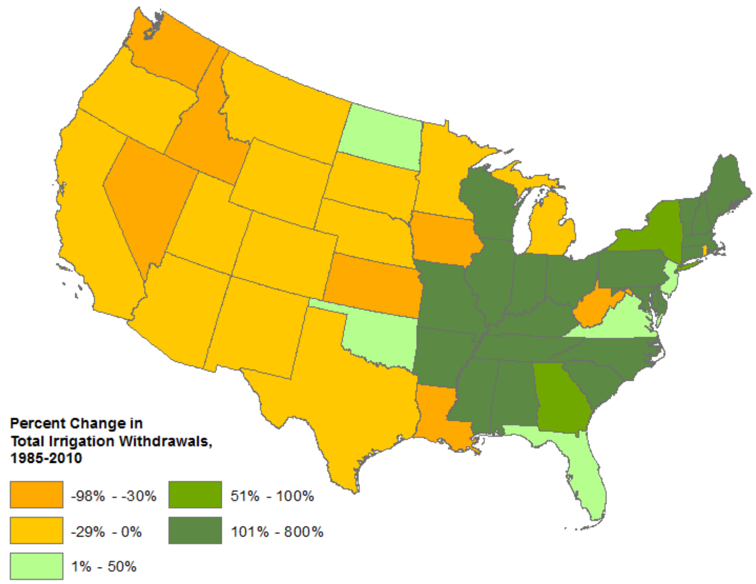
Because of differing assumptions used by each Water Management District, crop water use per acre could appear to double in the same county by crossing the District boundary. Regional supply concerns highlighted differences in District methodologies, and eventually gave rise to legislation directing FDACS to undertake a consistent statewide approach to estimating long-term agricultural water demand.

The Florida legislature set forth objectives for FDACS in Florida Statute 570.93. The Statute requires that the Department develop an agricultural water supply planning program with a 20-year period, using a consistent methodology and metered data, and produce crop-specific, spatially distributed irrigation demand for historic, current and future conditions.

Trends

Total irrigation water use can increase as a result of cropping system changes and expansion of irrigated areas, even as agricultural land areas are reduced. Over the last 25 years, the top irrigating states, which include Florida, have steadily increased their share of agricultural land that is irrigated. The exception to this is California; the longstanding agricultural water infrastructure in California is perceived as a constraint that was optimized long ago, and is unlikely to increase. California farmers irrigate more of their land than any other state; this trend appears to be migrating elsewhere. **Figure 2** Illustrates the changes in total irrigation withdrawals between 1985 and 2010 for all continental U.S. states.

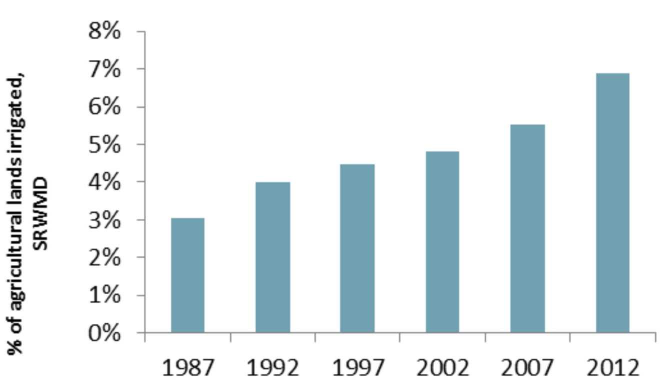
Figure 2. Changes in irrigation withdrawals: 1985-2010



Source: USGS historical irrigation water withdrawals for the U.S.

In some parts of Florida, including the Everglades Agricultural Area, irrigation infrastructure has been in place for decades, is managed collectively to a degree, and is likely to maintain current levels for some time. The existing situation may serve as an upper bound constraint to additional water use, as in California. In other parts of the State, particularly the northern portions where dry land farming has been more common, long-term trends reflect an increasing share of agricultural land being irrigated. **Figure 3** shows the National Agricultural Statistics Service (NASS) data for the counties that overlap Suwanee River Water Management District (SRWMD) boundaries. While the share of irrigated land is still very low, compared to the rest of the state, the trend is clearly increasing.

Figure 3. Trends in Irrigated vs. Agricultural Land, SRWMD



Analysis of long-term urbanization trends indicate that urban acreage is likely to displace at least 30,000 acres of agricultural land in the southern half of the state, which is heavily irrigated, over the next twenty years. A reasonable future scenario includes shifting of irrigated agricultural land from the southern half of the state to existing land that is currently unirrigated in the northern half of the state. Recent permit activity reflects the shift, with producers from out of state or from the southern half of the state expanding to northern Florida and irrigating acreage that was previously unirrigated, or multi-cropping where previous producers irrigated only a single crop. Taken in the aggregate, these shifts increase the share of irrigated land in the northern counties, while maintaining the share of irrigated land in the southern counties; overall, the trend increases overall irrigated acreage in Florida even as overall agricultural land decreases or stays flat.

Long-term water use for agriculture will continue to be an important factor in water supply planning. The objective of the FSAID planning process is to identify potential future demand to support planning at the statewide level.

2015 Agricultural Land Acreage Estimates

Geographic Information System (GIS) databases of all agricultural lands in Florida, as well as irrigated lands, were created for the FSAID project. The baseline estimates for 2010 Florida statewide agricultural water use were based on the Irrigated Lands Geodatabase (ILG) and Agricultural Lands Geodatabase (ALG) created in 2014. Detailed descriptions of the methodology used to create the baseline datasets are included in the FSAID 2014 Report.[4]

The Irrigated Lands database was updated to 2015 conditions. New and modified Consumptive Use Permits (CUPs) were manually checked to update the ILG; this process included several iterations of Quality Control to confirm field boundaries, crop type, and irrigation system. CUP information on crop type and irrigation system were combined with data from the Cropland Data Layer (CDL), National Agricultural Imagery Program (NAIP) aerial imagery, and Google earth imagery to correctly classify field geometry, crop type, and irrigation system. The CDL is a gridded dataset (30 meter resolution) that classifies crop type based on satellite data and groundtruth data from the Farm Service Agency (FSA) Common Land Unit (CLU). It is updated annually based on satellite data during the peak growing season (April to September). The NAIP provides annually updated peak growing season aerial photography. Manually checking irrigated or non-irrigated agricultural areas consists of using a GIS to visually review aerial photography (NAIP and Google Earth), CDL, and permit data (reading permit documents to extract crop type, irrigation system, and irrigated area). U.S. Geological Survey (USGS) groundtruthing datasets of irrigated areas were compared to the 2015 ILG, and areas having differences were manually reviewed using recent aerial imagery and the CDL; resulting 2015 ILG acreage is within ~400 acres of USGS estimates. The 2015 ILG in Jackson County contains 32,378 irrigated acres; the most recent draft USGS irrigated layer in Jackson County contains 31,951 irrigated acres. The 2015 ILG in Osceola County contains 25,010 irrigated acres; the most recent USGS irrigated layer in Osceola County contains 27,457 irrigated acres.

The ten largest fields in each water management district were manually checked using aerial imagery, CDL, and CUP information to confirm geometry, crop type, and irrigation system. Manual checks were completed for the six largest CUPs in each district, to confirm that the largest irrigated permits are correctly represented. The largest 100 irrigated hay or pasture fields were also manually checked to evaluate geometry, crop type, and irrigation system, the decrease in Hay acreage results from some

[4] FDACS 2014.

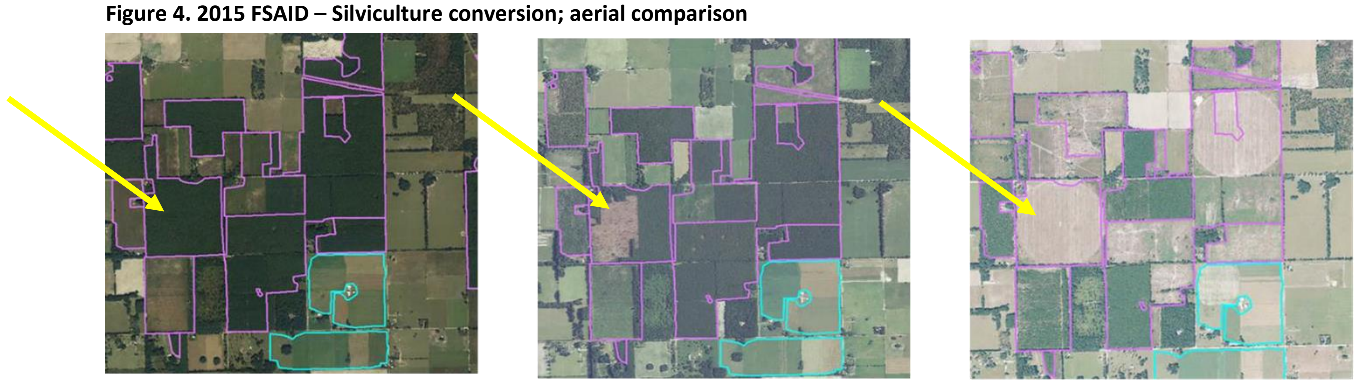
crop reclassifications to Field Crops and some Hay acreage being changed to non-irrigated based on permit data and updated aerial imagery. Specific irrigation systems were manually checked; e.g. center pivot and travelling gun irrigated polygons, to confirm areas, crop type, and irrigation system where appropriate. These results in hay and pasture changes from the 2010 ILG are summarized in **Appendix A.** These changes bring the total hay or pasture acreage in the ILG to 115,021 acres, which is similar to the USDA Farm and Ranch Irrigation Survey (FRIS) of 119,158 acres of irrigated hay or pasture in 2013.

The resulting ILG included 26,236 polygons totaling 1,800,312 acres. The corresponding ALG was updated as well, then cross referenced with the ILG to ensure no irrigated lands were included as non-irrigated fields in the ALG. Conversely, fields that were reported in the 2010 ILG as unirrigated but updated to irrigated via 2015 data were removed from the ALG and transferred to the ILG.

Sliver clean-up was performed in GIS to combine small field polygons that were created artificially through geoprocessing or as artifacts of prior data into adjacent fields. As a result, the quantity of polygons was reduced considerably from over 300,000 in the 2010 ALG to 147,328, although total acreage change was minimal. The final ALG includes 6,708,408 acres of unirrigated agricultural land.

Silviculture lands were identified and included in the 2015 ILG update. Florida Land Use and Cover Classification System (FLUCCS) data and CUP data were used to screen potential FLUCCS areas coded for pine plantation or other planted forested areas. Each area was reviewed for indications of conversion to irrigated agricultural land, including intersection with CUP permit data, and fields that changed FLUCCS coding from plantation in 2010 to Ag in 2015. Similar processes were followed as with non-silviculture ILG polygons: permit data, aerials and surrounding crop land were checked, then data were assigned for crop, irrigation system, and remaining attributes (soil, Rainfall, ET, etc.). **Figure 4** provides an example of changes noted over time that were evident from aerial imagery, and captured as Silviculture conversion to irrigated agriculture.

Figure 4. 2015 FSAID – Silviculture conversion; aerial comparison



2007 **2010** **2013**

Source: TBG Work product, NAIP

Irrigated agricultural Land acreage for the State of Florida in 2015 is estimated to total 1,800,312 irrigated acres, out of 8,508,719 total agricultural acres. This compares with an estimated 1,738,961 irrigated acres in 2010, out of total agricultural land of 8,613,770 acres. The updated estimate reflects an increase in irrigated land of about 4%, and a reduction in total agricultural land of about 1%.

Table 4 provides a comparison of the total acreage in the 2010 and 2015 ILG and ALG. **Table 5** provides a breakdown by crop acreage at the statewide level. **Appendix B** provides detailed tables by Water Management District and County.

Table 4. Summary of ALG and ILG

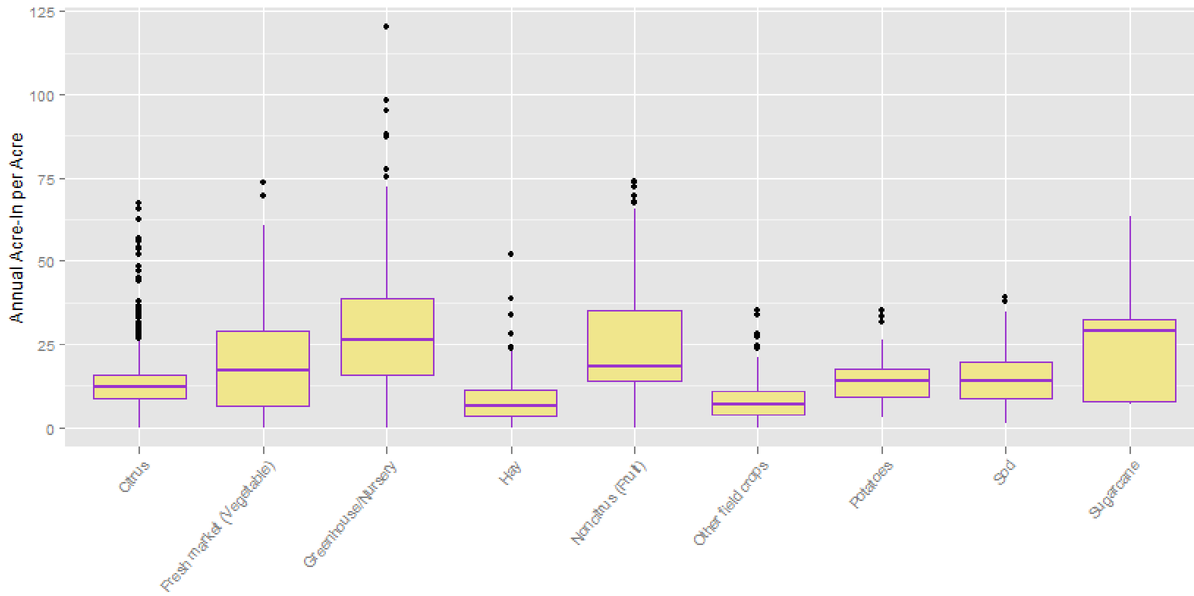
WMD	ALG 2015	ALG 2015	ILG 2015	ILG 2015	ILG 2010	ILG 2010
	Parcels	Acres	Parcels	Acres	Parcels	Acres
NWFWMD	23,846	651,854	1,001	56,829	1,020	50,539
SFWMD	37,525	3,618,898	6,721	1,045,697	7,160	1,031,061
SJRWMD	31,818	1,393,327	5,634	177,371	6,044	201,638
SRWMD	16,785	679,586	1,798	123,956	1,466	87,210
SWFWMD	37,354	2,165,055	11,082	396,459	11,639	368,513
Total	147,328	8,508,719	26,236	1,800,312	27,329	1,738,961

Table 5. 2015 Florida Irrigated Cropland Acreage by Primary Crop

Primary Crop	2010	2015	% Change
Citrus	533,385	567,741	6%
Fruit (Non-citrus)	30,144	32,155	7%
Potatoes	25,863	28,712	11%
Vegetables (Fresh Market)	220,039	220,880	0%
Field Crops	84,217	132,909	58%
Greenhouse/Nursery	62,496	64,902	4%
Hay	162,975	115,021	-29%
Sod	70,082	70,561	1%
Sugarcane	549,761	567,431	3%
Total	**1,738,961**	**1,800,312**	4%

Primary crop categories were assigned based on analysis of water use data. Detailed crop descriptions were retained at the field level but aggregated to primary crops based on analysis of like water use. Detailed description of the process is included in **Appendix A**; **Figure 5** shows a summary boxplot of annual crop water use (inches/year) for the entire state.

Figure 5. Summary Boxplot for State of Florida



As an example, citrus shows a median water use of approximately 15 inches /year, with observations higher or lower than 15 inches very tightly grouped around the median, and several outliers. Where median water use and distribution of water use was similar, crops were grouped accordingly. Detailed description of the crop category analysis is provided in **Appendix A.**

Comparisons to Other Estimates

Other published estimates of Florida crop land for the time period in question include the Ag Census, prepared by USDA every five years. **Table 6** provides a snapshot of the most recent estimates of statewide agricultural land and irrigated land available from other frequently-cited sources; the ranges of variation are considered reasonable, for the dates provided and differences in data collection precision. In **Table 7** the crop-specific irrigated acreages are compared to estimates from other sources.

Table 6. Estimated Florida Agricultural Acreage, Other Sources

	Agricultural Land	Irrigated Land	Implied Share of Irrigated Land
FSAID 2015	8,613,315	1,800,312	21%
Ag Census 2012	9,548,342	1,492,808	16%
FRIS 2013	Not comparable	1,493,320	n/a
FSAID 2010	8,613,770	1,738,961	20%
Ag Census 2007	9,231,570	1,558,137	17%

Table 7. Estimated Florida Agricultural Acreage by Crop, Other Sources

Acreage by Primary Crop	2015 FSAID	Other Estimates
Citrus	567,741	531,493[1]
Fruit (Non-citrus)	32,155	39,900[1]
Potatoes	28,712	22,742[2]
Fresh market (Vegetable)	220,880	201,400[1]
Field crops	132,909	71,305[2]
Greenhouse/Nursery	64,902	Not available
Hay	115,021	119,158[2]
Sod	70,561	Not available
Sugarcane	567,431	462,667[2]

Source: [1]FDACS, Florida Ag by the Numbers 2013; [2]FRIS 2013

Estimating Crop Land Water Use

The updated ILG was used as the baseline dataset to prepare water use estimates. To accommodate the application of coefficients and simulation of future conditions, the attribute values assigned to each farm for the ILG were assembled as a matrix.

An econometric model was employed to predict irrigation water demand in order to allow for crop price and production cost projections to impact future irrigation water use. For predicting current or historical irrigation water use, a process-based irrigation demand model is the appropriate tool (Agricultural Field Scale Irrigation Requirements Simulation (AFSIRS), the Agricultural Water Use Model used by SWFWMD (AGMOD), etc.). However, for projecting future irrigation water use, an approach that links biophysical factors (crop type, irrigation system, evapotranspiration (ET), rainfall, and others) with economic factors (revenues and costs) is more appropriate. This approach allows for irrigation demand changes to be responsive to the economics that influence farm management decisions. An econometric model was used in FSAID I, with the structure and coefficients being developed to fit AFSIRS-based irrigation estimates. The same type of econometric model, with some refinements in form, is used in FSAID II, but the coefficients are based on fitting to metered or reported pumpage data.

Econometric models acknowledge that water use is an economic decision rather than a biological one. In Florida, there are examples of behavioral responses to non-biological factors. Farmers will stress their crop temporarily if doing so will maximize profit. Citrus greening is an example of the converse situation: stress harms profits, and farmers respond by adjusting their water use. Pecan and blueberry prices affected significant changes in acreage for both crops that reflect human behavior adjustments rather than purely process-based responses.

Model and Forecasting Approach

The model uses two stages to forecast water use in agriculture. First, historical water use is explained by farmers' profit maximizing behavior. The underlying model treats water demand as resulting from farmers' applying the optimal amount of water to maximize net revenue from their production of crops, subject to constraints on soil quality, water supply, and climatic conditions. The resulting equation treats water use as a function of net revenue, which depends on the specific crop mix, location, climatic conditions, irrigation system, and irrigated area. The approach is consistent with literature including Florida-specific work (de Bodisco 2007; Moss 1998) [5]. Specification and coefficients are included in **Appendix A** at **Technical Note 3**.

Future water use is estimated by applying the estimated model to forecasted values for the individual explanatory variables. Once the historical effect of these factors on water use has been quantified, the second stage treats the land allocation as endogenous to crop mix and irrigation decisions, in line with literature (Schoengold 2005). Given pressures on land use from non-agricultural factors, long-term acreage trends are estimated separately and then brought into the model (Livanis 2006).

Thus, the first stage primarily consists of developing future values for each of the explanatory variables used in the model. Discussion of input sources follows.

Selection of Input data

Water Use Data & Share Irrigated

Water Use

Input data included metered water use data wherever available from the Water Management Districts. In each District, data reflecting actual agricultural water use is collected, maintained and reported differently. Each water management district provided metered water use data from at least three different years between 2007 and 2013.

Data is collected in a variety of ways. In some Districts, data is collected monthly, and the total amount of water pumped according to each meter is reported; meters are required to be calibrated periodically. In other Districts, data is self-reported by the producer, and reflects the amount of time a pump has been operated, which is then transformed into water use by District staff using District equations. In some Districts, missing values are estimated by District staff using District-developed equations.

Given the objectives of the FSAID project, records were rejected for use in the model if the time series data for a given year and farm contained more than three 'estimated' records. Additionally, outliers were rejected, such as records that reflected water use of more than six times the estimate of AFSIRS, or if the number reflected use of more than 100 inches of water in a given month. Within a crop or irrigation system, consistency checks compared individual usage versus averages of all users for that crop-irrigation system combination. Values exceeding 2 standard deviations from the mean were given special scrutiny as potential outliers.

[5] Moss (2015). Dr. Charles Moss, Professor and Research Coordinator of the Food and Resource Economics Department at the University of Florida. Florida Statewide Agricultural Irrigation Demand (FSAID): Review. 2015.

Table 8 shows the overall statewide averages by predominant crop, from AFSIRS estimates and water use data. The average Water Use quantities are overall years, over all observations for all Districts. The AFSIRS estimates used 2010 crop and irrigation equipment with average climate conditions (1996-2013).

Table 8. Water Use, AFSIRS and Reported or Metered usage

Statewide	**Average IN/YR**	
Predominant Crop	**FSAID1 AFSIRS**	**FSAID2 Metered or Reported Usage Input**
Citrus	14.37	13.69
Fruit (Non-citrus)	16.63	20.71
Potatoes	12.46	16.30
Vegetables (Fresh Market)	11.85	20.28
Field Crops	10.16	9.21
Greenhouse/Nursery	48.55	28.95
Hay	15.12	11.51
Sod	37.52	13.34
Sugarcane	24.63	25.10
Total	21.53	16.00

Methodology for assigning water use to fields

Metered data or pumpage data reports the actual volume of water pumped at a location, and may be reported either voluntarily or as a condition of a permit. Data availability varied by District; data for 2010 were obtained for all Districts. As one objective of the FSAID model is to identify responses to market conditions, two other temporal data points were obtained for each District. The years for which data were available are reflected in **Table 9** below.

Table 9. Years of District Data

	2007	**2008**	**2010**	**2012**	**2013**
NWFWMD	●		●		●
SFWMD	●		●		●
SJRWMD	●		●		●
SRWMD		●	●	●	
SWFWMD	●		●		●

GIS analysis of individual fields shows that metered water use does not necessarily align exactly with the area of land included in the permit. Permitted areas for irrigation may exceed the areas actually irrigated at any given point in time. In addition, water use is not necessarily uniform across irrigated areas; one permit often covers more than one field, and different fields may have a different crop mix. Some producers will grow a second crop side by side with a primary crop at certain points in the year/season, or may rotate a second or third crop in addition to their primary crop.

