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DEVELOPMENT OF PARCEL-LEVEL URBAN WATER USE ESTIMATES FOR THE U.S. GEOLOGICAL SURVEY PENINSULAR FLORIDA MODEL FOR GROUNDWATER RECHARGE AND WATER CONSERVATION POTENTIAL

Development of Parcel-Level Urban Water Use Estimates for the U.S. Geological Survey Peninsular Florida Model for Groundwater Recharge and Water Conservation Potential

Contract 27523

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Executive Summary

The objective of this project was to advance conservation of urban water use. The project produced a database that could be used by the St Johns River Florida Water Management District and participating utilities to support parcel-level analysis of conservation efforts. In addition, scientists in the groundwater modeling department may use the results in their analysis of groundwater recharge.

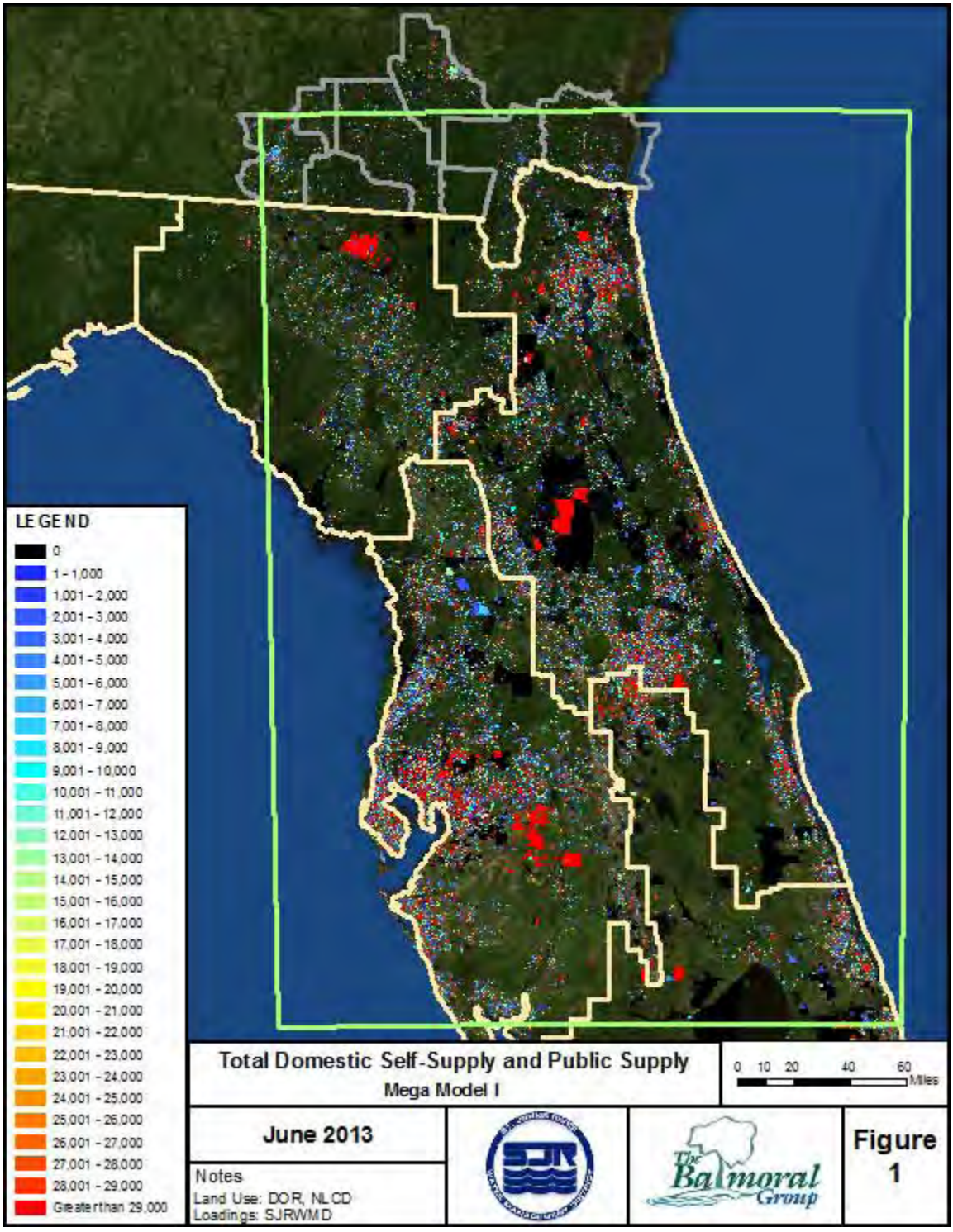
The District has developed a linear programming tool to calculate water conservation potential using GIS. Modeling was performed on SJRWMD parcel-level data to identify the effects of various approaches to water conservation. Monthly water use profiles were developed for single family, multi-family and commercial classes using data from participating utilities. Profiles included alternative volumes for outdoor use based on climatic conditions and seasonality, resulting in 36 separate load profiles (a wet, dry, and normal profile for each month of the year). The Balmoral Group was retained to populate the geodatabase for several Water Management Districts and Georgia counties included in the USGS Mega Model I. (See Map, **Figure 1**).

GIS data was obtained from the District, the U.S. Census, and other public sources. For Florida counties, land use was standardized to categories for which water use conservation Best Management Practices have been adopted by the District. For Georgia counties, land use categories are not standardized within available GIS data; consequently, National Land Cover Data was used to generate land use categories comparable to those used for Florida. Once underlying land use was determined and categorized, load profiles were assigned stochastically across all parcels by type.

Final Results for the study included 44 Florida and 7 Georgia counties, comprised of 6.2 million parcels and 436,000 parcels, respectively. Based on the load profiles assigned to each parcel, total public supply and domestic self-supply water consumption estimated for the Florida counties range from 1,393 to 2,059 million gallons per day (MGD), depending on climatic conditions. The estimates will be calibrated to the District Water Supply Plan, and by definition are not comprehensive. Suggestions for further research and applications of the database generated are included in the Conclusions and Recommendations section of the Report.

The District's Project Manager was Max Castaneda, Water Conservation Policy Analyst.

Figure 1. Total Water Use Mega Model 1



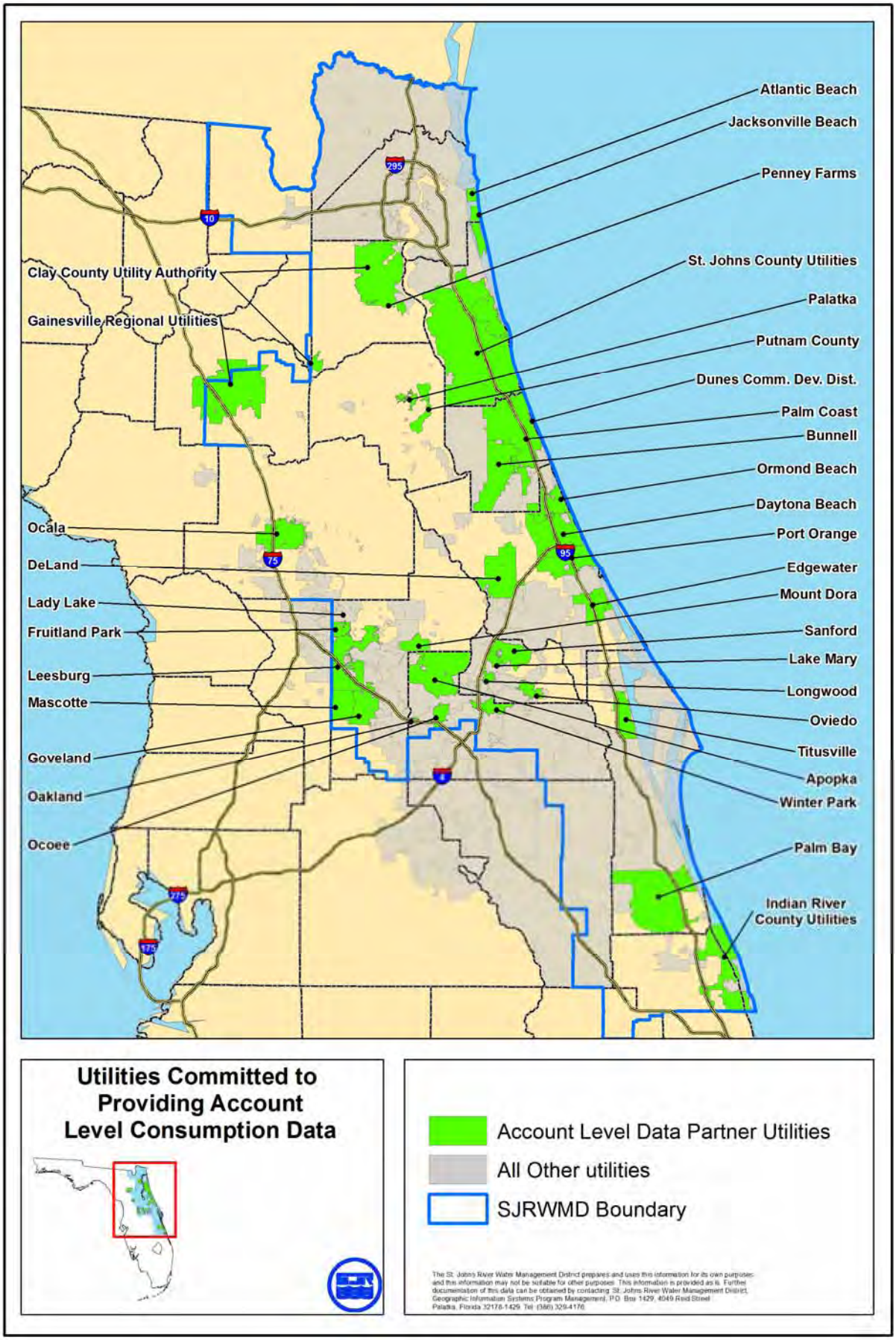
1.1 Background

The St. Johns River Water Management District has developed a linear programming tool in GIS to calculate water conservation potential. The District performed modeling on parcel-level data to identify the effects of various conservation approaches. Water use profiles were developed for single family, multi-family and commercial classes using data from contributing utilities. A map of contributing utilities and the status of their data as of February 2013 follows at **Figure 2**. The Balmoral Group was retained to populate the model for several Water Management Districts and Georgia counties included in the USGS Mega Model I. (See Map, **Figure 1**).

In the SJRWMD linear programming model, conservation potential is calculated across parcels. Change in efficiency rate is based on the year built versus the Best Management Practices replacement for each specific fixture. Water savings are estimated by the product of percent efficiency change, fixture share of water use, and total water consumption group. Passive replacement is estimated for each fixture, and reduces the total number of replaceable fixtures per group (based on year built). Conservation priorities are identified by maximizing total gallons saved per day for a specified budget amount. Savings are generated based on the fixtures selected for replacement, subject to four constraints. The first constraint is the total number of replacement opportunities or total cost. The second constraint is the total savings from all BMPs selected. The third limits replacements according to the number of available opportunities for each fixture type and each level of consumption. The final constraint prevents double counting of irrigation savings. Utilities can perform their own conservation analysis using the tool to identify the highest return on investment from the perspective of utility (including foregone revenue), customer, and District.

The analysis requires an underlying database of baseline parcel-level water use. The underlying database is used to develop distributions of water use by the percentage of customers at every 1,000 gallon level of consumption. These distributions are applied randomly to parcels, as a proxy for account level data. The amount of outdoor water use serves as a proxy for water that eventually flows back into the aquifer as recharge. Actual data provided by participating utilities, as well as proxy data developed in the subject database, are used to develop recharge calculations in the groundwater modeling processes, as well as to develop estimates of water conservation potential for the U.S.G.S. Peninsular Florida Model.

Figure 2. Utilities Map



2.1 Data Analysis and Review

GIS files were obtained from public sources at project outset to build the project geodatabase; data sources are enumerated throughout this section.

3.1 Florida Land Use data fields

Many data fields are available from County Property Appraisers records, and the District previously retained a consultant to standardize land use data across Florida Counties. Accordingly, no Florida parcel data required acquisition. In the course of data review, it was determined that Taylor and Palm Beach counties were missing from the standardized database, and that eleven counties did not have standardized data. Since the extent of the project extended only minimally into Taylor County, that county was omitted. Palm Beach County data were obtained separately from the other 43 Florida counties. Manual adjustments were made to standardize the eleven counties. Florida Department of Revenue Land use codes were consolidated into categories predetermined by the SJRWMD, as shown in **Table 1**.

Table 1. Consolidated DOR Land use Codes

Single Family		**Office Buildings**	
Single Family	001	Office buildings, non-professional (one story)	017
Mobile Homes	002	Office buildings, non-professional (multi story)	018
Multi-Family		Professional service buildings	019
Multi-family (10+ Units)	003	Financial Institution (banks, saving and loan co, mortgage co., credit services)	023
Condo	004	Insurance company offices	024
Cooperatives	005	Counties (other than public schools, college, hospitals) including non-municipal governments	086
Multi-family (<10 units)	008	State, other than military, forests, parks, recreational areas, hospitals, colleges	087
Hospitals		Federal, other than military, forests, parks, recreational areas, hospitals, colleges	088
Privately owned hospitals	073	Municipal, other than parks, recreational areas, colleges, hospitals	089
Hospitals	085	**Restaurants**	
Hotels		Restaurants, cafeterias	021
Hotels, motels	039	Drive-in restaurants	022
Indoor Recreation		Nightclubs, cocktail lounges, bars	033
Enclosed theaters, enclosed auditoriums	032	**Retail**	
Bowling alleys, skating rinks, pool halls, enclosed arenas	034	Stores, one story	011
Churches	071	Department store	013
Clubs, lodges, union halls	077	Regional shopping centers	015
Cultural organizations, facilities	079	Community shopping centers	016
Live-In Care		**Schools**	
Retirement Homes (not eligible for exemption. Other given institutional classification)	006	Private schools and colleges	072
Homes for the aged	074	public county schools	083
Orphanages, other non profit or charitable services	075	Colleges	084
Sanitariums, convalescent and rest homes	078		

Source: Developed by District staff, using data from FDOR

Table 2 lists the fields that were compiled from property appraiser parcel files, and the label of the corresponding source:

Table 2. Attributes from Property Appraisal Data

GDB attribute	Name of data field in Property Appraiser data
PARUSECODE	DOR Code
JUST_VAL	Land Value or Parcel Value
ACT_AREA	Total Living Area
YEAR_BUILT	Year Built Actual
CITY_NAME	City Name

In addition, a number of fields were calculated from data obtained from the Property Appraiser; a summary is provided in **Table 3** and detailed descriptions follow.

Table 3. Attributes calculated from Property Appraiser Data

GDB Attribute	Property Appraiser data used to calculate	Calculation
RES_CAT Residential Category	Total Parcel Value/ Just Value	Quantiles were calculated for all single family residential parcels, using ArcGIS Symbology tools
CUST_CLASS Customer Class	CNTYLUC	Cross walked Customer Class assignments from Land use codes to SJRWMD categories
BO_CONDITION Build-out Condition	Year Built	Based on year built, one of 5 Build out condition categories was assigned[1]
ADJ_RES_UNITS Number of Multi-family units	Number of Residential Units, for Multi-family	Number of Multi-family units was calculated using total building area and number of units

Residential Category reflects the relative distribution of housing values within counties (see **A1** in Appendix). Load profiles have been established for each utility's existing customer classes, and were found in previous work by Jones Edmunds to correlate with the distribution of housing stock. [2] "Residential" 1 represents housing stock that is least expensive for a given county, while "Category" 5 represents the housing stock that is most expensive for a given county. As example, the top quantile ranges from a threshold of $400,000 in Lafayette County but nearly $50 million in Palm Beach County. Similarly, the second highest quantile reflects a low of $75,000 in Hamilton County and a high of $290,000 in Martin County. Because each County exhibits distinct property value patterns, quantiles were calculated using ArcGIS for each of the 44 Florida counties; a summary of the just value breaks for each quantile by county is provided in the Appendix. A reasonableness review of the quantile breaks was conducted to identify outliers within counties. For example, in Polk County, a large mobile home park was classified as Single Family Residential, resulting in an extremely high value; the parcel was recoded to properly reflect a mobile home park. Other anomalies were identified and cleaned. Regardless of the dollar threshold, the categories are labeled 1 – 5.

Customer Class reflects the assigned land use for purposes of the Water Conservation Tool analysis, as shown in **Table 1**.

The ***Build-out Condition*** represents the assumed efficiencies of the existing fixtures on a parcel given the actual year built. **Table 4** provides the breakdown of assumed efficiencies, based on the federal water efficiency plumbing code standard in effect at time of construction.

Table 4. Fixture efficiency classification by plumbing code

Category	Years built	Plumbing Code
BO1	1984 and earlier	Pre-plumbing standard
BO2	195 through 1993	National Plumbing Code
BO3	1994 to present	Federal Energy Act
BO4	Future growth	Current efficiencies assumed

Source: Castaneda & Blush 2012.

[1] Per Castaneda, 2012.
[2] Jones Edmunds 2011.

Number of Units was calculated for all Multi-Family parcels using a series of decision rules. The data for this attribute varied widely between counties and within counties. Using data from a sampling of parcels with validated square footage across counties with unit data, a mean of 1,071 square foot per unit was calculated. Other research completed recently by the District found an average area of 1,100 square feet per multi-family unit, so the 1,071 sq. ft. seems reasonable. Total Living Area (TLA) and Average Unit Size were employed to estimate an "Adjusted" number of units on Multi-Family Parcels. Where the reported TLA was below the mean, the mean was substituted for TLA; otherwise the reported TLA was used. The TLA was then multiplied by the number of reported units, and the product was divided by the mean to estimate the Adjusted Multi-family units.

4.1 Georgia Land Use Data

Georgia land use data lack the detail available in Florida, and a methodology was established to generate standardized land use categories in the seven Georgia counties reviewed. NLCD land cover data was used to generate land use types based on density classification. NLCD classes 21, 22 and 23 (representing Open Space and Rural Residential, Low- and Medium- intensity residential, respectively) were extracted in raster format and converted to polygons to generate a Single Family Residential (SFR) layer. The remaining class 24 (High Density) was used to build multi-family and commercial/industrial/institutional (CII) parcels. U.S. Census data provides the number of Multi-family units for each County. Using national HUD data regarding the average number of units per multi-family structure (9), the number of multi-family parcels was calculated and extracted. The remaining parcels in High Density were deemed CII, and were assigned to CII classes proportionately by NAICS code data for the respective County.

Maps showing land use by County are provided in the Appendix.

5.1 Non-Land Use Data

In addition to parcel-related data, several fields were populated from data provided by the District or through publicly available records. **Table 5** provides a summary of the remaining attributes populated prior to assignment of load profiles.

Table 5. Additional Attributes

Attribute	Source
Utility Name	Provided by SJRWMD
Reuse destination	Provided by SJRWMD
Water Management District Name	Provided by SJRWMD
Water Management District Planning Area	Provided by SJRWMD
Billing Data or Estimated	All are estimated, per scope
Irrigation Type	Estimated, per scope
Indoor Indicator	For Single Family, Multi-family and Commercial, will be "1"; all others will be "0"
Outdoor Indicator	For Single Family, all will be "1"; all others will be "0"
Average Household size	Calculated from Census data

Irrigation Type reflects hose irrigation or in-ground sprinkler systems for Single Family Residential properties. Hose or Irrigation indicators were assigned with estimates of water use, as described in Section 6.1 (Assignment of Water Use).

For ***Average Household size***, each parcel was joined by its centroid to a Census Block. The Census-reported total population for the respective census block then was divided by number of households, and the result was assigned to all parcels with a centroid within the Census Block.

6.1 Assignment of Water Use

Estimates of indoor and outdoor water use were provided by the District for wet, normal and dry years, based on utility billing data from the 21 participating utilities. The data were provided in Excel spreadsheets with tables of statistical distributions by 1,000 gallon increment per month. All tables are included in the Index. A sample is provided in **Table 6** below.

