CENTRAL FLORIDA WATER INITIATIVE (CFWI) SMALL AREA ESTIMATES AND PROJECTIONS

Prepared For

Central Florida Water Initiative

Under Contract To

Southwest Florida Water Management District
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Agreement 17UN0000448

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December 6, 2017

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INTRODUCTION

The University of Florida's Bureau of Economic and Business Research (BEBR) produces the official population estimates and projections for the State of Florida through a contract with the Florida Legislature. That contract funds the development of estimates at the state, county and city levels, and projections at the state and county levels. Because finer spatial precision is required for water supply planning, BEBR also develops small-area population estimates and projections for water management and utilities. The purpose of this document is to describe the methods used by BEBR to develop small-area population estimates and projections for the Central Florida Water Initiative (CFWI) Regional Water Supply Planning (RWSP) Area.

GEOSPATIAL SMALL-AREA POPULATION ESTIMATION AND FORECASTING MODEL OVERVIEW

The Geospatial Small-Area Population Estimation and Forecasting Model ("Model") was used to estimate and project permanent residential population at the parcel level, and then normalize those projections to BEBR's latest county level forecasts. First, County Build-out Submodels were developed using property parcel data for each of the six counties that are entirely or partly within the CFWI area. (Note that Brevard County was included because the City of Cocoa's wellfield is in Orange County.) The purpose of the County Build-out Submodel is to develop maximum residential development potential at the parcel level. A detailed description of this model is included in the section titled "County Build-out Submodels". Current permanent population was estimated and then the maximum population to which a county can grow was modeled by the County Build-out Submodels. Areas which cannot physically or lawfully sustain residential development (built-out areas, water bodies, public lands, commercial areas, etc.) were excluded from the County Build-out Submodel. Conversely, the model identified areas where growth is more likely to occur based on proximity to spatial features (e.g., roads) that tend to drive growth to certain areas. This is explained in detail in the section titled "Growth Drivers Submodel".

Historical population was estimated for each year from 2010-2016. A combination of parcel-based unit estimates, average occupancy and household size from the U.S. Census Bureau, surveys of large group quarters, and BEBR's own official population estimates for cities and counties were used to construct the 2010-2016 historical estimates.

Next, population growth was modeled between the current estimated population and the build-out population. Projections are based on a combination of historic growth trends (using an approach similar to what we use for our county level forecasts), and spatial constraints and influences, which both restrict and direct growth. This process is described in detail in the section titled "Geospatial Small-Area Population Estimation and Forecasting Model". Population growth calculations were controlled to BEBR's 2017 medium projections (BEBR's latest population forecasts for the years 2020 through 2045), which were available in five-year increments. The source of this data is the BEBR publication *Projections of Florida Population by County, 2020-2045, with Estimates for 2016.* (Florida Population Studies, Bulletin 177, April 2017).

The launch year for the version of the model described in this document was 2016, which was calibrated to the 2016 BEBR estimates of county population. Projections were made through the year 2045 in the following increments:

1. April 2, 2016 through April 1, 2020
2. April 2, 2020 through April 1, 2025
3. April 2, 2025 through April 1, 2030
4. April 2, 2030 through April 1, 2035
5. April 2, 2035 through April 1, 2040
6. April 2, 2040 through April 1, 2045

Finally, the parcel-level estimates and projections were summarized by water utility service area boundaries that the three water management districts (SFWMD, SJRWMD, and SWFWMD) maintain in a Geographic Information System (GIS) format. These summaries were exported to a Microsoft Excel spreadsheet with separate tabs for each county to facilitate the review and distribution of the results.

COUNTY BUILD-OUT SUBMODELS

The County Build-out Submodels are composed of multiple GIS data elements. Each model is based on each county property appraiser’s GIS parcel database, including the associated tax roll information. Other elements incorporated into each build-out model include the 2010 US Census data, wetland data, local government future land use maps, large planned development plans and BEBR population estimates.

Parcels

GIS parcel layers and county tax roll databases were obtained from each county property appraiser’s office. Parcel geometry was checked for irregular topology, particularly overlaps and fragments. Parcel tables were checked for errors, particularly non-unique parcel identifiers and missing values. Required tax roll table fields include actual year built, Florida Department of Revenue (DOR) land use code, and the total number of existing residential units for each parcel. In cases where values or fields were missing, other relevant information was extrapolated and used as a surrogate. For example, data reported by the State of Florida was used to identify the number of residential units (and population) in large group quarters facilities.