Data analysis was conducted on metered data to determine the relative water use by crop, where the primary crop may be one of up to three categories, allowing for double and triple crop scenarios. Average theoretical water use was computed in AFSIRS by:

- primary crop, where a single crop is identified
- primary crop plus a second crop, for double crop fields
- Primary crop plus a second and third crop, for triple crop fields.

Statistical analysis of the output suggested some outliers. In some cases, minor adjustments were made based on judgment of professional agricultural engineers. For example, the primary crop for an individual farm may be re-categorized as a secondary crop. Remaining outliers tended to be producers with a second or third crop that had been initially missed during data collection.

The relationship between primary crops and their ancillary second or third crops was computed on a proportionate basis. This results in a two-step process for assigning water use:

1. Identification of the crop by field
2. Assigning the proportional water use by crop to each field.

Figure 6. Hypothetical Farm

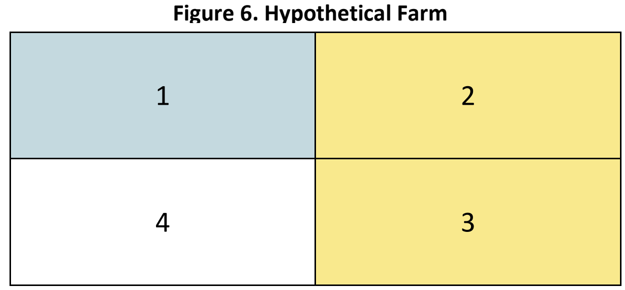


Figure 6 demonstrates a hypothetical example. The entirety of the Figure represents 800 acres under one permit; each field is 200 acres. The metered data reflected total water use of 40,000 gallons.

Field 1 is identified as growing Corn, as a single crop. The average AFSIRS estimated water use for single crop corn is 10.04 inches/acre/year. Fields 2 and 3 are identified as producing Potatoes with a double crop, with an AFSIRS average estimate of 16.88 inches/acre/year. Field 4 is identified as unirrigated for the period in question. The estimated use of the 40,000 gallons is apportioned to the fields based on relative water use intensity from AFSIRS estimates using the formula as shown in **Table 10.**

Table 10. Example of Water Use Allocation for Metered Data

	Acreage (a)	Crop mean AFSIRS intensity (b)	Combined mean (a) x (b)	Share of Total Water Use [(a) x (b)]/T	Water use allocated to field
Field 1:	200	10.04	2,008	23%	9,200
Fields 2 & 3:	400	16.88	6,752	77%	30,800
Field 4:	200	n/a	0	0%	0
Totals (T)	800	26.92	8,760	100%	40,000

Metered water use was allocated to the fields in the Irrigated Lands geodatabase (ILG) using this protocol.

Revenue

Net revenue is a measure of the profit farmers earn from each crop. Net Revenue for each crop is determined using average crop price for each crop minus estimated costs for the year of record, adjusted for inflation. Historical pricing data were assigned based on the primary cash crop in each group, adjusted for multiple harvests if multiple harvests were identified. Crop prices per acre were multiplied by appropriate acreage for each farm. Hence a $700/acre price for corn would equate to $70,000 for a 100 acre field. USDA pricing data[6] was obtained for each crop with the exception of sod, which was obtained from University of Georgia[7]. Chemical costs were used as a proxy for input costs; this is consistent with the literature, which has found that real chemical costs vary by crop and over time. Historical chemical costs per acre were obtained from University of Georgia crop profiles; costs were assigned based on University of Georgia Farm Gate Value Reports, per the direction of UF-IFAS, which no longer produces the crop specific reports traditionally relied upon. **Table 11** provides mean revenue values per acre by crop for 2010 as an example. Detailed revenue and cost values are provided in **Appendix A**.

Table 11. Mean Revenue Value by Crop, 2010

Predominant Crop	Average Revenue ($/ac) 2010
Citrus	$4,370
Fresh market (Vegetable)	$6,964
Greenhouse/Nursery	$29,493
Hay	$257
Lumber	$224
Noncitrus (Fruit)	$5,622
Other field crops	$804
Potatoes	$4,020
Sod	$8,841
Sugarcane	$1,414

Share of Acreage Irrigated

The share of acreage that that a farmer chooses to irrigate is an important component of crop yields per acre and farm costs. For each metered data record, the share of land currently irrigated was computed as a proportion of land covered by the permit. Data shows that the irrigated share of agricultural land varies by District, but tends to increase over time. **Figure 7** shows the irrigated share of agricultural land by District for the model dataset; averages shown are over all data years for a given District.

[6] USDA. Retrieved January 2015. http://www.ers.usda.gov/media/1279439/oce141d.pdf
[7] University of Georgia. Annual Georgia Sod Producers Survey. Accessed February 4, 2015.

Figure 7. Share of Permitted Acreage that is Irrigated

Rainfall/ET/Soils/Irrigation System data

Rainfall

Because rainfall replaces irrigation water, it can be an important component of water demand. Rain gage data were used in the initial FSAID (I) estimates, since it is collected statewide and provides seventeen years of consistent statewide data. However in some districts this resulted in very few location-specific measures of precipitation. For FSAID II, NOAA Advanced Hydrologic Prediction Service (AHPS) was used[8]. This set of data is provided in the form of daily point shapefiles for the entire continental USA and Puerto Rico. Within Florida, there are 12,656 points spaced approximately 3.5 to 4 km apart (point spacing decreases from north to south). The available period of record is from 2005 to 2013, or nine years. Detailed analysis is provided in **Appendix A**.

Evapotranspiration (ET)

Evapotranspiration (ET) rates, which vary by crop and conditions such as wind, and humidity, affect the biological water needs of the crop. USGS Reference ET (RET) data were used in both FSAID I and FSAID II. The entire USGS RET dataset consists of 39,168 points with 2-km spacing; the period of record is 1996 to 2013. Detailed analysis of the ET sensitivity is provided in **Appendix A**.

Soils

Soil type affects water demand in two ways: it affects the crop's biological water needs, and it constrains the type of crop that can be planted. For example, as farmers adjust to changing prices, soil type constrains the choice set of crops they could transition to. Soils data were based on the USDA/Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) database. The SSURGO database has more than a thousand major soil types for Florida, while AFSIRS has 766. The

[8] NOAA Gridded Observed Precipitation Data http://water.weather.gov/precip/DailyObservedPrecip.xml

Available Water Content (AWC) for each soil and soil horizon (up to six per soil) is provided in County-level soil survey tables to represent the amount of water storage available for a given root depth. The average soil AWC option was used to generalize soil types into 10 soil type groupings. The predominant soil type from each ILG polygon was computed and used in the analysis. A detailed table of soil types is included in **Appendix A**.

Irrigation System

Water application rates depend on the type of irrigation system. Irrigation system data were collected from permit data where available. Where not available, irrigation systems were identified based on historical imagery, in combination with assigned crop, published information and NRCS contacts to assign the most common irrigation practices for the particular crop, region, and time period. Irrigation Systems data were grouped as shown in **Table 12.**

Table 12. Irrigation System Groupings

	Irrigation Systems
1	Center Pivot / Lateral Move
2	Container Nursery
3	Drip
4	Gravity Systems
5	Impact Sprinkler
6	Micro Spray
7	Overhead
8	Traveling Gun
9	None

Source: TBG Work Product

Frost-Freeze

Under certain circumstances, farmers may apply substantial amounts of water to prevent a crop from freezing. Analysis of the NOAA and USGS RET data were conducted to identify counties which showed frost-freeze events, which were defined as exceeding three days with a minimum temperature below 32°F. Metered data records relating to crops with a freeze event, and with total annual irrigation more than one standard deviation from the mean for that crop, were assigned a freeze variable in the model to capture supplemental water that may have been applied for freeze protection.

Results

Estimated 2015 Water Use

Model results including coefficients and statistical attributes are provided in **Appendix A**. The coefficients were applied to existing ILG attributes. Estimated water use in 2015 totals 2,132 MGD for the entire state, compared to the estimated water use from 2010 of 2,587 MGD. The 17% decline results from the EAA Sugarcane water use being held constant at 14.5" per year in the FSAID 2015 approach. Without this limitation (if modeled irrigation intensity for sugarcane were used), 2015 estimates would be 2,524 MGD, a 2% decline from 2010.[9]

Overall irrigated acreage reflects a 4% increase from FSAID 2010 estimates. Overall water use is approximately 0.0012 MGD/acre (or 15.9 in/year), which is roughly in line with various District planning documents. By comparison, the 2010 estimate totaled approximately 0.0015 MGD/acre (or 20.2 in/year), reflecting the slightly higher irrigation intensities predicted by AFSIRS compared with actual metered or reported water use. Where AFSIRS will estimate the optimal irrigation quantity on a daily basis, producers will use judgment in determining when to irrigate, and may not irrigate as intensively as predicted by AFSIRS, particularly for some lower margin crops. The decline also reflects slightly lower water use per acre for field crops driven by lower revenue projections released by USDA at the end of February 2015. University of Georgia Farm Gate values for 2015 will be released in October 2015, allowing a timely review of the projections versus actual performance.

As an additional check on reasonableness, the imputed revenues from the statewide dataset were calculated and compared to FDACS published numbers for statewide agricultural production. If the water estimates based on revenue are reasonable, statewide agricultural revenues should be able to be estimated from the water use estimates. Revenues by crop category were back-calculated from the water use (Sod and Greenhouse/nursery were not able to be computed, due to lack of available comparable data). Results indicate that estimates are appropriate to measure relative changes over time: FSAID estimated statewide *net* revenues total approximately 73% of published FDACS statewide *gross* revenues. **Appendix A** provides the detailed computations underlying the estimate.

Simulation

Future water use estimates were simulated by updating each explanatory variable in the model, and using the regression equation to estimate future water use. Each variable was estimated as follows:

1. Prices and costs were forecast for periods 2020, 2025, 2030 and 2035 using 10 year crop price forecasts from USDA and The Food and Agricultural Policy Research Institute (FAPRI), and extended using a crop specific growth trend. Forecast net revenue was used to adjust crop mix to maximize farm profit subject to soil and land use constraints.
2. Irrigated acreage was forecast using auto regression techniques to fit a trend line to changes in the irrigated share of agricultural land at the county level, using 25 years of data from NASS.
3. Finally, the net revenue variable was calculated by applying updated net revenue values to forecast acreage.
4. ET and rainfall variables were updated by calculating mean historical values for an average year and dry year. The Average year calculation for future periods used the average ET and rainfall data over a 9 year period assigned at the farm level.

Estimated coefficients from the regression model were applied to forecast variables to simulate projected water use. The change in total water use was estimated at the field level, and applied to the acreage increase or decrease in each county.

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[9] Similarly, if the FSAID 2010 approach were adjusted with sugarcane irrigation intensity held constant, total water use would have been 2,202 MGD, or 3% higher than the 2015 estimate.

Crop mix changes

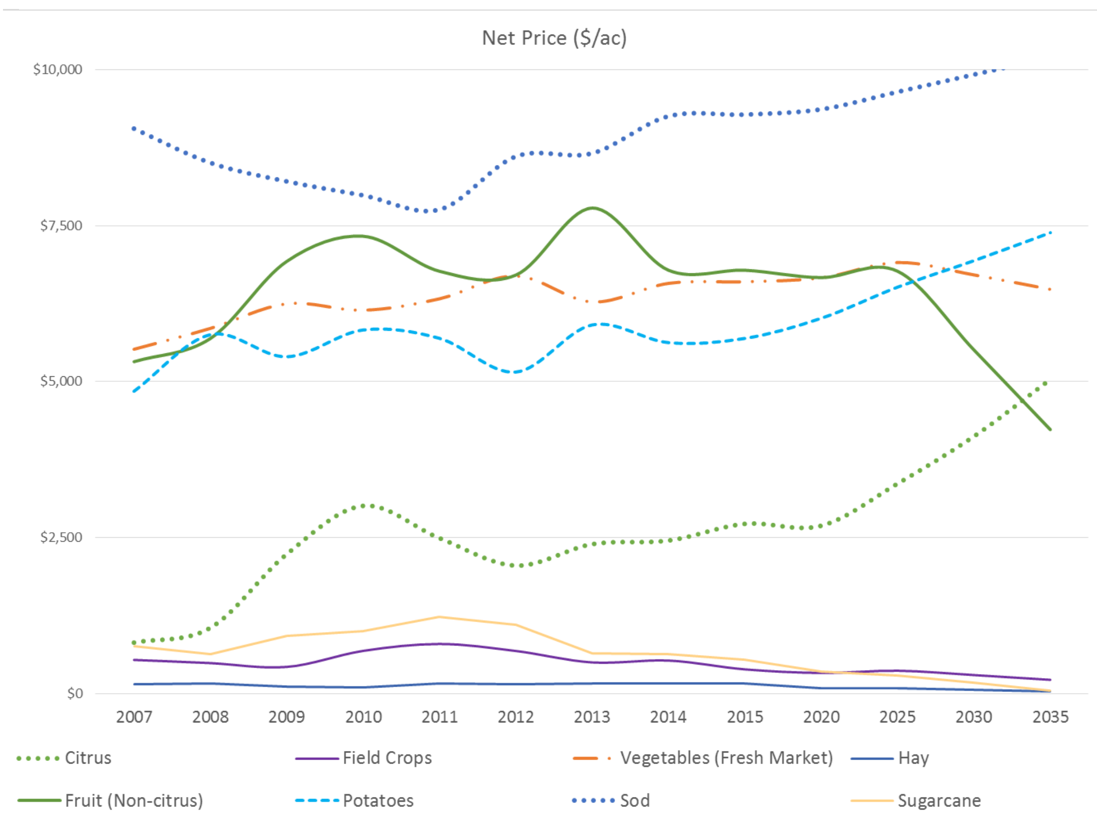
If price projections indicated that a specific crop would produce less net revenue than an alternative crop that could be harvested using existing soils and irrigation systems, the crop would shift to the higher revenue alternative for the next five year increment. The new crop pricing - after the shift - was applied to the field and new water use estimates generated. Existing irrigation system type constrains much of the potential crop shifts that would occur strictly based on net price projections. For example, a shift from Vegetables (fresh-market) to Potatoes occurred in the ILG only for polygons with existing seepage irrigation. Assuming stability of irrigation system type mitigates any radical swings in production of a specific crop.

Based on crop price projections from USDA FAPRI, some crop mix transitions are anticipated, at least for suitable farms in indicated Districts, as shown in **Table 13**. No broad scale crop changes are anticipated for the first five-year period, based on the updated FAPRI Release of February 2015. **Figure 8** shows the overall effect of revenue projections.

Table 13. Summary of Crop Transitions

Five Year Period Ending	Existing Crop	New Crop
2025	Noncitrus fruit	Potatoes (not in SRWMD or NWFWMD)
2030	Fresh Market Vegetables	Potatoes (not in SRWMD or NWFWMD)

Figure 8. Net Price Projections by Crop Category



Several trends are notable. First, citrus is expected to decline further before increasing in later years of the forecast. This is consistent with input from a number of researchers and producers who anticipate that citrus greening will become a management issue over the next five years, rather than decimating the citrus production industry, and that ongoing drought issues in California will bolster Florida production – large California producers have reportedly leased tracts of land for citrus production in Martin, St. Lucie and Okeechobee Counties. However, there is no guarantee that citrus will rebound to said levels.

Secondly, significant shifts toward potatoes in areas not previously noted for potato production are forecast, based on long term revenue projections. Interviews with producers and extension agents throughout the state indicated that potato production is occurring in areas not previously seen before including South Florida; at the same time, areas with long-term production contracts such as in the Hastings area were reportedly being cut back due to better storage times in other regions.

Finally, a share of non-citrus fruit and fresh market vegetables are forecast to shift into other crops in the out years. This is contrary to the conventional wisdom of recent years, but reflects an emerging global trend: namely, agricultural products that can be processed for shipment overseas provide a less expensive alternative for other nations like China. USDA's Economic Research Services arm released statistics in June 2015 showing long-term demand for fresh market vegetables are expected to be outweighed by demand for vegetables for processing overseas.

Acreage projections

County-specific long-term trends in irrigated lands as a percentage of agricultural land were estimated using an auto regressive procedure to forecast future percentages of irrigated share. NASS-reported total agricultural land was used to chart each county from 1987-2012, the longest consistent data stream available; **Appendix C** provides graphs for each of Florida's 67 counties. Total irrigated land for each county was used to build a ratio of the two and to forecast projected trends based on statistical fit. The functional form of each regression was selected based on best fit criteria from logarithmic, linear, moving average and quadratic forms. Quadratic functional forms that showed explosive out of sample growth were rejected and replaced with linear projections. Exceptions were made; for example, counties with the bulk of acreage included in the Everglades Agricultural Area were excluded from the projection. Acreage and water use agreed to in the Lower East Coast Water Supply Plan were used for the EAA. In addition, in some areas projected growth may not be bound by a legal or policy constraint, but the costs to obtain water supply currently would indicate a low likelihood of converting unirrigated into irrigated land; for example, in Escambia and Santa Rosa counties. Over time, business models and market conditions may change such that converting subprime land may become financially feasible, if no binding constraint is imposed in the interim.

In some areas of the state, the share of agricultural land that is irrigated has remained relatively constant, while in other areas the data shows steady, significant increases. The trend in agricultural land was projected to 2035 for each county, and the projected change in share of agricultural land that is irrigated was used to forecast irrigated land. Projected agricultural acreage and irrigated acreage through 2035 by county are provided in **Appendix A**.

The amount of acreage change resulting from the calculation was subtracted from the ILG, in the case of negative growth, or in the case of positive growth, extracted from the unirrigated ALG and brought into the ILG. Discussion of the methodology for spatially assigning water use is provided in the next section with details in **Appendix A.**

Spatial distribution of future water use

Future water use changes that exceed water applied to current acreage were allocated across fields that were selected from the ALG. For additional acreage, the pool of currently unirrigated land was considered subject to constraints. Constraints included poor soils, defined as soil grade with Land Capability Classification of 4 or greater, lands designated in water resource caution areas, and/or Florida Natural Areas Inventory.

Additional detail describing the spatial distribution process is provided in **Appendix A**.

Estimated Water Use Projections

Overall the estimates project a net increase of 17% in water use for a 5% increase in acreage over the next twenty years. Below the state level, shifts in irrigated acreage and water use are more pronounced. **Table 14** provides detail at the Water Management District level. In the Northwest Florida Water Management District (NWFWMD), irrigated acreage is expected to increase 17%, but overall water use increases by 28%, due to increased irrigation indicated by revenue projections in the last half of the planning horizon; overall the irrigation intensity increases slightly, from 0.0008 MGD/acre to 0.0009 MGD/acre. In the South Florida Water Management District (SFWMD), acreage increases by 8%, with water use increasing at a higher rate, of 17%; SFWMD absorbs most of the increased citrus and potato acreage in the last ten years of the planning horizon, based on revenue projections – a departure from tradition, but consistent with feedback from some producers. In the St. Johns River Water Management District (SJRWMD) and Southwest Florida Water Management District (SWFWMD), acreage declines by about 11% and 7%, respectively, but water use is estimated to increase by about 7% and 14%, respectively, due to increased production of potatoes and citrus. In SRWMD, a 30% increase in irrigated agricultural acreage generates a 40% increase in water use dispersed across crops, driven by growth in potatoes and fresh market vegetables; relative intensity remains unchanged at 0.0009 MGD/acre.

Table 14. Projected water use estimates by District, 2015-2035

WMD	2015	2015	2020	2020	2025	2025	2030	2030	2035	2035	
	Acres	Avg Year MGD	Acres	Avg Year MGD	Acres	Avg Year MGD	Acres	Avg Year MGD	Acres	Avg Year MGD	Dry Year MGD
NWFWMD	56,829	46	57,374	47	61,879	52	63,260	55	66,713	59	67
SFWMD	1,045,697	1,237	1,064,518	1,248	1,085,635	1,263	1,108,037	1,369	1,129,211	1,448	1,665
SJRWMD	177,371	208	172,698	201	168,708	197	161,006	210	157,536	223	256
SRWMD	123,956	107	133,201	118	142,671	128	151,765	140	162,106	151	174
SWFWMD	396,459	534	389,062	518	382,800	506	378,117	574	369,888	611	703
Total	1,800,312	2,132	1,816,852	2,132	1,841,693	2,146	1,862,185	2,346	1,885,453	2,491	2,865

FSAID future water use projections show increasing irrigation intensities resulting from crop type changes and increased multi-cropping. This results from additional irrigated acreage being assigned higher-margin crops due to the simulated excess water use that is associated with those cropping systems. In the absence of cropping system changes and irrigated acreage additions, irrigation intensities would be expected to decrease as a result of the management and equipment changes that would conserve irrigation water. The irrigation water conservation estimates can be expected to partially offset the projected irrigation intensity increases resulting from crop mix changes.