Table 6. Indoor Single Family Residential Load Profile – Sample

Utility	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Atlantic Beach	0.67%	19.50%	23.34%	20.22%	13.99%	7.85%	5.44%	2.92%	1.83%	1.00%	3.24%
Daytona Beach	0.07%	13.55%	21.01%	23.25%	18.64%	11.15%	6.04%	2.89%	1.49%	0.71%	1.20%
DeLand	0.05%	15.80%	17.19%	17.40%	13.10%	9.58%	6.64%	4.23%	3.35%	2.56%	10.10%
Edgewater	0.26%	33.90%	22.78%	16.69%	10.98%	6.43%	2.57%	1.31%	0.79%	0.32%	3.96%
GRU	0.00%	8.52%	18.39%	20.14%	16.93%	12.56%	8.28%	5.15%	3.08%	2.15%	4.80%
Indian River	0.36%	17.85%	20.31%	21.40%	16.69%	10.67%	5.85%	3.15%	1.60%	0.76%	1.37%
Jacksonville Beach	0.21%	16.14%	22.87%	22.19%	16.05%	10.47%	5.45%	2.94%	1.60%	0.82%	1.25%
Lake Mary	1.60%	3.76%	6.75%	7.25%	7.80%	6.11%	5.79%	5.36%	4.95%	4.47%	46.16%
Leesburg	1.41%	9.10%	9.18%	12.47%	11.30%	7.86%	9.16%	7.64%	5.57%	5.31%	21.00%
Mount Dora	0.16%	17.33%	13.90%	12.72%	11.11%	7.57%	7.24%	5.73%	3.68%	3.15%	17.42%
Oakland	0.51%	21.92%	13.33%	13.85%	12.18%	10.64%	8.59%	7.69%	2.56%	2.95%	5.77%
Ocala	5.36%	28.48%	12.20%	11.77%	18.08%	5.98%	4.28%	5.26%	1.67%	1.38%	5.54%
Oviedo	0.59%	3.31%	9.61%	11.97%	10.66%	9.61%	8.03%	7.80%	6.89%	5.60%	25.92%
Palm Bay	4.31%	35.76%	34.12%	16.76%	6.19%	1.84%	0.63%	0.18%	0.11%	0.03%	0.07%
Palm Coast	1.74%	23.03%	30.54%	20.05%	10.74%	5.79%	3.04%	1.71%	1.09%	0.67%	1.59%
Penney Farms	0.75%	30.60%	29.85%	14.93%	8.21%	6.72%	0.75%	1.49%	1.49%	1.49%	3.73%
Sanford	0.20%	44.94%	17.94%	12.67%	9.08%	5.97%	3.78%	2.43%	1.23%	0.79%	0.99%
St. Augustine	31.02%	27.85%	20.95%	10.95%	5.53%	1.84%	0.84%	0.43%	0.21%	0.04%	0.33%
St. Johns County	2.90%	31.56%	32.67%	16.58%	7.58%	3.70%	2.01%	1.03%	0.64%	0.43%	0.89%
Titusville	7.57%	8.50%	14.04%	15.97%	15.00%	11.83%	8.37%	5.62%	3.49%	2.41%	7.20%
Winter Park	0.11%	40.07%	17.47%	13.10%	8.65%	6.05%	4.45%	2.89%	1.99%	1.32%	3.89%
Weighted AVG	**2.76%**	**20.58%**	**20.25%**	**17.16%**	**12.95%**	**8.27%**	**5.37%**	**3.55%**	**2.18%**	**1.52%**	**5.40%**

Residential Water Use

Load profiles were assigned stochastically, as follows. Random identification numbers were assigned to each parcel in file. The random numbers were sorted largest to smallest, and the percentages were then assigned for each profile segment. For example, using the above weighted averages, the first 1.34% of the parcels would receive an assignment of "0" gallons per the load profile, and the next 21.23% of parcels would be assigned "1,000" gallons; the next 21.89% would be assigned 2,000; and so

on. This process was used to assign water use consumption for 36 months – January through December for Wet, Dry and Normal Climatic Conditions.

To apply Single Family Outdoor profiles, another random number was generated and features sorted accordingly. The first 49.91% were assigned using Hose Outdoor use profiles, as provided in **Table A-3** in the Appendix. The remaining 50.09% were assigned using Irrigation Outdoor use profiles; see **Table A-3** in Appendix. This process was used to assign water use consumption for 36 months – January through December for Wet, Dry and Normal Climatic Conditions.

Multi-Family Water Use

Water use was assigned to Multi-family units on a per unit basis. All identified Multi-Family parcels were assigned a number of units as described above. If the number of units was equal to one, the parcel received a randomly assigned water distribution using the same process as for Single Family Residential. If there was more than one unit, each unit was assigned a water use value of 3,413 gallons per month.

Commercial, Industrial & Institutional

Commercial, Industrial and Institutional (CII) use properties were assigned water use based on factors derived from the structure's operations or function. **Table 7** provides a breakdown of the different type of uses, the typical rates of consumption and the source of the information.

Table 7. CII Factors

Customer Class	Gallons/Sq.Ft./Month	Source
Hospitals	1.2164	Jones Edmunds WC DWSP 2010 Document Table 6.2 Pre 1984 Use
Hotels	6.951726	Morales JAWWA Article Table 6
Indoor Recreation	1.5205	Jones Edmunds WC DWSP 2010 Document Table 6.2 All 3 build-outs
Industrial(Manufacturing)	1.508336	Morales JAWWA Article Table 6, Total Industrial
Live-In care	6.082	Jones Edmunds WC DWSP 2010 Document Table 6.2 Pre 1984
Warehousing/ Storage	2.1287	Morales JAWWA Article Table 6
Office Buildings	3.041	Jones Edmunds WC DWSP 2010 Document Table 6.2 Pre 1994 to present
Restaurants	14.5968	Jones Edmunds WC DWSP 2010 Document Table 6.2 Pre 1994 and later
Retail	2.4328	Jones Edmunds WC DWSP 2010 Document Table 6.2 All 3 build-outs
Schools	4.8656	Jones Edmunds WC DWSP 2010 Document Table 6.2 Pre 1994 to present

Source: SJRWMD

There are several land use categories that are not captured as part of this effort, including Agriculture, Transportation, and Golf Courses, to provide a few examples. Water use was not assigned to these parcels in Florida for the following reasons. Firstly, the CII categories for which water use was assigned tend to be the largest users in terms of total volume. The remaining categories are either small users or there are very few of them. The District intends to calibrate total water use by county to water supply planning numbers; the omitted categories will be accounted for in the aggregate. Secondly, the available utility billing data does not contain many accounts for the omitted CII categories, or there is a very wide distribution of use in these categories, resulting in poor estimates of gallons per square foot. Finally, for most of the omitted categories, the District has not established water conservation BMPs. For some categories, recommendations will likely be site-specific, and less amenable to a modeling approach.

For Commercial, Industrial, and Institutional properties, loadings are assigned by gallons/square foot of building area. For the most part, counties consistently record building area data. However, in some

instances, the building area is recorded as null or zero. In these cases, averages calculated from actual data across counties were applied. **Table 8** reflects the averages used in the absence of data.

Table 8. Average Area for CII Parcel Types used in database

CII Type	Average Total Living Area (SF)
Hospitals	123,799
Hotels	34,198
Indoor Rec	12,275
Live-In Care	57,459
Manufacturing	38,779
Office Buildings	7,195
Restaurants	4,610
Retail	24,510
Schools	65,218
Warehousing / Storage	21,556

The Appendix provides maps of total, indoor, and outdoor water use, organized by property type, Water Management District, and sample counties, for both Florida and Georgia.

7.1 Conclusions and Recommendations

The estimated Total Urban water use for all areas included in the Florida conservation analysis ranges from 1,372 to 2,054 million gallons per day (MGD), depending on climatic conditions considered in the load profile. Totals for all areas included in the conservation analysis are shown in **Table 9**. For context, the most recent USGS Report (2005) shows 1,843 MGD for Public Supply and Domestic Supply.

Table 9. Estimated Public Supply and Domestic Supply, Mega Model Area, MGD

State	Total Estimated Public Supply and Domestic Self-Supply	
	Min	Max
Florida	1,393	2,059
Georgia	23	39
Total	**1,416**	**2,098**

Table 10 provides the distribution of water use by Water Management District. **Table 11** shows the composition of water use by district.

Table 10. Florida Estimated Public Supply and Domestic Supply by District, MGD

District	Commercial	Multi Family	Single Family			Total	
	Indoor	Indoor	Indoor	Outdoor		Min	Max
				Wet December	Dry July		
SFWMD	70	23	81	73	196	247	370
SJRWMD	131	53	171	154	413	510	768
SRWMD	9	1	10	9	25	30	45
SWFWMD	211	57	178	160	429	607	875
Total	421	134	441	397	1,062	1,393	2,059

Table 11. Florida Composition of Public Supply and Domestic Supply by District

District	Indoor		Outdoor	
	% of Total		% of Total	
	Min	Max	Min	Max
SFWMD	70%	47%	30%	53%
SJRWMD	70%	46%	30%	54%
SRWMD	68%	45%	32%	55%
SWFWMD	74%	51%	26%	49%
Total	**72%**	**48%**	**28%**	**52%**

Georgia has Water Planning Regions rather than Water Management Districts; the distribution of urban water use is separated by use type and region in **Table 12**. **Table 13** provides water use composition by region.

Table 12. Georgia Estimated Public Supply and Domestic Supply by Region, MGD

District	Commercial	Multi Family	Single Family			Total	
	Indoor	Indoor	Indoor	Outdoor		Min	Max
				Wet December	Dry July		
Coastal Georgia	0.2	0.1	1.6	1.4	3.9	3.4	0.2
Suwannee-Satilla	1.3	0.3	9.3	8.3	22.3	19.3	1.3
Total	**1.6**	**0.4**	**10.9**	**9.8**	**26.2**	**22.6**	**1.6**

Table 13. Georgia Composition of Public Supply and Domestic Supply by Region

District	Indoor		Outdoor	
	% of Total		% of Total	
	Min	Max	Min	Max
Coastal Georgia	57.1%	33.2%	42.9%	66.8%
Suwannee-Satilla	56.7%	32.8%	43.3%	67.2%
Total	**56.7%**	**32.9%**	**43.3%**	**67.1%**

An important consideration in developing and populating the water conservation analysis was the participation of utilities. Utilities ultimately drive the pricing mechanisms that impact water use, and the conservation message that most consumers are likely to hear. Throughout the project, utilities were invited to participate in Progress Meetings and to raise questions, to ensure relevance of the output to daily operations and long-term prospects for conservation at the local level. More than half of the utilities that contributed billing data for the analysis participated in the Progress Meetings on a regular basis. While minimal comments were received during the meetings questions were posed for the following specific topics:

- A question was raised as to how reuse estimates would be incorporated into the analysis. SJRWMD staff intends to incorporate reuse estimates into the volume of conservation analysis on project completion. Likewise, District staff will reconcile study estimates to the Central Florida Water Initiative estimates.

- A question was raised as to how the indoor/outdoor split for single family residential properties would be assigned to Florida vs. Georgia. The same split used for Florida loadings is assigned to Georgia loadings, as a placeholder until Georgia account level data is available.

- A question was raised as to the expected updating of the NLCD data, which is currently the 2006 version. The next version is based on 2011 data and is expected to be released in December 2013.

- Discussion was held regarding how the model's conservation estimates could be calibrated to a utility's goal-based plan for CUPCON (Consumptive Use Permitting Consistency). One approach may be to use the range of the demand estimates provided by the study as the bounds of a "confidence interval" when compared to consumption based on utility billing information. The difference between model's estimates and historical consumption may be an appropriate factor

to include into goal-based plan conservation projections. The District informed participants that a related project focused on water shortage management was about to commence, and all utilities were invited to continue participation with the new project.

- Discussion was held regarding the District's service to perform on-site analysis at major users to identify retrofit opportunities. The utilities requested a workshop to learn more about the program.

- Discussion was held regarding the use of financial incentives, including discounted impact fees, to promote energy conservation and BMP's. Local ordinance language has been adopted in some municipalities to further this effort; DeLand was named as a specific example.

- Opportunities to match savings in agricultural water use to utility supply needs was discussed, through private sector "swaps".

- Submetering by private property owners in multi-family buildings or large developments was noted as a potential target for substantial conservation progress. Individual users are often not aware of their water use due to flat rate charges regardless of consumption level. Requiring individually metered consumption through local ordinance may reap significant water savings.

Suggestions for Further Research

A primary benefit of modeling water use estimates at the parcel level is the granular level of data available for multiple types of analysis. The project summarized herein focused on water quantity, and in future, water quality will be increasingly important. From a water quality perspective, information that is geared to a local scale allows prioritization of efforts by utilities, local governments, and regulatory bodies. An example of the value of localized maps in changing behavior that affects water quality can be found in a simple mapping project launched by the Tampa Bay Estuary Program. In the project, maps of dog waste in a Tampa park were updated and displayed in poster size every week for eight weeks to demonstrate the cumulative effects of failing to bag and dispose of pet waste. The quantity of dog waste declined substantially. Evidently, the realization that the cumulative effects of individual actions were causing significant water quality issues was a catalyst for individuals to change their daily behavior: the local maps exhibited specific local conditions that residents could recognize and affect. Water quality impacts that may lend readily to the use of data produced in this project include non-point sources. An example may be lawn chemical application. Substantial research has been completed in Florida linking lawn fertilizer directly to surface and groundwater quality impacts. Water use patterns generated from the conservation analysis model could also be applied to nutrient uptake (and residual) estimates for lawn chemicals. Combined with local soil types and topography data, neighborhood-scale analysis may be achievable.

As discussed in Section 6.1, several categories of commercial, industrial, and institutional water use were omitted from analysis. Further research may be warranted to establish appropriate load profiles and prioritize the omitted water uses for analysis. Large individual permit holders, like power plants, pulp or paper mills, large manufacturing facilities, etc. may also be incorporated to reflect specific locations of concentrated withdrawals; in Georgia, this information is maintained by the Department of Natural Resources and in Florida by the Department of Environmental Protection.

This project focused on non-agricultural water uses. Combined with a parallel project estimating agricultural uses, the total water use estimates provide a framework for considering water supply planning on a regional scale. The total urban water use estimates calculated for the 44 Florida counties and 6.2 million parcels in the database range from 1,393 to 2,059 MGD[3], spatially assigned to specific parcel addresses; the USGS 2005 estimates 1,843 MGD total public supply and DSS for the defined area. The estimates imply a 10% increase in water consumption accompanied a 7% increase in population. A wide variety of approaches are currently used by water management districts across the state currently. Given that all of the data used in the subject model is publicly available and can be calibrated to water supply plans, consideration may be given to generating estimates for the entire State in a consistent, predictable and reliable manner.

NLCD data was used to assign land uses. Using Census block data to assign water use to residential parcels may produce adequate analysis for the scale intended for Mega model purposes. Future work may investigate whether assignment of census block data produces superior results to the NLCD approach used herein for residential parcels. In the study, Georgia's 7 counties resulted in 436,000 polygons, whereas census block data would have produced only 14,815 polygons.

Last, economic literature posits a significant relationship between household income and residential water consumption. Given the extensive data that has been compiled from utility billing data, econometric testing of the hypothesis begs application. Results may reveal low-hanging fruit for potential water savings through straightforward price elasticity that could be leveraged by local utilities.

[3] depending on climatic assumptions

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Appendix

Table A- 1. Residential Category By Parcel Value Breakout

County	Residential Category					
	1	2	3	4	5	Quantity
Alachua	68,000	100,500	132,700	182,700	1,623,600	61,612
Baker	47,644	68,417	95,338	132,906	834,874	6,210
Bradford	36,847	54,972	76,184	115,220	909,327	8,055
Brevard	49,120	71,690	98,540	145,450	3,037,430	190,600
Charlotte	48,500	75,910	111,178	170,805	4,772,638	71,831
Citrus	40,644	62,999	89,875	139,261	2,513,299	68,315
Clay	66,940	94,798	118,851	159,231	3,498,089	64,400
Columbia	38,969	59,686	84,508	126,052	1,335,871	19,559
De Soto	32,415	46,857	63,599	95,784	1,016,521	8,135
Dixie	22,200	34,500	50,600	81,000	1,056,950	6,443
Duval	66,828	96,852	129,522	177,029	6,268,354	259,461
Flagler	86,876	105,459	126,069	163,906	2,460,657	39,198
Gilchrist	39,311	57,667	77,278	113,130	521,798	4,881
Glades	30,375	44,625	63,820	93,710	664,728	3,854
Hamilton	24,401	37,408	51,281	75,906	437,106	3,267
Hardee	27,575	40,301	54,463	84,598	1,679,175	5,580
Hernando	47,786	69,035	89,619	120,449	2,109,648	72,877
Highlands	39,340	60,135	81,770	120,346	2,153,417	37,745
Hillsborough	58,080	84,189	113,814	166,777	6,779,357	326,697
Indian River	55,590	82,350	120,920	204,220	13,142,480	49,193
Lafayette	25,236	43,094	67,144	103,749	418,472	1,702
Lake	62,581	96,178	123,274	163,395	3,172,988	111,250
Levy	28,635	45,786	67,732	106,846	804,204	16,449
Madison	24,684	40,471	57,893	87,733	644,801	4,560
Manatee	64,103	103,065	145,645	218,721	4,519,327	97,915
Marion	41,913	66,786	93,574	137,654	3,928,629	125,043
Martin	80,060	135,220	195,380	292,730	46,406,210	48,559
Nassau	72,597	111,119	151,063	237,957	9,756,083	26,262
Okeechobee	32,408	46,625	60,789	95,160	1,637,331	13,225
Orange	63,550	100,110	135,478	189,389	12,469,364	287,166
Osceola	57,800	76,800	99,400	139,900	3,358,400	87,595
Palm Beach	66,624	110,938	167,583	231,319	59,651,000	361,261
Pasco	46,189	66,819	106,080	147,091	2,463,929	174,336
Pinellas	61,535	86,762	116,186	174,313	7,130,661	263,149
Polk	38,629	57,827	84,249	120,682	2,535,811	185,937
Putnam	30,707	49,968	71,952	114,033	6,626,493	31,679
Sarasota	65,200	93,100	136,200	223,700	11,373,300	141,160
Seminole	85,871	119,027	150,426	211,716	5,110,446	121,981
St. Johns	93,713	144,635	191,671	279,385	11,587,535	65,205
St. Lucie	50,900	72,400	95,900	129,200	3,947,800	98,389
Sumter	74,822	121,718	149,694	197,294	2,160,470	45,522
Suwannee	34,814	53,228	74,586	110,776	924,122	11,618
Union	33,150	48,538	67,560	100,172	515,679	2,218
Volusia	54,876	73,141	97,976	140,761	4,776,691	171,698
Total						3,80