2010 US Census Data

Some of the essential attribute information to translate parcels to population in the County Build-out Submodels was derived from data from the 2010 Decennial Census. Average population per housing unit by census tract was calculated and then transferred to each county's parcel data. No adjustment for vacant units was required, as the calculation was made using total housing units (not limited to occupied units). However, slight adjustments were made using trends in average household size and unit occupancy from the U.S. Census Bureau's American Community Survey (ACS) data. This average population per housing unit enabled parcel-level estimation of population from parcel-based housing unit estimates.

BEBR Historical Population Estimates

Historical population was estimated using the parcel and census data for each year from 2010-2016. Starting with the 2016 estimate, we applied average occupancy and household size metrics from the 2010 Census (with some small adjustments using trends in the American Community Survey) to the parcel-level residential unit estimates provided by the county property appraisers. We then added population in large group quarters facilities (e.g., nursing homes, college dormitories, prisons). Then annual estimates were created for 2010-2015 using a combination of the year in which the residential structure was built, BEBR's electric utility-based unit estimates, and 2010 Census data. The 2010-2016 estimates were controlled at the city and county levels to BEBR's official estimates.

Water Management District Boundaries

Each parcel in the County Build-out Submodels was also attributed with the water management district that it fell within, which enabled the county submodels for any counties split between two or more water management districts to be summarized by district.

Wetlands

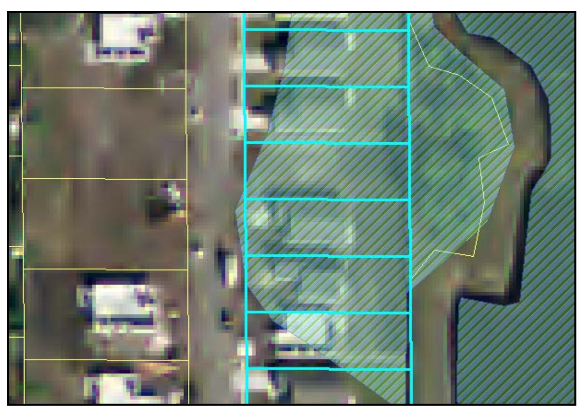

Figure 1. Example of inconsistencies between wetland delineation and residential parcels (outlined here in light blue)

Wetlands (including surface water) are an important consideration when modeling a county's build-out. Wetland GIS data were overlaid with a county's land parcels. The area of wetlands within parcels were calculated and subtracted from the total area of the parcel feature to determine the developable area in that parcel. There were exceptions to this. In some cases, parcels with little or no developable area after wetlands were removed were already developed, thus the estimated unit total was not reduced by the wetland acreage. In other cases, inaccurate wetland delineations were overridden, such as when platted residential parcels were shown to be covered by the edge of a wetland (Figure 1). In such a case, the parcel was considered developable by the submodel.

Future Land Use

Future land use maps were essential elements of the County Build-out Submodels. These maps helped guide where and at what density residential development could occur within a county (Figure 2). Future land use maps are a part of the local government comprehensive plans required for all local governments by Chapter 163, Part II, F.S. They are typically developed by the local government's planning department, or, in some cases, a regional planning council on behalf of the local government. The latest available future land use maps were obtained and applied to the build-out model. The planning horizons for these are a minimum of 10 years, and they often extend for 15 to 20 years into the future.

Figure 2. Future land use helps identify future residential areas (here shaded in yellow)

Each land parcel in the County Build-out Submodels received a future land use designation. In places where parcels overlapped multiple future land use areas due to mapping errors, the parcel was assigned the future land use class within which its center fell. Build-out population was modeled only for future land use classes designated to allow residential development (which include agriculture and mixed use). Table 1 below shows which future land use map classes were assigned residential densities in the County Build-out Submodels. Future land use map classifications for residential land uses are assigned maximum housing unit densities (per acre).