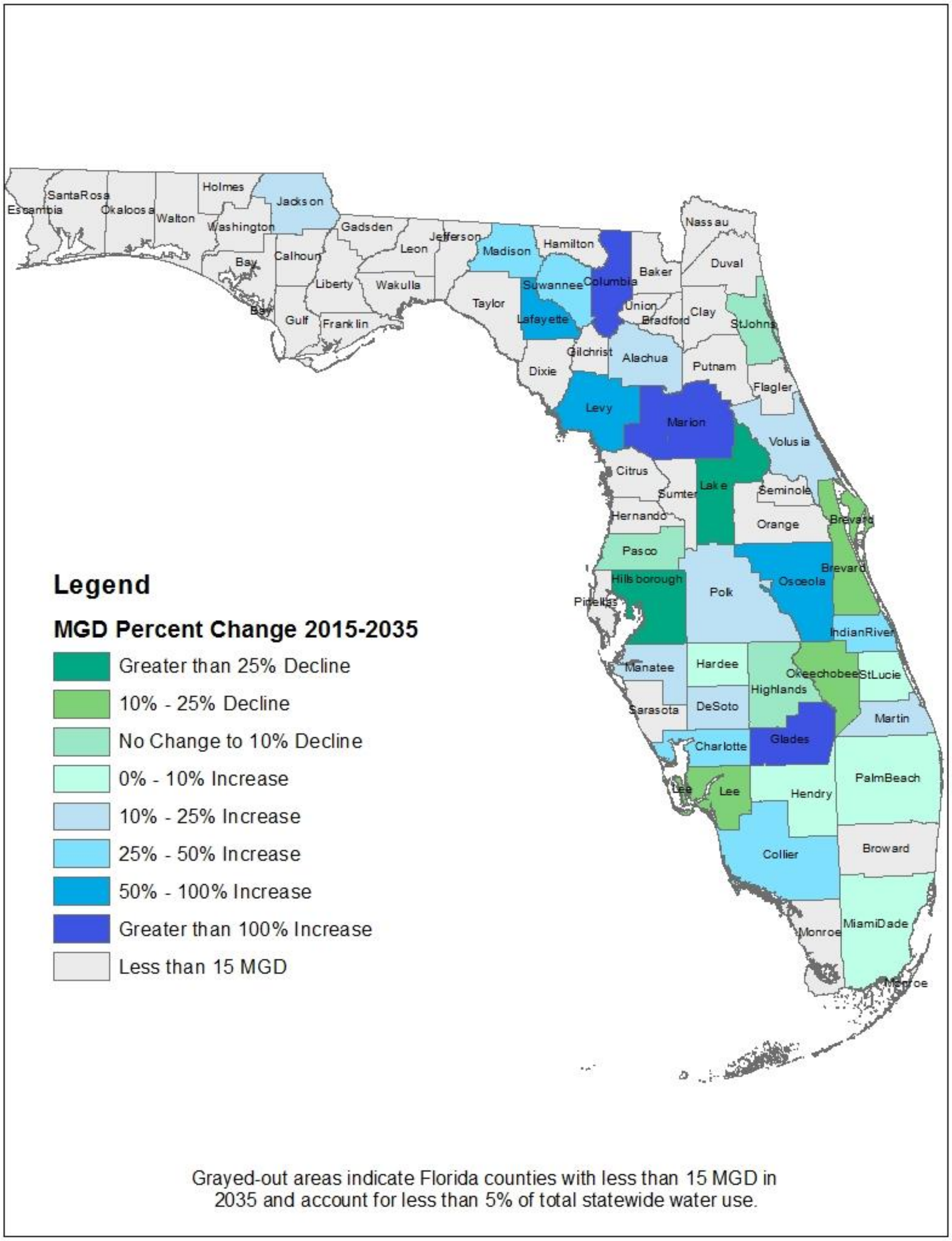
Table 15 provides estimated water use projections by crop acreage for 2015-2035. The results indicate an overall increase of approximately 25% for a 7% increase in acreage. Increased water use results from shifts in crop mix and increased acreage, based on revenue projections. From a long-term perspective, water use grows at just under 1% annually; accompanied by a potential conservation estimate of 343 MGD by 2035, the ending statewide irrigation demand could be similar to current demand (2,148 MGD if all the conservation estimate is realized).

Table 15. Irrigated Acreage Estimates and Projections by Crop – Statewide

Statewide	2015		2020		2025		2030		2035		
Predominant Crop	**Avg Year MGD**	**Acres**	**Avg Year MGD**	**Acres**	**Avg Year MGD**	**Acres**	**Avg Year MGD**	**Acres**	**Avg Year MGD**	**Acres**	**Dry Year MGD**
Citrus	689	567,741	700	587,112	711	608,270	876	626,231	1,006	646,160	1,157
Fruit (Non-citrus)	51	32,155	51	32,314	50	32,489	52	32,552	52	32,822	60
Potatoes	40	28,712	41	31,794	45	36,119	197	124,337	221	135,049	254
Vegetables (Fresh Market)	337	220,880	340	225,429	348	233,903	232	159,019	232	161,173	267
Field Crops	92	132,909	90	130,244	87	126,377	86	124,284	84	122,815	97
Greenhouse/Nursery	119	64,902	119	65,102	124	68,142	126	65,783	125	64,714	144
Hay	106	115,021	98	111,584	95	108,104	91	104,288	87	99,705	100
Sod	84	70,561	80	67,562	77	64,951	78	64,217	79	64,095	90
Sugarcane	616	567,431	613	565,711	610	563,339	608	561,474	605	558,919	695
Total	2,132	1,800,312	2,132	1,816,852	2,146	1,841,693	2,346	1,862,185	2,491	1,885,453	2,865

Projected changes in water use at the County level are shown in the Map at **Figure 9.**

Figure 9 . Map of water use



The Everglades Agricultural Area comprises most of SFWMD's agricultural acreage. The EAA is almost one third of the agricultural irrigation in the state, and is not expected to significantly change in the next twenty years. As a result, the increased acreage and water use are not dispersed throughout the state but concentrated in other districts. Significant increases in potato and citrus acreage occur in their respective areas. Citrus greening has reduced citrus acreage over the past five years, but many Florida scientists and producers believe that resolution of greening issues is probably within the next 3-5 years. Restoration of prior citrus acreage is already occurring in some areas, and expansion of acreage is projected in other areas with little urbanization pressures. The shift between vegetables and potatoes in part reflects increasing global demand for irrigated agricultural products, and the increase in processing facilities within Florida may well support increased potato production.

Detailed crop and acreage changes at the County level are provided in **Appendix B.**

Dry Year Water Use Estimates

Water use estimates for dry year conditions were assessed in several ways. A dry year describes a year of below-average rainfall that occurs with probability of 10%, or 1-in-10 years. Different Districts use different algorithms to estimate the effects of reduced rainfall or a "dry" year. Dry-to-average factors included in District Regional Water Supply Plans were reviewed; factors vary by Planning Area, but generally total 100 – 130% of average water use estimates by crop. At the end of the respective planning periods, dry year estimates approximate 110 - 115% of average year demand overall. AFSIRS estimates for water demand by crop using the average of the two lowest year's rainfall for every observation vary from 106% - 131% of average demand at the field level, totaling 110% at the District and Statewide levels. Permitted limits for dry year versus average year water use, based on review of selected permits, authorize approximately 130 – 145% of estimated average year demand.

Estimates of dry year demand were replicated using water use data and the minimum rainfall year in place of actual rainfall for the year of record and average year rainfall over all years in the dataset, with corresponding ET factors. Estimates varied by crop and District, but generally totaled approximately 110% of average year demand overall. In severe droughts, producers may choose not to irrigate or to abandon crops once certain thresholds are met, which tends to mitigate total demand versus AFSIRS or AGMOD estimates. For demand planning purposes, 115% of average year demand was estimated across crops and districts as the 1-in-10 year demand.

Detailed dry year demand estimates are included in tabulated totals and all GIS files.

Sensitivity Analysis

A number of model iterations were run to test the sensitivity of various parameters and alternative approaches to measuring variables. Notable tests include:

- As noted in the Inputs section, the effects of using rain gauge versus AHPS time series for rainfall data were tested and found to cause results to vary by less than 2% overall.
- ET data were tested to determine the impact of the RET data applied to the smaller, regression dataset versus the entire ILG, and found to vary by approximately 3%.

- Crop categories were tested in multiple combinations. ANOVA analysis[10] of different crop categories was conducted to identify differences in actual water use among different combinations of crops. At least three iterations were completed for each District prior to finalizing crop categories. For example, corn was modeled separately and as part of Field Crops, with about 6% difference in overall estimated water use for 2% of irrigated acreage – in other words, immaterial.
- The effects of different screening thresholds for excluding outlier records was tested, and resulted in inclusion of about 200 additional metered data records.
- Using different temperature thresholds to detect frost-freeze protection in water use varied frost-freeze estimates from 2.0% of water overall to 2.6% of overall water, but did not change overall water use estimates.

Quality Control Methods

One of numerous quality control measures was to review the water use estimates for the six largest permits in each water management district; irrigation volumes and intensities were checked to ensure that simulated irrigation demands were reasonable based on metered average intensities by crop type. The selected farms comprise 7% of statewide irrigation water use.

Additionally, randomly selected fields were tracked from raw data through final calculations, including assignment of net price, rainfall, ET, calculation of acreage, and application of coefficients, to confirm output results. Reference tables were checked by backcheckers not involved with the generation of the reference data to ensure validity of input information and identify any transposition or calculation errors. Conversion of crop yields, price adjustments for inflation, and other unit transitions were manually checked and automatically checked through algorithms applied to identify outliers.

Algorithms and processing steps used to generate acreage changes, water use estimates and spatial distribution were manually checked for 120 records; no errors were detected.

Other Agricultural Water Demands

Frost projection, livestock watering, and aquaculture are other agricultural water demands included in FSAID estimates. These water uses are not included in a traditional crop water demand model. Consideration was given to the water demand related to crop establishment, fertigation, and chemigation, but these were not separately accounted for. The assumption is that growers absorb these demands within their designated allocation, and these uses are not substantial contributors to total irrigation water use. Several WMDs specifically include these uses in calculating a water allocation.

Frost Protection

Frost protection is used on a variety of crops in areas such as Central Florida, where freezes occur regularly (but not every year). Citrus, strawberries, blueberries, peaches, and ferns are examples of crops commonly protected from freezes. While strategies vary by crop and the capabilities of particular

[10] Analysis of variance (ANOVA) is a collection of statistical models used in order to analyze the differences among group means.

irrigation systems, the most common method is to apply a constant high supply of water to the plant. As ice forms around the plant, the heat of fusion (resulting from the transition of a liquid to a solid) protects the plant. Published literature recommends that 0.20 to up to 0.40 inches per hour of water be applied so that the heat of fusion and heat of vaporization (liquid to water vapor) balance (Parsons and Boman, 2003; Crane, 2002; Williamson et al 2004). If too little water is applied, the practice can be more damaging than if no water were applied at all. For some farms, the capacity of the irrigation system limits frost protection to a portion of the field. The high water requirements from frost protection have led to short-term groundwater drawdown, and more farms are adding surface water capacity to supply water for frost protection. Frost protection was limited to the major crops commonly requiring freeze protection: strawberries, blueberries, peaches, citrus, and ferns. Additionally, a frost protection region (**see Appendix A**) was defined to exclude areas in the northern part of the state where freezing conditions are commonplace. In these areas, it is assumed that crops that would require frost protection are scheduled around the winter months. Freeze events were estimated to occur on days with minimum temperature at or below freezing for fields in the ILG contained in the frost protection region and where crop type matched one of those listed above. The USGS GOES ET data from 1996 to 2013 were used for establishing the frost protection region and initiating daily freeze events at appropriate fields. **Technical Note 6** provides more detail on the frost/freeze methods.

Of the 18 years of data, the average annual frost protection demand was 97.1 MGD on an average annual daily flow (AADF) basis. **Table A-6** in **Appendix A** provides a breakdown of the average frost protection demand for each county in the frost protection zone that contained fields that would be freeze protected based on the above-listed crop types.

Freeze protection water volumes are a relatively small percentage of the total statewide demand for normal irrigation (4.5% average), but the withdrawals happen in a short time frame, meaning that planning and/or mitigating for the potential impacts from this short-term water demand is necessary.

Livestock Demands

Livestock demands were determined based on the animal inventories from USDA Ag Census data and the WMD's suggested allocation per animal. These numbers are relatively consistent among the WMDs. The Ag Census for both 2007 and 2012 were used to estimate the number of cattle (both dairy and beef), and the Ag Census for 2012 alone was used to define the number of other livestock. Livestock inventories from the Ag Census have remained relatively stable in Florida for the last three censuses (2002, 2007, and 2012). Without a sufficiently reliable dataset to develop trends in livestock, we are projecting stable livestock inventories and water use in the coming decades. There have been recent land acquisitions of exceptional size that might suggest future expansion of cattle operations in parts of the state. Additionally, there is a consumer-driven trend of increasing demand for grass-finished beef, as evidenced by the recent addition of grass fed beef to the USDA's monthly market reports (USDA, 2015). This could result in expanded pasturelands and livestock water use in Florida. However, without a sufficiently reliable dataset to develop trends in livestock, we are projecting stable livestock inventories and water use in the coming decades. Spatial distribution of livestock and aquaculture production areas was achieved by searching attribute fields in the CUP datasets to identify areas of livestock and aquaculture. Separate shapefiles were assembled for livestock and aquaculture permits with and without irrigated areas; more details are provided in **Appendix A** at **Technical Note 6**.

Table 16 summarizes the livestock water demands. A breakdown of the livestock inventory and water use by county are presented in **Appendix A**.

Table 16. Statewide Livestock Water Demand Summary

Animal	Estimated Number of Animals	Water Use Per Animal (gpd/head)	Total Demand (mgd)
Dairy Cattle	121,200	150	18.18
Beef Cattle	1,575,531	12	18.91
Poultry, chickens	13,026,011	0.09	1.17
Goats	57,613	2	0.12
Hogs	17,622	2	0.04
Sheep	11,763	2	0.02
Total	**14,809,740**		**38.43**

Note: Unless otherwise specified, water use estimates are in MGD for an average year

Aquaculture Demand

Aquaculture demands are difficult to estimate in an automated fashion because the water demand is based on a specific flow-through rate for the system. Based on a review of aquaculture permits throughout the state, no specific set of guidelines were identified. To estimate the county-level water withdrawals for aquaculture, reported water use was compiled for all CUPs found to be associated with aquaculture. CUPs for several counties were found to have available metered data for aquaculture withdrawals, and these were used in conjunction with the USGS county-level aquaculture withdrawals to produce statewide aquaculture water demands. The maximum of county level sums of CUP-reported water use and USGS aquaculture water use was used.

The statewide aquaculture demand was calculated to be 5.5 mgd. **Appendix A** gives a county-by-county breakdown of the calculated livestock and aquaculture demands. Future demand is held constant.

Water Demand Summary

The total statewide irrigation water demand estimate for 2015 conditions is 2,176.1 mgd (**Table 17**). An additional 97.1 mgd may be required for Frost Protection in an “average” year. Estimates were based on current market and field conditions, and an average year for rainfall and ET; in some parts of the state, more rainfall than average has occurred as of May, and this estimate may be considered conservative.

Table 17. Summary of Estimated Agricultural Water Demand

Water Use Component	Average Annual Demand (mgd)
Crop Irrigation	2132.2
Livestock/Dairy	38.4
Aquaculture	5.5
Subtotal	**2,176.1**
Frost Protection	97.1

Comparisons to Other Studies

The Water Use estimates were compared to published reports, including USGS and USDA estimates. **Table 18** provides a summary of other estimates. The FSAID estimates are in line with other estimates. While the USDA Farm and Ranch Irrigation Survey (FRIS) is significantly lower, the FRIS acreage has consistently been 10-25% lower than other estimates, and the water use estimates are significantly lower, accordingly.

Table 18. Statewide Water Use, Comparison to Other Sources

	Irrigated Acreage	Water Use Estimate (MGD)
FRIS 2013[2]	1,364,559	1,419
FRIS 2008[1]	1,222,797	1,519
FSAID 2015	1,800,312	2,132
USGS 2010	1,991,320	2,920

Source: [1] USDA NASS (2009), [2] USDA NASS (2014), USGS (2010).

Estimates of Future Irrigation Water Conservation

Emerging pressures on freshwater resources are requiring water users in all sectors to improve water use efficiency, and this is especially true for irrigated agriculture. Future improvements in agricultural water conservation must conserve water both at the field scale and the basin scale in order to really contribute to more sustainable water resources (Schaible and Aillery 2012). Historical changes in irrigation efficiency were used to project future trends in irrigation conservation in Florida. The FRIS data for Florida (1978 to 2013; seven FRIS during this time period; **Table 19**) were used to develop a time series of acres irrigated and irrigation water applied. The historical trend in the ratio of water applied to irrigated area was used to predict future irrigation conservation through 2035.

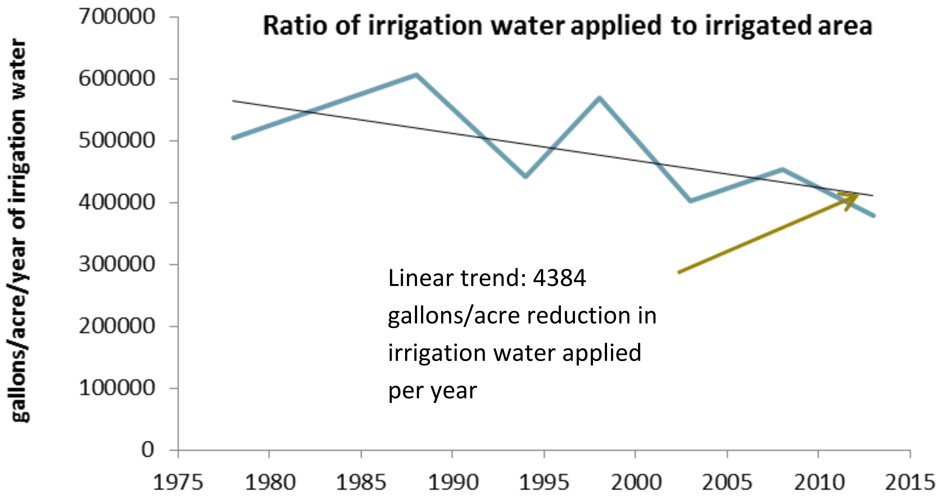
Table 19. Irrigated farms, irrigated area, and volume of irrigation water applied in Florida

Year	Irrigated Farms	Acres Irrigated	Irrigation water applied, acre-feet	Irrigation intensity, gallons/acre
1978	8,002	1,854,902	2,873,393	504,770
1988	6,841	1,460,137	2,712,334	605,298
1994	7,215	1,416,019	1,922,166	442,325
1998	6,452	1,613,719	2,813,458	568,110
2003	8,335	1,497,653	1,851,324	402,801
2008	5,250	1,222,797	1,701,120	453,315
2013	7,270	1,356,561	1,573,095	377,864

Source: Farm and Ranch Irrigation Survey data, 1978 to 2013

A linear trend in irrigation conservation from 1978 to 2013, as approximated by the irrigation applied to irrigated area ratio, results in an annual irrigation conservation estimate of about 4400 gallons/acre less irrigation water applied each year. In 1978, about 504,800 gallons/acre/year of irrigation were applied statewide on irrigated areas in Florida, and in 2013 about 377,900 gallons/acre/year were applied statewide on irrigated areas in Florida **(Figure 10).**

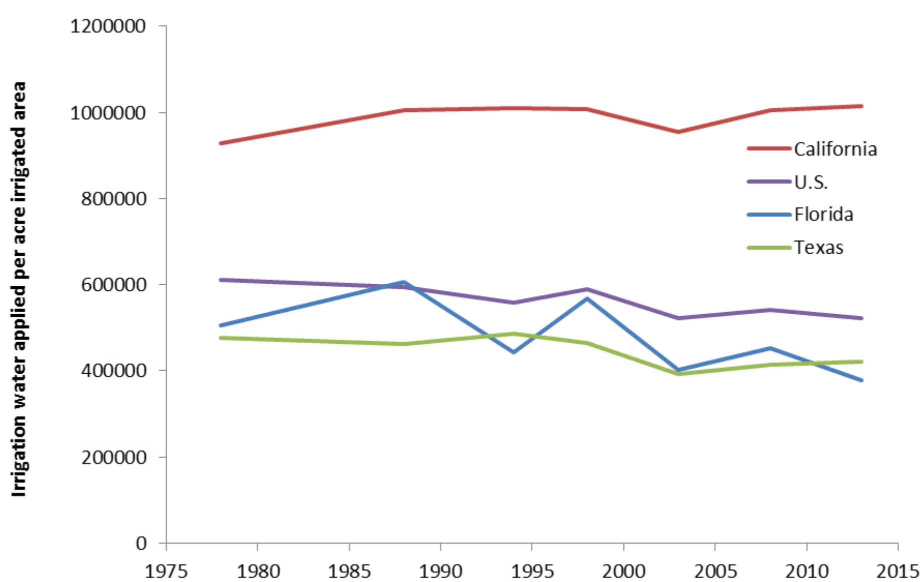
Figure 10. Long-term trends in irrigation efficiency



Source: Calculated, from 1978 to 2013 Farm and Ranch Irrigation Survey (FRIS).

Future irrigation conservation assumes this annual trend of approximately 4400 gallons/acre less irrigation water continues through 2035. Total water savings from irrigation conservation improvements is the product of that slope and the statewide irrigated area, excluding the Everglades Agricultural Area, at each 5 year increment. The advantages of using the FRIS data to estimate conservation are that it captures all possible types of irrigation advances (improved scheduling, sensor-based automation, changes in irrigation systems, minor efficiency improvements, and crop changes, among others) and also implicitly includes reductions in irrigation efficiency due to the statewide aggregation of all irrigated area. The ratio of irrigation water applied to irrigated area, used here as a proxy for efficiency, for Florida is similar to that of Texas, one of the largest irrigators nationally. The Florida irrigation water to irrigated area ratio is well below the national average **(Figure 11)**.

Figure 11.The ratio of total irrigation water applied to total irrigated area



Source: 1978 to 2013 Farm and Ranch Irrigation Survey (FRIS); Florida, California, Texas, and the U.S.

Irrigation conservation is calculated as a statewide total conservation potential (MGD) for 2020 through 2035. This statewide conservation estimate is divided among counties based on the proportion of total statewide irrigation demand within a county. Estimated potential irrigation conservation is provided at the District and statewide scale (**Table 20**), based on the 36 year trend in FRIS data. By 2035, with a projected irrigation demand of 2,023 MGD statewide (2,491 MGD including EAA), there is potentially 343 MGD of irrigation water that could be conserved to reduce the total expected demand by about 14%. Conservation potential relative to total irrigation demand at the District level at any 5-year increment was not allowed to exceed the statewide average ratio of conservation water to total irrigation demand. This creates more conservative conservation estimates at the District level.

Table 20. Potential Irrigation Conservation and Total Irrigation Demand, 2020 to 2035

WMD	2020		2025		2030		2035	
	MGD	**Conservation MGD**	**MGD**	**Conservation MGD**	**MGD**	**Conservation MGD**	**MGD**	**Conservation MGD**
NWFWMD	47	2	52	5	55	7	59	10
SFWMD	779	38	795	79	900	121	979	166
SJRWMD	201	10	197	20	210	28	223	38
SRWMD	118	6	128	13	140	19	151	26
SWFWMD	518	25	506	50	574	77	611	104
Florida, totals; excluding EAA	**1,663**	**82**	**1,678**	**166**	**1,878**	**253**	**2,023**	**343**

Note: Excluding EAA, and potential irrigation conservation estimates. Based on FRIS trend of declining ratio of irrigation water applied to irrigated acres. Unless otherwise specified, water use estimates are in MGD for an average year

Data from Mobile Irrigation Labs were explored extensively for use in estimating future conservation. MIL-based projections of future irrigation conservation were limited due to the shorter time period (2009 to 2015) for MIL data and the smaller sample in terms of area served by MILs that have documented actual water savings (AWS). Approximately 20,300 irrigated acres have been shown to have documented actual water savings based on MIL data from 2009 to March 2015. The documented actual water savings are based largely on improvements in irrigation system uniformity and efficiency. The data available for MIL-based irrigation improvements from scheduling changes and sensor-based automation and other management improvements are not of sufficient length to develop long-term future projections in conservation. **Table 21** summarizes the water savings and MIL-served area having documented water savings for the top two irrigation systems by area in the MIL data[11].