Figure A-1. Camden County NLCD Land Use

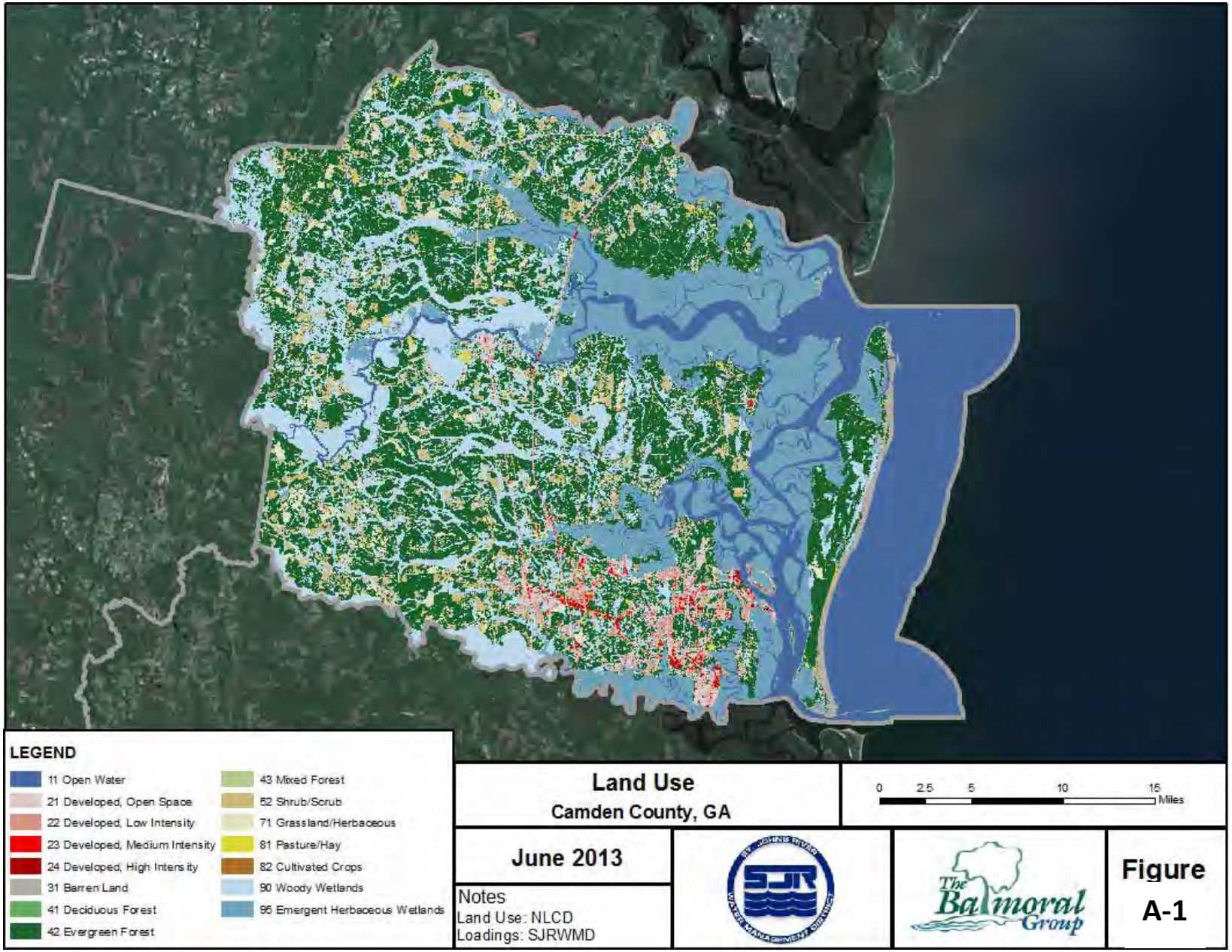


Figure A-2. Charlton County NLCD Land Use

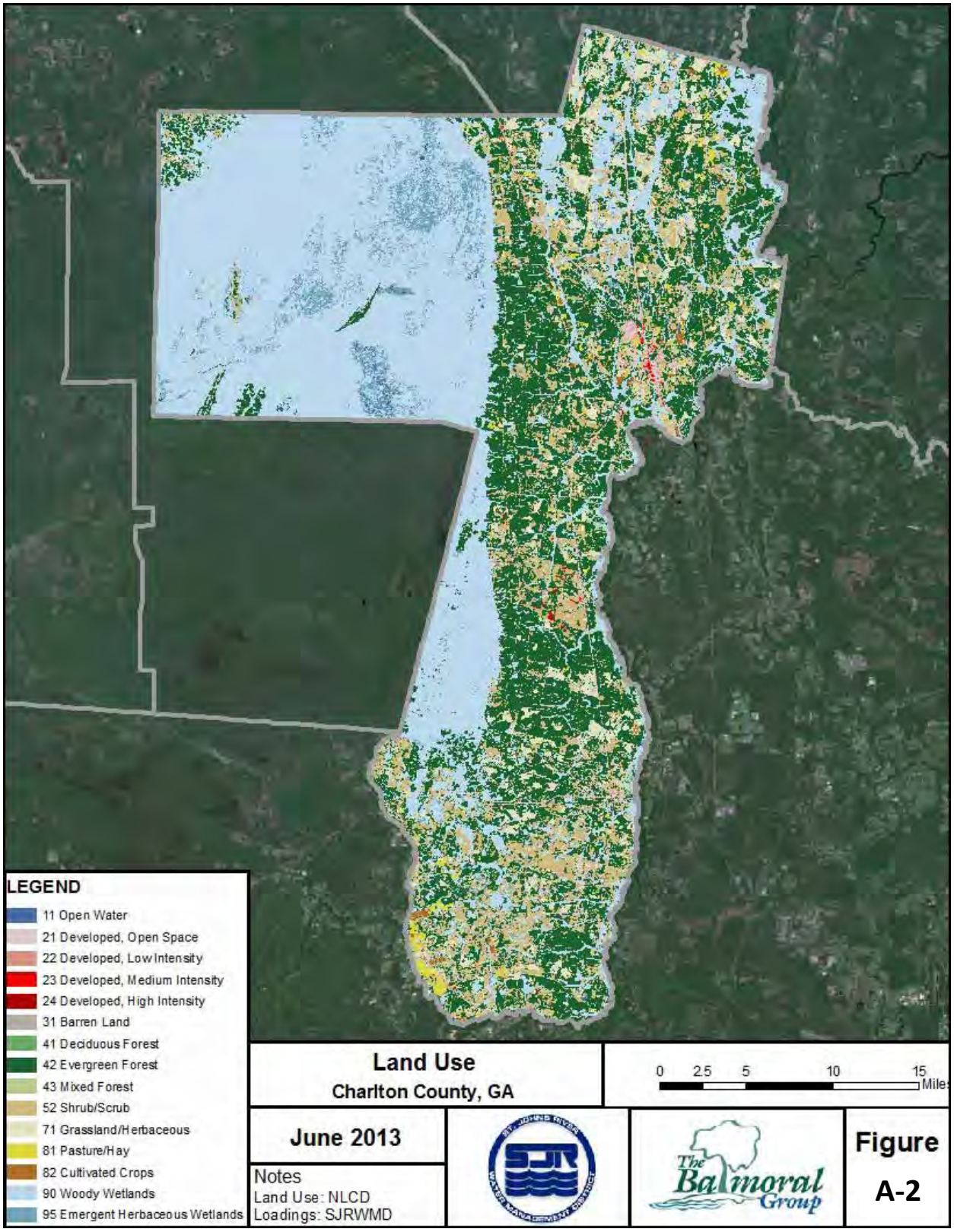


Figure A-3.Clinch County NLCD Land Use

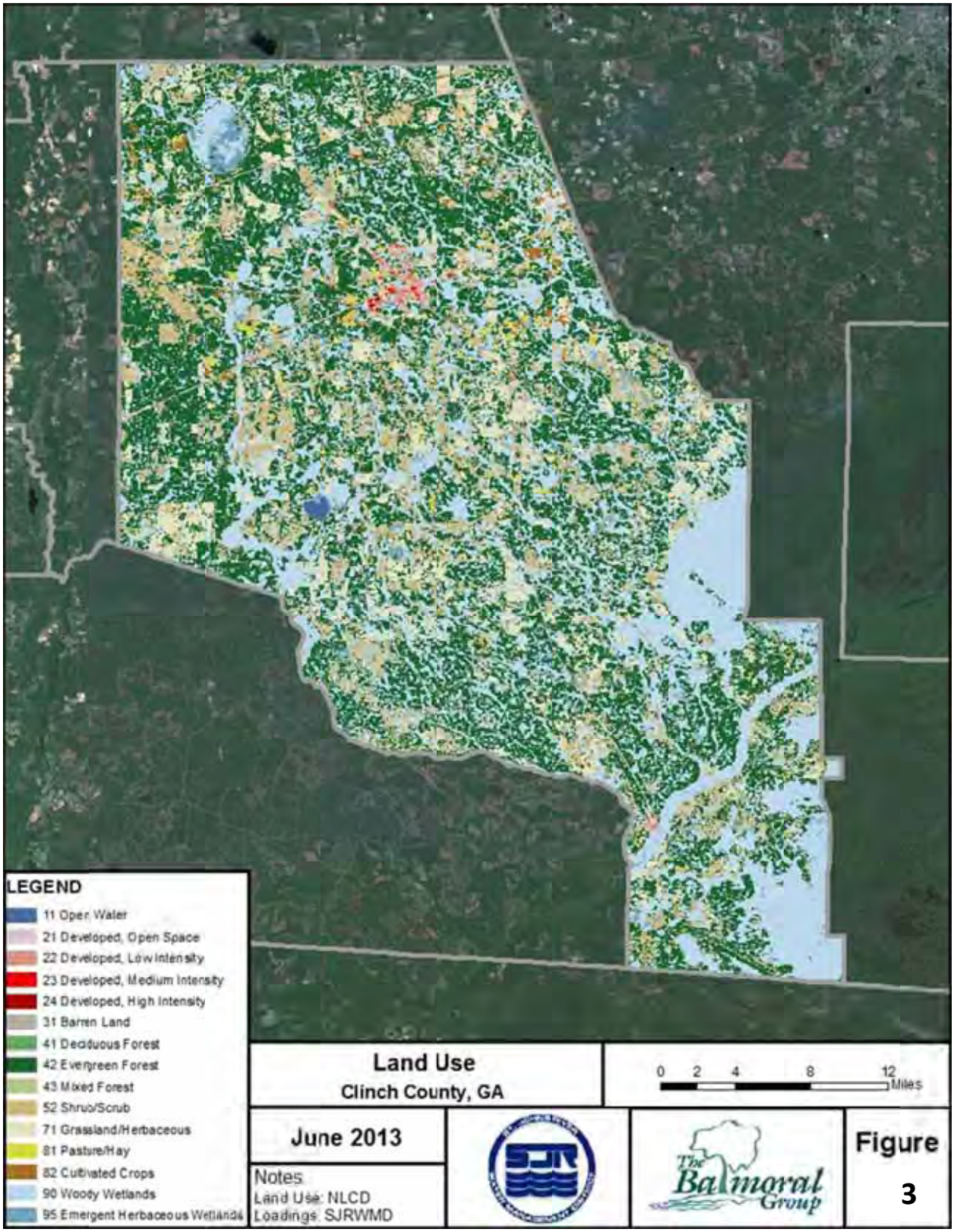


Figure A-4. Echols County NLCD Land Use

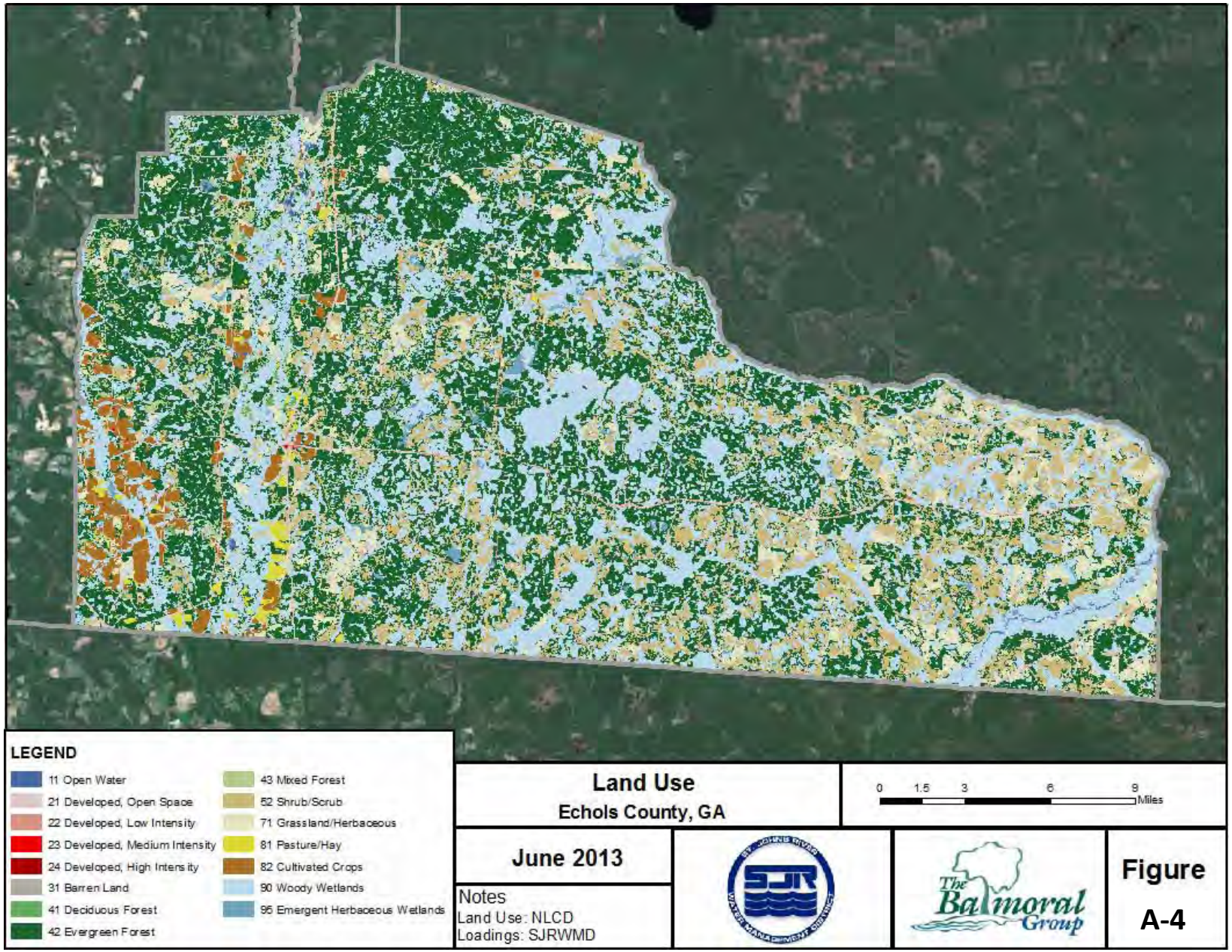


Figure A-5. Lanier County NLCD Land Use

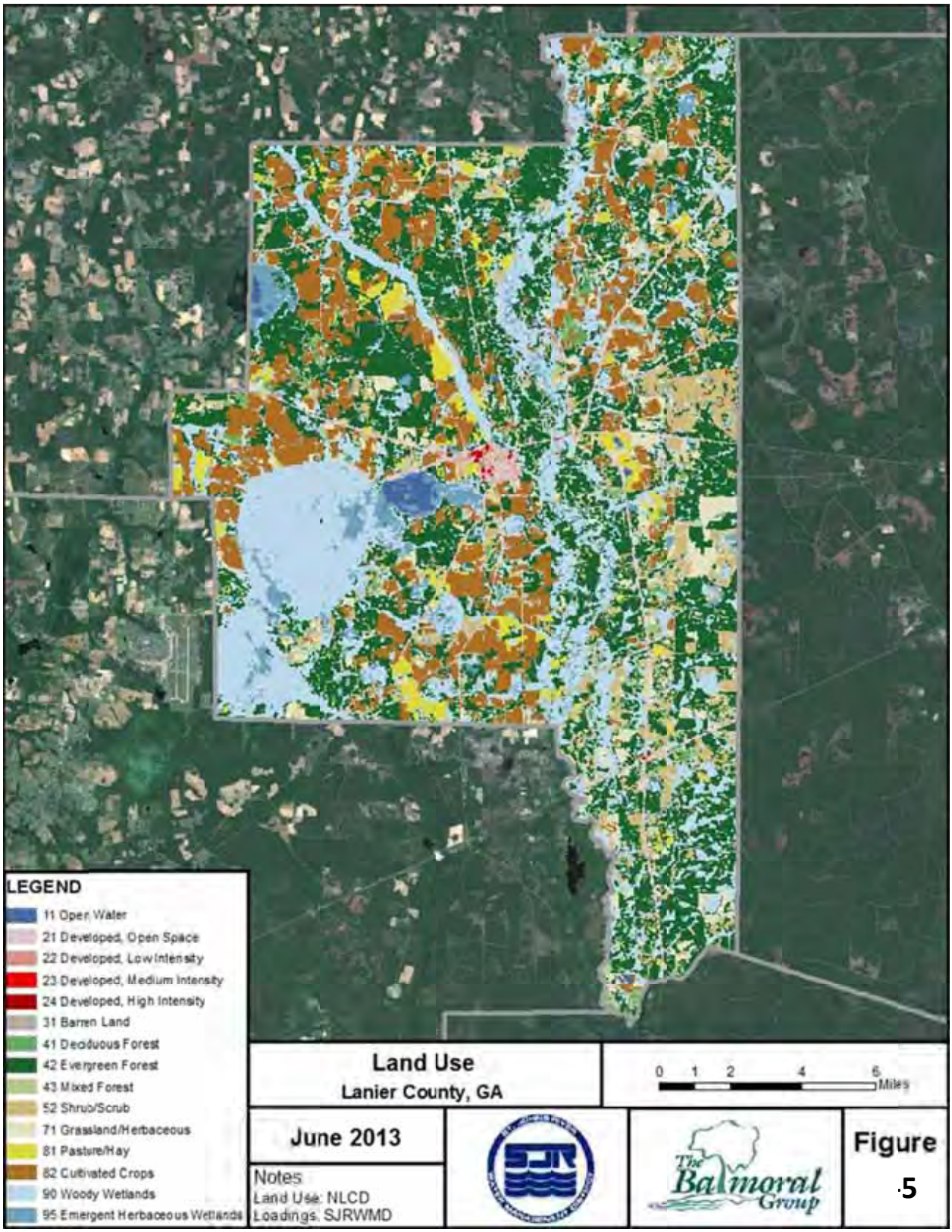


Figure A-6. Lowndes County NLCD Land Use

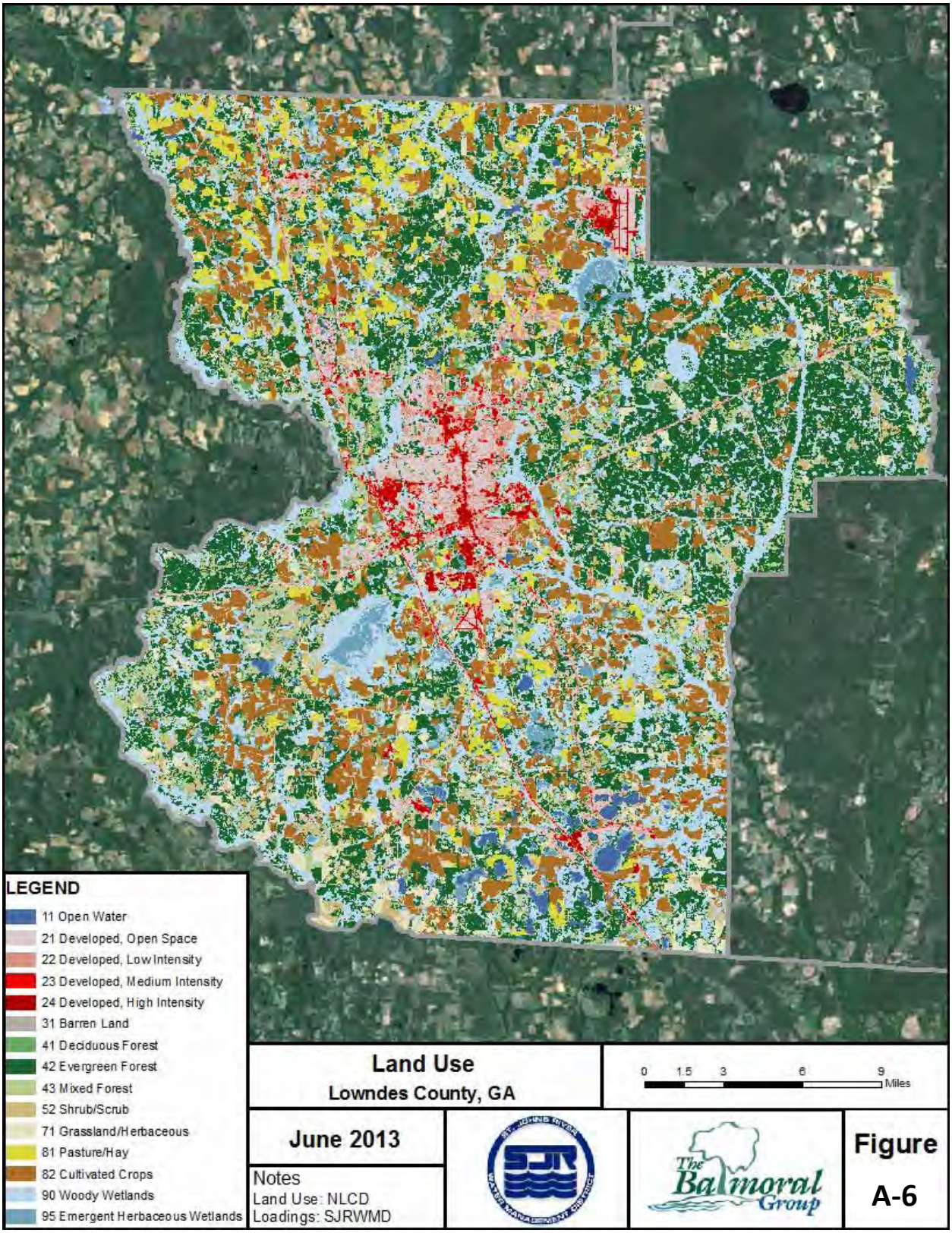


Figure A-7. Ware County NLCD Land Use

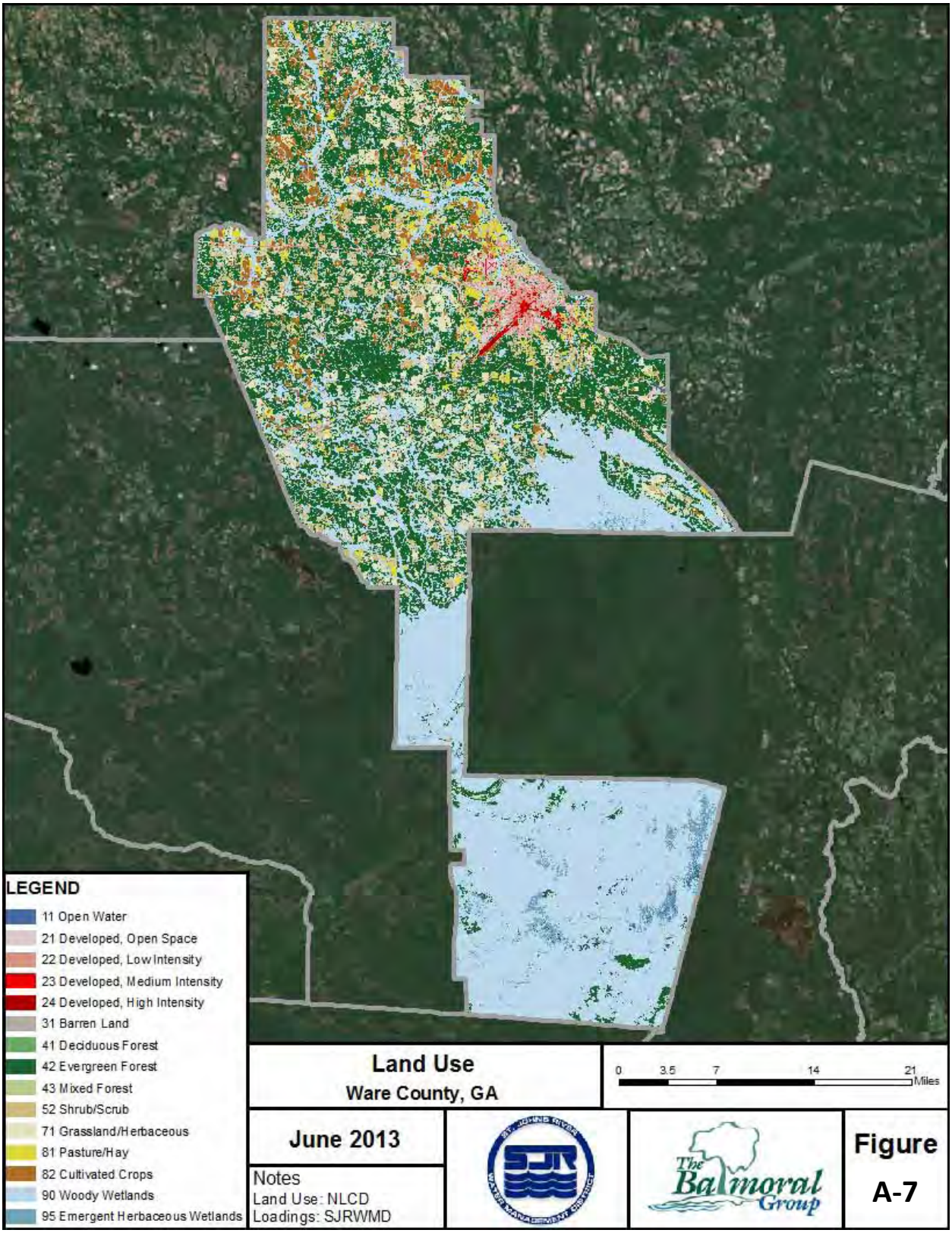


Table A- 2. Single Family Indoor Load Profiles

Utility	0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Atlantic Beach	0.67%	19.50%	23.34%	20.22%	13.99%	7.85%	5.44%	2.92%	1.83%	1.00%	3.24%
Daytona Beach	0.07%	13.55%	21.01%	23.25%	18.64%	11.15%	6.04%	2.89%	1.49%	0.71%	1.20%
DeLand	0.05%	15.80%	17.19%	17.40%	13.10%	9.58%	6.64%	4.23%	3.35%	2.56%	10.10%
Edgewater	0.26%	33.90%	22.78%	16.69%	10.98%	6.43%	2.57%	1.31%	0.79%	0.32%	3.96%
GRU	0.00%	8.52%	18.39%	20.14%	16.93%	12.56%	8.28%	5.15%	3.08%	2.15%	4.80%
Indian River	0.36%	17.85%	20.31%	21.40%	16.69%	10.67%	5.85%	3.15%	1.60%	0.76%	1.37%
Jacksonville Beach	0.21%	16.14%	22.87%	22.19%	16.05%	10.47%	5.45%	2.94%	1.60%	0.82%	1.25%
Lake Mary	1.60%	3.76%	6.75%	7.25%	7.80%	6.11%	5.79%	5.36%	4.95%	4.47%	46.16%
Leesburg	1.41%	9.10%	9.18%	12.47%	11.30%	7.86%	9.16%	7.64%	5.57%	5.31%	21.00%
Mount Dora	0.16%	17.33%	13.90%	12.72%	11.11%	7.57%	7.24%	5.73%	3.68%	3.15%	17.42%
Oakland	0.51%	21.92%	13.33%	13.85%	12.18%	10.64%	8.59%	7.69%	2.56%	2.95%	5.77%
Ocala	5.36%	28.48%	12.20%	11.77%	18.08%	5.98%	4.28%	5.26%	1.67%	1.38%	5.54%
Oviedo	0.59%	3.31%	9.61%	11.97%	10.66%	9.61%	8.03%	7.80%	6.89%	5.60%	25.92%
Palm Bay	4.31%	35.76%	34.12%	16.76%	6.19%	1.84%	0.63%	0.18%	0.11%	0.03%	0.07%
Palm Coast	1.74%	23.03%	30.54%	20.05%	10.74%	5.79%	3.04%	1.71%	1.09%	0.67%	1.59%
Penney Farms	0.75%	30.60%	29.85%	14.93%	8.21%	6.72%	0.75%	1.49%	1.49%	1.49%	3.73%
Sanford	0.20%	44.94%	17.94%	12.67%	9.08%	5.97%	3.78%	2.43%	1.23%	0.79%	0.99%
St. Augustine	31.02%	27.85%	20.95%	10.95%	5.53%	1.84%	0.84%	0.43%	0.21%	0.04%	0.33%
St. Johns County	2.90%	31.56%	32.67%	16.58%	7.58%	3.70%	2.01%	1.03%	0.64%	0.43%	0.89%
Titusville	7.57%	8.50%	14.04%	15.97%	15.00%	11.83%	8.37%	5.62%	3.49%	2.41%	7.20%
Winter Park	0.11%	40.07%	17.47%	13.10%	8.65%	6.05%	4.45%	2.89%	1.99%	1.32%	3.89%
Weighted AVG	**2.76%**	**20.58%**	**20.25%**	**17.16%**	**12.95%**	**8.27%**	**5.37%**	**3.55%**	**2.18%**	**1.52%**	**5.40%**

Table A- 3. Single Family Outdoor Load Profiles - Wet Climatic Conditions

Hose Irrigators		**49.91%**										
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	23%	35%	24%	33%	31%	32%	34%	35%	39%	33%	9%	26%
1000	47%	16%	23%	22%	23%	21%	20%	24%	15%	17%	11%	21%
2000	6%	15%	20%	18%	17%	17%	16%	17%	13%	14%	20%	21%
3000	5%	13%	13%	12%	11%	11%	11%	10%	11%	10%	23%	15%
4000	3%	8%	7%	7%	7%	7%	7%	6%	6%	6%	18%	9%
5000	2%	4%	4%	4%	4%	4%	4%	3%	4%	4%	9%	5%
6000	2%	3%	2%	2%	2%	2%	2%	2%	3%	3%	6%	2%
7000	1%	2%	1%	1%	1%	1%	1%	1%	2%	2%	3%	1%
8000	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%
9000	1%	1%	1%	0%	1%	1%	1%	0%	1%	1%	0%	0%
10000	8%	3%	3%	0%	2%	2%	2%	1%	5%	9%	0%	0%
In-Ground Irrigators		**50.09%**										
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	25%	29%	18%	16%	17%	17%	17%	19%	39%	21%	5%	19%
1000	33%	8%	13%	9%	8%	8%	9%	11%	8%	11%	4%	10%
2000	7%	9%	14%	10%	9%	10%	10%	11%	9%	11%	7%	13%
3000	6%	11%	13%	11%	8%	9%	10%	10%	9%	9%	12%	13%
4000	5%	9%	10%	10%	7%	8%	9%	9%	7%	7%	11%	10%
5000	4%	7%	7%	8%	6%	7%	7%	7%	5%	6%	10%	8%
6000	3%	6%	5%	6%	5%	6%	6%	5%	4%	5%	10%	6%
7000	3%	4%	4%	6%	5%	5%	5%	4%	3%	4%	8%	5%
8000	2%	3%	3%	4%	4%	4%	4%	3%	3%	3%	5%	4%
9000	2%	3%	2%	3%	3%	3%	3%	3%	2%	3%	4%	2%
10000	1%	2%	2%	3%	3%	3%	3%	2%	2%	2%	4%	2%
11000	1%	1%	1%	2%	3%	2%	2%	2%	1%	2%	3%	1%
12000	1%	1%	1%	1%	2%	2%	2%	2%	1%	2%	2%	1%
13000	1%	1%	1%	2%	2%	2%	2%	1%	1%	1%	2%	1%
14000	1%	1%	1%	1%	2%	2%	1%	1%	1%	1%	2%	1%
15000	1%	1%	1%	1%	2%	1%	1%	1%	1%	1%	1%	1%
16000	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%
17000	1%	0%	1%	1%	1%	1%	1%	1%	0%	1%	1%	0%
18000	0%	0%	0%	1%	1%	1%	1%	1%	0%	1%	1%	0%
19000	0%	0%	0%	1%	1%	1%	1%	1%	0%	1%	1%	0%
20000	0%	0%	0%	0%	1%	1%	1%	1%	0%	1%	1%	0%
21000	0%	0%	0%	0%	1%	1%	1%	1%	0%	1%	1%	0%
22000	0%	0%	0%	0%	1%	1%	0%	1%	0%	1%	1%	0%
23000	0%	0%	0%	0%	1%	1%	0%	0%	0%	1%	1%	0%
24000	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%
25000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
26000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
27000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
28000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
29000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30000	2%	1%	1%	2%	3%	3%	3%	3%	2%	4%	2%	1%

Table A- 4. Single Family Outdoor Load Profiles – Normal Climatic Conditions

Hose Irrigators		**49.91%**											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	23%	24%	22%	19%	23%	20%	24%	28%	26%	28%	27%	23%
1000	27%	30%	29%	25%	24%	25%	27%	27%	28%	27%	29%	28%
2000	22%	23%	23%	23%	21%	22%	22%	20%	20%	19%	21%	23%
3000	14%	12%	13%	15%	13%	14%	13%	11%	12%	11%	11%	13%
4000	7%	6%	6%	8%	7%	8%	7%	6%	6%	6%	5%	6%
5000	3%	3%	3%	4%	4%	4%	3%	3%	3%	3%	2%	3%
6000	1%	1%	1%	2%	2%	2%	2%	2%	1%	2%	1%	1%
7000	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
8000	0%	0%	0%	1%	1%	1%	1%	1%	0%	0%	0%	0%
9000	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
10000	2%	1%	2%	2%	3%	2%	2%	2%	2%	2%	2%	2%
In-Ground Irrigators		**50.09%**											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	6%	8%	7%	4%	8%	4%	5%	9%	10%	9%	8%	6%
1000	10%	13%	11%	7%	7%	6%	9%	10%	10%	11%	10%	10%
2000	13%	16%	13%	10%	9%	9%	12%	12%	11%	12%	13%	14%
3000	14%	14%	13%	12%	11%	10%	12%	12%	11%	11%	12%	13%
4000	12%	11%	11%	11%	9%	10%	11%	10%	10%	9%	10%	11%
5000	9%	8%	9%	9%	8%	8%	9%	8%	8%	7%	8%	8%
6000	7%	6%	6%	7%	7%	7%	7%	6%	6%	6%	6%	6%
7000	5%	4%	5%	6%	5%	6%	5%	5%	5%	5%	5%	5%
8000	4%	3%	4%	5%	4%	5%	4%	4%	4%	4%	4%	4%
9000	3%	3%	3%	4%	3%	4%	4%	3%	3%	3%	3%	3%
10000	2%	2%	2%	3%	3%	4%	3%	3%	3%	3%	3%	2%
11000	2%	2%	2%	3%	2%	3%	3%	2%	2%	2%	2%	2%
12000	2%	1%	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%
13000	2%	1%	1%	2%	2%	3%	2%	2%	2%	2%	2%	2%
14000	1%	1%	1%	2%	2%	2%	2%	1%	1%	1%	2%	1%
15000	1%	1%	1%	2%	2%	2%	1%	1%	1%	1%	1%	1%
16000	1%	1%	1%	1%	1%	2%	1%	1%	1%	1%	1%	1%
17000	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
18000	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
19000	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
20000	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