Table 1. Generalized future land use classes allowing future residential development

Generalized Future Land Use Classes	Whether Residential Development Is Allowed by the Model
Agricultural	Yes
Low Density Residential	Yes
Medium Density Residential	Yes
High Density Residential	Yes
Mixed Use	Yes
Commercial	No
Recreation / Open Space	No
Conservation / Preservation	No
Industrial	No
Institutional	No
Right of Way	No
Water	No

Development typically does not occur at the maximum densities allowed for each future land use category, so recent development densities were considered a better proxy for future densities than the maximum allowable density. For this reason, the County Build-out Submodels reflect the median density of recent development for each future land use category in the specific incorporated place. For example, if a city's medium density residential future land use designation allows up to 8 housing units per acre, but the average density of units built is 5.7 housing units per acre, the submodel assumed future densities at 5.7 housing units per acre for that future land use designation in that city. Typically the median density calculation was limited to the last 20 years of development within each unique combination of land use and jurisdiction, as more recent development was deemed a better proxy for future densities than older development.

In some cases, limiting the historical data to the last 20 years resulted in too small a sample, so either county average values were used (extended beyond the jurisdiction) or all historical development was used (not limited to the last 20 years). In those cases, the determination of which sample to use depended upon the heterogeneity of the category across county jurisdictions and the heterogeneity of historical densities prior to the last 20 years. Also, vacant or open parcels less than one acre in size were considered single family residential, with one housing unit as the maximum allowable density.

Build-out Density Calculation

Using GIS overlay techniques, attributes of the census, political boundary, wetlands, and future land use data were attributed to each county's parcel data to develop the County Build-out Submodels. These submodels forecast the maximum residential population by parcel at build-out, as exemplified in Figure 3.

Figure 3. Example of Build-out Density Model shaded by housing units per acre

Census tracts where the 2010 population was zero, and therefore the average persons per housing unit was zero, were assigned the county's average persons per housing unit. Also, if there were tracts with 2010 census values for persons per housing unit greater than zero that were based on a small number of homes with greater than five persons per housing unit, the county's average persons per housing unit was typically used.

Large Planned Developments

The final step in the development of the County Build-out Submodels was adjusting build-out densities within large planned developments (such as Developments of Regional Impact, Sector Plans, and Rural Land Stewardship Areas) to correspond with approved development plans wherever the boundaries are available in a GIS format. Although large planned developments often do not develop as originally planned by the developer, the total number of units planned (regardless of timing) is likely to be a better forecast of the units at build-out than one based on the median historic densities. Therefore, in each of the County Build-out Submodels, parcels with centroids within a large planned development were attributed with the name of the development. The build-out densities for those parcels were adjusted so that the total build-out for the development was consistent with the development plan, and the build-out population for that area was recalculated.

GROWTH DRIVERS SUBMODEL

The Growth Drivers Submodel is a regional, raster (cell-based) GIS model representing development potential. The submodel is a continuous surface of 10-meter cells containing values of 0-100, with '100' having the highest development potential and '0' having the lowest development potential. It influences the Model by factoring in the attraction of certain spatial features, or growth drivers on development. These drivers were identified from transportation and land use/land cover data. They included the following:

1. Proximity to roads and interchanges prioritized by level of use (with each road type modeled separately)
2. Proximity to existing residential development
3. Proximity to existing commercial development (based on parcels with commercial land use codes deemed attractors to residential growth)
4. Proximity to coastal and inland waters
5. Proximity to large planned developments