[11] The protocol for calculating actual water savings is available in the MIL Handbook, which can be accessed at http://freshfromflorida.s3.amazonaws.com/Mobile+Irrigation+Lab+Handbook

Table 21. Mobile Irrigation Lab summary by irrigation system

Year	Irrigation system	Irrigated Farms	Acres with AWS	Total AWS, acre-feet/yr
2009	Center Pivot (low pressure)	17	1,610	552
	Micro Spray	73	1,997	1,019
2010	Center Pivot (low pressure)	68	6,853	1,768
	Micro Spray	37	976	337
2011	Center Pivot (low pressure)	52	4,520	1,055
	Micro Spray	42	706	304
2012	Center Pivot (low pressure)	105	10,778	2,804
	Micro Spray	110	2,802	1,121
2013	Center Pivot (low pressure)	30	1,470	625
	Micro Spray	45	820	144
2014	Center Pivot (low pressure)	67	4,317	1,429
	Micro Spray	78	2,166	889
2015	Center Pivot (low pressure)	12	1,102	241
	Micro Spray	15	824	288

Note: AWS indicates actual water savings based on a measured improvement in irrigation uniformity

The costs to achieve conservation of irrigation water vary based on the type of management and/or equipment changes. To provide some context for irrigation water conservation costs, **Table 22** summarizes costs from several different sources of information.

Table 22. Costs of irrigation water conservation ($/MGD)

Data source	Cost: $/MGD water savings
FRIS data, Florida; 2003 - 2013[12]	$484,095
FRIS data, U.S.; 2003 - 2013	$847,565
MIL data, center pivots; 2009 - 2015[13]	$264,517
SWFWMD conservation study, 2000[14]	$485,450

Findings & Recommendations

Overall, projections indicate a 17% growth in statewide agricultural irrigation water use for a 5% increase in irrigated acreage from 2015 to 2035. Compared to 2010, overall acreage increases 8% and water use 17% (holding sugarcane constant). The increased water use reflects a combination of long-term shifts in crop mix and increased irrigated acreage. Specific increases projected in citrus and potatoes acreage are partly offset by declines in vegetable acreage. The increases are based on projected revenues; if a different crop emerges which offers similar profit margins, producer behavior may be diverted accordingly, with similar outcomes for overall water use. The relative value of water to

[12] Based on FRIS data on Expenditures for Irrigation Equipment, Facilities, Land Improvement, and Computer Technology for primary purpose of water conservation

[13] MIL water savings for center-pivot irrigation; average cost of $5,500/pivot for efficiency/uniformity improvements

[14] Microspay irrigated citrus: implementing all BMPs for efficiency and scheduling improvements; SWFWMD study

the value of the crop will override the importance of the specific crop; as more valuable crops are constrained to smaller land areas, irrigation will increase to optimize the value of the land. The trends are consistent with market reports that indicate increasing reliance of China, the world's largest economy and among the largest populations, on the US for agricultural products requiring irrigation – essentially, importing American water through agricultural products. Demand for agricultural water appears poised to gradually increase accordingly.

The estimates provided in this report rely on water use data from select years for each district. As a first effort to incorporate a statewide dataset of actual water use for demand modeling, the results will benefit from an additional year of data that is consistent across all districts. Current year data (2015) will allow further testing of the veracity of the results and additional refinement of the estimates. Equally importantly, extending the data period may allow for techniques that simplify future statewide demand modeling efforts.

Important factors that may impact future water use intensity include the share of dry land farming that converts to irrigated agriculture, and the conversion of single crop to multi-crop fields. Data availability for this effort precluded a comprehensive analysis of the effects of long-term trends in multi-cropping on irrigation intensity. As described herein, average multi-crop behavior by crop type by district from the water use model dataset was used for estimating statewide water use. Given anecdotal reports from permit reviewers and producers that permittees are increasingly adopting more intensive farming techniques, this aspect warrants further exploration.

The spatial simulation model may capture behaviour that is forward-looking, while the regression model captures the historical structure of irrigation decisions. For example, the spatial allocation process revealed increases in water use acre-for-acre on citrus, based on irrigation responses to market and climate conditions from 2007 to 2013. The model cannot foretell the density or size of trees a citrus farmer may use to reset a grove lost from greening, yet producers report increased density and smaller size of plantings, and avoiding all stress to the tree. This is consistent with the output. Similarly, the increased intensity indicated for crops that accommodate multi-cropping may reflect change in behaviour. A longer data stream may accommodate further analysis of his aspect, which is warranted.

Long-term urbanization effects in the southern half of the state are expected to exert pressure on the less urbanized northern half of the state. Coupled with the emergence of more intensive farming practices, the demand for agricultural water use is likely to exceed historical quantities in the northern part of the state. Agricultural lands, including irrigated areas, can substantially contribute to groundwater recharge; therefore, agricultural water use may be considered differently than water use in some other sectors. Evaluation of the extent to which various irrigation systems and crops can optimize the field-scale water balance may be warranted, especially given the context of increasing water demands.

The conservation estimates provided herein aggregate long-term expectations based on past behavior. To the extent that long-term water use expectations are in conflict with increased demand from the agricultural sector, significant incentives are likely to be required to meaningfully shift the trajectory of water use.

A number of factors present uncertainty in future projections for Florida agricultural irrigation demand. Citrus greening is the most obvious, but other significant factors include agricultural policy as it affects sugar tariffs, energy policy as it affects field crop prices, and environmental regulations pertaining to water quality. Peer review of the model and its outcomes was completed, including sensitivity to these issues[15]. Feedback from the peer review was incorporated, and explanations of methods, data sources, and results were improved based on review comments. Water use for citrus and sugarcane, which contribute the vast majority of forecast demand, are sensitive to risks that could result in overestimating associated demand beyond the next five years. However, better data is not available to estimate the likelihood of this risk. With regards to policy changes, data to forecast these changes are not yet available and further, these changes are not likely to affect the overall agricultural demand for water in Florida.

Online Interface and Geodatabase

An important element of the project included coordination with external stakeholders, including producers, water management district staff, and stakeholder advisory groups. The Acknowledgments page recognizes the contributions that many individuals made with their time and input to improve this report and process. One consistent area of feedback was the request for simple access to commonly-used graphs and charts. While all of the ILG data is provided simultaneous with this report in a geodatabase, not everyone has access to GIS or specialized staff to pull GIS queries for them.

An online user interface (available at www.fsaid2.com) was created to allow easier access to data maps and tables for use in the future. The interface allows users to extract water use and acreage data by crop, county, planning area, and Water Management District. Users can stratify irrigated acreages and water demand by spatial units (County, planning area or WMD) or crops, and see how changes occur over time based on projections. The interface generates charts based on the chosen attributes, and allows data to be exported for further analysis in excel, access or other database programs. Charts can be printed or downloaded in a number of formats for use as graphics in other documents. **Figure 12** provides a screen shot of the interface. The interface can be accessed at www.fsaid2.com.

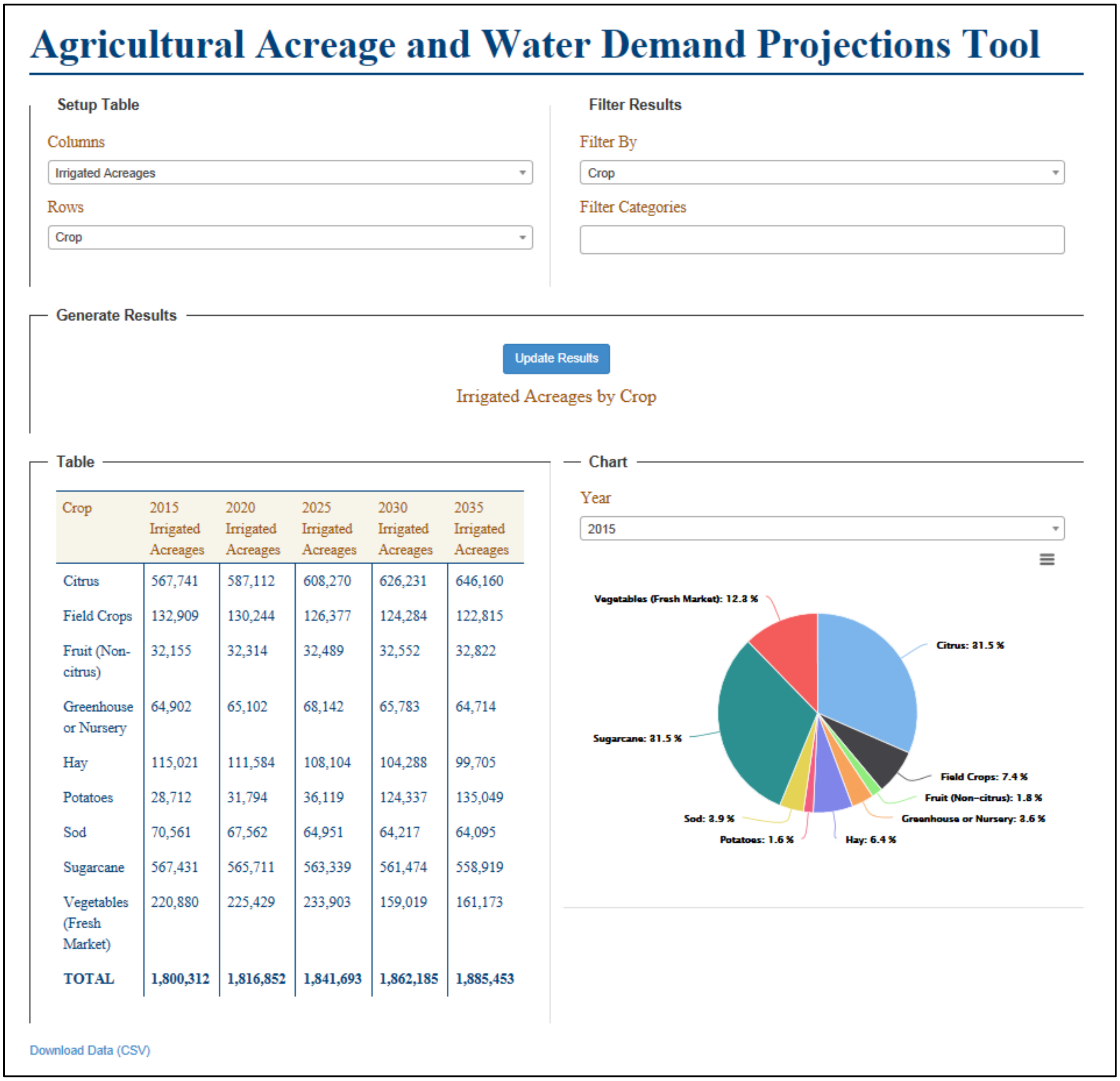
The FSAID2 Geodatabase contains shapefiles of water demand to facilitate further analysis and application of spatial water demand data. The FSAID2 Geodatabase includes:

- ILG: 2015 to 2035 irrigated acreage, crop type, average year and dry year water demand at the field level
- ALG
- Livestock and Aquaculture: permit-level water demand estimates for all livestock and for aquaculture

[15] Dr. Charles Moss, Professor and Research Coordinator of the Food and Resource Economics Department at the University of Florida. Florida Statewide Agricultural Irrigation Demand (FSAID): Review. 2015.

- Freeze Protection: field level freeze protection demands for polygons having freeze-protected crops in the freeze protection region
- Irrigation Water Conservation: field level spatial disaggregation of statewide irrigation conservation potential

Figure 12. Online interface screenshot



Crop	2015 Irrigated Acreages	2020 Irrigated Acreages	2025 Irrigated Acreages	2030 Irrigated Acreages	2035 Irrigated Acreages
Citrus	567,741	587,112	608,270	626,231	646,160
Field Crops	132,909	130,244	126,377	124,284	122,815
Fruit (Non-citrus)	32,155	32,314	32,489	32,552	32,822
Greenhouse or Nursery	64,902	65,102	68,142	65,783	64,714
Hay	115,021	111,584	108,104	104,288	99,705
Potatoes	28,712	31,794	36,119	124,337	135,049
Sod	70,561	67,562	64,951	64,217	64,095
Sugarcane	567,431	565,711	563,339	561,474	558,919
Vegetables (Fresh Market)	220,880	225,429	233,903	159,019	161,173
TOTAL	**1,800,312**	**1,816,852**	**1,841,693**	**1,862,185**	**1,885,453**

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Appendix A

Technical Note 1: Crop Categorization

Statistical analysis of water use data were conducted to identify like categories of crops for purposes of estimating irrigation practice. Detailed crop descriptions were initially crosswalked to primary crop categories. Crop aggregations were compiled from USGS, ERS and Water Management Districts. All water use data observations were included. ANOVA analysis was completed by District and statewide, and boxplots of each crop grouping were generated for review.

The box plots display the median water use by crop, with the next lower quartile of observations included within the box below the median line, and the next quartile of observations within the box above the median line. Additional observations that fall within 1.5 times this range are represented by the tails or lines extending beyond the box. Outliers, which fall outside 1.5 times the interquartile range, are identified as dots beyond the lines.

The process was used to identify whether crop categories should be further disaggregated or collapsed. In addition, records which reflected as outliers were researched individually to determine whether data or other anomalies existed. In some cases, the outliers identified that a second or third crop was included in a field for which data initially reflected only a single crop. In other cases, outliers reflected water use for frost-freeze protection.

Figures A-1 through **A-9** below show the ending box plots for each crop category. Two examples are explained in detail. Sod shows a median water use of approximately 11 inches/acre/year, with the next lowest quartile clustered between 11 and 4 inches/acre/year, and the next higher quartile reaching to just over 20 inches/acre/year. Some observations reflected water use of up to 38 inches per acre per year, and there were no outliers.

Freshmarket shows 44 different detailed crop combinations, with 19 reflecting median water use above 10 inches/acre/year, and 25 reflecting water use below. Outliers were identified for cucumbers, melons, small vegetables, and tomatoes, however most of the outliers fell within the range for alternative crops, that in most cases, producers can shift between from season to season. An anomaly was mushrooms, which represents a small percentage of acreage in the state and was immaterial to overall estimates.

Table A-1 provides the crosswalk from detailed crop description in the ILG to crop categories used for projection.