21000	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
22000	0%	0%	0%	1%	1%	1%	0%	0%	1%	1%	1%	1%
23000	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	1%	0%
24000	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%
25000	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
26000	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
27000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
28000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
29000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30000	1%	1%	1%	2%	5%	3%	2%	2%	3%	3%	2%	2%

Table A- 5. Single Family Outdoor Load Profiles – Dry Climatic Conditions

Hose Irrigators		**49.91%**										
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	42%	32%	29%	29%	30%	22%	21%	33%	34%	28%	24%	28%
1000	14%	27%	19%	19%	19%	23%	15%	23%	24%	27%	19%	29%
2000	14%	17%	18%	17%	16%	20%	15%	19%	18%	20%	17%	23%
3000	11%	10%	13%	12%	11%	14%	12%	11%	11%	12%	11%	12%
4000	7%	7%	8%	8%	8%	9%	10%	7%	6%	6%	7%	5%
5000	4%	4%	4%	5%	5%	5%	7%	3%	3%	3%	5%	2%
6000	2%	2%	3%	3%	3%	4%	5%	2%	2%	2%	4%	1%
7000	2%	1%	1%	2%	3%	2%	4%	1%	1%	1%	3%	0%
8000	1%	0%	1%	1%	2%	1%	3%	0%	1%	1%	2%	0%
9000	1%	0%	1%	1%	1%	1%	2%	0%	0%	0%	1%	0%
10000	3%	0%	3%	2%	2%	0%	8%	0%	1%	1%	7%	0%
In-Ground Irrigators		**50.09%**										
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	37%	17%	18%	14%	9%	10%	7%	22%	18%	11%	17%	18%
1000	7%	11%	8%	6%	5%	8%	4%	10%	10%	10%	9%	10%
2000	9%	11%	10%	8%	5%	9%	5%	11%	10%	11%	9%	13%
3000	9%	10%	10%	7%	5%	10%	6%	10%	9%	10%	8%	12%
4000	8%	9%	9%	7%	5%	9%	6%	9%	8%	8%	7%	10%
5000	6%	8%	8%	6%	4%	8%	6%	7%	6%	7%	5%	7%
6000	5%	7%	6%	5%	4%	7%	4%	6%	5%	5%	4%	5%
7000	3%	5%	5%	4%	4%	6%	4%	5%	4%	4%	4%	4%
8000	3%	4%	4%	4%	4%	5%	3%	3%	4%	4%	3%	3%
9000	2%	4%	3%	3%	4%	4%	3%	3%	3%	3%	3%	3%
10000	2%	3%	3%	3%	4%	4%	3%	2%	3%	3%	2%	2%
11000	1%	2%	2%	3%	3%	3%	2%	2%	2%	2%	2%	2%
12000	1%	2%	2%	2%	3%	3%	2%	2%	2%	2%	2%	1%
13000	1%	1%	2%	2%	3%	2%	2%	1%	2%	2%	2%	1%
14000	1%	1%	1%	2%	3%	2%	2%	1%	1%	2%	2%	1%
15000	1%	1%	1%	2%	2%	1%	1%	1%	1%	1%	2%	1%
16000	1%	1%	1%	2%	3%	1%	3%	1%	1%	1%	1%	1%
17000	0%	1%	1%	2%	2%	1%	2%	1%	1%	1%	1%	1%
18000	0%	0%	1%	1%	2%	1%	2%	0%	1%	1%	1%	1%
19000	0%	0%	1%	1%	2%	1%	2%	0%	1%	1%	1%	0%
20000	0%	0%	0%	1%	2%	1%	2%	0%	1%	1%	1%	0%
21000	0%	0%	0%	1%	2%	1%	2%	0%	1%	1%	1%	0%
22000	0%	0%	0%	1%	2%	1%	2%	0%	1%	1%	1%	0%
23000	0%	0%	0%	1%	1%	0%	2%	0%	0%	1%	1%	0%
24000	0%	0%	0%	1%	1%	0%	2%	0%	0%	0%	1%	0%
25000	0%	0%	0%	1%	1%	0%	2%	0%	0%	0%	1%	0%
26000	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	1%	0%
27000	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	1%	0%
28000	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	0%	0%
29000	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%
30000	1%	1%	2%	6%	10%	2%	15%	1%	4%	4%	7%	1%

Table A- 6. Florida File Geodatabase Breakout

District	Count	District	Count
SFWMD	1,047,217	**SRWMD**	205,567
Charlotte (Partial)	1,671	Alachua (Partial)	36,353
Glades	11,256	Baker (Partial)	356
Highlands (Partial)	11,763	Bradford (Partial)	13,656
Indian River (Partial)	2	Clay (Partial)	5
Martin	77,420	Columbia	35,965
Okeechobee (Partial)	31,233	Dixie	16,159
Orange (Partial)	135,221	Gilchrist	13,329
Osceola (Partial)	126,885	Hamilton	12,643
Palm Beach	431,111	Lafayette	6,695
Polk (Partial)	58,521	Levy (Partial)	18,871
St. Lucie	162,134	Madison	15,576
SJRWMD	2,264,355	Putnam (Partial)	82
Region 1	841,021	Suwannee	29,880
Alachua (Partial)	64,059	Union	5,997
Baker (Partial)	11,551	**SWFWMD**	2,643,932
Bradford (Partial)	1,160	***Tampa Bay Region***	1,149,051
Clay (Partial)	87,175	Hillsborough	466,402
Duval	355,923	Pasco	249,731
Flagler (Partial)	77,423	Pinellas	432,918
Nassau	43,955	***Other Regions***	1,494,881
Putnam (Partial)	98,828	Charlotte (Partial)	211,448
St. Johns	100,947	Citrus	146,224
Region 2	526,162	DeSoto	19,765
Flagler (Partial)	12	Hardee	14,182
Lake (Partial)	112,377	Hernando	115,659
Marion (Partial)	155,152	Highlands (Partial)	101,861
Seminole (Partial)	10	Lake (Partial)	3,733
Sumter (Partial)	19	Levy (Partial)	28,270
Volusia	258,592	Manatee	166,659
Region 3	531,404	Marion (Partial)	111,441
Lake (Partial)	53,157	Polk (Partial)	294,626
Orange (Partial)	303,869	Sarasota	216,851
Osceola (Partial)	2,898	Sumter (Partial)	64,162
Seminole (Partial)	171,480	**FL Total**	**6,161,071**
Region 4	365,768		
Brevard	288,164		
Indian River (Partial)	76,312		
Okeechobee (Partial)	1,292		

Table A- 7. Georgia File Geodatabase Breakout

Region	Count
Coastal Georgia	60,689
Camden	60,689
Suwannee-Satilla	375,465
Charlton	63,634
Clinch	80,027
Echols	46,767
Lanier	22,386
Lowndes	84,673
Ware	77,978
GA Total	**436,154**

Table A- 8. Florida Estimated Water Consumption by County, MGD

County	Indoor	Outdoor		Total	
		Wet December	Dry July	Min	Max
Alachua	17.2	6.4	17.2	23.7	34.5
Baker	9.0	0.7	1.7	9.6	10.7
Bradford	1.7	0.8	2.3	2.5	4.0
Brevard	37.8	19.9	53.3	57.7	91.1
Charlotte	14.0	7.5	20.1	21.5	34.1
Citrus	10.5	7.1	19.1	17.6	29.6
Clay	11.2	6.7	18.0	17.9	29.2
Columbia	4.6	2.0	5.5	6.7	10.1
DeSoto	2.1	0.9	2.3	2.9	4.3
Dixie	1.1	0.7	1.8	1.7	2.9
Duval	76.0	27.1	72.5	103.1	148.5
Flagler	6.7	4.1	11.0	10.8	17.7
Gilchrist	0.9	0.5	1.4	1.4	2.3
Glades	0.9	0.4	1.1	1.3	2.0
Hamilton	1.5	0.3	0.9	1.9	2.5
Hardee	1.5	0.6	1.6	2.1	3.0
Hernando	11.8	7.6	20.4	19.5	32.2
Highlands	9.0	3.9	10.5	12.9	19.5
Hillsborough	186.6	34.1	91.3	220.7	277.9
Indian River	10.3	5.1	13.7	15.4	24.0
Lafayette	0.3	0.2	0.5	0.5	0.8
Lake	20.8	11.6	31.1	32.4	51.9
Levy	2.9	1.7	4.6	4.6	7.5
Madison	1.2	0.5	1.3	1.7	2.5
Manatee	23.8	10.2	27.4	34.0	51.1
Marion	23.6	13.1	34.9	36.7	58.6
Martin	9.2	5.1	13.6	14.3	22.8
Nassau	5.3	2.7	7.3	8.1	12.6
Okeechobee	2.7	1.4	3.7	4.1	6.4
Orange	106.6	30.0	80.2	136.6	186.9
Osceola	19.1	9.1	24.5	28.2	43.5
Palm Beach	78.6	37.7	101.0	116.4	179.6
Pasco	31.7	18.2	48.7	49.9	80.4
Pinellas	74.9	27.5	73.5	102.4	148.4
Polk	40.2	19.4	52.0	59.7	92.2
Putnam	5.8	3.3	8.9	9.1	14.7
Sarasota	27.0	14.7	39.4	41.7	66.4
Seminole	29.5	12.7	34.1	42.2	63.5
St. Johns	12.9	6.8	18.2	19.7	31.1
St. Lucie	18.7	10.3	27.5	29.0	46.2
Sumter	6.9	4.8	12.7	11.6	19.6
Suwannee	1.9	1.2	3.2	3.1	5.2
Union	0.5	0.2	0.6	0.7	1.1
Volusia	37.6	17.9	48.0	55.5	85.6
Total	**996.3**	**397.0**	**1,062.5**	**1,393.3**	**2,058.7**

Table A- 9. Georgia Estimated Water Consumption by County, MGD

County	Indoor	Outdoor		Total	
		Wet December	Dry July	Min	Max
Camden	1.9	1.4	3.9	3.4	5.8
Charlton	1.4	1.2	3.3	2.7	4.7
Clinch	2.5	2.2	5.9	4.7	8.4
Echols	0.9	0.8	2.1	1.6	2.9
Lanier	0.5	0.4	1.0	0.8	1.5
Lowndes	3.3	2.0	5.3	5.3	8.6
Ware	2.3	1.8	4.8	4.1	7.1
Total	**12.8**	**9.8**	**26.2**	**22.6**	**39.0**

Figure A- 8. Total Domestic Self Supply and Public Supply, Monthly Consumption, SWFWMD