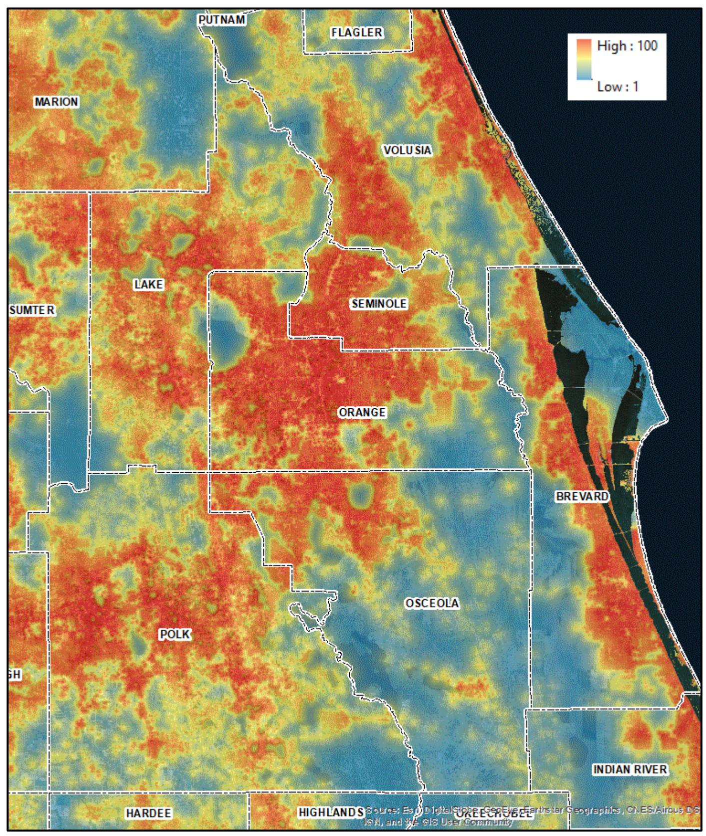

Figure 4. Growth Drivers Submodel

Figure 4 depicts the Growth Drivers Submodel for the CFWI region, with high development potential in red, moderate development potential in yellow and low development potential in blue. Data used for generating the Growth Drivers Submodel and their sources are listed in Table 2 below.

Table 2. GIS datasets used in the Growth Drivers Submodel

Growth Driver	Data Source
Roads and Limited Access Road Interchanges	Florida Department of Transportation (FDOT) Major Roads: Functional Classification (FUNCLASS), and FDOT Limited Access Road Interchanges
Existing Residential Land Uses	County Property Appraiser Parcel Data
Selected Existing Commercial Land Uses	County Property Appraiser Parcel Data
Coastal and Inland Waters	Land Cover Data, and Florida Geographic Data Library (FGDL) Coastline Data
Large Planned Developments	Multiple sources, including Regional Planning Councils, local governments, GIS Associates and BEBR

Each of the drivers listed in Table 2 were used as independent variables in a logistic regression equation. Dependent variables included existing residential units built during or after 1995 as the measure of “presence”, and large undeveloped vacant parcels outside of large planned developments were used to measure “absence”. The resulting equation could then be applied back to each of the regional grids resulting in a single regional grid with values 0 through 100, for which a value of 0 represented the lowest relative likelihood of development, and a value of 100 represented the highest relative likelihood of development.

This seamless, “regional” submodel encompasses all the counties all or partially within CFWI Regional Water Supply Planning (RWSP) Area, plus a one-county buffer to eliminate “edge effects”. In this case, the edge effects refer to the presence or absence of growth drivers outside the CFWI area that could influence growth within it. This submodel was used by the Model to rank undeveloped parcels based on their development potential, which is explained in the Growth Calculation Methodology section. Note that growth may still occur in areas assigned relatively low values from this model based on the historical growth trends. This model only helps guide growth when the Model projections are below the BEBR targets.

GEOSPATIAL SMALL-AREA POPULATION ESTIMATION AND FORECASTING MODEL

BEBR’s Geospatial Small-Area Population Estimation and Forecasting Model (“Model”) integrates the County Build-out Submodels and the Growth Drivers Submodel with the Population Projection Engine™, which makes the projection calculations using a combination of those submodels, historic growth trends, and growth controls from BEBR’s county-level forecasts.

Historic Growth Trends

The historic growth trends were derived from historic census population estimates for 1990, 2000, and 2010. For 1990 and 2000, census block population estimates from the Florida House of Representatives Redistricting Data (available at the Office of Economic and Demographic Research's website http://edr.state.fl.us/Content/population-demographics/redistricting/2010-redistricting/index.cfm) were summarized at the 2010 tract level, and combined with the 2010 tract population estimates. These estimates were used to produce twelve tract level projections using six different demographic extrapolation methods. The highest four and lowest four calculations were discarded to moderate the effects of extreme projections (Smith and Rayer 2004). The remaining four projections were then averaged. This method resulted in county projections with the lowest mean absolute percentage error (MAPE) statewide of the ten combinations of methods and calculations studied.

The six demographic extrapolation methods for projecting population utilized by the model were:

1. Linear
2. Exponential
3. Constant Population
4. Constant Share
5. Share-of-Growth
6. Shift-Share

The Linear, Exponential, and Constant Population techniques employ a bottom-up approach, extrapolating the historic growth trends or population of each census tract with no consideration for the county's overall growth. The Constant Share, Share-of-Growth and Shift-Share techniques employ a ratio allocation, or top-down approach, allocating a portion of the total projected county population or growth to each census tract based on that census tract's percentage of county population or growth over the historical period. Each of the six methods is a good predictor of growth in different situations and growth patterns, so using a combination of all six was the best way to avoid the largest possible errors resulting from the least appropriate techniques for each census tract within the 16-county area (Sipe and Hopkins 1984). This approach is similar to the one BEBR uses for its county population forecasts, but the base periods and the number of projections are somewhat different because annual estimates are not available at the tract level.