Figure A- 1. Intensity by Predominant Crop - Statewide

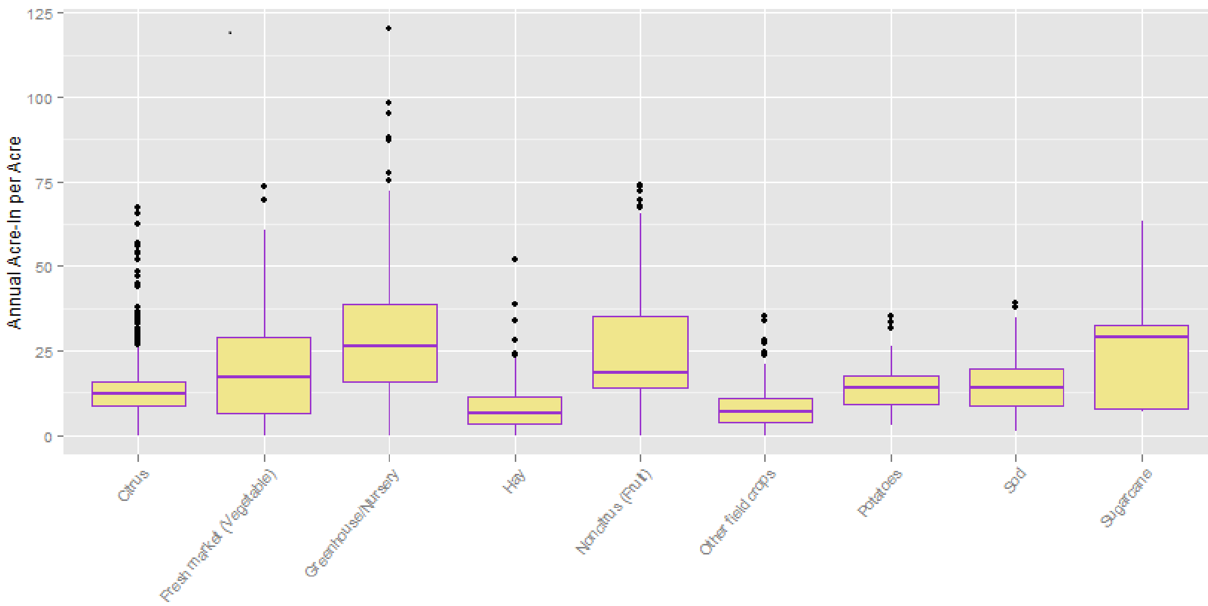


Figure A- 2. Box Plot-Citrus Crops

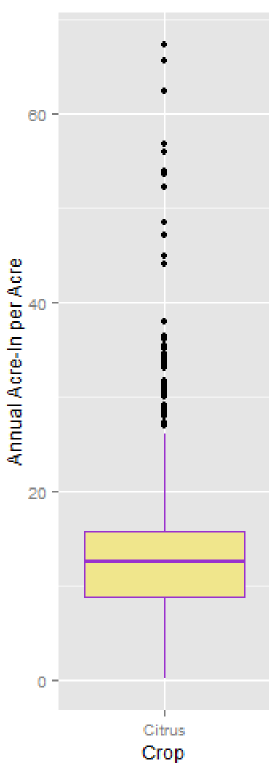


Figure A- 3. Box Plot-Sod

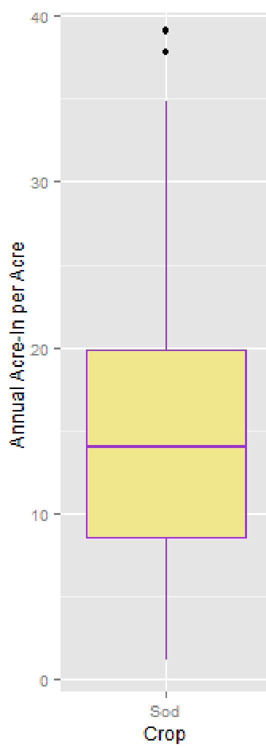


Figure A- 4. Box Plot-Sugarcane

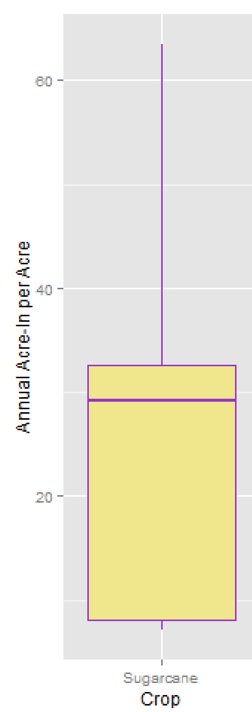


Figure A- 5. Box Plot-Fresh Market Vegetable

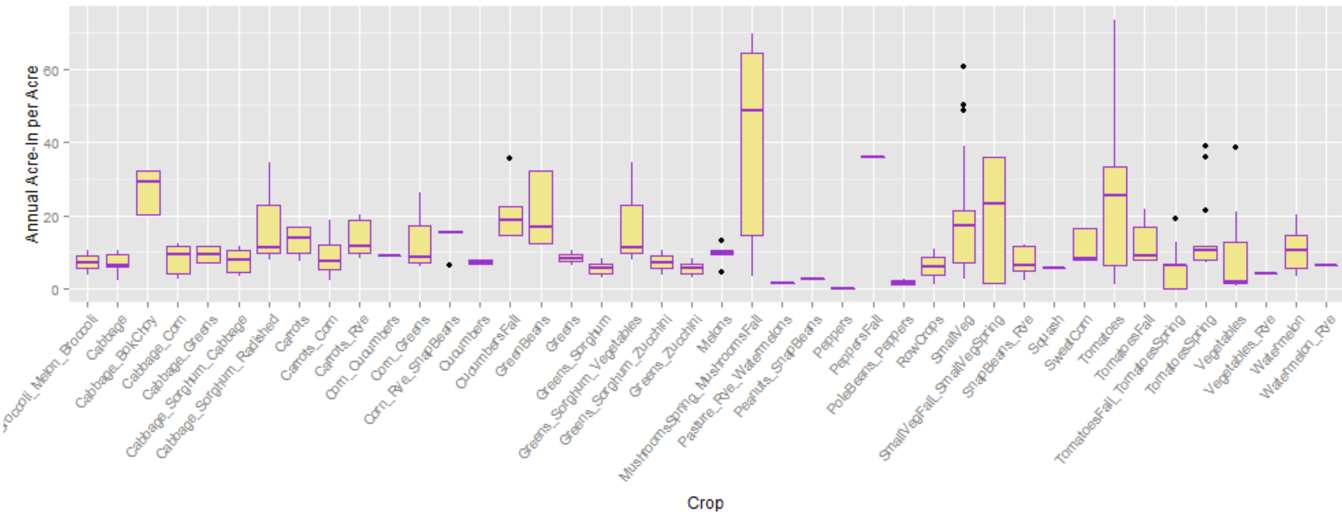


Figure A- 6. Box Plot-Hay Crop

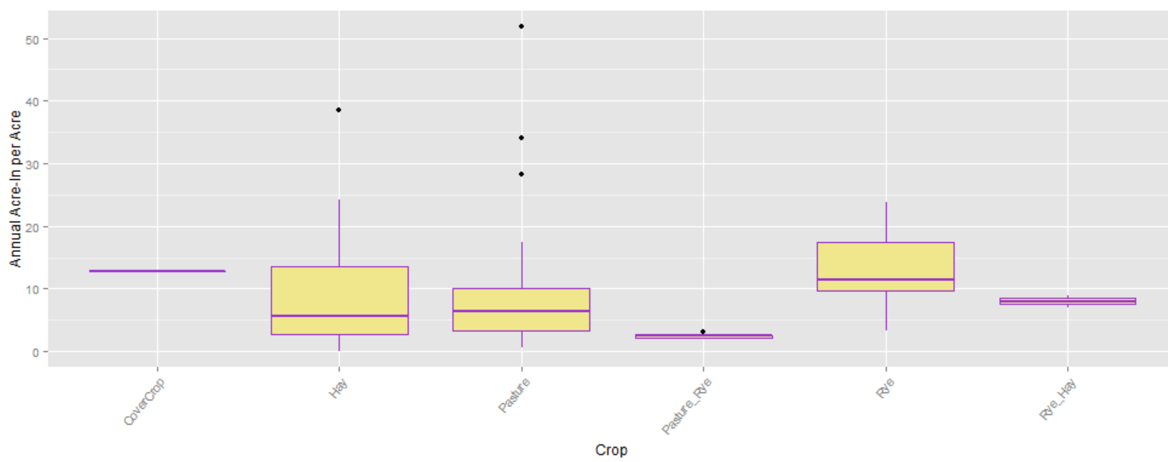


Figure A- 7. Box Plot-Greenhouse Crops

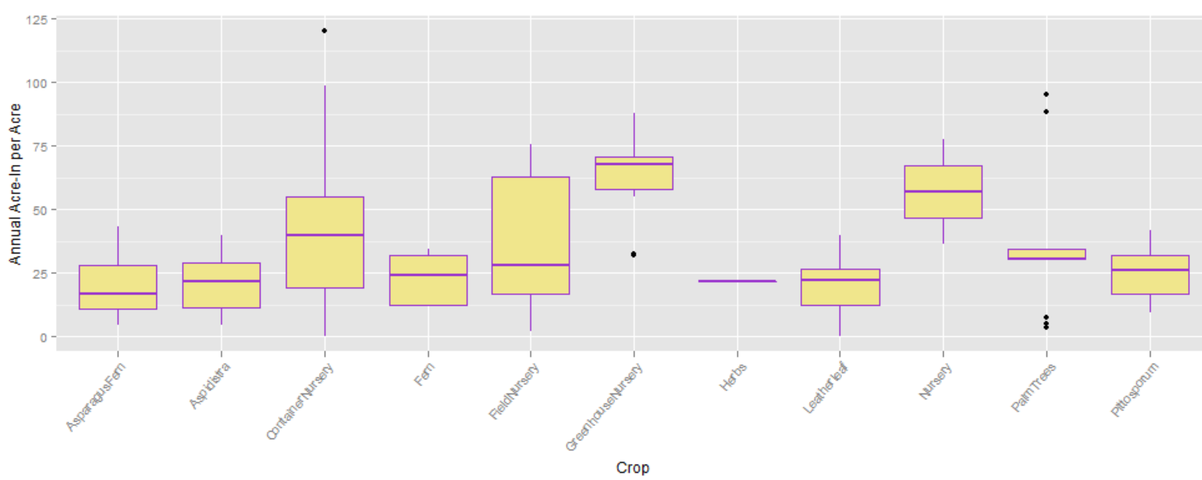


Figure A- 8. Box Plot-Non Citrus Fruit Crops

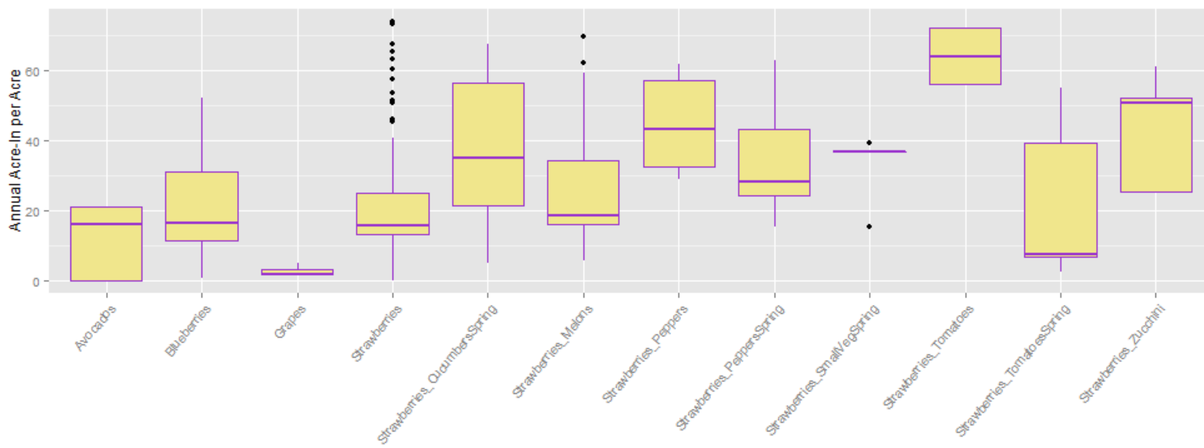


Figure A- 10. Box Plot- Field Crops

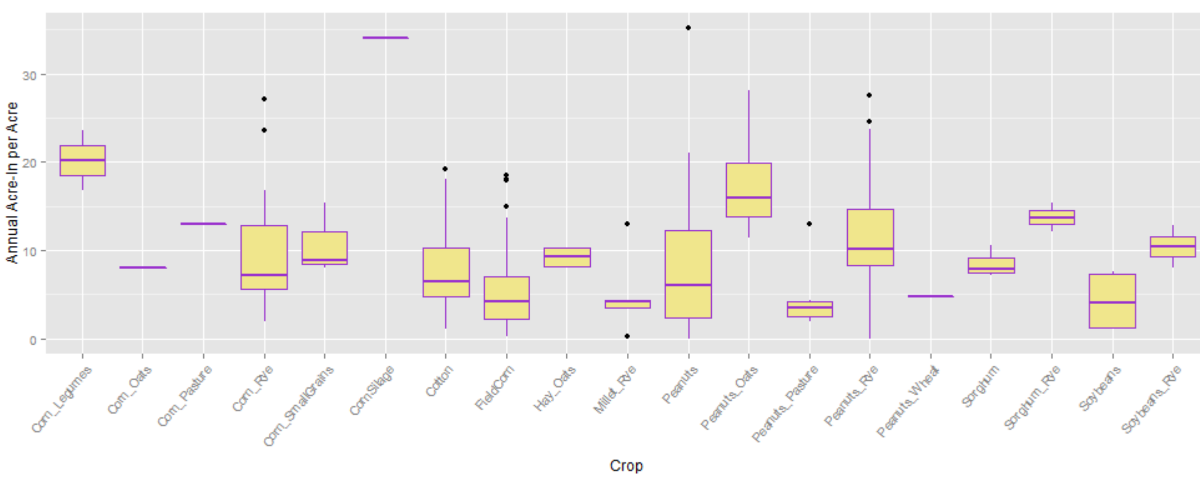


Figure A- 9. Box Plot-Potatoes

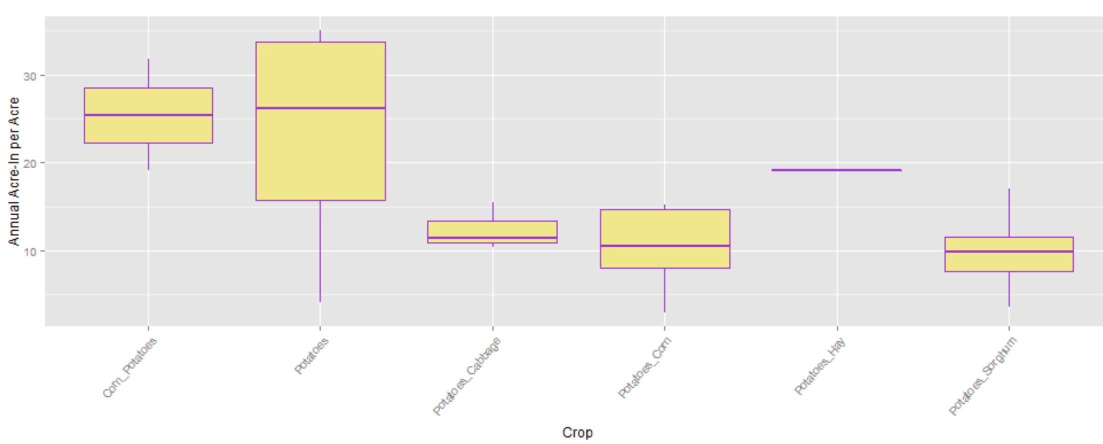


Table A- 1. Detailed Crop Table

Detailed Crop	Predominant Crop		Detailed Crop	Predominant Crop
Alfalfa	Hay		Peanuts_Pasture	Field Crops
AsparagusFern	Greenhouse/Nursery		Peanuts_Rye	Field Crops
Aspidistra	Greenhouse/Nursery		Peanuts_SnapBeans	Vegetables (Fresh Market)
Avocados	Fruit (Non-citrus)		Peanuts_Wheat	Field Crops
Beans_Cucumbers_SmallVeg	Vegetables (Fresh Market)		PeanutsFall	Field Crops
Beans_Peas	Vegetables (Fresh Market)		PeanutsSpring	Field Crops
Blueberries	Fruit (Non-citrus)		Peas	Vegetables (Fresh Market)
Broccoli	Vegetables (Fresh Market)		Pecans	Fruit (Non-citrus)
Broccoli_Cabbage_Cabbage	Vegetables (Fresh Market)		Peppers	Vegetables (Fresh Market)
Broccoli_Corn	Vegetables (Fresh Market)		Peppers_Squash	Vegetables (Fresh Market)
Broccoli_Corn_Broccoli	Vegetables (Fresh Market)		PeppersFall	Vegetables (Fresh Market)
Broccoli_Corn_Cabbage	Vegetables (Fresh Market)		PeppersFall_CucumbersSpring	Vegetables (Fresh Market)
Broccoli_Melon_Broccoli	Vegetables (Fresh Market)		PeppersFall_Melons	Vegetables (Fresh Market)
Broccoli_Peas	Vegetables (Fresh Market)		PeppersFall_PeppersSpring	Vegetables (Fresh Market)
Broccoli_Sorghum_Broccoli	Vegetables (Fresh Market)		PeppersFall_Zucchini	Vegetables (Fresh Market)
Broccoli_Sorghum_Greens	Vegetables (Fresh Market)		PeppersSpring	Vegetables (Fresh Market)
Broccoli_Sorghum_Sorghum	Vegetables (Fresh Market)		PeppersSpring_CucumbersSpring	Vegetables (Fresh Market)
Broccoli_Vegetables	Vegetables (Fresh Market)		PeppersSpring_PeppersFall	Vegetables (Fresh Market)
Cabbage	Vegetables (Fresh Market)		PeppersSpring_PeppersFall_CucumbersFall	Vegetables (Fresh Market)
Cabbage_BokChoy	Vegetables (Fresh Market)		PeppersSpring_SmallVegFall	Vegetables (Fresh Market)
Cabbage_Cabbage	Vegetables (Fresh Market)		PeppersSpring_Zucchini	Vegetables (Fresh Market)
Cabbage_Corn	Vegetables (Fresh Market)		Persimmons	Fruit (Non-citrus)
Cabbage_Corn_Cabbage	Vegetables (Fresh Market)		Pine	Greenhouse/Nursery
Cabbage_Corn_Greens	Vegetables (Fresh Market)		Pittosporum	Greenhouse/Nursery
Cabbage_Greens	Vegetables (Fresh Market)		PoleBeans_Peppers	Vegetables (Fresh Market)
Cabbage_Hay	Vegetables (Fresh Market)		Potatoes	Potatoes
Cabbage_Melon	Vegetables (Fresh Market)		Potatoes_Cabbage	Potatoes
Cabbage_Sorghum	Vegetables (Fresh Market)		Potatoes_Cantaloupe_Watermelon	Vegetables (Fresh Market)

Table A- 1. Detailed Crop Table (continued)

Detailed Crop	Predominant Crop		Detailed Crop	Predominant Crop
Cabbage_Sorghum_Cabbage	Vegetables (Fresh Market)		Potatoes_Corn	Potatoes
Cabbage_Sorghum_Radished	Vegetables (Fresh Market)		Potatoes_Corn_Cabbage	Vegetables (Fresh Market)
Cabbage_Sorghum_Sorghum	Vegetables (Fresh Market)		Potatoes_Corn_Cucumber	Vegetables (Fresh Market)
Cabbage_Vegetables	Vegetables (Fresh Market)		Potatoes_Corn_Peas	Vegetables (Fresh Market)
Cantaloupe	Vegetables (Fresh Market)		Potatoes_Corn_Vegetables	Vegetables (Fresh Market)
Carambola	Fruit (Non-citrus)		Potatoes_Eggplant	Potatoes
Carrots	Vegetables (Fresh Market)		Potatoes_Hay	Potatoes
Carrots_Corn	Vegetables (Fresh Market)		Potatoes_Pasture	Potatoes
Carrots_Rye	Vegetables (Fresh Market)		Potatoes_Sorghum	Potatoes
CattleFeedingOperations	Hay		Potatoes_Sorghum_Broccoli	Potatoes
Chestnuts	Fruit (Non-citrus)		Potatoes_Sorghum_Cabbage	Potatoes
Citrus	Citrus		Potatoes_Sorghum_Cucumber	Potatoes
Cleared	Hay		Potatoes_Sorghum_Greencovercrop	Potatoes
CollardGreens_Corn	Vegetables (Fresh Market)		Potatoes_Sorghum_Greens	Potatoes
ConiferousPlantations	Lumber		Potatoes_Sorghum_Mustardgreens	Potatoes
ContainerNursery	Greenhouse/Nursery		Potatoes_Watermelon	Potatoes
CoontieFern	Greenhouse/Nursery		PoultryFeedingOperations	Hay
Corn_Cucumbers	Vegetables (Fresh Market)		Radishes_Sorghum	Vegetables (Fresh Market)
Corn_Greens	Vegetables (Fresh Market)		Radishes_Vegetables	Vegetables (Fresh Market)
Corn_Hay	Field Crops		Rice	Field Crops
Corn_Legumes	Field Crops		RowCrops	Vegetables (Fresh Market)
Corn_Oats	Field Crops		Rye	Hay
Corn_Pasture	Field Crops		Rye_Hay	Hay
Corn_Peas_Oats	Field Crops		ShadeFerns	Greenhouse/Nursery
Corn_Potatoes	Potatoes		SmallGrains	Field Crops
Corn_Rye	Field Crops		SmallGrains_Cotton	Field Crops
Corn_Rye_SnapBeans	Vegetables (Fresh Market)		SmallGrains_Peanuts	Field Crops
Corn_SmallGrains	Field Crops		SmallVeg	Vegetables (Fresh Market)

Table A- 1. Detailed Crop Table (continued)

Detailed Crop	Predominant Crop		Detailed Crop	Predominant Crop
Corn_Sorghum_Cabbage	Vegetables (Fresh Market)		SmallVegFall	Vegetables (Fresh Market)
Corn_Vegetables	Vegetables (Fresh Market)		SmallVegFall_SmallVegSpring	Vegetables (Fresh Market)
Corn_Wheat	Field Crops		SmallVegFall_SmallVegSpring_SmallVegSum	Vegetables (Fresh Market)
CornSilage	Field Crops		SmallVegFall_SmallVegSum	Vegetables (Fresh Market)
Cotton	Field Crops		SmallVegSpring	Vegetables (Fresh Market)
CoverCrop	Hay		SmallVegSum	Vegetables (Fresh Market)
Cucumbers	Vegetables (Fresh Market)		SnapBeans_Rye	Vegetables (Fresh Market)
CucumbersFall	Vegetables (Fresh Market)		Sod	Sod
CucumbersFall_CucumbersSpring	Vegetables (Fresh Market)		Sorghum	Field Crops
CucumbersSpring	Vegetables (Fresh Market)		Sorghum_Rye	Field Crops
Dairies	Hay		Soybeans	Field Crops
DryBeans	Vegetables (Fresh Market)		Soybeans_DryBeans	Vegetables (Fresh Market)
DryBeans_Potatoes	Potatoes		Soybeans_Rye	Field Crops
DryBeans_SweetCorn	Vegetables (Fresh Market)		SpecialtyFarms	Greenhouse/Nursery
Eggplant	Vegetables (Fresh Market)		Spinach_Corn	Vegetables (Fresh Market)
Eggplant_Zucchini	Vegetables (Fresh Market)		Spinach_RedPeppers_CollardGreens	Vegetables (Fresh Market)
Fallow	Hay		Squash	Vegetables (Fresh Market)
Fern	Greenhouse/Nursery		Squash_Vegetables	Vegetables (Fresh Market)
FieldCorn	Field Crops		Strawberries	Fruit (Non-citrus)
FieldCrops	Field Crops		Strawberries_Corn	Fruit (Non-citrus)
FieldNursery	Greenhouse/Nursery		Strawberries_CucumbersFall	Fruit (Non-citrus)
ForestRegenerationAreas	Lumber		Strawberries_CucumbersSpring	Fruit (Non-citrus)
Grains	Field Crops		Strawberries_DryBeans	Fruit (Non-citrus)
Grapes	Fruit (Non-citrus)		Strawberries_Eggplant	Fruit (Non-citrus)
GreenBeans	Vegetables (Fresh Market)		Strawberries_GreenBeans	Fruit (Non-citrus)
GreenhouseNursery	Greenhouse/Nursery		Strawberries_Melons	Fruit (Non-citrus)
Greens	Vegetables (Fresh Market)		Strawberries_Melons	Fruit (Non-citrus)
Greens_Corn_Broccoli	Vegetables (Fresh Market)		Strawberries_Melons_Peas	Fruit (Non-citrus)

Table A- 1. Detailed Crop Table (continued)

Detailed Crop	Predominant Crop		Detailed Crop	Predominant Crop
Greens_Corn_Cabbage	Vegetables (Fresh Market)		Strawberries_Onions	Fruit (Non-citrus)
Greens_Hay_CropPeas	Vegetables (Fresh Market)		Strawberries_Peas	Fruit (Non-citrus)
Greens_Sorghum	Vegetables (Fresh Market)		Strawberries_Peppers	Fruit (Non-citrus)
Greens_Sorghum_Broccoli	Vegetables (Fresh Market)		Strawberries_PeppersFall	Fruit (Non-citrus)
Greens_Sorghum_Cabbage	Vegetables (Fresh Market)		Strawberries_PeppersSpring	Fruit (Non-citrus)
Greens_Sorghum_Cauliflower	Vegetables (Fresh Market)		Strawberries_SmallVegFall	Fruit (Non-citrus)
Greens_Sorghum_Cucumber	Vegetables (Fresh Market)		Strawberries_SmallVegSpring	Fruit (Non-citrus)
Greens_Sorghum_Greens	Vegetables (Fresh Market)		Strawberries_SmallVegSum	Fruit (Non-citrus)
Greens_Sorghum_Vegetables	Vegetables (Fresh Market)		Strawberries_Sorghum_Strawberries	Fruit (Non-citrus)
Greens_Sorghum_Zucchini	Vegetables (Fresh Market)		Strawberries_Squash	Fruit (Non-citrus)
Greens_Vegetables	Vegetables (Fresh Market)		Strawberries_Tomatoes	Fruit (Non-citrus)
Greens_Zucchini	Vegetables (Fresh Market)		Strawberries_TomatoesFall	Fruit (Non-citrus)
HammockFerns	Greenhouse/Nursery		Strawberries_TomatoesSpring	Fruit (Non-citrus)
Hay	Hay		Strawberries_Zucchini	Fruit (Non-citrus)
Hay_ImprovedPastures	Hay		Sugarcane	Sugarcane
Hay_Oats	Field Crops		SweetCorn	Vegetables (Fresh Market)
HayAFO	Hay		SweetCorn_PeanutsFall	Vegetables (Fresh Market)
Herbs	Greenhouse/Nursery		SweetCornCoverCrop	Vegetables (Fresh Market)
HorseFarms	Hay		Tobacco	Greenhouse/Nursery
ImprovedPastures	Hay		Tomatoes	Vegetables (Fresh Market)
Leatherleaf	Greenhouse/Nursery		Tomatoes_Melons	Vegetables (Fresh Market)
Ligustrum	Greenhouse/Nursery		Tomatoes_Peppers	Vegetables (Fresh Market)
Liriope	Greenhouse/Nursery		Tomatoes_SmallVeg	Vegetables (Fresh Market)
Mangos	Fruit (Non-citrus)		Tomatoes_Watermelon	Vegetables (Fresh Market)
Melons	Vegetables (Fresh Market)		TomatoesFall	Vegetables (Fresh Market)
Melons_Cucumber	Vegetables (Fresh Market)		TomatoesFall_Melons	Vegetables (Fresh Market)
Melons_CucumbersFall	Vegetables (Fresh Market)		TomatoesFall_TomatoesSpring	Vegetables (Fresh Market)
Melons_CucumbersSpring	Vegetables (Fresh Market)		TomatoesSpring	Vegetables (Fresh Market)

Table A- 1. Detailed Crop Table (continued)

Detailed Crop	Predominant Crop		Detailed Crop	Predominant Crop
Melons_Hay	Vegetables (Fresh Market)		TomatoesSpring_CucumbersFall	Vegetables (Fresh Market)
Melons_PeppersFall	Vegetables (Fresh Market)		TomatoesSpring_DryBeans	Vegetables (Fresh Market)
Melons_SmallVegFall	Vegetables (Fresh Market)		TomatoesSpring_Melons	Vegetables (Fresh Market)
Melons_SmallVegSpring_SmallVegFall	Vegetables (Fresh Market)		TomatoesSpring_PeppersFall	Vegetables (Fresh Market)
Melons_TomatoesFall	Vegetables (Fresh Market)		TomatoesSpring_SmallVegFall	Vegetables (Fresh Market)
Melons_TomatoesSpring	Vegetables (Fresh Market)		TomatoesSpring_SmallVegSpring	Vegetables (Fresh Market)
Melons_TomatoesSpring_TomatoesFall	Vegetables (Fresh Market)		TreeCrops	Fruit (Non-citrus)
Millet	Field Crops		TreeNurseries	Greenhouse/Nursery
Millet_Rye	Field Crops		TreePlantations	Lumber
Millet_SmallGrains	Field Crops		TropicalFruit	Fruit (Non-citrus)
MixedVegetables_Sorghum	Vegetables (Fresh Market)		TropicalFruit_SmallVeg	Fruit (Non-citrus)
MushroomsSpring_MushroomsFall	Vegetables (Fresh Market)		Turf	Sod
NoCrop	Field Crops		Turnips_Sorghum	Vegetables (Fresh Market)
Nursery	Greenhouse/Nursery		UnimprovedPastures	Hay
Oats	Field Crops		Vegetables	Vegetables (Fresh Market)
Olives	Vegetables (Fresh Market)		Vegetables_Corn_Vegetables	Vegetables (Fresh Market)
Onions	Vegetables (Fresh Market)		Vegetables_Rye	Vegetables (Fresh Market)
Onions_Corn	Vegetables (Fresh Market)		Vegetables_Sorghum	Vegetables (Fresh Market)
Onions_Corn_Vegetables	Vegetables (Fresh Market)		Watermelon	Vegetables (Fresh Market)
Onions_Sorghum	Vegetables (Fresh Market)		Watermelon_MixedVegetables	Vegetables (Fresh Market)
Onions_Sorghum_Vegetables	Vegetables (Fresh Market)		Watermelon_MixedVegetables_Cucumber	Vegetables (Fresh Market)
Onions_Vegetables	Vegetables (Fresh Market)		Watermelon_MixedVegetables_Watermelon	Vegetables (Fresh Market)
Onions_Vegetables_Cabbage	Vegetables (Fresh Market)		Watermelon_Potato	Potatoes
OrientalVegetables	Vegetables (Fresh Market)		Watermelon_Pumpkin	Vegetables (Fresh Market)
OrientalVegetables_Corn	Vegetables (Fresh Market)		Watermelon_Rye	Vegetables (Fresh Market)
OrientalVegetables_Corn_Radishes	Vegetables (Fresh Market)		Wheat	Field Crops
Ornamentals	Greenhouse/Nursery		WoodlandPastures	Hay
OtherGroves	Fruit (Non-citrus)		Zucchini	Vegetables (Fresh Market)

Table A- 1. Detailed Crop Table (continued)

Detailed Crop	Predominant Crop		Detailed Crop	Predominant Crop
PalmTrees	Greenhouse/Nursery		Zucchini_DryBeans_PeppersSpring	Vegetables (Fresh Market)
Papaya	Fruit (Non-citrus)		Zucchini_Eggplant	Vegetables (Fresh Market)
Pasture	Hay		Zucchini_GreenBeans_Melons	Vegetables (Fresh Market)
Pasture_Rye	Hay		Zucchini_Melons	Vegetables (Fresh Market)
Pasture_Rye_Watermelons	Vegetables (Fresh Market)		Zucchini_Peas	Vegetables (Fresh Market)
Peaches	Fruit (Non-citrus)		Zucchini_PeppersFall	Vegetables (Fresh Market)
Peanuts	Field Crops		Zucchini_SweetCorn	Vegetables (Fresh Market)
Peanuts_Oats	Field Crops		Zucchini_TomatoesSpring	Vegetables (Fresh Market)

Table A- 2 illustrates an example of ILG crop classification refinements using updated aerial imagery and the Cropland Data Layer. These improvements reduced irrigation hay and pasture areas through reclassification of crop type and changing to non-irrigated hay or pasture.