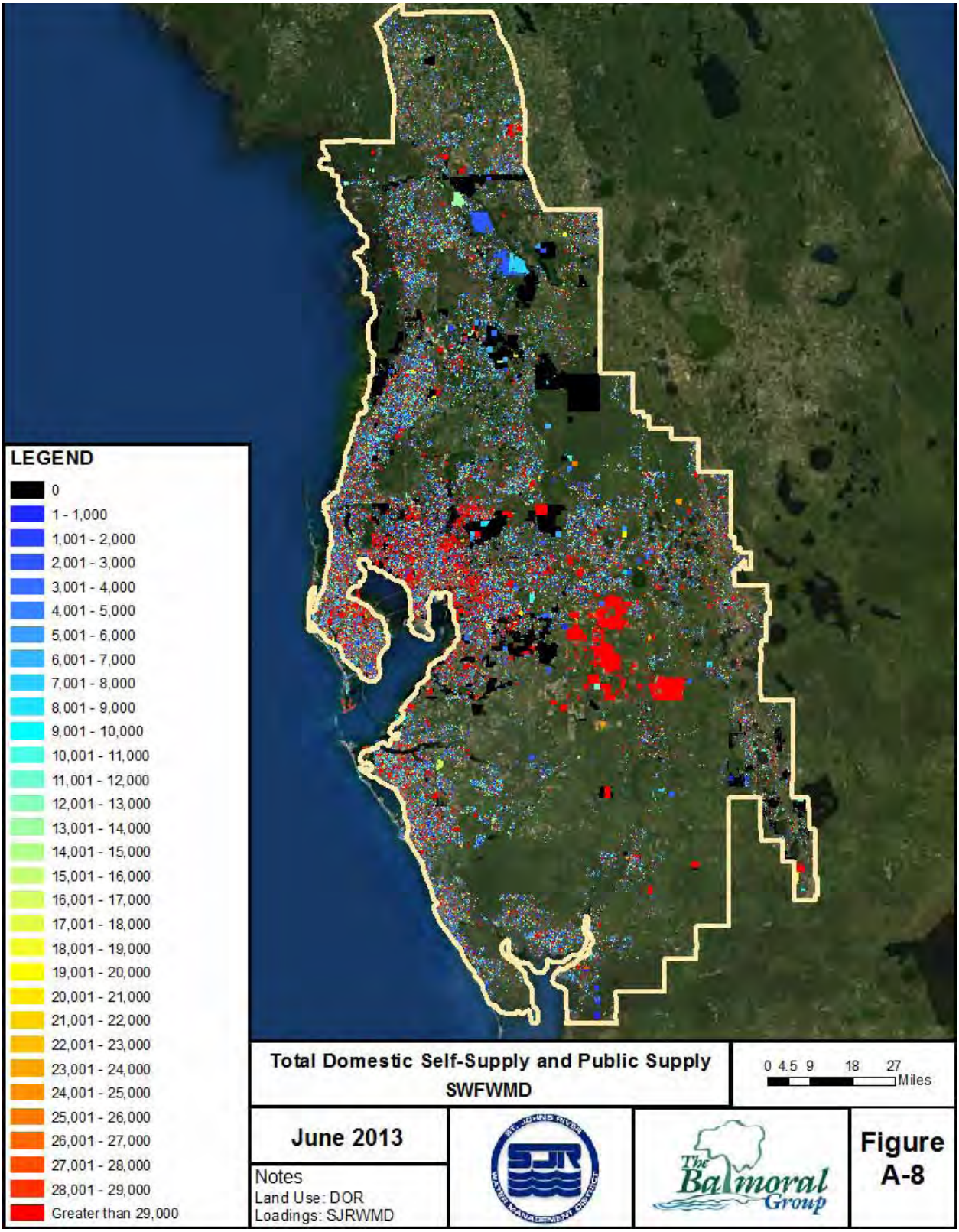
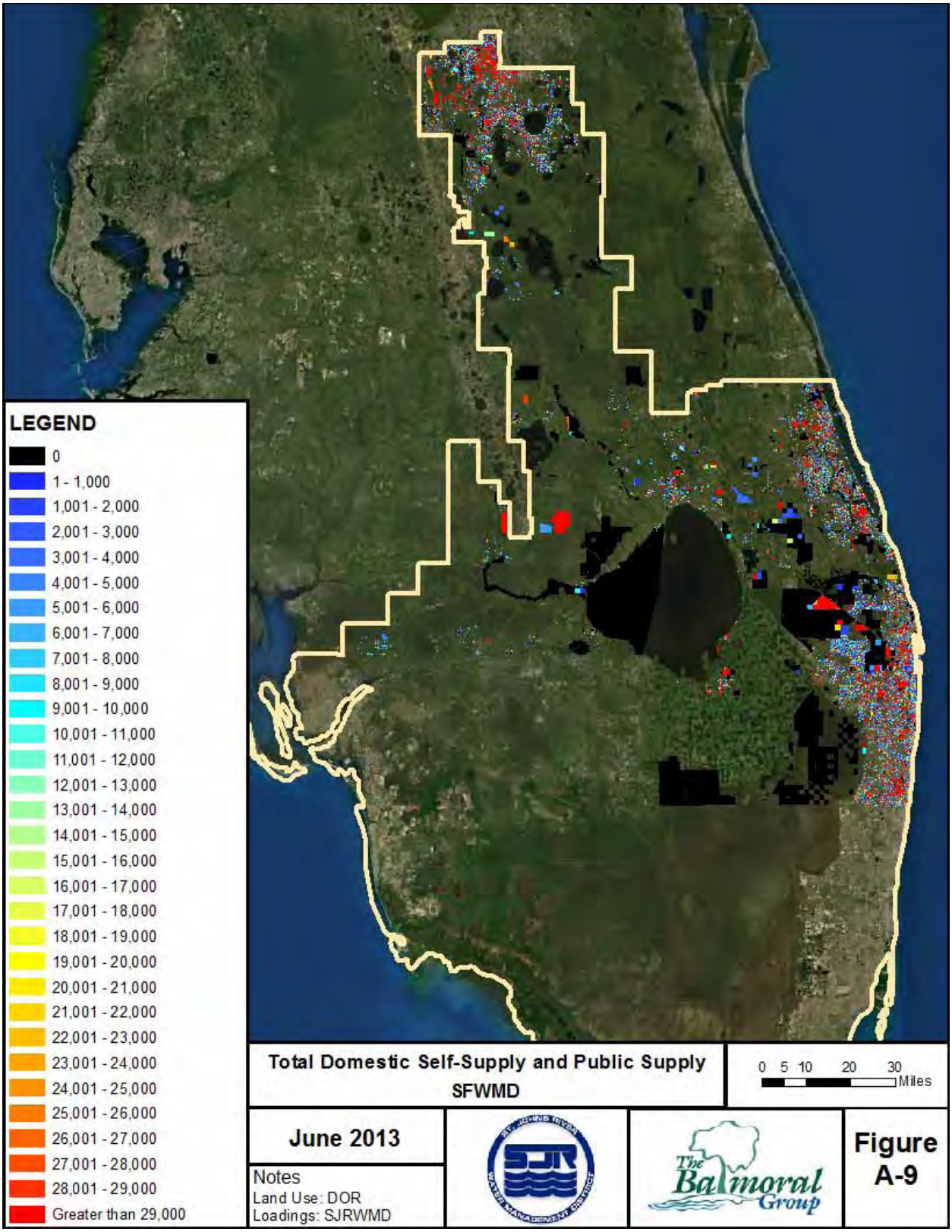
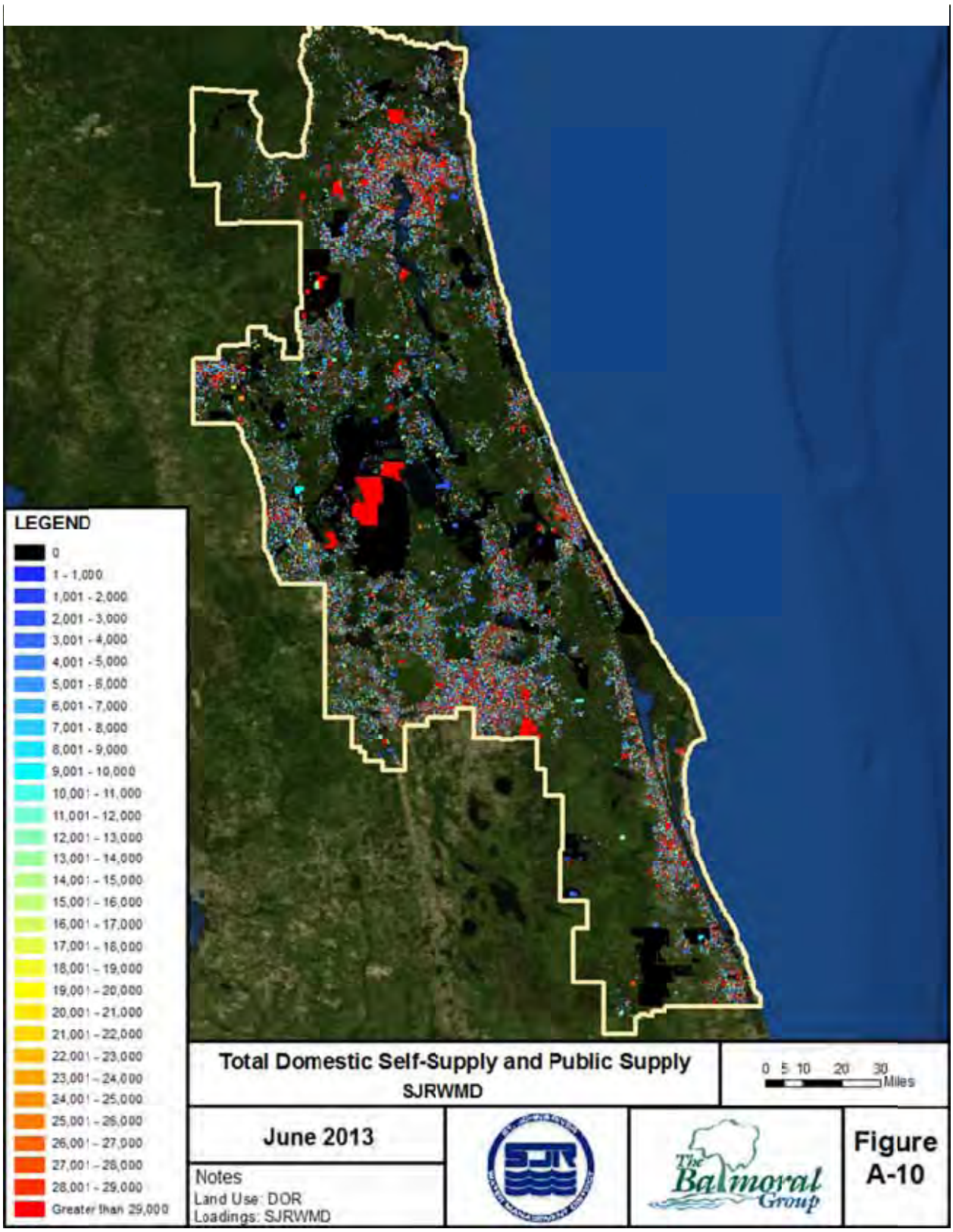


Figure A-9. Total Domestic Self Supply and Public Supply, Monthly Consumption, SFWMD




LEGEND
0
1 - 1,000
1,001 - 2,000
2,001 - 3,000
3,001 - 4,000
4,001 - 5,000
5,001 - 6,000
6,001 - 7,000
7,001 - 8,000
8,001 - 9,000
9,001 - 10,000
10,001 - 11,000
11,001 - 12,000
12,001 - 13,000
13,001 - 14,000
14,001 - 15,000
15,001 - 16,000
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17,001 - 18,000
18,001 - 19,000
19,001 - 20,000
20,001 - 21,000
21,001 - 22,000
22,001 - 23,000
23,001 - 24,000
24,001 - 25,000
25,001 - 26,000
26,001 - 27,000
27,001 - 28,000
28,001 - 29,000
Greater than 29,000
Total Domestic Self-Supply and Public Supply
SJRWMD
0 5 10 20 30
Miles
June 2013
Notes
Land Use: DOR
Loadings: SJRWMD
The Balmoral Group
Figure A-10

Figure A-11. Total Domestic Self Supply and Public Supply, Monthly Consumption, SRWMD

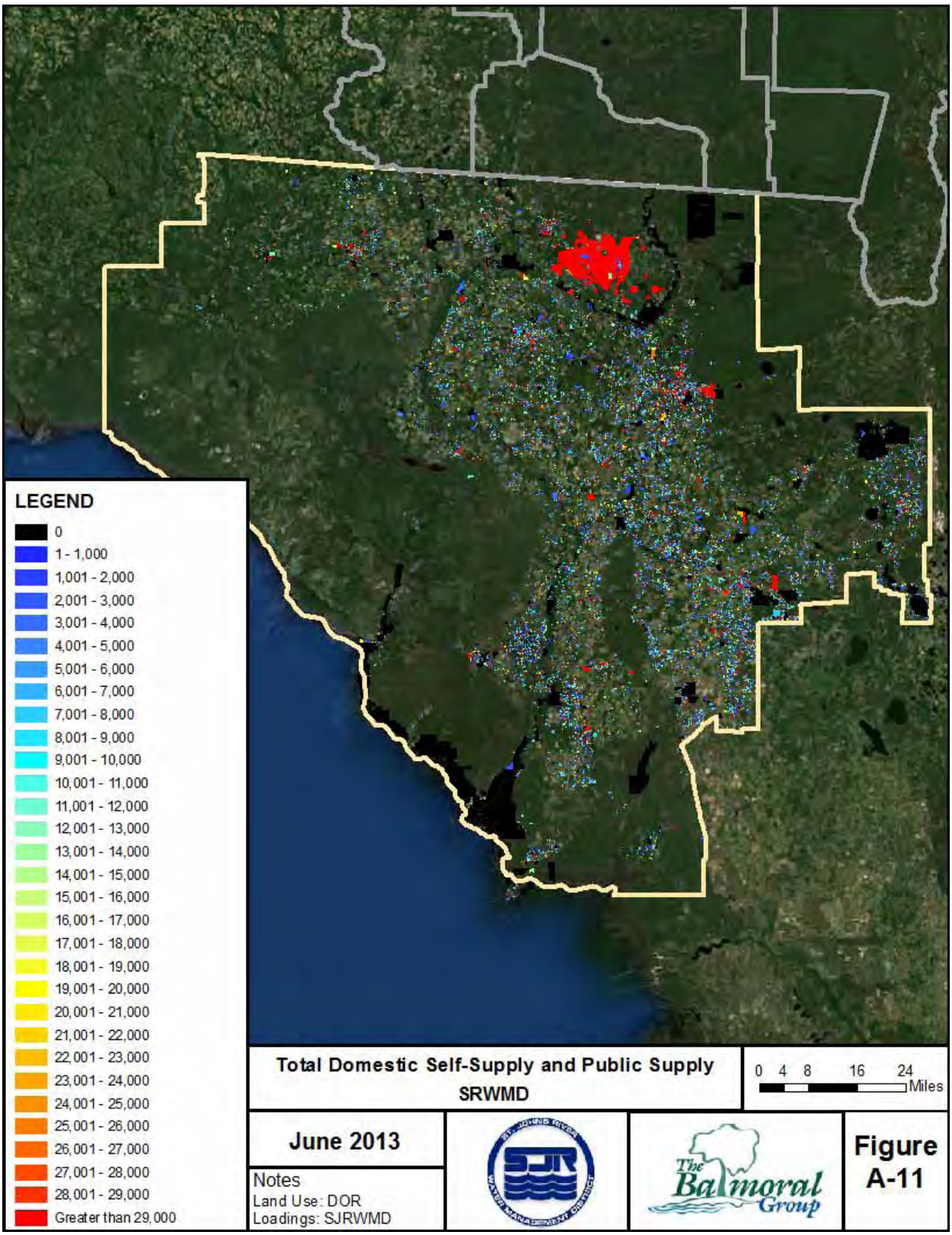


Figure A-12. Indoor Domestic Self Supply and Public Supply, Monthly Consumption, SWFWMD

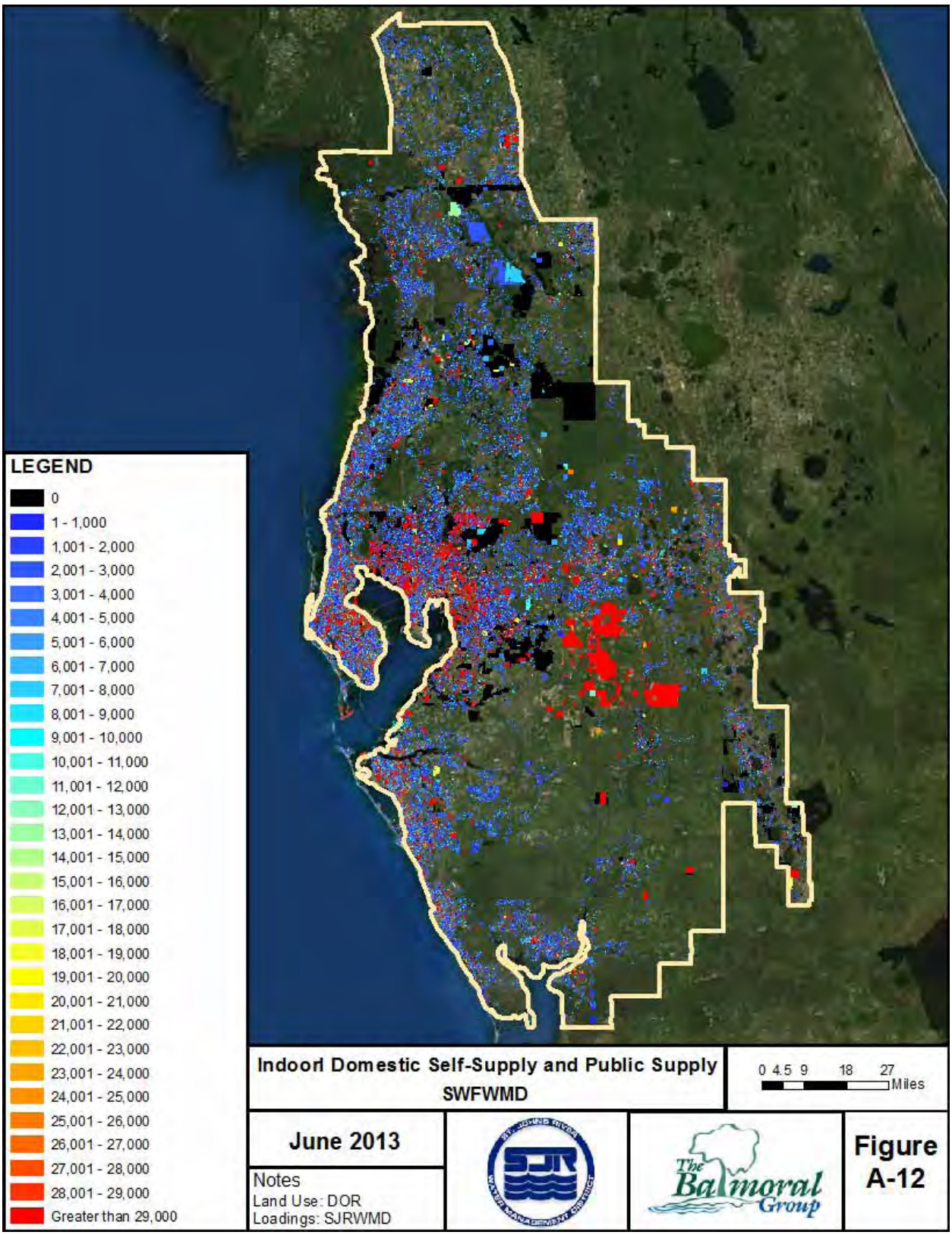


Figure A- 13. Indoor Domestic Self Supply and Public Supply, Monthly Consumption, SFWMD