The calculations associated with the six statistical methods are described below. The launch year was 2016, which we estimated using parcel-level data and controlled at the city and county levels to the 2016 BEBR estimates. The projections were made for 2020, 2025, 2030, 2035, 2040 and 2045. Note that for the 2016-2020 iteration, the typical five-year growth was reduced to reflect only a four-year change.

1. **Linear Projection Method:** The Linear Projection Method assumes that the change in the number of persons for each census tract will be the same as during the base period (Rayer and Wang, 2017). Three linear growth rate calculations were made, one from 1990

through 2010 (20-year period), one from 1990 through 2000 (10-year period), and one from 2000 through 2010 (10-year period). In the three Linear methods (LIN), population growth was calculated using the following formulas:

$$LIN_1 = \frac{(TractPop2010 - TractPop1990)}{20} * 5$$

$$LIN_2 = \frac{(TractPop2000 - TractPop1990)}{10} * 5$$

$$LIN_3 = \frac{(TractPop2010 - TractPop2000)}{10} * 5$$

2. **Exponential Projection Method:** The Exponential Projection Method assumes that population will continue to change at the same percentage rate as during the base period (Rayer and Wang, 2017). One calculation was made from 2000 through 2010 (10-year period). The prior 10-year period (1990-2000) and the 20-year period (1990-2010) produced too many extreme results to be used. In the Exponential method (EXP), population growth was calculated using the following formula:

$$EXP = (TractPop2010 * e^{5r}) - TractPop2010$$

where,

$$r = \frac{\ln \frac{TractPop2010}{TractPop2000}}{10}$$

3. **Constant Population Method:** The Constant Population Method assumes that future population will remain constant at its present value (Smith and Rayer, 2013). In the Constant Population (CON) method, no growth was calculated for each model iteration.

$$CON = 0$$

4. **Constant Share Projection Method:** The Constant Share Projection Method assumes that each census tract's percentage of the county's total population will be the same as over the base period (Rayer, 2015). One Constant Share (CS) calculation was made for 2010. Population growth was calculated using the following formula (using 2020–2025 as an example):

$$CS = \frac{TractPop2010}{CountyPop2010} * (CountyPop2025 - CountyPop2020)$$

5. **Share-of-Growth Projection Method**: The Share-of-Growth Projection Method assumes that each census tract's percentage of the county's total growth will be the same as over the base period (Smith and Rayer, 2013). However, if population change is negative at the tract level and positive at the county level or vice versa, higher county level projections would result in larger declines in tract projections. This is counterintuitive, so the "Plus-minus" variant of the Share-of-Growth Method was used. Three Share-of-Growth calculations were made, one from 1990 through 2010 (20-year period), one from 1990 through 2000 (10-year period), and one from 2000 through 2010 (10-year period). In the three Share-of-Growth (SOG) calculations, population growth was calculated using the formulas on the following page if the changes in growth over the base period for the tract and county were both positive or both negative (using 2020–2025 as an example):

$$SOG_1 = \left[SOG \div (CountyPop2025 - CountyPop2020)\right] * \left[\begin{bmatrix}\left[CountySum\left[ABS(SOG) \div (CountyPop2025 - CountyPop2020)\right]\right] \\ + \left[1 - CountySum\left[SOG \div (CountyPop2025 - CountyPop2020)\right]\right]\end{bmatrix} \\ \div \left[CountySum\left[ABS(SOG) \div (CountyPop2025 - CountyPop2020)\right]\right]\right] * (CountyPop2025 - CountyPop2020)$$

$$where,$$

$$SOG = \frac{(TractPop2010 - TractPop1990)}{(CountyPop2010 - CountyPop1990)} * (CountyPop2025 - CountyPop2020),$$