Table A- 2. Pasture and hay acreage adjustments from 2010 ILG

	2010 ILG	hay or pasture removed, acres		hay or pasture removed, %	
District	hay or pasture, acres	crop change	change to non-irr	crop change	change to non-irr
NWFWMD	4,192	318	0	8%	0%
SFWMD	44,365	1,744	6,750	4%	15%
SJRWMD	56,914	1,229	18,550	2%	33%
SRWMD	47,131	0	338	0%	1%
SWFWMD	14,313	0	721	0%	5%
Statewide	166,915	3,291	26,360	2%	16%

Table A- 3. Projected Revenue and Cost by Crop Category

Primary Crop	Unit	2010	2015	2020	2025	2030	2035
Citrus*	Crop Price	$4,370	$4,329	$4,814	$5,266	$5,621	$6,000
	Chemical Cost	$1,357	$1,613	$2,158	$2,425	$2,725	$3,062
Fresh market (Vegetable)	Crop Price	$6,964	$7,875	$8,299	$8,997	$10,220	$11,609
	Chemical Cost	$1,183	$1,419	$1,899	$2,134	$2,398	$2,695
Greenhouse/ Nursery	Crop Price	$29,493	$25,457	$26,100	$26,743	$27,378	$28,027
	Chemical Cost	$547	$656	$878	$986	$1,108	$1,246
Hay	Crop Price	$257	$345	$340	$365	$377	$386
	Chemical Cost	$155	$185	$248	$279	$313	$352
Noncitrus (Fruit)	Crop Price	$5,622	$7,729	$8,322	$8,984	$9,737	$10,554
	Chemical Cost	$1,367	$1,640	$2,195	$2,466	$2,772	$3,114
Other field crops	Crop Price	$804	$604	$659	$778	$815	$853
	Chemical Cost	$255	$294	$356	$400	$449	$505
Potatoes	Crop Price	$4,020	$3,843	$4,119	$4,457	$4,893	$5,372
	Chemical Cost	$432	$518	$694	$780	$876	$985
Sod	Crop Price	$8,841	$10,303	$10,735	$11,184	$11,653	$12,141
	Chemical Cost	$857	$1,028	$1,375	$1,545	$1,736	$1,951
Sugarcane	Crop Price	$1,414	$1,283	$1,315	$1,401	$1,445	$1,491
	Chemical Cost	$408	$488	$654	$735	$825	$928

Source: USDA, National Agricultural Statistics Service; Foreign Agricultural Service; Economic Research Service; University of Georgia. The Center for Agribusiness and Economic Development. 2006-2013 Georgia Farm Reports. University of Georgia. Annual Georgia Sod Producers Survey.

Note: Citrus prices are for total production which includes processed and fresh product.

Table A- 4. Historical and Projected Irrigated Acreage by County

COUNTY	1987	1992	1997	2002	2007	2012	2015 ILG	2020	2025	2030	2035
Alachua	9,068	7,371	8,081	13,488	13,387	10,708	15,264	16,339	17,152	17,900	18,665
Baker	447	456	811	920	699	303	283	335	340	368	405
Bay	417	309	520	421	417	417	1,148	826	630	346	53
Bradford	568	553	331	295	156	696	1,030	1,133	1,133	1,133	1,133
Brevard	17,174	24,958	30,884	24,792	20,486	13,414	17,661	16,288	15,045	13,716	12,379
Broward	6,125	3,388	2,184	4,883	1,651	1,828	1,698	1,698	1,698	1,698	1,698
Calhoun	805	1,148	1,108	1,765	1,455	1,647	3,360	2,778	2,092	1,510	984
Charlotte	8,807	17,882	26,295	24,516	19,965	13,716	25,166	25,305	25,327	26,258	26,313
Citrus	691	658	774	867	1,375	669	1,486	1,309	1,181	952	765
Clay	270	1,293	1,494	1,286	913	579	775	1,114	1,422	1,602	1,977
Collier	43,147	64,611	53,326	55,181	31,361	26,412	75,220	80,696	81,372	84,018	86,669
Columbia	1,597	2,597	2,901	1,929	2,693	6,070	5,011	8,082	10,831	13,577	16,479
De Soto	48,078	58,806	73,265	79,147	56,162	47,695	75,826	73,344	70,864	68,368	65,841
Dixie	340	990	639	1,751	2,957	3,439	6,744	6,274	5,244	4,454	3,957
Duval	1,341	1,203	687	2,005	2,024	1,115	1,287	1,009	776	527	260
Escambia	807	641	1,130	2,329	2,552	4,628	3,456	3,456	4,566	5,121	5,681
Flagler	5,913	4,744	7,924	4,443	6,812	3,936	10,906	9,153	7,487	5,818	4,167
Franklin	25	25	25	25	25	25	-	20	53	53	53
Gadsden	2,025	3,378	5,352	3,834	2,209	2,650	4,522	4,200	3,655	3,375	3,080
Gilchrist	4,496	6,440	6,431	3,832	7,808	12,563	13,379	13,877	14,141	14,536	14,949
Glades	49,506	60,239	26,210	49,147	46,726	88,509	61,662	89,622	125,596	156,499	190,542
Gulf	13	13	13	13	13	13	96	73	49	-	-
Hamilton	2,878	3,591	4,266	4,503	5,518	9,548	11,708	11,860	11,912	11,951	12,134
Hardee	43,878	53,777	54,359	56,882	44,141	36,038	48,963	46,640	44,294	41,911	39,457
Hendry	144,808	178,504	183,612	206,043	188,817	193,073	203,703	199,700	195,484	191,536	187,525
Hernando	608	521	1,146	1,393	1,488	2,669	2,659	3,564	4,683	5,689	6,690

Table A- 4. Historical and Projected Irrigated Acreage by County (Continued)

COUNTY	1987	1992	1997	2002	2007	2012	2015 ILG	2020	2025	2030	2035
Highlands	71,665	83,301	88,538	99,269	73,713	61,785	81,730	75,565	69,296	63,128	56,897
Hillsborough	37,839	45,709	48,623	42,969	29,923	26,096	35,619	32,607	29,548	26,528	23,513
Holmes	602	421	280	584	2,033	1,100	1,923	1,711	1,472	1,280	1,111
Indian River	83,771	77,493	78,505	95,174	66,866	57,627	58,518	57,606	56,350	55,049	54,095
Jackson	15,541	13,365	17,872	13,374	20,275	21,508	32,378	33,446	34,424	35,302	36,150
Jefferson	6,573	4,257	1,514	4,081	2,148	2,388	4,425	4,793	5,008	5,189	5,352
Lafayette	2,319	3,198	3,860	4,147	7,426	10,658	10,584	12,376	13,520	14,900	16,285
Lake	29,020	24,373	26,256	20,153	15,013	15,163	19,235	17,114	14,947	12,795	10,683
Lee	16,812	17,114	26,669	23,935	14,612	13,585	22,730	20,740	18,677	16,745	14,847
Leon	747	2,781	2,553	2,523	1,467	2,010	543	1,146	1,803	2,430	3,053
Levy	3,844	9,895	13,245	19,501	14,488	13,661	18,960	21,172	22,876	26,400	28,329
Liberty	29	18	6	18	18	18	31	41	63	85	139
Madison	2,366	2,686	4,389	3,646	3,119	8,067	18,156	19,459	21,227	22,768	24,310
Manatee	41,204	54,568	58,304	54,710	50,791	50,108	62,352	64,243	66,236	67,446	68,713
Marion	5,597	5,217	6,543	5,605	9,666	13,214	14,004	16,838	23,180	27,866	32,513
Martin	58,664	58,742	61,446	55,805	48,521	34,806	40,806	40,249	39,837	39,399	39,007
MiamiDade	53,185	52,363	58,648	43,615	45,236	45,236	36,018	36,558	37,585	38,311	39,030
Monroe	6	10	33	35	30	37	-	5	5	5	5
Nassau	50	33	61	111	270	112	824	603	8	-	-
Okaloosa	525	1,778	201	435	421	161	1,059	686	339	109	-
Okeechobee	19,280	27,662	34,124	22,085	20,545	19,443	24,159	21,883	19,489	17,550	15,143
Orange	34,447	25,249	25,581	15,103	11,870	9,478	7,036	7,119	7,327	7,479	7,697
Osceola	25,868	14,474	58,090	18,651	31,420	29,153	25,009	27,687	28,878	31,138	33,042
Palm Beach	422,619	422,966	417,807	418,455	387,755	362,478	428,615	428,635	428,662	429,047	429,080
Pasco	9,082	11,024	13,754	11,751	10,599	6,594	12,688	11,820	10,946	10,027	9,164
Pinellas	278	288	272	319	189	120	17	14	12	-	-

Source: USDA, National Agricultural Statistics Service (historical acreage); TBG Work Product (projected acreages)

Table A-4. Historical and Projected Irrigated Acreage by County (Continued)

COUNTY	1987	1992	1997	2002	2007	2012	2015 ILG	2020	2025	2030	2035
Polk	114,996	116,734	119,773	116,094	98,404	79,869	92,422	90,957	89,448	88,064	86,690
Putnam	7,601	9,560	6,799	5,738	4,620	5,487	11,943	10,548	9,198	7,856	6,487
Santa Rosa	416	337	5,373	6,064	2,562	2,443	3,570	3,943	7,351	8,108	10,751
Sarasota	4,583	5,207	5,145	5,002	2,348	2,023	6,855	6,692	6,563	6,419	6,250
Seminole	3,596	3,155	4,002	1,698	1,829	1,180	1,784	1,547	1,320	1,099	697
StJohns	21,896	24,208	19,895	21,759	14,359	11,650	24,050	22,989	22,175	21,262	20,433
StLucie	109,809	138,133	140,125	102,629	69,302	59,245	59,895	56,258	52,899	49,376	45,925
Sumter	3,543	3,974	2,342	3,975	2,013	3,093	4,051	3,415	2,806	2,180	1,550
Suwannee	11,131	12,869	15,192	17,910	20,096	27,808	30,657	32,125	35,345	37,714	40,091
Taylor	424	433	503	196	389	389	398	738	766	863	968
Union	1,141	470	1,673	1,012	1,036	1,046	1,241	1,165	1,050	990	927
Volusia	5,114	8,460	10,871	8,792	9,068	8,996	10,369	10,849	11,049	11,292	11,536
Wakulla	186	186	154	145	282	162	123	130	213	257	282
Walton	867	989	696	1,533	718	1,316	1,336	1,249	1,040	849	662
Washington	341	179	338	958	888	1,136	1,187	1,437	1,724	1,964	2,195
TOTAL	1,621,408	1,781,974	1,873,823	1,815,249	1,558,137	1,492,808	1,800,312	1,816,852	1,841,693	1,862,185	1,885,453

Source: USDA, National Agricultural Statistics Service (historical acreage); TBG Work Product (projected acreages)

Table A- 5. Forecasted Irrigated and Agricultural Land in Acres, 2015-2035

COUNTY	Forecasted Irrigated and Agriculture Land in Acres									
	2015		2020		2025		2030		2035	
	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag
Alachua	15,264	118,494	16,339	118,310	17,152	118,149	17,900	118,292	18,665	118,421
Baker	283	15,342	335	15,358	340	15,373	368	15,386	405	15,374
Bay	1,148	11,001	826	9,960	630	9,912	346	9,870	53	9,908
Bradford	1,030	22,841	1,133	22,544	1,133	22,286	1,133	22,059	1,133	22,263
Brevard	17,661	136,179	16,288	135,165	15,045	134,282	13,716	133,502	12,379	134,204
Broward	1,698	17,323	1,698	15,926	1,698	14,794	1,698	13,856	1,698	14,699
Calhoun	3,360	36,811	2,778	36,480	2,092	36,192	1,510	35,939	984	36,167
Charlotte	25,166	186,549	25,305	184,430	25,327	182,592	26,258	180,973	26,313	182,431
Citrus	1,486	34,870	1,309	33,017	1,181	31,475	952	30,163	765	31,342
Clay	775	51,914	1,114	49,538	1,422	47,546	1,602	45,841	1,977	47,374
Collier	75,220	233,325	80,696	213,362	81,372	197,279	84,018	183,989	86,669	195,919
Columbia	5,011	57,615	8,082	57,356	10,831	57,129	13,577	56,928	16,479	57,109
De Soto	75,826	322,635	73,344	318,340	70,864	314,623	68,368	311,353	65,841	314,297
Dixie	6,744	23,296	6,274	22,931	5,244	22,615	4,454	22,338	3,957	22,588
Duval	1,287	18,501	1,009	17,840	776	17,280	527	16,796	260	17,231
Escambia	3,456	46,539	3,456	47,314	4,566	48,004	5,121	48,627	5,681	48,066
Flagler	10,906	34,287	9,153	32,546	7,487	31,618	5,818	30,815	4,167	31,537
Franklin	-	63	20	57	53	52	53	48	53	52
Gadsden	4,522	41,226	4,200	40,632	3,655	40,117	3,375	39,666	3,080	40,072
Gilchrist	13,379	63,016	13,877	62,723	14,141	62,468	14,536	62,242	14,949	62,446
Glades	61,662	339,870	89,622	356,771	125,596	372,269	156,499	386,625	190,542	373,668
Gulf	96	3,131	73	2,644	49	2,280	-	1,999	-	2,251
Hamilton	11,708	42,682	11,860	42,250	11,912	41,876	11,951	41,546	12,134	41,843
Hardee	48,963	310,390	46,640	308,252	44,294	306,391	41,911	304,744	39,457	306,227
Hendry	203,703	655,005	199,700	649,484	195,484	644,685	191,536	640,444	187,525	644,263
Hernando	2,659	63,494	3,564	63,083	4,683	62,726	5,689	62,409	6,690	62,694
Highlands	81,730	497,842	75,565	505,065	69,296	511,480	63,128	517,256	56,897	512,050
Hillsborough	35,619	161,810	32,607	158,600	29,548	155,841	26,528	153,425	23,513	155,600
Holmes	1,923	66,885	1,711	68,793	1,472	70,510	1,280	72,074	1,111	70,664
Indian River	58,518	186,839	57,606	184,429	56,350	182,344	55,049	180,508	54,095	182,161
Jackson	32,378	194,862	33,446	195,418	34,424	195,907	35,302	196,342	36,150	195,950
Jefferson	4,425	52,017	4,793	52,362	5,008	52,666	5,189	52,938	5,352	52,693
Lafayette	10,584	38,044	12,376	37,756	13,520	37,505	14,900	37,282	16,285	37,482
Lake	19,235	161,316	17,114	154,806	14,947	149,317	12,795	144,598	10,683	148,843
Lee	22,730	78,860	20,740	76,655	18,677	74,774	16,745	73,139	14,847	74,610
Leon	543	28,737	1,146	28,179	1,803	27,699	2,430	27,279	3,053	27,657
Levy	18,960	131,548	21,172	130,808	22,876	130,162	26,400	129,591	28,329	130,106
Liberty	31	3,824	41	3,824	63	3,825	85	3,825	139	3,825

Table A- 5. Forecasted Irrigated and Agricultural Land in Acres, 2015-2035 (Continued)

COUNTY	Forecasted Irrigated and Agricultural Land in Acres									
	2015		2020		2025		2030		2035	
	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag	Irrigated	Total Ag
Madison	18,156	87,303	19,459	88,241	21,227	89,070	22,768	89,815	24,310	89,144
Manatee	62,352	220,149	64,243	212,760	66,236	206,489	67,446	201,065	68,713	205,945
Marion	14,004	250,756	16,838	249,521	23,180	248,444	27,866	247,489	32,513	248,349
Martin	40,806	193,172	40,249	185,769	39,837	179,515	39,399	174,128	39,007	178,974
MiamiDade	36,018	78,373	36,558	77,855	37,585	77,404	38,311	77,004	39,030	77,364
Monroe	-	5	5	7	5	8	5	9	5	8
Nassau	824	21,017	603	20,484	8	20,029	-	19,632	-	19,989
Okaloosa	1,059	30,012	686	30,041	339	30,067	109	30,090	-	30,070
Okeechobee	24,159	359,782	21,883	361,491	19,489	362,996	17,550	364,340	15,143	363,129
Orange	7,036	122,330	7,119	120,821	7,327	119,513	7,479	118,362	7,697	119,399
Osceola	25,009	545,279	27,687	532,432	28,878	521,424	31,138	511,821	33,042	520,464
Palm Beach	428,615	526,830	428,635	515,581	428,662	505,921	429,047	497,478	429,080	505,077
Pasco	12,688	130,959	11,820	127,262	10,946	124,108	10,027	121,368	9,164	123,834
Pinellas	17	1,355	14	1,167	12	1,024	-	912	-	1,012
Polk	92,422	435,384	90,957	431,410	89,448	427,958	88,064	424,909	86,690	427,654
Putnam	11,943	64,301	10,548	62,213	9,198	60,440	7,856	58,904	6,487	60,285
Santa Rosa	3,570	71,710	3,943	72,014	7,351	72,282	8,108	72,521	10,751	72,305
Sarasota	6,855	89,882	6,692	83,867	6,563	78,928	6,419	74,778	6,250	78,506
Seminole	1,784	30,322	1,547	28,082	1,320	26,255	1,099	24,730	697	26,100
StJohns	24,050	40,814	22,989	39,422	22,175	38,241	21,262	37,220	20,433	38,139
StLucie	59,895	257,193	56,258	245,529	52,899	235,743	49,376	227,364	45,925	234,899
Sumter	4,051	133,259	3,415	128,623	2,806	124,693	2,180	121,297	1,550	124,352
Suwannee	30,657	130,531	32,125	130,737	35,345	130,919	37,714	131,080	40,091	130,935
Taylor	398	20,608	738	19,338	766	18,289	863	17,404	968	18,200
Union	1,241	18,920	1,165	18,498	1,050	18,135	990	17,819	927	18,104
Volusia	10,369	64,103	10,849	60,415	11,049	57,358	11,292	54,769	11,536	57,096
Wakulla	123	4,622	130	4,850	213	5,058	257	5,251	282	5,077
Walton	1,336	49,180	1,249	50,127	1,040	50,971	849	51,735	662	51,047
Washington	1,187	41,585	1,437	41,223	1,724	40,908	1,964	40,630	2,195	40,880
TOTAL	1,800,312	8,508,719	1,816,852	8,392,784	1,841,693	8,298,237	1,862,185	8,218,629	1,885,453	8,290,423

Source: USDA, National Agricultural Statistics Service (historical acreage); TBG Work Product (projected acreages)

Technical Note 2. Detailed Input Analysis

Metered Water Use

Metered or reported water use data were obtained from each Water Management District. Data were cleaned using a number of checks prior to use in the final dataset. Outliers were detected for the overall data set by District and for individual crops based on Tukey inter-quartile range (IQR) analysis and standard deviation from the mean for that District. The Tukey analysis used 1.5 times the IQR from the first and third quartiles to determine the range. The standard deviation methodology used two standard deviations from the mean to identify potential outliers. In both cases, farms with no irrigation were not determined to be outliers. These ranges were applied to crop irrigation intensity measures of inches per acre for metered measurements of water use and acreage. These variables were chosen over total water use, since outliers for this variable would depend heavily on farm size. In addition, the analysis was conducted by crop type to identify outliers in irrigation intensity among crops with widely varying water application rates. Tukey measures were more sensitive in general, identifying considerably more potential outliers.

Analysis by crop refined identified outliers. For example, in the overall data set, outliers were highly concentrated in sod farms due to their high water use combined with high levels of variation in their use. When analyzing only sod farms, no outliers were identified for intensity measures.

Outliers were reviewed individually and included where deemed appropriate.

Rainfall

Analysis was performed to compare the estimated net irrigation demand using both sets of data. **Table A-6** shows the overall differences in annual rainfall by crop for the two types of rainfall data; overall, AHPS data results in about 7% lower estimates of precipitation, presumably due to interpolation processes. However, the benefits of greater spatial precision were considered more useful for water use planning decisions than the potential consequences of slightly understated rainfall amounts.