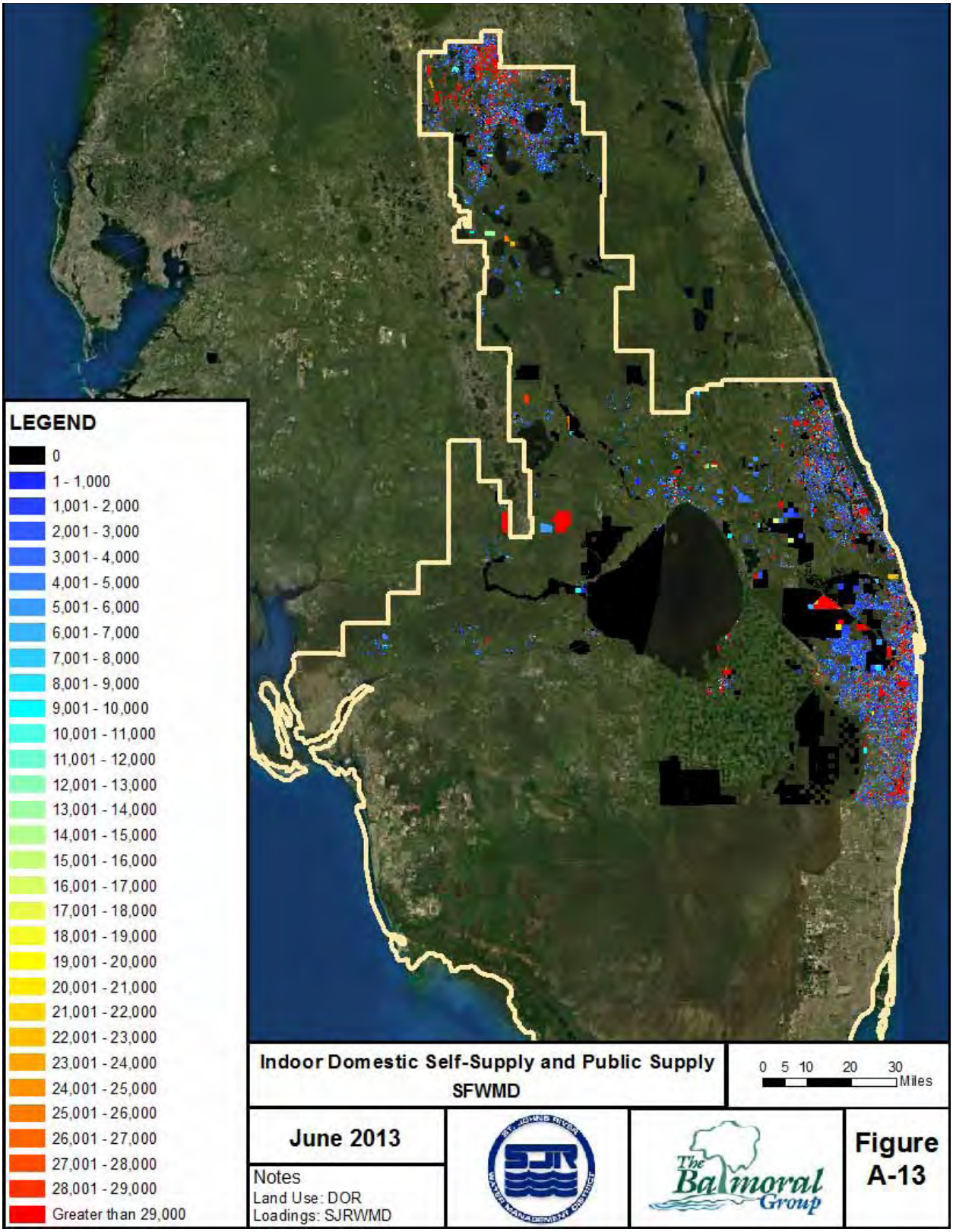


Figure A-14. Indoor Domestic Self Supply and Public Supply, Monthly Consumption, SJRWMD

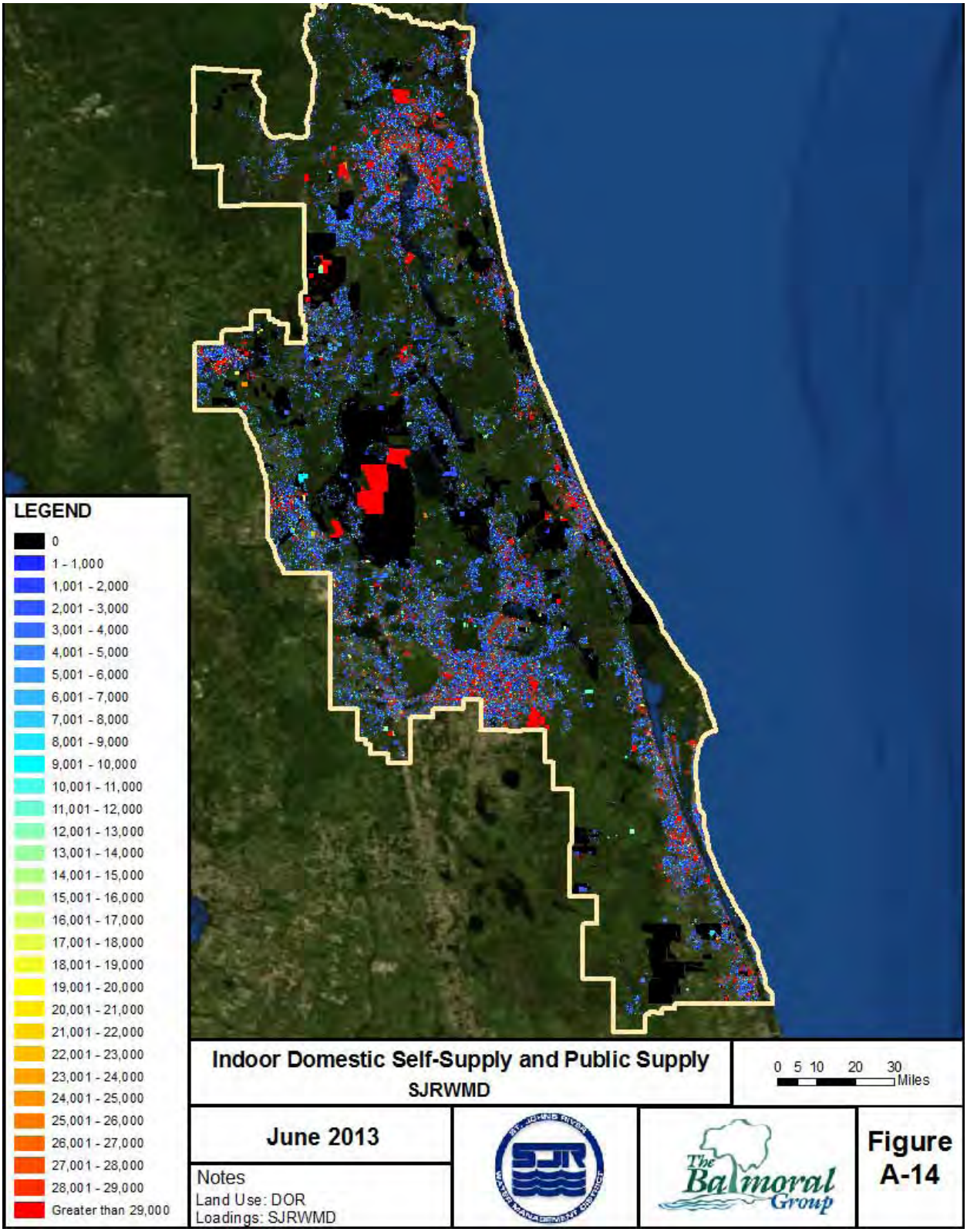


Figure A-15. Indoor Domestic Self Supply and Public Supply, Monthly Consumption, SRWMD

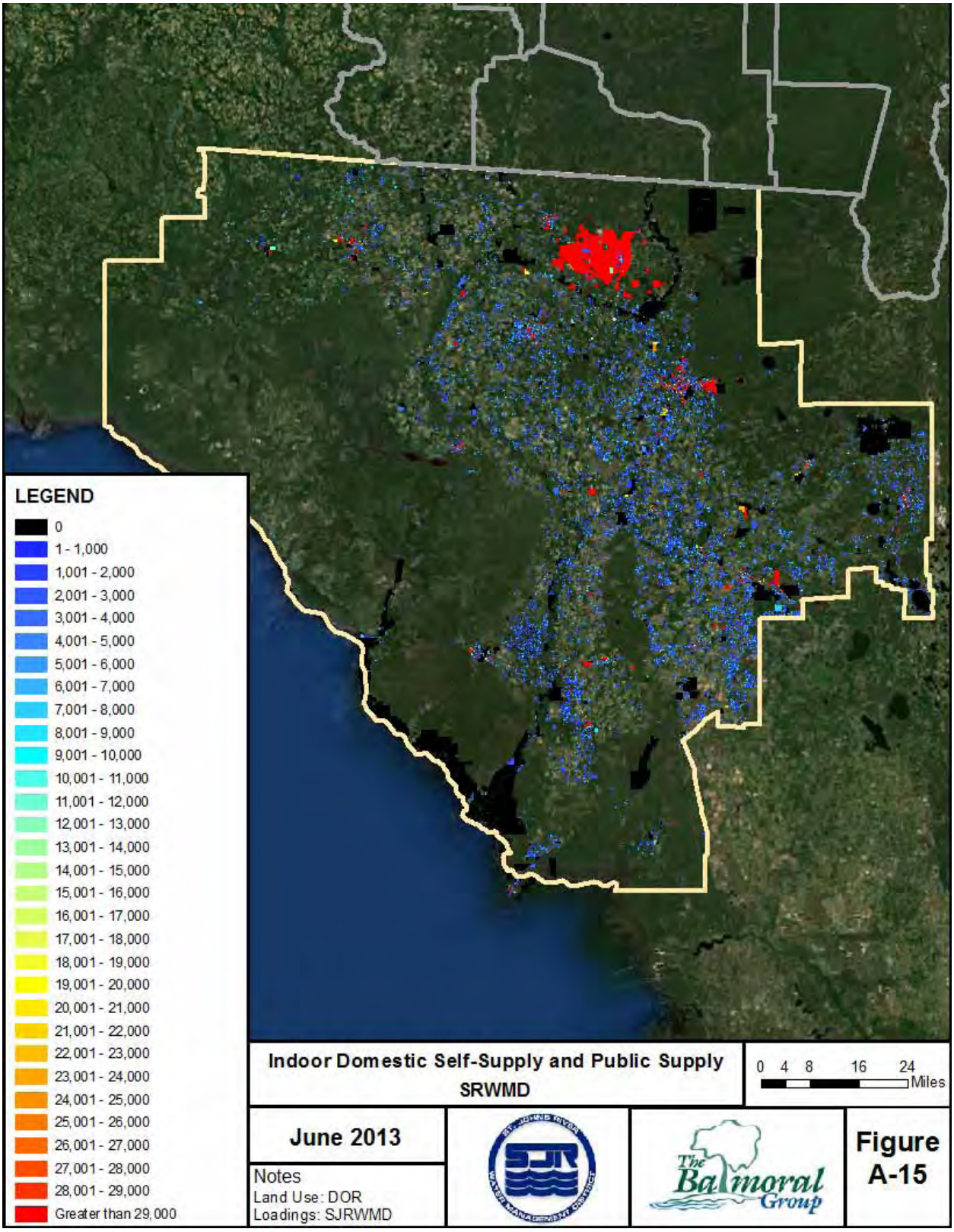


Figure A-16. Outdoor Domestic Self Supply and Public Supply, Monthly Consumption, SWFWMD

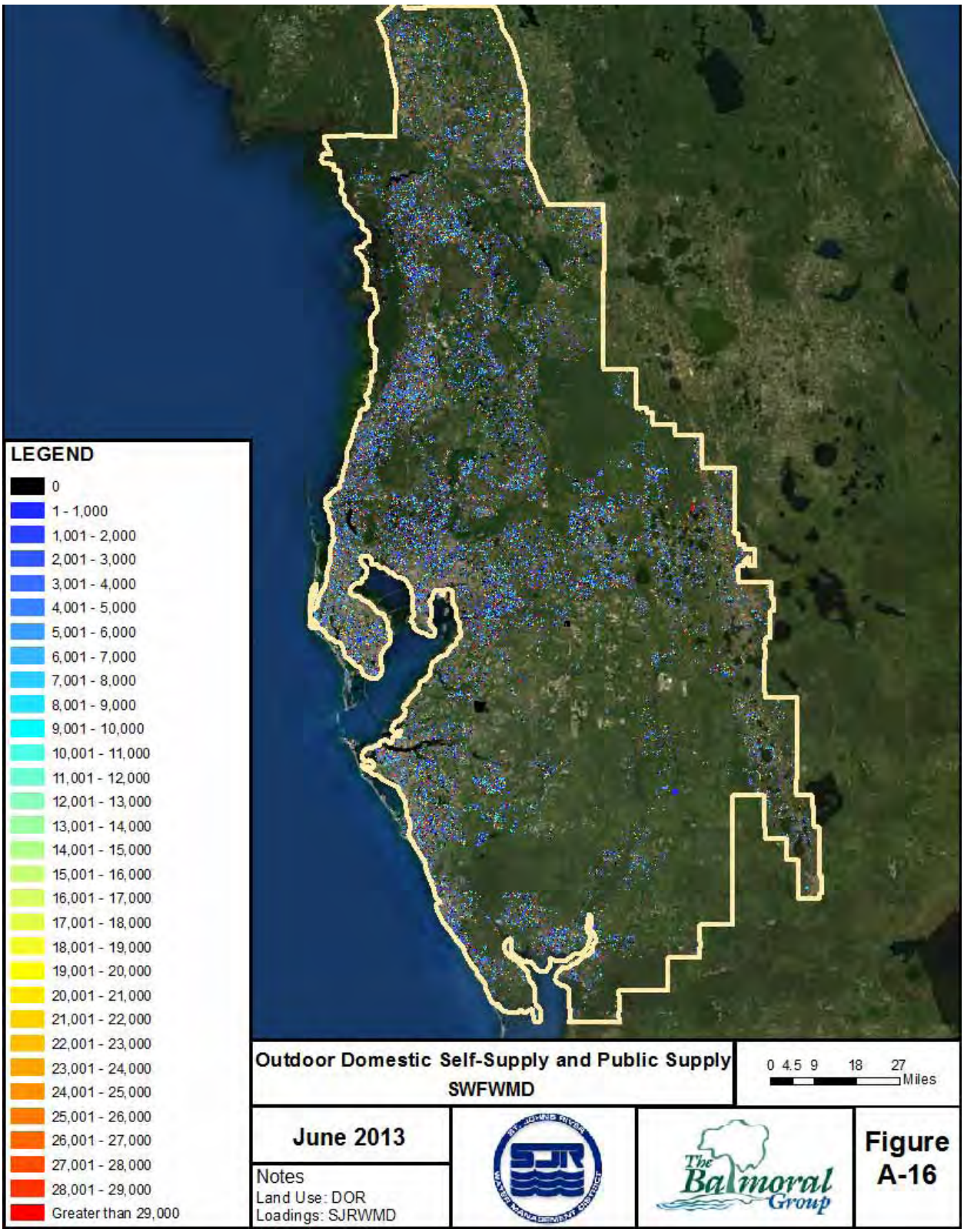


Figure A-17. Outdoor Domestic Self Supply and Public Supply, Monthly Consumption, SFWMD

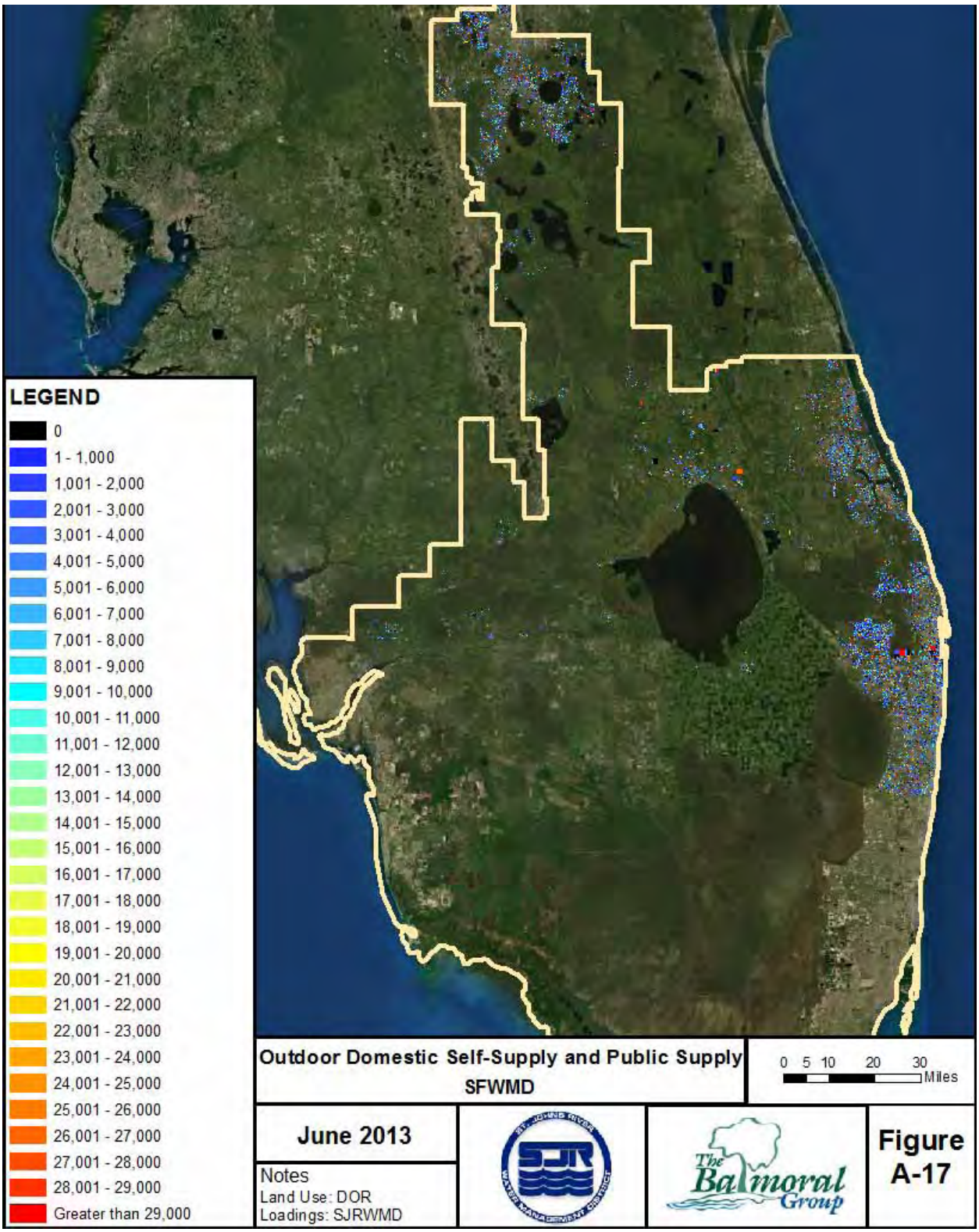


Figure A-18. Outdoor Domestic Self Supply and Public Supply, Monthly Consumption, SJRWMD

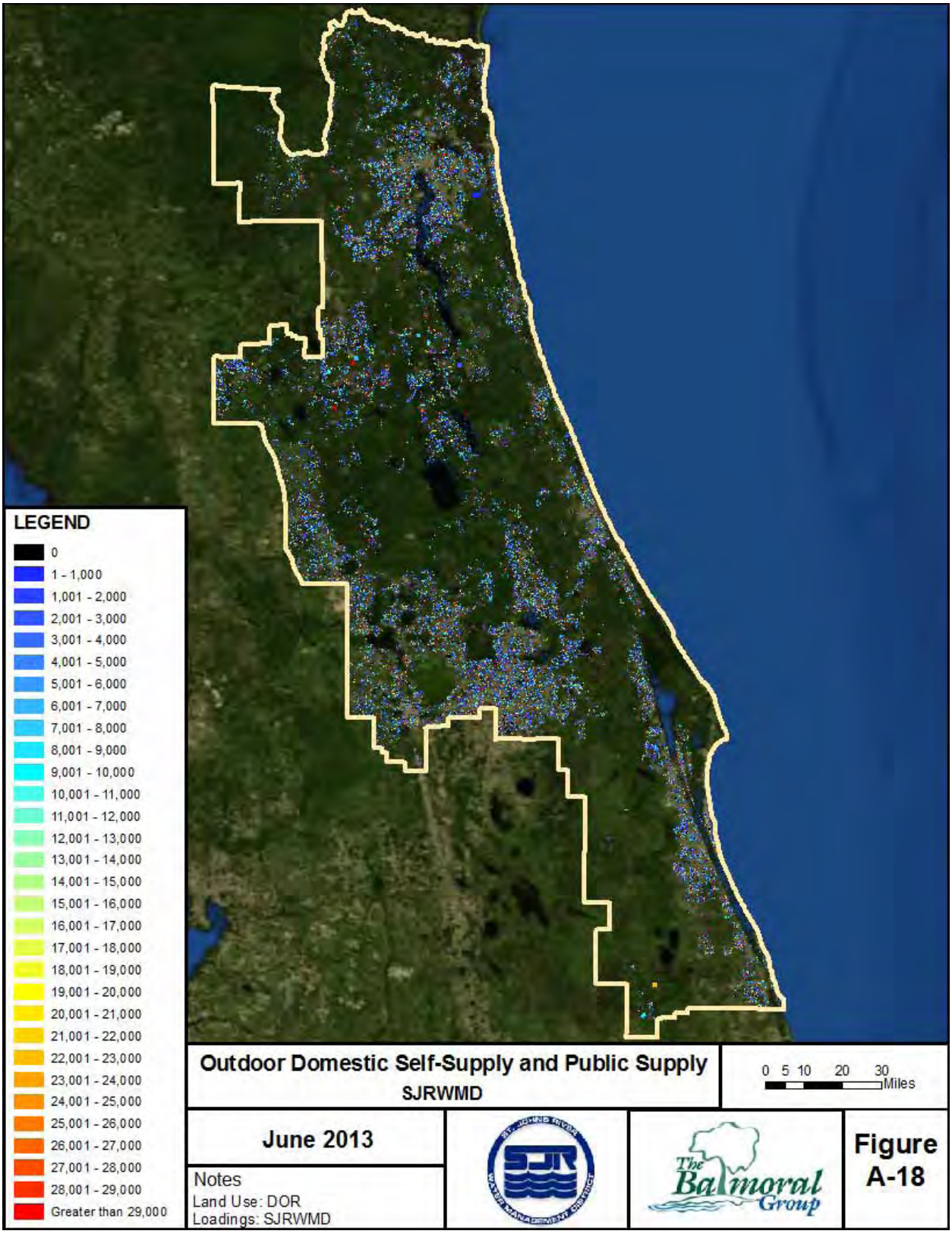


Figure A-19. Outdoor Domestic Self Supply and Public Supply, Monthly Consumption, SRWMD