$$and\ ABS = AbsoluteValue$$

$$SOG_2 = \left[SOG \div (CountyPop2025 - CountyPop2020)\right] * \left[\begin{bmatrix}\left[CountySum\left[ABS(SOG) \div (CountyPop2025 - CountyPop2020)\right]\right] \\ + \left[1 - CountySum\left[SOG \div (CountyPop2025 - CountyPop2020)\right]\right]\end{bmatrix} \\ \div \left[CountySum\left[ABS(SOG) \div (CountyPop2025 - CountyPop2020)\right]\right]\right] * (CountyPop2025 - CountyPop2020)$$

$$where,$$

$$SOG = \frac{(TractPop2000 - TractPop1990)}{(CountyPop2000 - CountyPop1990)} * (CountyPop2025 - CountyPop2020),$$

$$and\ ABS = AbsoluteValue$$

$$SOG_3 = \left[SOG \div (CountyPop2025 - CountyPop2020)\right]$$
$$* \begin{bmatrix} \begin{bmatrix} [CountySum[ABS(SOG) \div (CountyPop2025 - CountyPop2020)]] \\ + [1 - CountySum[SOG \div (CountyPop2025 - CountyPop2020)]] \end{bmatrix} \\ \div [CountySum[ABS(SOG) \div (CountyPop2025 - CountyPop2020)]] \end{bmatrix}$$
$$* (CountyPop2025 - CountyPop2020)$$

where,

$$SOG = \frac{(TractPop2010 - TractPop2000)}{(CountyPop2010 - CountyPop2000)} * (CountyPop2025 - CountyPop2020),$$

$$and\ ABS = AbsoluteValue$$

If the changes in growth over the base period were negative at the tract level and positive at the county level or vice versa, the population growth was calculated using the following formulas (using 2020–2025 as an example):

$$SOG_1 = \left[SOG \div (CountyPop2025 - CountyPop2020)\right] \div 5$$
$$* \begin{bmatrix} \begin{bmatrix} [CountySum[ABS(SOG) \div (CountyPop2025 - CountyPop2020)]] \\ + [1 - CountySum[SOG \div (CountyPop2025 - CountyPop2020)]] \end{bmatrix} \\ \div [CountySum[ABS(SOG) \div (CountyPop2025 - CountyPop2020)]] \end{bmatrix}$$
$$* (CountyPop2025 - CountyPop2020)$$

where,

$$SOG = \frac{(TractPop2010 - TractPop1990)}{(CountyPop2010 - CountyPop1990)} * (CountyPop2025 - CountyPop2020),$$

$$and\ ABS = AbsoluteValue$$

$$SOG_2 = \left[SOG \div (CountyPop2025 - CountyPop2020)\right] \div 5$$
$$* \begin{bmatrix} \begin{bmatrix} [CountySum[ABS(SOG) \div (CountyPop2025 - CountyPop2020)]] \\ + [1 - CountySum[SOG \div (CountyPop2025 - CountyPop2020]] \end{bmatrix} \\ \div [CountySum[ABS(SOG) \div (CountyPop2025 - CountyPop2020)]] \end{bmatrix}$$
$$* (CountyPop2025 - CountyPop2020)$$

where,

$$SOG = \frac{(TractPop2000 - TractPop1990)}{(CountyPop2000 - CountyPop1990)} * (CountyPop2025 - CountyPop2020),$$

$$and\ ABS = AbsoluteValue$$

$$SOG_3 = \left[SOG \div (CountyPop2025 - CountyPop2020)\right] \div 5$$
$$* \left[\begin{array}{l} \left[\left[CountySum\left[ABS(SOG) \div (CountyPop2025 - CountyPop2020)\right]\right]\right. \\ \left. + \left[1 - CountySum\left[SOG \div (CountyPop2025 - CountyPop2020)\right]\right]\right] \\ \div \left[CountySum\left[ABS(SOG) \div (CountyPop2025 - CountyPop2020)\right]\right] \end{array}\right]$$
$$* (CountyPop2025 - CountyPop2020)$$

$$where,$$
$$SOG = \frac{(TractPop2010 - TractPop2000)}{(CountyPop2010 - CountyPop2000)} * (CountyPop2025 - CountyPop2020),$$
$$and\ ABS = AbsoluteValue$$