Table A- 6. Differences in rainfall by crop for different data sources

	Estimated average annual irrigation in inches /year using:		
Crop Category	Rain Gage data	AHPS data	Difference
Citrus	49.78	45.64	-8%
Corn	55.22	49.59	-10%
Fresh market (Vegetable)	53.71	46.65	-13%
Greenhouse/Nursery	52.24	45.42	-13%
Hay	52.90	48.59	-8%
Noncitrus (Fruit)	54.48	49.81	-9%
Other field crops	52.80	50.76	-4%
Potatoes	60.00	42.08	-30%
Sod	52.67	49.71	-6%
Sugarcane	52.78	56.55	7%

ET

For purposes of assessing sensitivity of the ET variable inputs for the model output versus the larger dataset, the mean ET was calculated by crop, using the model dataset and also using the entire ILG dataset from FSAID I. **Table A-7** shows the results. Differences will reflect the spatial variation in the model dataset as contrasted with the greater distribution in the larger ILG dataset; overall the difference is within 2%.

Table A- 7. Difference in Calculations from Model Dataset and Entire ILG from FSAID I

	Estimated ET in inches per year		
Crop Category	ET, calibration dataset	ET, all ILG	Difference
Citrus	50.25	54.50	8%
Corn	50.26	50.22	0%
Fresh market (Vegetable)	50.03	53.96	8%
Greenhouse/Nursery	50.31	51.08	2%
Hay	50.45	51.02	1%
Noncitrus (Fruit)	50.48	52.43	4%
Other field crops	50.39	48.90	-3%
Potatoes	49.90	49.94	0%
Sod	50.35	50.22	0%
Sugarcane	50.00	55.04	10%

Soils

The Average soil AWC option was used to generalize soil types into 10 soil type groupings, as shown in **Table A-8.** The predominant soil type from each ILG polygon was computed and used in this analysis.

Table A- 8. Soil Type Groupings

Soil type	USDA/NRCS Capability Rating	Capability subclass
1	Excellent	In Class 1 there are no subclasses because the soils of this class have few limitations.
2e	Good	Shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained.
2s	Good	Shows that the soil is limited mainly because it is shallow, droughty, or stony.
2w	Good	Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).
3e	Marginal	Shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained.
3s	Marginal	Shows that the soil is limited mainly because it is shallow, droughty, or stony.
3w	Marginal	Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).
4e	Marginal	Shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained.
4s	Marginal	Shows that the soil is limited mainly because it is shallow, droughty, or stony.
4w	Marginal	Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).
5s	Poor	Shows that the soil is limited mainly because it is shallow, droughty, or stony.
5w	Poor	Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).
6e	Poor	Shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained.
6s	Poor	Shows that the soil is limited mainly because it is shallow, droughty, or stony.
6w	Poor	Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).
7e	Poor	Shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained.
7s	Poor	Shows that the soil is limited mainly because it is shallow, droughty, or stony.
7w	Poor	Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).
8	Poor	N/A
Not Rated	N/A	N/A

Technical Note 3. Model Specifications and Results

The specification is estimated using Ordinary Least Squares regression analysis as follows:

$$Y = \beta_0 + \beta_1(RF) + \beta_2\,(ET) + \beta_3\,(NP) + \beta_4(PERIRR) + \beta_6\,(IRR) + \beta_5\,(FF) + \beta_L L + \varepsilon$$

where Y = water use (million gallons per year, calculated at the field scale), RF is rainfall, ET is evapotranspiration, NP is a Crop-specific revenue variable, $PERIRR$ is the percentage of permitted acreage that is irrigated, IRR is a dummy representing the type of irrigation system, and FF is a dummy indicating if the field had a freeze-protected crop and was in an area of freeze for the year of water use in question, L is a vector of location attributes including Latitude/Longitude coordinates from GIS and Water Management District dummies.

Model Coefficients & Simulation

The primary model coefficients are provided in **Table A-9**; most of the coefficients have the hypothesized signs and are statistically significant. An additional inch of ET, ceteris paribus, results in 2 MG additional water use per year, while an additional inch of rainfall results, on average in 0.09 MG less water use. An additional dollar in revenue/crop price increases water use for each crop, all else equal. For example, a one dollar increase in net revenue increases water use in citrus by 115 MG per field, but in greenhouses by 13 MG, with average field sizes of 122 acres and 10 acres, respectively. An Impact Sprinkler system, on average increases water use by 21 MG relative to the mean, while a Center Pivot increases water use by 11MG, holding other factors constant. Detailed coefficients are provided for all variables at **Table A-10**.

The overall explanatory value of the model drops materially when SFWMD data is included; R^2 values drop from the .65 - .70 range to .54 - .55 range. However, individual coefficients varied little, and SFWMD was included in the overall model used for projections.

Table A- 9. Model Coefficients

Variable	Coefficient	Standard error	*p*-value	Mean
Citrus	114.63	3.03	-	0.11
Fresh market (Vegetable)	72.38	1.48	-	0.15
Greenhouse/Nursery	12.77	4.31	-	0.02
Hay	1614.57	253.29	0.00	0.00
Noncitrus fruit	68.23	5.06	-	0.02
Field crops	523.55	51.50	-	0.00
Potatoes	91.19	5.72	-	0.01
Sod	40.17	2.94	-	0.02
Sugarcane	90.99	5.74	-	0.01
Citrus Freeze Protection	41.77	5.68	0.00	0.02
Noncitrus Freeze Protection	54.50	9.81	0.00	0.00