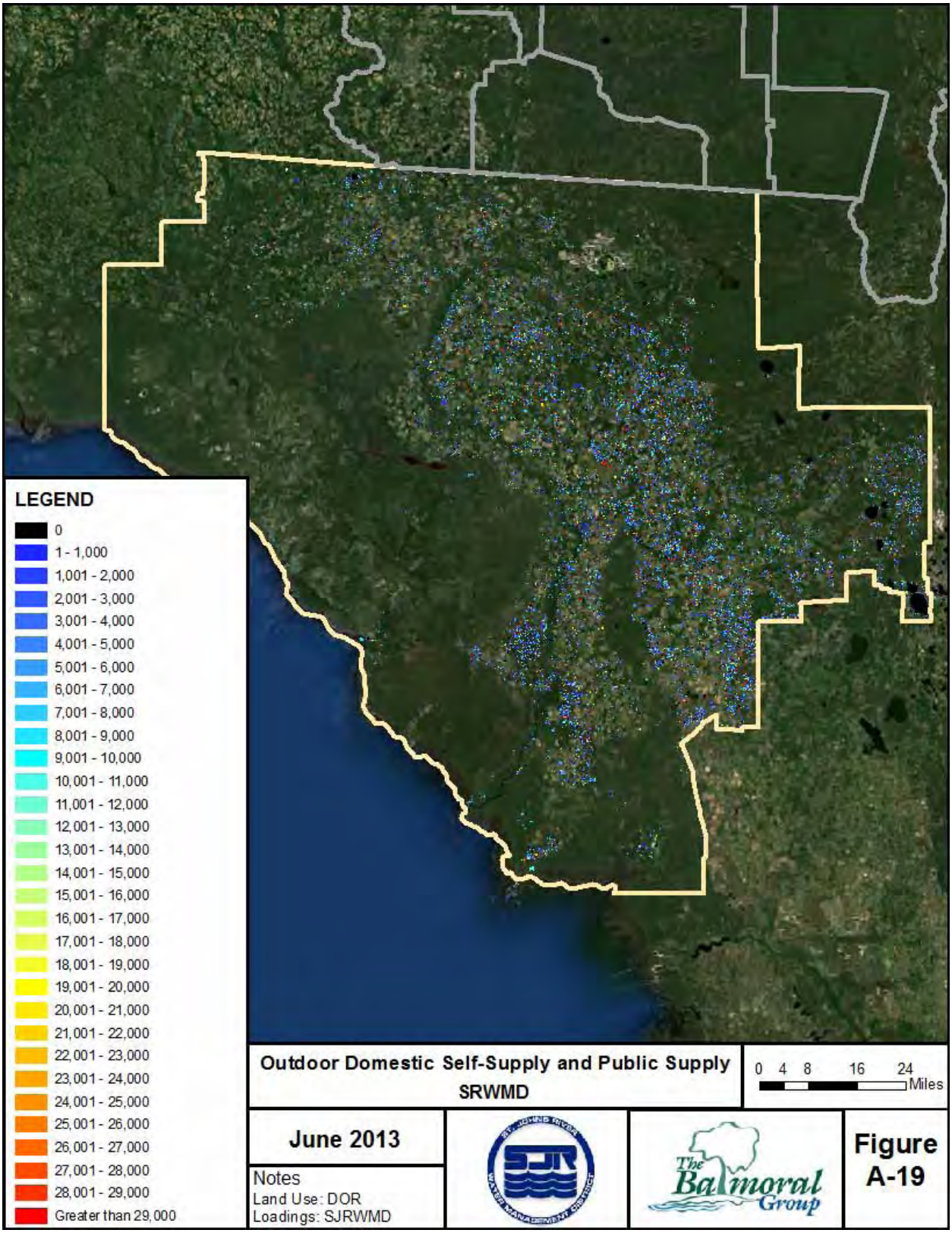


Figure A-20. Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Orange County, Florida

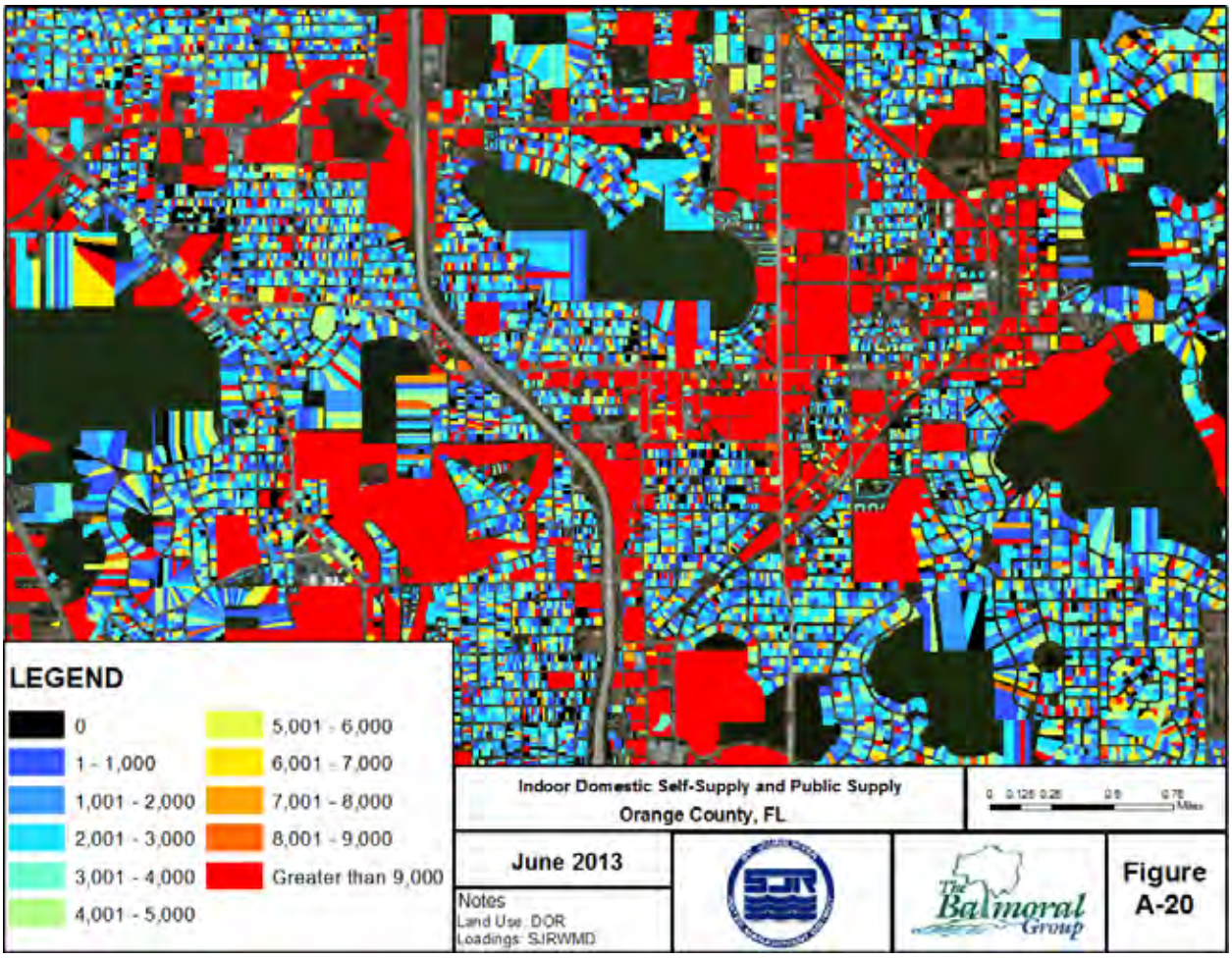


Figure A-21. Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Camden County, GA

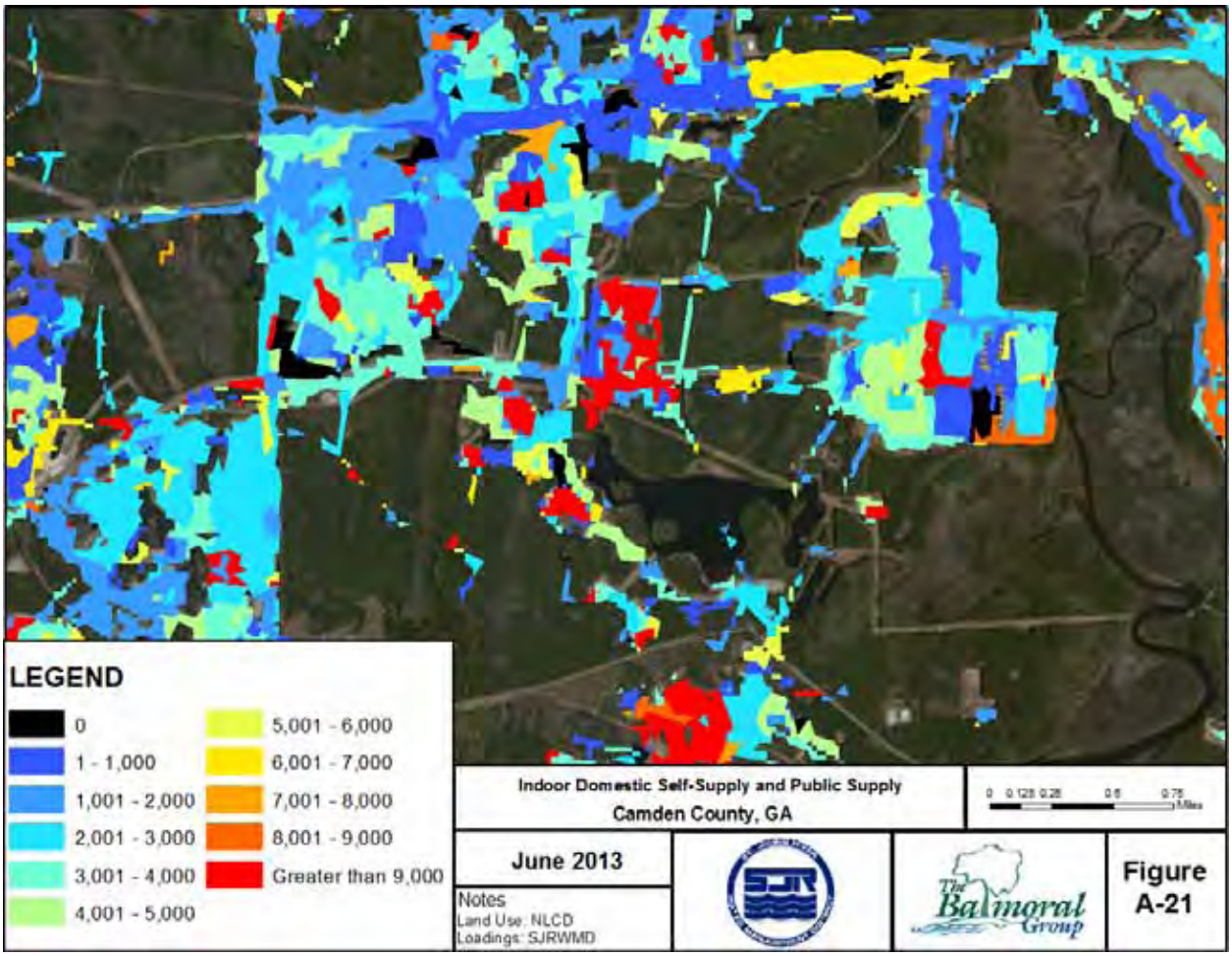


Figure A-22. Single Family Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Orange County, FL

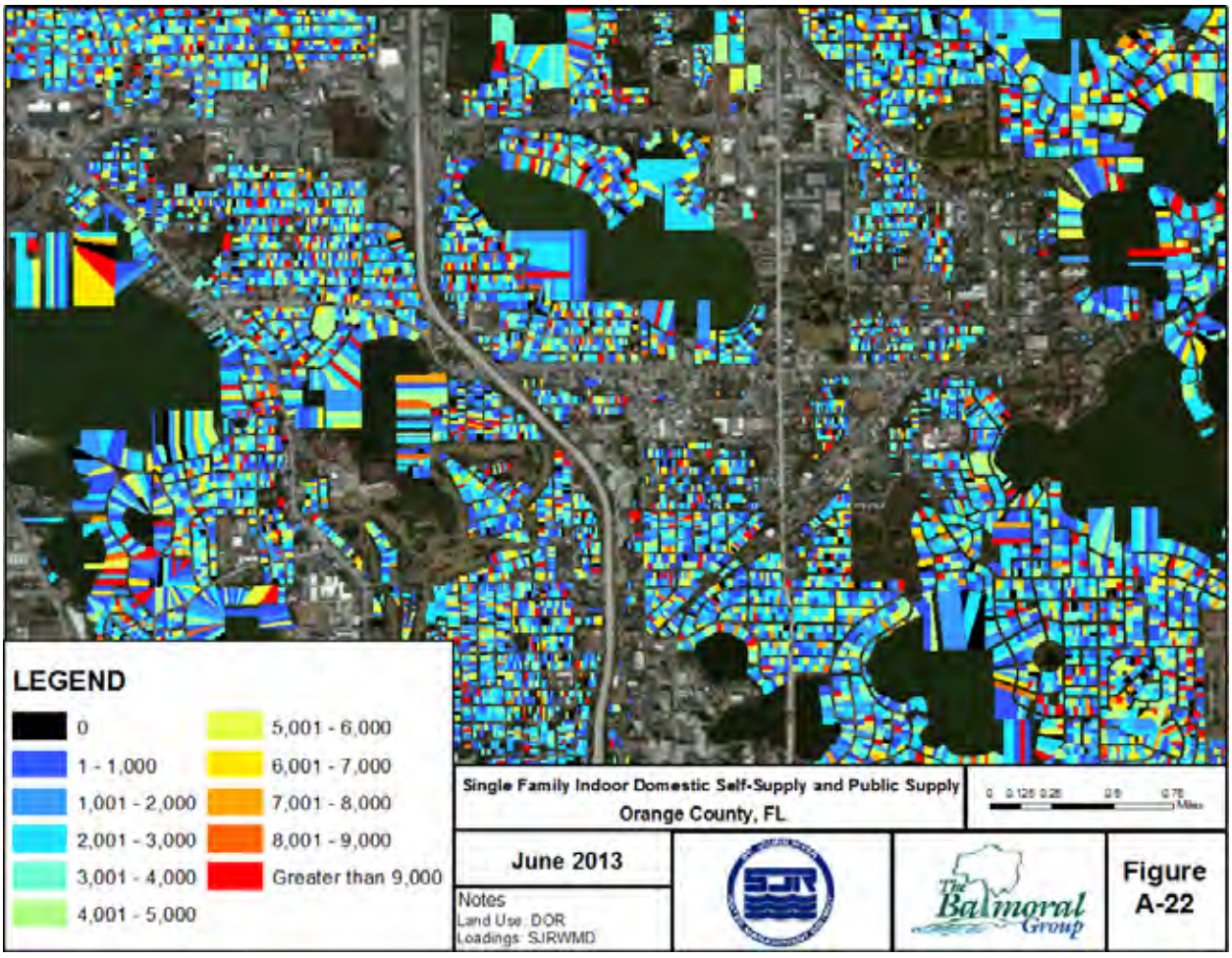


Figure A-23. Single Family Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Camden County, GA

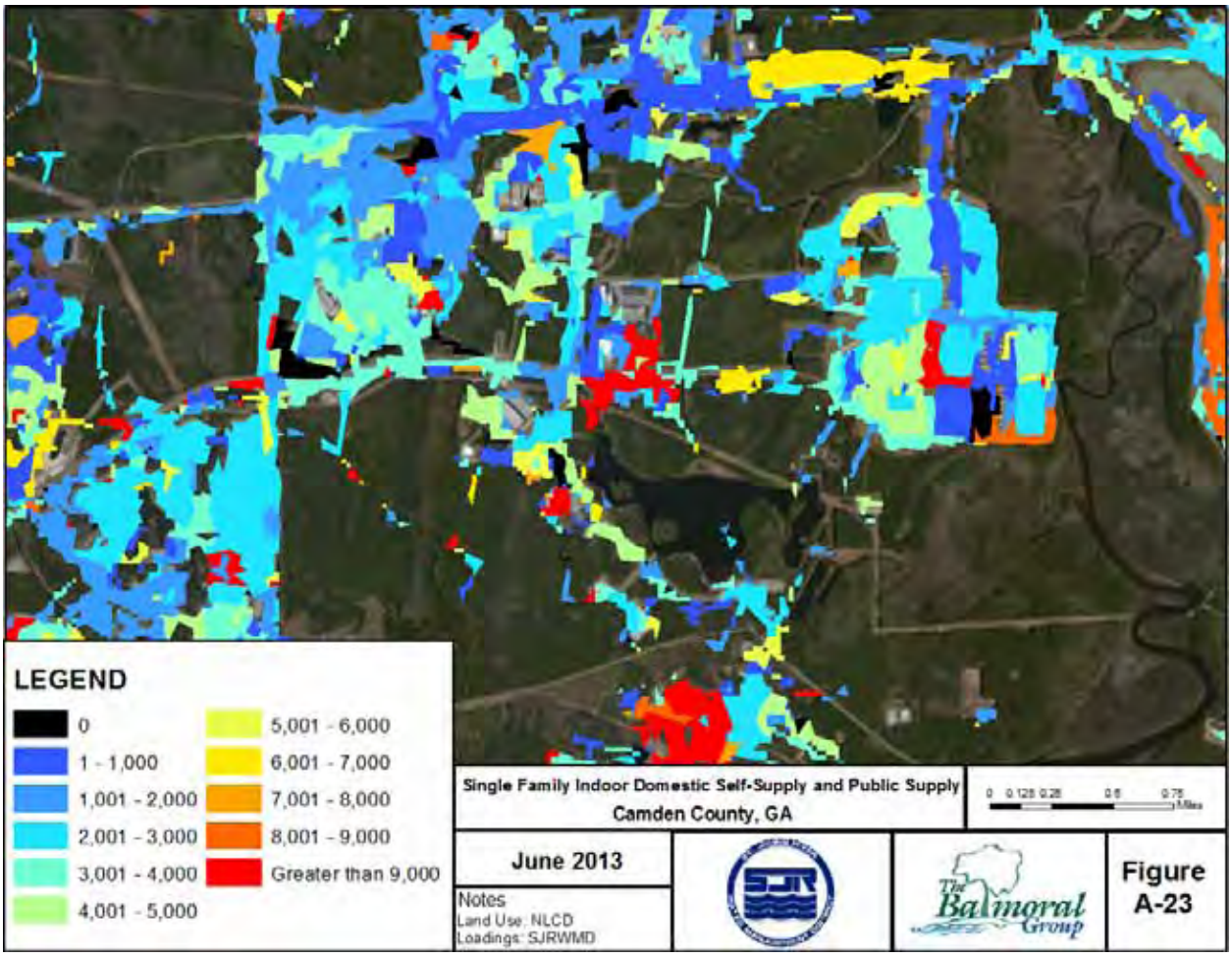


Figure A-24. Single Family Outdoor Domestic Self Supply and Public Supply, Monthly Consumption, Orange County, FL