Table A- 10. Model Output

```
+----------------------------------------------------------------------+
| Ordinary    least squares regression    Weighting variable = none     |
| Dep. var. = GALMIL   Mean=   40.01397655    , S.D.=   67.43082203     |
| Model size: Observations =    6022, Parameters =  28, Deg.Fr.=   5994 |
| Residuals:  Sum of squares= 12261454.15    , Std.Dev.=       45.22855 |
| Fit:       R-squared=  .552125, Adjusted R-squared =         .55011 |
| Model test: F[ 27,   5994] =  273.67,    Prob value =         .00000 |
| Diagnostic: Log-L = -31485.0439, Restricted(b=0) Log-L =  -33903.6054 |
|            LogAmemiyaPrCrt.=    7.628, Akaike Info. Crt.=     10.466 |
| Autocorrel: Durbin-Watson Statistic =   1.39803,   Rho =       .30099 |
+----------------------------------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	(122.96)	24.10	(5.10)	-	
LAT	(0.02)	0.02	(1.34)	0.18	405.37
LONG	0.03	0.02	1.51	0.13	614.61
NWFWMD	24.31	9.60	2.53	0.01	0.04
SFWMD	3.43	2.79	1.23	0.22	0.40
SJRWMD	(3.58)	4.35	(0.82)	0.41	0.08
SRWMD	2.40	7.14	0.34	0.74	0.06
PERIRR	(8.33)	2.63	(3.17)	0.00	0.67
ET	2.17	0.21	10.17	-	53.76
RAIN	(0.09)	0.09	(1.03)	0.30	49.12
CITFREE	41.77	5.68	7.36	-	0.016
FRUFREE	54.50	9.81	5.55	-	0.004
CITRUS	114.63	3.03	37.77	-	0.11
FRSHVEG	72.38	1.48	49.05	-	0.15
GRENNUR	12.77	4.31	2.96	0.00	0.02
HAY	1,614.57	253.29	6.37	-	0.00
FRUIT	68.23	5.06	13.48	-	0.02
FIELD	523.55	51.50	10.17	-	0.00
POTATO	91.19	5.72	15.95	-	0.01
SOD	40.17	2.94	13.65	-	0.02
SUGAR	717.15	28.26	25.38	-	0.00
IRRONE	10.88	5.74	1.90	0.06	0.07
IRRTWO	13.11	8.03	1.63	0.10	0.01
IRRTHR	2.55	6.34	0.40	0.69	0.25
IRRFOU	16.47	6.47	2.55	0.01	0.23
IRRFIV	21.96	6.74	3.26	0.00	0.05
IRRSIX	15.89	6.44	2.47	0.01	0.36
IRRSEV	14.79	10.01	1.48	0.14	0.01

Technical Note 4. Comparison of FSAID Crop Revenue to Statewide Crop Revenue Estimates

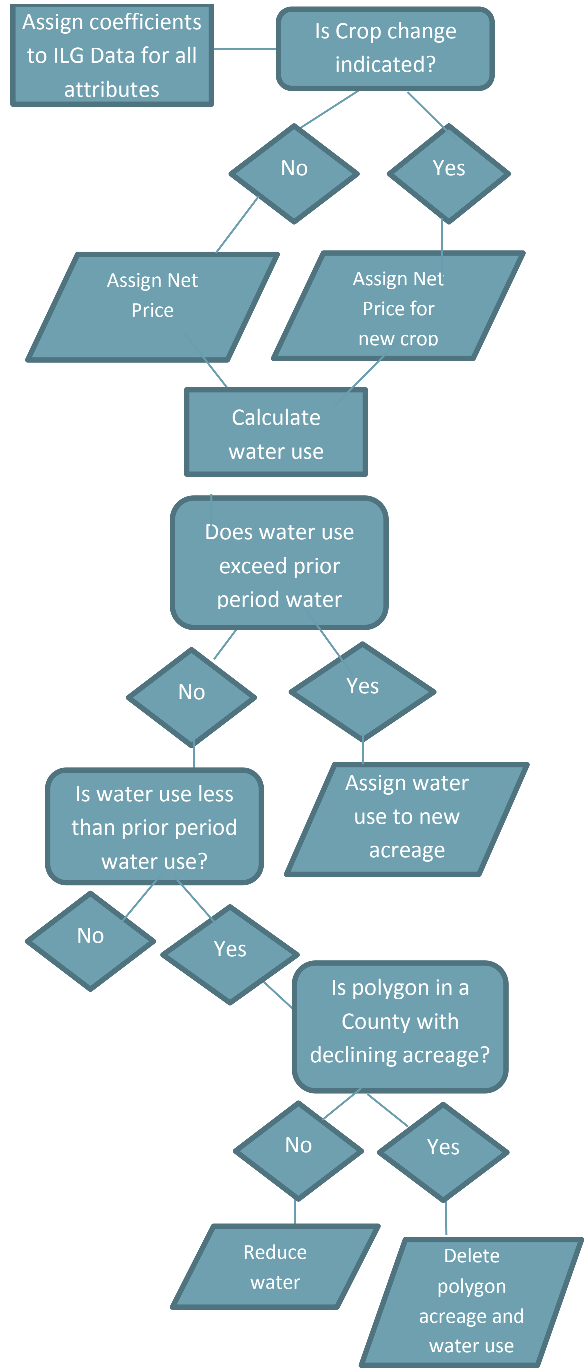
Table A- 11. Comparison of FSAID-computed Crop revenue to Statewide Crop revenue estimates

	Avg Acres	Share of n	Total Acres	Imputed Net Price/acre	Input Price	Total FL acreage	Total FL rev	FDACS Reports
CITRUS	122.40	53%	293,395	$ 1,659	$ 2,187	515,000	854,579,489	1,792,000,000
FRSHVEG	83.88	27%	149,813	$ 6,537	$ 6,102	42,000	274,559,596	180,180,000
GRENNUR		1%	4,314		No comparable category			
HAY	77.71	2%	11,267	$ 179	$ 151	320,000	57,181,956	122,912,000
FRUIT	32.63	4%	21,370	$ 16,484	$ 6,581	45,900	756,611,411	424,639,000
FIELD	91.15	5%	30,079	$ 586	$ 582	702,000	411,275,570	491,000,000
POTATO	153.15	2%	13,630	$ 2,701	$ 5,500	35,600	96,147,026	144,769,000
SOD	143.69	2%	12,645		No comparable category			
SUGAR	193.16	3%	18,157	$ 389	$ 820	410,000	159,428,632	424,000,000
		1.00	554,670			2,070,500	2,609,783,680	3,579,500,000
			Imputed Net Revenue from Model vs FDACS Reported Total Revenue:					73%

Technical Note 5. Spatial distribution of water use

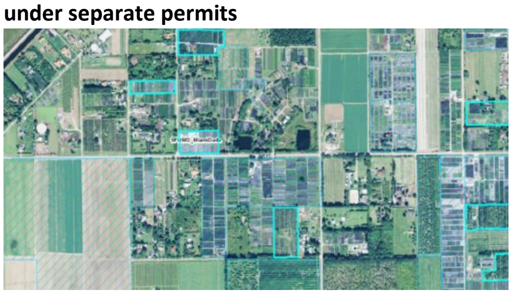
Spatial distribution of water use was applied according to the process outlined in **Figure A-11**. The projected irrigated acreage trend was used to identify areas requiring addition or deletion in the existing irrigated lands for each county. Fields were selected from the ALG until the total amount of new acreage was obtained but not divided; i.e. if a field was identified as required for new acreage and slightly exceeded the new acreage needed, the entire field was moved into the ILG; as a result, new acreage may vary slightly from the exact acreage forecast. In some counties, agricultural acreage was not sufficient to absorb projected acreage after the constraints were applied, and if so, the acreage was capped once the available land identified in the ALG was used. Conversely, if a County indicated fewer irrigated acres, the process identified fields to remove from the ILG, with accordant water use. Crops were assigned based on the indicated crop mix from modeling results; i.e. the "excess" water from crops (crops which show higher water use for increased acreage). The predominant irrigation system used in the county for the crop was assigned. Rainfall and ET were assigned in the same manner as the rest of the ILG.

Figure A- 11. Methodology for spatially assigning changes in water use and acreage



Coefficients were applied to all records in the ILG and water use estimates calculated for each observation. Statistically, approximately 2.5% were outliers, which included both very high estimates relative to field size, typically for very small parcels, and very low estimates. In order to construct realistic maps of water use, corrections were made to align estimates with realistic practice through a series of statistical adjustments:

Figure A- 12. Select small greenhouse parcels under separate permits



1. For records with excessively low estimated water use, the mean inches /year were applied to the farm acreage to recalculate estimated water use.

2. The amounts added to farm acreage from step one were reduced from excess water use on high estimates.

3. For Greenhouses with less than five acres, the mean annual usage by District was applied, regardless of the specific acreage. Overall, mean acreage for greenhouses was 10.4 acres.

The net effect of the adjustments was to reduce the size of the tails of the frequency distribution, while maintaining the same overall mean (except for NWFWMD which had a relatively high count of small greenhouse parcels, which lowered the mean by 1%).

Technical Note 6. Frost Protection, Livestock and Aquaculture, Irrigation Conservation

Frost Freeze Irrigation Demand

To define the frost protection region, the USGS GOES minimum daily temperature was analyzed at every available point and aggregated by county. If more than half the data points within a county experienced a freeze (minimum temperature at or below 32°F) in each of the 18 year period of record, or if the average number of frost protection days exceeded 5 days per year, the county was assumed to be in the northern region excluded from the freeze protection zone. The results of this analysis were mapped, and exceptions were created for counties where freeze protection is known to occur based on prevalence of freeze protected crops within a county (this added Alachua, Flagler, Levy, Putnam, and Volusia counties). **Figure A-13** shows the final frost protection zones.

Irrigation system type was not used as a means to decide if a particular field is frost protected. Some systems are virtually useless *during* a freeze (drip, center pivots), but could be utilized *before* the freeze like with the case for center pivots. Further, many crops (e.g., strawberries and blueberries) have two irrigation systems: overhead irrigation for establishment and/or frost protection, and drip irrigation during plant growth periods. This level of detail is not always available in the input data. Based on the argument that a farmer would not grow a cold-sensitive crop during the winter without a backup plan, it was decided that irrigation system type is an unreliable indicator of freeze protection potential.

The frost protection routine considers the daily minimum temperature for each day and for each polygon in the ILG where crop matched strawberries, perennial fruits (blueberries, citrus, peach), or ferns. To calculate the volume of freeze-protection water used, a rate of 0.07 inches/hour for micro-spray systems and 0.2 inches/hour for all other irrigation systems was assumed, and the duration of the frost protection event was set to 14 hours (e.g., 6pm to 8am). A frost protection irrigation event was initiated for each polygon having minimum temperature less than or equal to 32°F based on the daily USGS GOES ET data from 1996 to 2013.

Frost/freeze water demand for future projections vary from the 2015 frost/freeze demands based on the additions or deletions of ILG polygons classified as Greenhouse/Nursery (to include ferns), Non-citrus Fruit (which would include strawberry, blueberries, and peaches), and Citrus. County-average, crop-specific freeze protection intensity (MGD/acre) was calculated from the polygon-specific frost protection demands for 2015. These freeze protection intensities were used to assign water demand to new polygons in the above-listed crop categories for the future years.

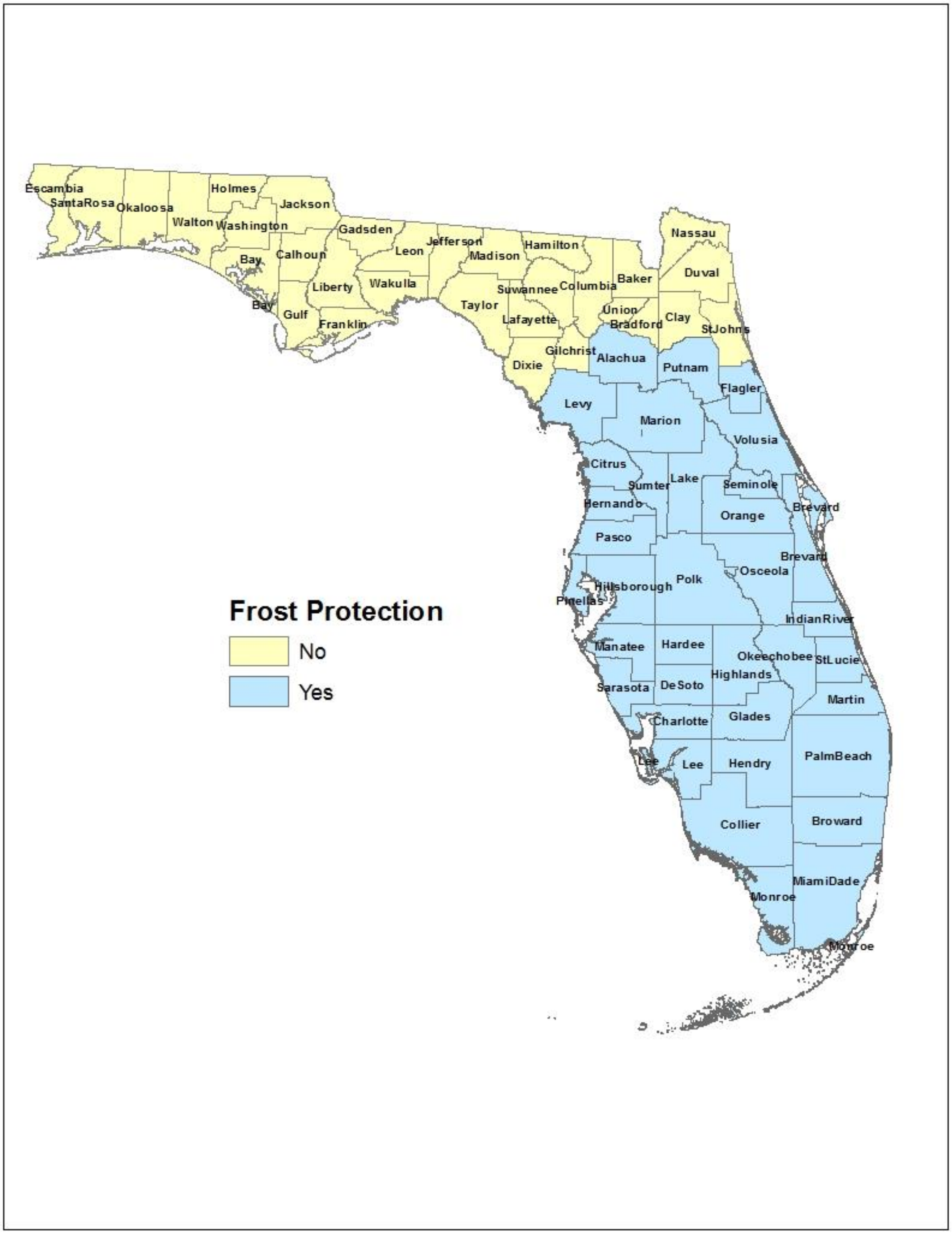


Figure A- 13. Frost Protection Zones

Table A- 12. Freeze protection irrigation demand (MGD) by county, 2015 to 2035

		FF, MGD 2015	FF, MGD 2020	FF, MGD 2025	FF, MGD 2030	FF, MGD 2035
Alachua	SJRWMD	1.60	1.76	1.83	2.15	2.77
Alachua	SRWMD	0.34	0.37	0.38	0.81	1.55
Brevard	SJRWMD	0.41	0.43	0.33	0.27	0.26
Charlotte	SFWMD	0.64	0.72	0.75	0.88	0.91
Charlotte	SWFWMD	0.27	0.29	0.28	0.20	0.21
Citrus	SWFWMD	0.19	0.18	0.16	0.13	0.12
Collier	SFWMD	2.82	3.62	3.83	4.30	4.86
DeSoto	SWFWMD	7.78	7.14	6.66	6.43	6.35
Glades	SFWMD	3.54	8.24	14.47	19.88	26.33
Hardee	SWFWMD	6.47	6.21	5.94	5.37	5.00
Hendry	SFWMD	10.99	11.50	11.32	11.34	11.29
Hernando	SWFWMD	0.21	0.28	0.52	0.58	0.91
Highlands	SFWMD	3.57	3.57	3.06	2.58	2.44
Highlands	SWFWMD	3.95	3.79	3.67	3.36	3.04
Hillsborough	SWFWMD	7.97	7.43	6.26	5.38	4.09
IndianRiver	SJRWMD	2.98	3.21	3.23	3.24	3.24
Lake	SJRWMD	1.75	1.50	1.04	0.72	0.42
Lake	SWFWMD	0.05	0.05	0.04	0.03	0.02
Lee	SFWMD	0.87	0.76	0.62	0.49	0.44
Levy	SWFWMD	0.24	0.26	0.27	0.28	0.28
Manatee	SWFWMD	3.50	4.04	4.52	4.81	5.08
Marion	SJRWMD	1.56	1.70	1.79	1.66	1.85
Marion	SWFWMD	0.22	0.24	0.22	0.23	0.24
Martin	SFWMD	2.05	2.18	2.21	2.27	2.32
MiamiDade	SFWMD	0.15	0.17	0.17	0.18	0.18
Okeechobee	SJRWMD	0.12	0.10	0.11	0.05	0.06
Okeechobee	SFWMD	0.55	0.58	0.41	0.33	0.30
Orange	SJRWMD	0.20	0.21	0.26	0.27	0.40
Orange	SFWMD	0.27	0.29	0.30	0.31	0.32
Osceola	SJRWMD	0.04	0.34	0.41	0.43	0.71
Osceola	SFWMD	1.75	1.96	2.17	2.46	2.59
PalmBeach	SFWMD	2.93	3.17	3.30	3.44	3.54
Pasco	SWFWMD	1.48	1.24	1.11	0.84	0.83
Polk	SFWMD	0.35	0.38	0.39	0.40	0.41
Polk	SWFWMD	12.97	13.46	13.52	13.45	13.13
Putnam	SJRWMD	3.14	2.37	1.94	1.48	1.20
Sarasota	SWFWMD	0.76	0.80	0.80	0.82	0.74

Table A- 12. Freeze protection irrigation demand (MGD) by county, 2015 to 2035 (Continued)

		FF, MGD 2015	FF, MGD 2020	FF, MGD 2025	FF, MGD 2030	FF, MGD 2035
Seminole	SJRWMD	0.09	0.08	0.07	0.06	0.02
StLucie	SFWMD	4.85	4.83	4.65	4.27	3.98
Sumter	SWFWMD	0.18	0.14	0.13	0.06	0.03
Volusia	SJRWMD	3.34	3.57	3.73	3.82	4.07
Statewide total, MGD		97.15	103.17	106.89	110.08	116.51

Source: based on 1996 to 2013 GOES ET temperature data

Livestock and Aquaculture

A GIS layer of livestock and aquaculture water use provides 2015 to 2035 aquaculture and livestock water demand, assuming constant demand for future periods. County-level livestock and aquaculture water use totals were spatially distributed among consumptive use permits (CUPs) for permits which could be identified as livestock or aquaculture permits. County-level aquaculture demand was divided equally among all aquaculture permits within the county. At the CUP level, there was insufficient, consistent statewide data available in the permits to reliably distinguish among types of livestock. For the purposes of the spatial distribution at the permit level, all livestock water uses are combined. County-level livestock demand was divided among livestock permits using area-weighting to scale demand to the size of the permit; meaning, the ratio of an individual permit area to the total livestock permit areas for the county was multiplied by the county total livestock demand. **Table A- 13** summarizes livestock and aquaculture water demands for all counties.

Table A- 13. Livestock inventory by County

County	Dairy Cows	Beef and Other Cows	Chickens, broilers	Chickens, layers	Goats	Hogs	Sheep
Alachua	1,682	41,857	665	3,411	3201	1055	436
Baker	194	5,312	90	1,413	625	331	0
Bay	2	840	0	1,251	291	94	0
Bradford	658	8,653	56	0	955	88	25
Brevard	197	24,387	572	2,856	823	120	664
Broward	4	1,856	151	1,094	264	8	0
Calhoun	188	4,161	73	366	337	309	0
Charlotte	10	26,090	0	349	255	46	16
Citrus	952	6,488	174	1,503	645	667	102
Clay	1,043	4,893	204	1,346	1860	365	127
Collier	7	10,864	150	758	410	358	150
Columbia	16	26,236	261	0	1844	413	338
Desoto	3,468	65,155	0	0	348	105	255
Dixie	437	6,565	0	0	469	76	96
Duval	249	5,722	71	483	1010	108	0
Escambia	217	5,909	175	1,820	824	110	232
Flagler	0	3,597	0	180	50	22	0
Franklin	0	20	0	0	0	0	0
Gadsden	94	5,322	0	656	723	97	116
Gilchrist	13,009	22,868	55	1,558	2152	378	223
Glades	453	58,065	293	598	112	97	9
Gulf	94	331	0	108	0	0	0
Hamilton	188	7,948	200,113	677	461	1007	51
Hardee	12,683	66,557	561	841	231	142	23
Hendry	343	60,648	2,976	1,520	434	136	106
Hernando	1,461	13,901	306	451,613	1842	532	467
Highlands	7,368	108,159	1,272	2,382	852	604	90
Hillsborough	947	53,892	2,028	0	2157	0	581
Holmes	947	26,849	479,272	1,610	875	233	117
Indianriver	0	19,840	0	0	31	154	32
Jackson	947	49,761	303	5,336	1573	516	138
Jefferson	871	13,433	119	1,173	1057	239	271
Lafayette	14,532	15,075	2,943,461	76,604	622	803	0
Lake	31	21,875	229	3,016	1841	304	434
Lee	23	11,499	785	3,357	1893	1129	437
Leon	78	2,221	14	645	698	330	77
Levy	628	30,982	289	1,758	1682	382	334
Liberty	0	889	140	108	0	0	0
Madison	2,533	35,247	1,379,466	9,471	747	221	0

Table A- 13. Livestock inventory by County (continued)

County	Dairy Cows	Beef and Other Cows	Chickens, broilers	Chickens, layers	Goats	Hogs	Sheep
Manatee	3,800	29,960	50	5,407	254	145	137
Marion	42	47,301	929	7,879	3448	1220	1176
Martin	249	28,949	169	0	500	263	60
Miamidade	31	3,604	17,640	7,965	925	135	972
Monroe	0	5	0	0	0	0	0
Nassau	1,544	4,836	0	2,489	755	169	109
Okaloosa	11	4,414	0	1,312	1671	168	221
Okeechobee	30,150	126,673	73	936	885	136	203
Orange	188	13,962	229	3,213	457	706	192
Osceola	4	99,658	167	313	451	45	80
Palmbeach	197	5,931	0	0	976	83	331
Pasco	1,639	30,796	1,653	0	1134	210	289
Pinellas	0	126	0	130	0	0	0
Polk	1,192	95,843	573	4,416	1853	419	446
Putnam	670	7,700	208	30,871	850	253	56
Santarosa	1	6,590	0	0	857	174	0
Sarasota	2,238	14,121	55	440	259	44	623
Seminole	101	4,593	0	904	907	80	216
Stjohns	0	2,266	0	605	189	58	0
Stlucie	172	28,217	926	377	219	158	35
Sumter	1,888	38,019	157	2,263	976	122	96
Suwannee	8,687	49,668	6,620,469	184,969	1638	373	83
Taylor	0	3,775	0	483	6	41	0
Union	0	9,142	48	805	662	278	40
Volusia	1,337	10,676	2,927	4,100	2201	368	353
Wakulla	3	1,078	0	554	361	180	0
Walton	81	25,023	513,193	11,208	635	171	98
Washington	421	8,638	186	561	350	44	0
TOTAL	**121,200**	**1,575,531**	**12,173,966**	**852,045**	**57,613**	**17,622**	**11,763**

Table A- 14. Calculated Livestock and Aquaculture Demand, by county (MGD)

County	WMD	Dairy Cows	Beef and Other Cows	Chickens, broilers	Chickens, layers	Goats	Hogs	Sheep	Aquaculture
Alachua	SJRWMD	0.12	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Alachua	SRWMD	0.13	0.26	0.00	0.00	0.00	0.00	0.00	0.00
Baker	SJRWMD	0.03	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Baker	SRWMD	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Bay	NWFWMD	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Bradford	SJRWMD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bradford	SRWMD	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Brevard	SJRWMD	0.03	0.29	0.00	0.00	0.00	0.00	0.00	0.26
Broward	SFWMD	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Calhoun	NWFWMD	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.36
Charlotte	SFWMD	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Charlotte	SWFWMD	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00
Citrus	SWFWMD	0.14	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Clay	SJRWMD	0.16	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Collier	SFWMD	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Columbia	SRWMD	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00
DeSoto	SWFWMD	0.52	0.78	0.00	0.00	0.00	0.00	0.00	0.47
Dixie	SRWMD	0.07	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Duval	SJRWMD	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Escambia	NWFWMD	0.03	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Flagler	SJRWMD	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Franklin	NWFWMD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gadsden	NWFWMD	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.01
Gilchrist	SRWMD	1.95	0.27	0.00	0.00	0.00	0.00	0.00	0.00
Glades	SFWMD	0.07	0.70	0.00	0.00	0.00	0.00	0.00	0.00
Gulf	NWFWMD	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Hamilton	SRWMD	0.03	0.10	0.02	0.00	0.00	0.00	0.00	0.00
Hardee	SWFWMD	1.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00
Hendry	SFWMD	0.05	0.73	0.00	0.00	0.00	0.00	0.00	0.00

Table A- 14. Calculated Livestock and Aquaculture Demand, by county (MGD)-(Continued)

County	WMD	Dairy Cows	Beef and Other Cows	Chickens, broilers	Chickens, layers	Goats	Hogs	Sheep	Aquaculture
Hernando	SWFWMD	0.22	0.17	0.00	0.04	0.00	0.00	0.00	0.00
Highlands	SFWMD	0.76	0.89	0.00	0.00	0.00	0.00	0.00	0.00
Highlands	SWFWMD	0.35	0.41	0.00	0.00	0.00	0.00	0.00	0.00
Hillsborough	SWFWMD	0.14	0.65	0.00	0.00	0.00	0.00	0.00	0.61
Holmes	NWFWMD	0.14	0.32	0.04	0.00	0.00	0.00	0.00	0.00
IndianRiver	SJRWMD	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Jackson	NWFWMD	0.14	0.60	0.00	0.00	0.00	0.00	0.00	1.17
Jefferson	NWFWMD	0.06	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Jefferson	SRWMD	0.07	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Lafayette	SRWMD	2.18	0.18	0.26	0.01	0.00	0.00	0.00	0.00
Lake	SJRWMD	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Lake	SWFWMD	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Lee	SFWMD	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Leon	NWFWMD	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Levy	SRWMD	0.06	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Levy	SWFWMD	0.03	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Liberty	NWFWMD	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Madison	SRWMD	0.38	0.42	0.12	0.00	0.00	0.00	0.00	0.00
Manatee	SWFWMD	0.57	0.36	0.00	0.00	0.00	0.00	0.00	0.00
Marion	SJRWMD	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00
Marion	SWFWMD	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00
Martin	SFWMD	0.04	0.35	0.00	0.00	0.00	0.00	0.00	0.00
MiamiDade	SFWMD	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Monroe	SFWMD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nassau	SJRWMD	0.23	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Okaloosa	NWFWMD	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Okeechobee	SJRWMD	0.52	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Okeechobee	SFWMD	4.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00
Orange	SJRWMD	0.02	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Orange	SFWMD	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Osceola	SJRWMD	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.03
Osceola	SFWMD	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.06
PalmBeach	SFWMD	0.03	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Pasco	SWFWMD	0.25	0.37	0.00	0.00	0.00	0.00	0.00	0.00
Pinellas	SWFWMD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A- 14. Calculated Livestock and Aquaculture Demand, by county (MGD)-(Continued)

County	WMD	Dairy Cows	Beef and Other Cows	Chickens, broilers	Chickens, layers	Goats	Hogs	Sheep	Aquaculture
Polk	SFWMD	0.04	0.24	0.00	0.00	0.00	0.00	0.00	0.10
Polk	SWFWMD	0.14	0.91	0.00	0.00	0.00	0.00	0.00	0.39
Putnam	SJRWMD	0.10	0.09	0.00	0.00	0.00	0.00	0.00	0.21
SantaRosa	NWFWMD	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.49
Sarasota	SWFWMD	0.34	0.17	0.00	0.00	0.00	0.00	0.00	0.14
Seminole	SJRWMD	0.02	0.06	0.00	0.00	0.00	0.00	0.00	0.00
StJohns	SJRWMD	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
StLucie	SFWMD	0.03	0.34	0.00	0.00	0.00	0.00	0.00	0.00
Sumter	SWFWMD	0.28	0.46	0.00	0.00	0.00	0.00	0.00	0.50
Suwannee	SRWMD	1.30	0.60	0.59	0.02	0.00	0.00	0.00	0.00
Taylor	SRWMD	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Union	SRWMD	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Volusia	SJRWMD	0.20	0.13	0.00	0.00	0.00	0.00	0.00	0.51
Wakulla	NWFWMD	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Walton	NWFWMD	0.01	0.30	0.05	0.00	0.00	0.00	0.00	0.00
Washington	NWFWMD	0.06	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Florida, totals (MGD)		**18.18**	**18.91**	**1.09**	**0.08**	**0.12**	**0.04**	**0.02**	**5.46**

Irrigation Water Conservation Potential

Conservation of irrigation water will of course depend on water availability, production costs, priorities of producers, type of irrigation system, availability of funding support for irrigation improvements, and other factors, but for the purposes of spatially distributing the conservation estimates, a uniform spatial distribution of conservation potential was assumed. The statewide trend in conservation of irrigation water (being estimated from a trend in statewide irrigation intensity is applied at the field scale, to facilitate applications in GIS, using the ratio of polygon-level water demand to total statewide irrigation demand. This ratio is multiplied by the statewide irrigation conservation estimate to calculate an estimate of irrigation conservation at the field scale.

Table A- 15. Irrigation water conservation at the county level for 2020 to 2035.

County	WMD	2020			2025			2030			2035		
		Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD
Alachua	SJRWMD	3,134	4	0.18	3,312	4	0.39	3,724	4	0.60	4,174	5	0.85
Alachua	SRWMD	13,205	12	0.61	13,840	13	1.28	14,176	13	1.80	14,491	14	2.34
Baker	SJRWMD	335	1	0.03	340	1	0.06	368	1	0.08	405	1	0.11
Baker	SRWMD	-	-	-	-	-	-	-	-	-	-	-	-
Bay	NWFWMD	826	1	0.04	630	1	0.06	346	0	0.05	53	0	0.01
Bradford	SJRWMD	69	0	0.00	69	0	0.01	69	0	0.01	69	0	0.01
Bradford	SRWMD	1,064	1	0.06	1,064	1	0.11	1,064	1	0.15	1,064	1	0.19
Brevard	SJRWMD	16,288	17	0.84	15,045	16	1.57	13,716	16	2.12	12,379	15	2.63
Broward	SFWMD	1,698	3	0.15	1,698	3	0.31	1,698	3	0.46	1,698	4	0.61
Calhoun	NWFWMD	2,778	2	0.10	2,092	2	0.16	1,510	1	0.15	984	1	0.12
Charlotte	SFWMD	13,652	16	0.79	13,674	16	1.60	14,605	19	2.58	14,659	21	3.54
Charlotte	SWFWMD	11,653	16	0.77	11,653	16	1.56	11,653	18	2.48	11,653	20	3.48
Citrus	SWFWMD	1,309	1	0.07	1,181	1	0.12	952	1	0.17	765	1	0.17
Clay	SJRWMD	1,114	2	0.08	1,422	2	0.20	1,602	2	0.30	1,977	3	0.45
Collier	SFWMD	80,696	108	5.31	81,372	109	10.83	84,018	127	17.10	86,669	141	23.97
Columbia	SRWMD	8,082	8	0.39	10,831	11	1.08	13,577	14	1.90	16,479	17	2.90
DeSoto	SWFWMD	73,344	90	4.42	70,864	87	8.58	68,368	102	13.73	65,841	112	19.02
Dixie	SRWMD	6,274	5	0.23	5,244	4	0.39	4,454	3	0.45	3,957	3	0.49
Duval	SJRWMD	1,009	1	0.07	776	1	0.11	527	1	0.10	260	0	0.05
Escambia	NWFWMD	3,456	2	0.12	4,566	4	0.39	5,121	5	0.62	5,681	5	0.87
Flagler	SJRWMD	9,153	11	0.53	7,487	9	0.90	5,818	8	1.02	4,167	6	1.00
Franklin	NWFWMD	20	0	0.00	53	0	0.01	53	0	0.01	53	0	0.01
Gadsden	NWFWMD	4,200	5	0.23	3,655	4	0.42	3,375	4	0.58	3,080	4	0.66
Gilchrist	SRWMD	13,877	11	0.55	14,141	11	1.14	14,536	12	1.62	14,949	12	2.12
Glades	SFWMD	89,622	106	5.18	125,596	139	13.75	156,499	173	23.35	190,542	210	35.57
Gulf	NWFWMD	73	0	0.00	49	0	0.00	-	-	-	-	-	-

Table A- 15. Irrigation water conservation at the county level for 2020 to 2035.

County	WMD	2020			2025			2030			2035		
		Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD
Hamilton	SRWMD	11,860	11	0.52	11,912	11	1.05	11,951	11	1.47	12,134	11	1.90
Hardee	SWFWMD	46,640	63	3.07	44,294	59	5.86	41,911	66	8.92	39,457	70	11.83
Hendry	SFWMD	162,392	208	10.21	158,176	203	20.10	154,228	222	29.88	150,217	235	39.92
Hernando	SWFWMD	3,564	5	0.23	4,683	6	0.58	5,689	8	1.04	6,690	9	1.53
Highlands	SFWMD	46,831	51	2.49	41,684	45	4.47	37,833	48	6.44	33,301	47	7.91
Highlands	SWFWMD	28,734	39	1.90	27,612	37	3.66	25,295	41	5.52	23,596	43	7.31
Hillsborough	SWFWMD	32,607	49	2.39	29,548	44	4.38	26,528	43	5.77	23,513	40	6.76
Holmes	NWFWMD	1,711	1	0.06	1,472	1	0.10	1,280	1	0.12	1,111	1	0.13
IndianRiver	SJRWMD	57,606	61	3.02	56,350	60	5.96	55,049	72	9.73	54,095	83	14.09
Jackson	NWFWMD	33,446	25	1.21	34,424	26	2.54	35,302	27	3.60	36,150	28	4.68
Jefferson	NWFWMD	2,234	2	0.12	2,403	3	0.26	2,471	3	0.37	2,519	3	0.48
Jefferson	SRWMD	2,558	3	0.14	2,605	3	0.30	2,718	3	0.43	2,833	3	0.56
Lafayette	SRWMD	12,376	11	0.54	13,520	12	1.20	14,900	14	1.84	16,285	15	2.56
Lake	SJRWMD	16,648	21	1.02	14,533	18	1.82	12,520	18	2.36	10,414	16	2.78
Lake	SWFWMD	465	1	0.03	413	1	0.05	274	0	0.06	268	0	0.08
Lee	SFWMD	20,740	28	1.40	18,677	26	2.59	16,745	26	3.55	14,847	25	4.28
Leon	NWFWMD	1,146	1	0.07	1,803	2	0.21	2,430	3	0.38	3,053	3	0.58
Levy	SRWMD	10,417	10	0.48	11,126	11	1.04	12,056	12	1.57	13,618	13	2.24
Levy	SWFWMD	10,755	10	0.51	11,750	12	1.16	14,345	15	1.98	14,711	15	2.57
Liberty	NWFWMD	41	0	0.00	63	0	0.01	85	0	0.01	139	0	0.02
Madison	SRWMD	19,459	16	0.78	21,227	18	1.76	22,768	20	2.65	24,310	21	3.62
Manatee	SWFWMD	64,243	87	4.28	66,236	89	8.86	67,446	99	13.37	68,713	106	17.92
Marion	SJRWMD	8,824	9	0.43	13,293	14	1.34	13,804	14	1.90	16,388	17	2.86
Marion	SWFWMD	8,014	8	0.41	9,888	10	1.02	14,062	15	2.06	16,125	17	2.94
Martin	SFWMD	40,249	51	2.51	39,837	51	5.03	39,399	57	7.63	39,007	61	10.37
MiamiDade	SFWMD	36,558	66	3.22	37,585	67	6.64	38,311	70	9.38	39,030	70	11.96

Table A- 15. Irrigation water conservation at the county level for 2020 to 2035.

County	WMD	2020			2025			2030			2035		
		Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD	Acres	MGD	Conservation MGD
Monroe	SFWMD	5	0	0.00	5	0	0.00	5	0	0.00	5	0	0.00
Nassau	SJRWMD	603	0	0.02	8	0	0.00	-	-	-	-	-	-
Okaloosa	NWFWMD	686	1	0.03	339	0	0.03	109	0	0.02	-	-	-
Okeechobee	SJRWMD	1,538	2	0.08	1,538	2	0.17	972	1	0.19	972	2	0.28
Okeechobee	SFWMD	20,346	26	1.30	17,952	23	2.31	16,579	24	3.28	14,171	23	3.82
Orange	SJRWMD	5,144	7	0.36	5,333	8	0.74	5,485	8	1.14	5,690	9	1.57
Orange	SFWMD	1,975	3	0.15	1,994	3	0.29	1,994	3	0.46	2,007	4	0.65
Osceola	SJRWMD	5,301	5	0.25	5,460	5	0.51	5,843	6	0.79	7,394	8	1.31
Osceola	SFWMD	22,386	27	1.30	23,419	28	2.73	25,295	34	4.54	25,648	38	6.40
PalmBeach	SFWMD	9,820	16	0.77	9,847	16	1.57	10,232	17	2.34	10,265	18	3.02
Pasco	SWFWMD	11,820	15	0.73	10,946	14	1.37	10,027	15	1.98	9,164	15	2.55
Pinellas	SWFWMD	14	0	0.00	12	0	0.00	-	-	-	-	-	-
Polk	SFWMD	5,165	6	0.31	5,098	6	0.62	5,098	7	0.94	5,098	7	1.27
Polk	SWFWMD	85,792	121	5.97	84,350	118	11.72	82,966	138	18.67	81,592	151	25.68
Putnam	SJRWMD	10,548	13	0.66	9,198	12	1.18	7,856	11	1.43	6,487	9	1.54
SantaRosa	NWFWMD	3,943	4	0.19	7,351	7	0.73	8,108	8	1.10	10,751	11	1.89
Sarasota	SWFWMD	6,692	9	0.44	6,563	9	0.87	6,419	9	1.24	6,250	9	1.58
Seminole	SJRWMD	1,547	2	0.11	1,320	2	0.19	1,099	2	0.23	697	1	0.21
StJohns	SJRWMD	22,989	27	1.33	22,175	27	2.67	21,262	28	3.78	20,433	28	4.82
StLucie	SFWMD	56,258	65	3.17	52,899	60	6.00	49,376	71	9.51	45,925	76	12.94
Sumter	SWFWMD	3,415	4	0.22	2,806	4	0.35	2,180	3	0.39	1,550	2	0.34
Suwannee	SRWMD	32,125	28	1.38	35,345	31	3.11	37,714	34	4.63	40,091	37	6.31
Taylor	SRWMD	738	1	0.04	766	1	0.09	863	1	0.13	968	1	0.18
Union	SRWMD	1,165	1	0.07	1,050	1	0.13	990	1	0.18	927	1	0.21
Volusia	SJRWMD	10,849	17	0.86	11,049	18	1.75	11,292	19	2.51	11,536	19	3.24
Wakulla	NWFWMD	130	0	0.01	213	0	0.03	257	0	0.04	282	0	0.06
Walton	NWFWMD	1,249	1	0.05	1,040	1	0.08	849	1	0.09	662	1	0.09
Washington	NWFWMD	1,437	1	0.06	1,724	1	0.14	1,964	2	0.23	2,195	2	0.33
Florida, totals; excluding EAA		1,360,729	1,663	82	1,385,570	1,678	166	1,406,062	1,878	253	1,429,330	2,023	343