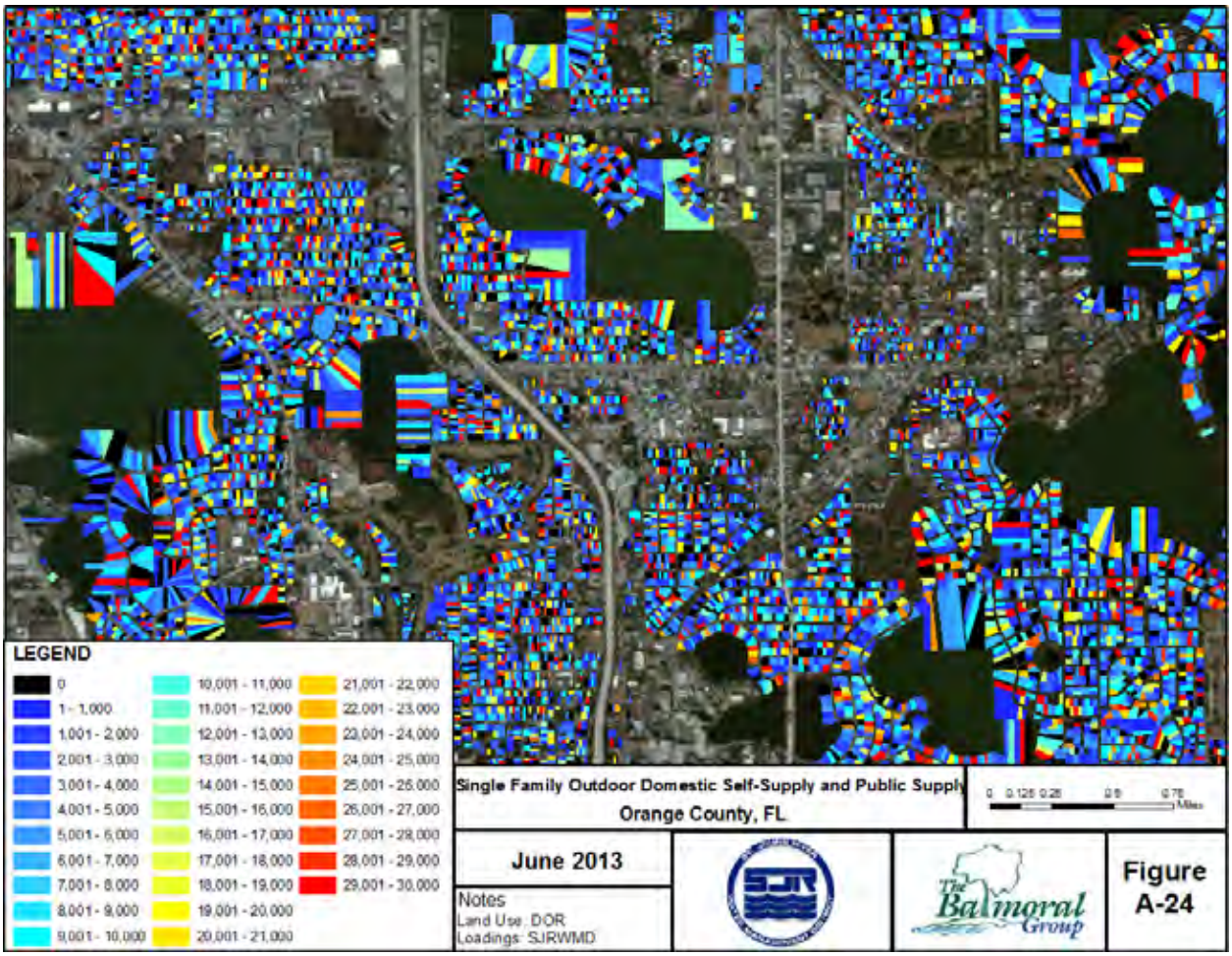


Figure A-25. Single Family Outdoor Domestic Self Supply and Public Supply, Monthly Consumption, Camden County, GA

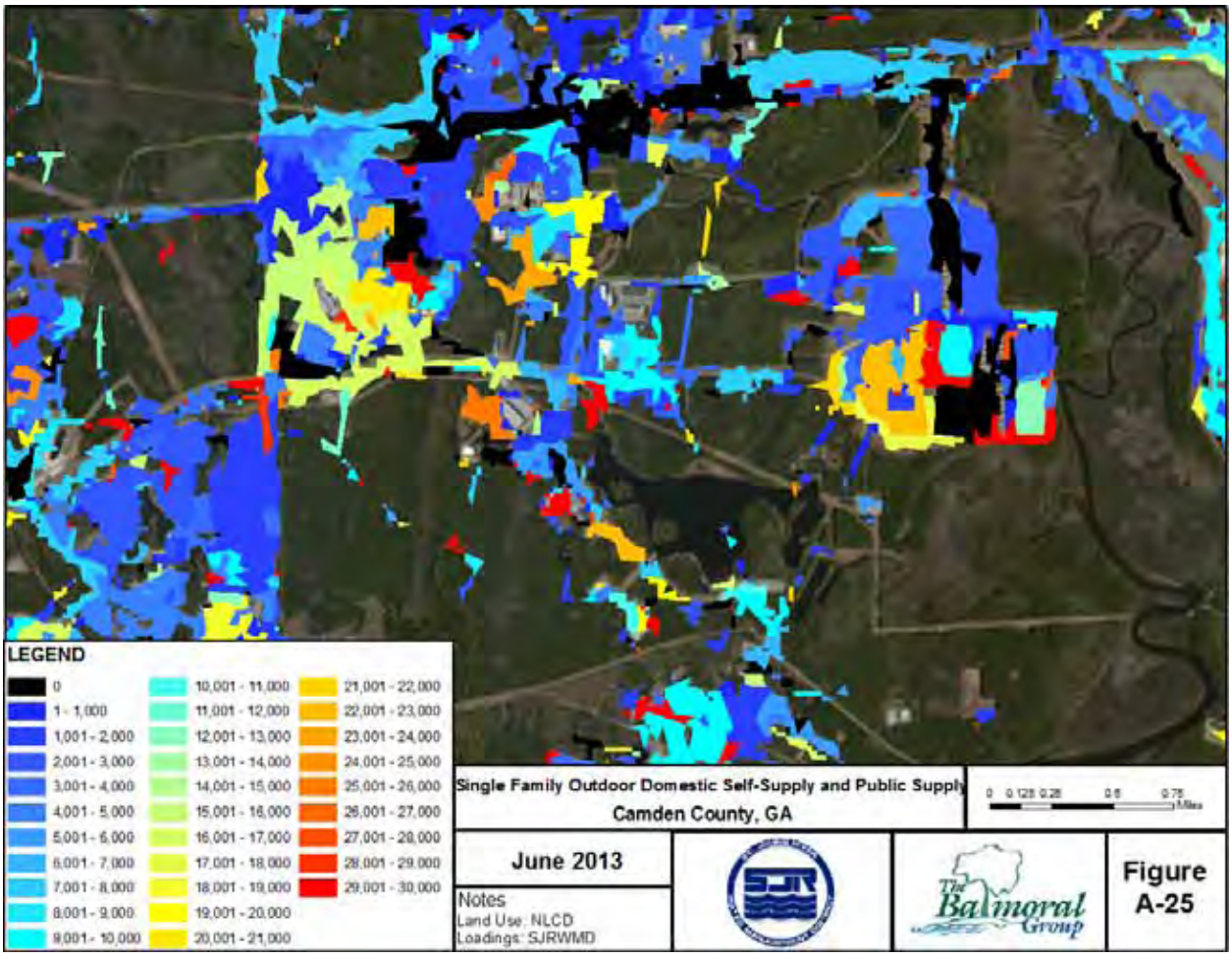


Figure A-26. Multi Family Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Orange County, FL

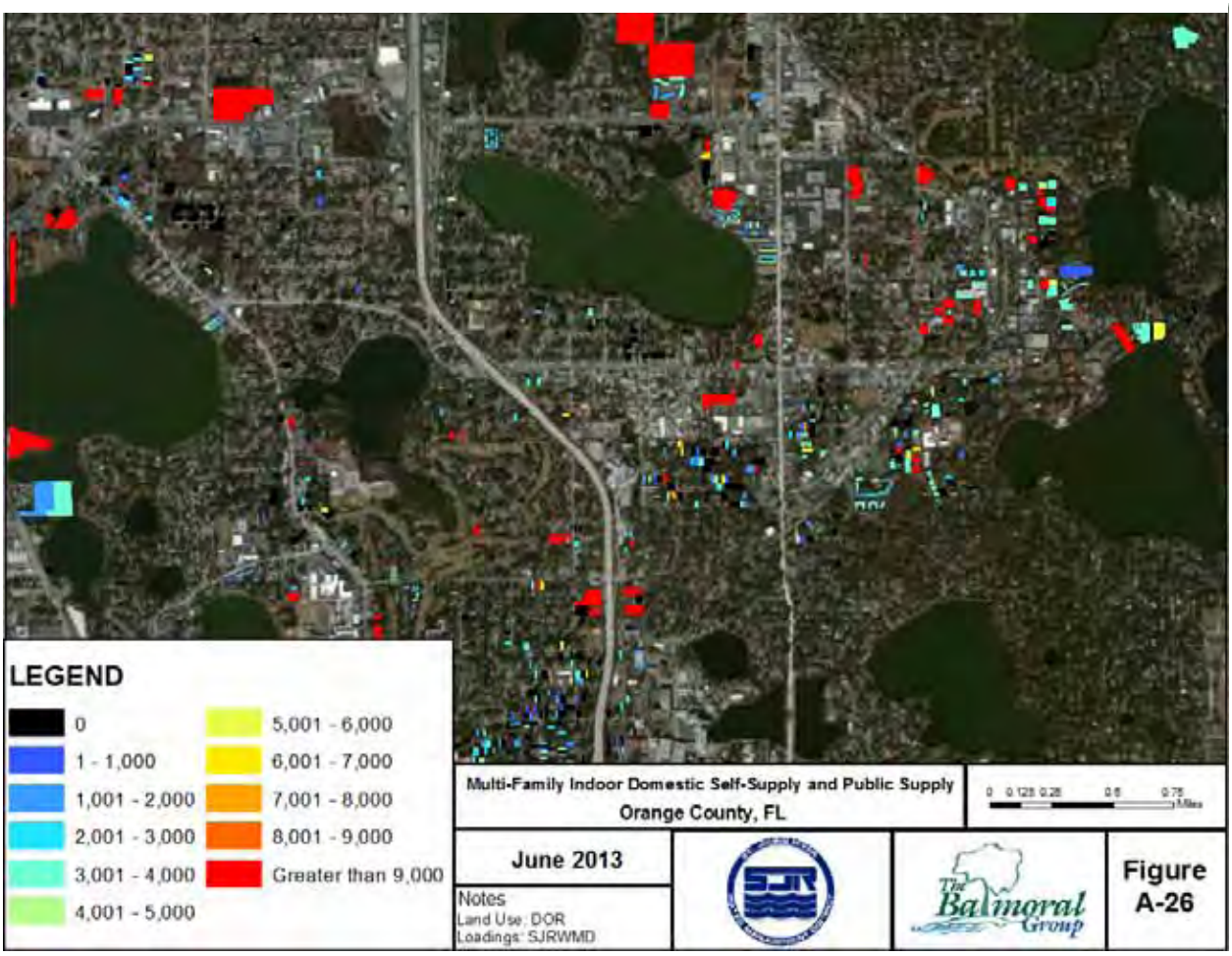


Figure A-27. Multi Family Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Camden County, GA

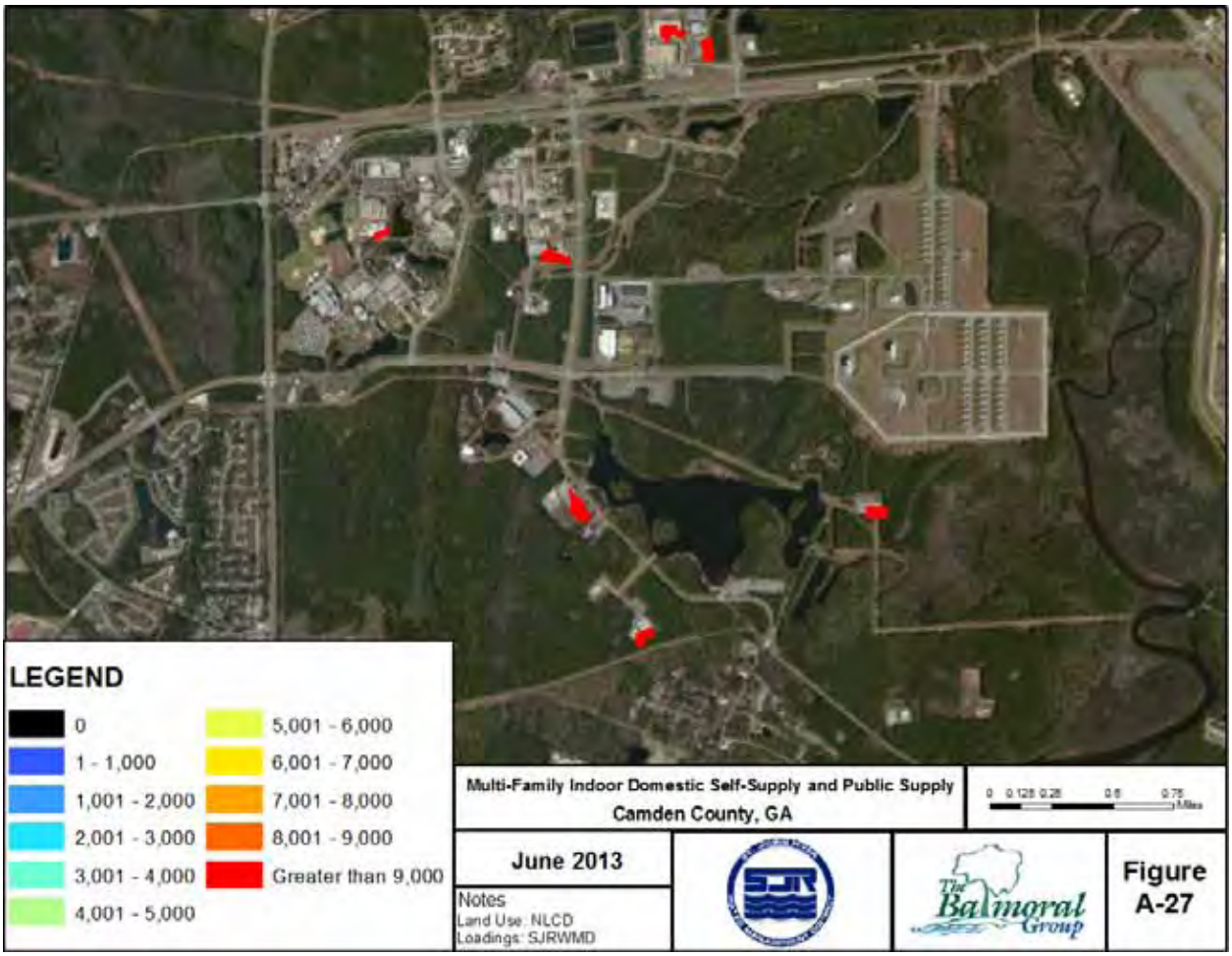


Figure A-28. Commercial Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Orange County, FL

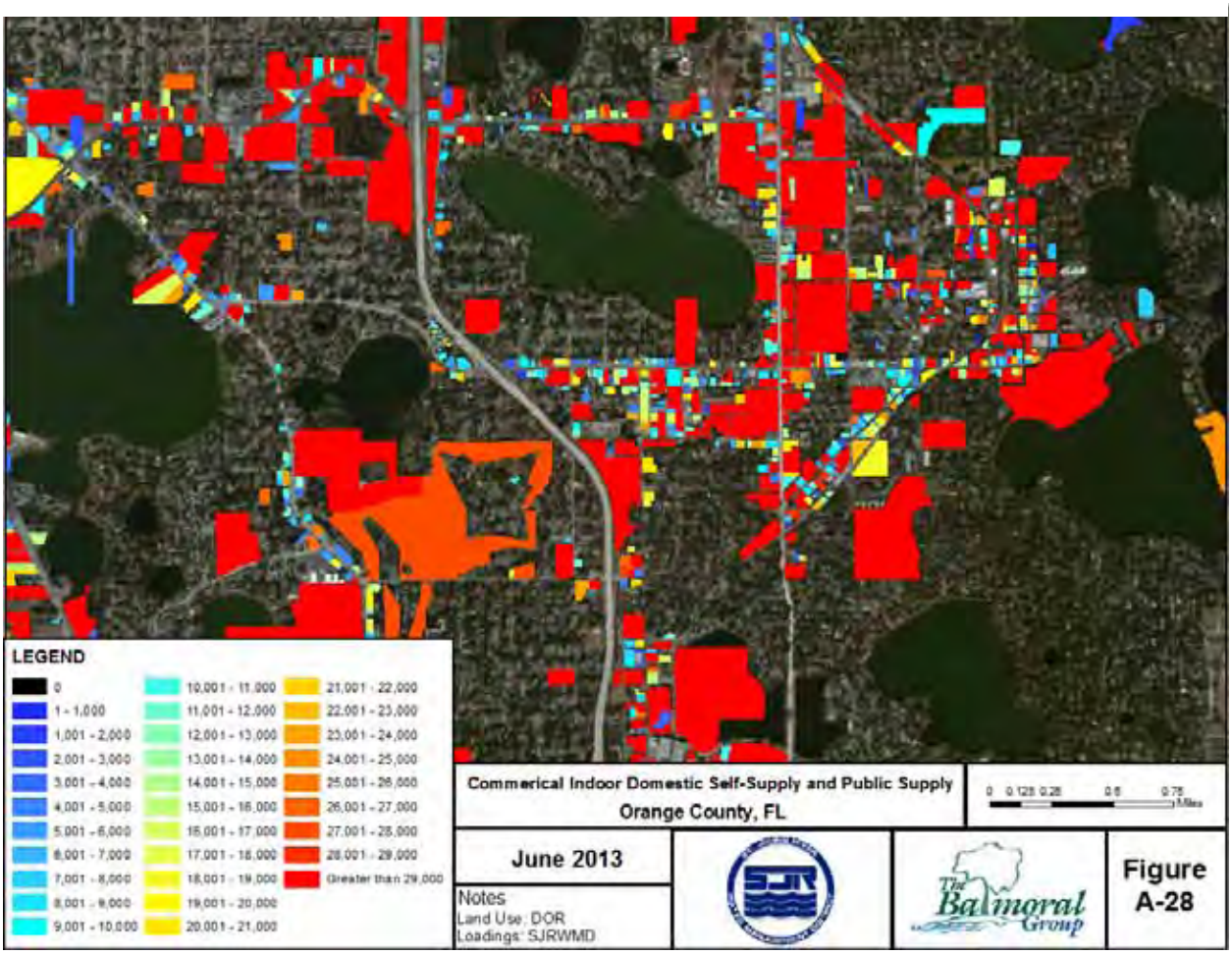
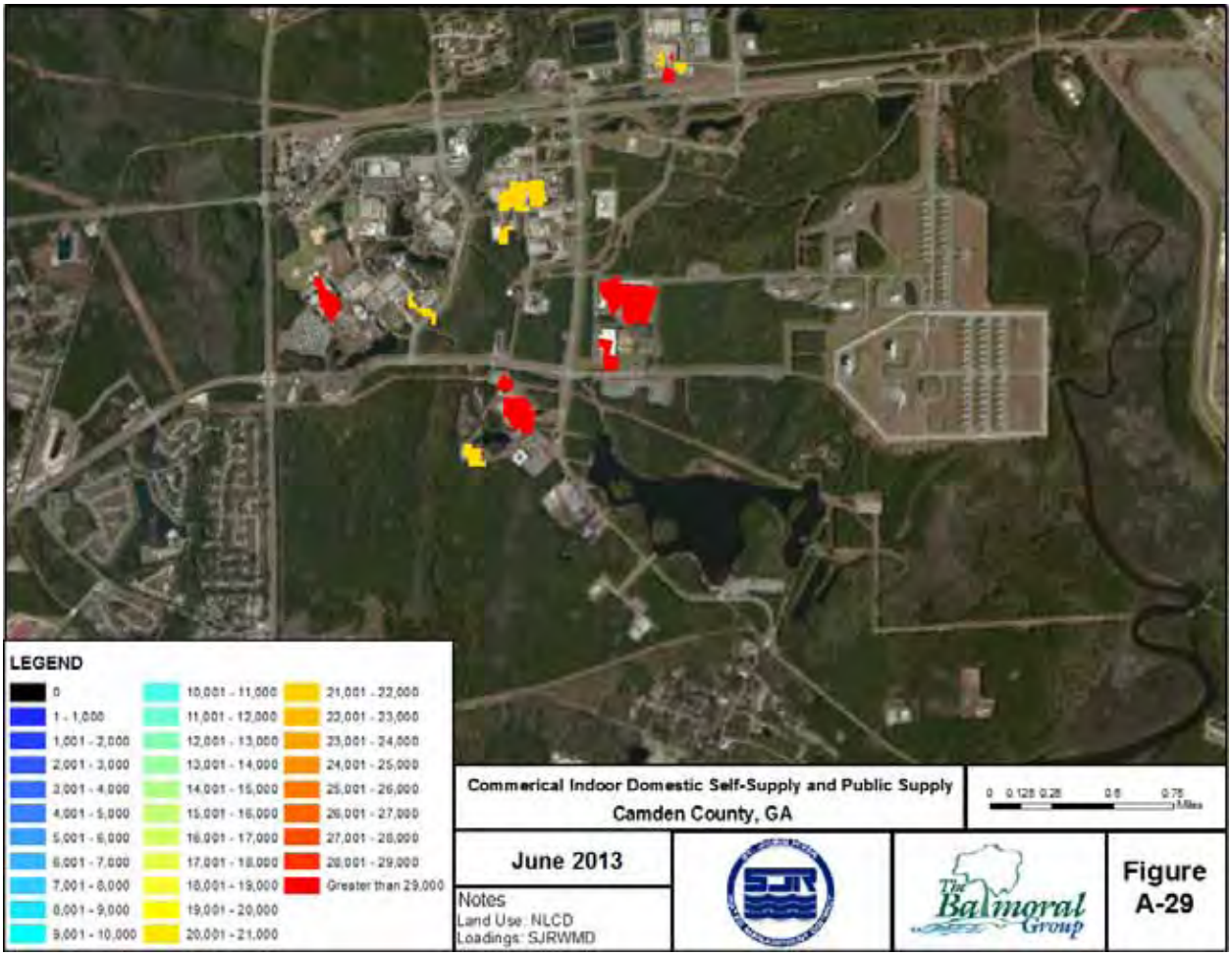


Figure A-29. Commercial Indoor Domestic Self Supply and Public Supply, Monthly Consumption, Camden County, GA



Development of Parcel-Level Urban Consumption for the U.S. Geological Survey Peninsular Florida Model for Groundwater Recharge and Water Conservation Potential

Contract 27523

The Balmoral Group

Submitted to:

SJRWMD
4049 Reid Street
Palatka, FL 32177

June 2013