6. **Shift-Share Projection Method:** The Shift-Share Projection Method assumes that each census tract's percentage of the county's total annual growth will change by the same annual amount as over the base period (Smith and Rayer, 2013). Three Shift-Share calculations were made, one from 1990 through 2010 (20-year period), one from 1990 through 2000 (10-year period), and one from 2000 through 2010 (10-year period). In the three Shift-Share Projection Method (SSH) calculations, population growth was calculated using the following formulas (using the five years from 2020–2025 as an example):

$$SSH_1 = \left[\frac{TractPop2010}{CountyPop2010} + \left(\left(\frac{TractPop2010}{CountyPop2010} - \frac{TractPop1990}{CountyPop1990}\right) \div 20 * 5\right)\right]$$
$$* (CountyPop2025 - CountyPop2020)$$

$$SSH_2 = \left[\frac{TractPop2000}{CountyPop2000} + \left(\left(\frac{TractPop2000}{CountyPop2000} - \frac{TractPop1990}{CountyPop1990}\right) \div 10 * 5\right)\right]$$
$$* (CountyPop2025 - CountyPop2020)$$

$$SSH_3 = \left[\frac{TractPop2010}{CountyPop2010} + \left(\left(\frac{TractPop2010}{CountyPop2010} - \frac{TractPop2000}{CountyPop2000}\right) \div 10 * 5\right)\right]$$
$$* (CountyPop2025 - CountyPop2020)$$

7. **Average of the Projection Extrapolations:** The four minimum and four maximum of the twelve calculations for each census tract were removed to eliminate the most extreme results of the thousands of heterogeneous census tracts within the 16-county area. The four remaining calculations were averaged to account for the considerable variation in growth rates and patterns over all of the census tracts within the 16-county area (Sipe and Hopkins 1984). All four remaining methods were weighted equally, and the average was calculated using the following formula:

$$AVG = \frac{\begin{array}{c}(LIN_1 + LIN_2 + LIN_3 + EXP + CON + CS + SOG_1 + SOG_2 + SOG_3 + SSH_1 + SSH_2 \\ + SSH_3) - (MIN_1 + MIN_2 + MIN_3 + MIN_4 + MAX_1 + MAX_2 + MAX_3 + MAX_4)\end{array}}{4}$$

where,

MIN_1, MIN_2, MIN_3 and MIN_4 are the 4 lowest growth calculations for each tract

and MAX_1, MAX_2, MAX_3 and MAX_4 are the 4 highest growth calculations for each tract

Growth Calculation Methodology

After the development of the County Build-out Submodels and the Growth Drivers Submodel, the Population Projection Engine™ developed by GIS Associates was used to make the growth calculations. The methodology for calculating growth for each projection increment included the following steps:

1. Applying census tract-level average historical growth rate to parcels within a particular tract.
2. Checking growth projections against build-out population, and reducing any projections exceeding build-out to equal the build-out numbers.
3. After projecting growth for all census tracts within a particular county, summarizing the resulting growth and comparing it against countywide BEBR target growth. This step led to two scenarios:
    a. If the Small-Area Population Forecasting Model's projections exceeded the BEBR target, projected growth for all tracts was reduced by the percentage that the projections exceeded the BEBR target.
    b. If the Small-Area Population projection model's projections were less than the BEBR target (which is more common due to high growth tracts building out), the model would continue growing the county using the Growth Drivers Submodel until the BEBR target growth for each five-year increment was reached. This process involved developing parcels with growth driver values in the highest decile that had available capacity for growth.
4. Summarizing growth and checking against build-out.
5. Continuing this process until the county growth target was met.

UTILITY SERVICE AREA POPULATION SUMMARIES

The parcel-level population estimates and projections were then summarized by water utility service area boundaries. These service areas, maintained by the three water management districts, were overlaid with each county's parcel-level results, and each parcel within a service area was assigned a unique identifier for that service area. The projected population was then summarized by that identifier and exported to a spreadsheet. Note that these service areas change over time, so for any future use of these deliverables, it is important to match this projection set only with the service areas included in the GIS deliverables for this project.

Spatial Incongruity of Boundaries

Due to mapping errors, the service area boundaries often bisect parcel boundaries (Figure 5). In the present modeling activity, parcels were deemed to be within a given service area if their center points (or "centroids") fell inside the service area boundaries. The error associated with this spatial incongruity at the parcel level was much smaller than would be the case with census tract level data. This is one of the primary benefits of disaggregating census tract level data to the parcel level. The percentage of parcels erroneously attributed or excluded from a service area by this process is insignificant.

Figure 5. Parcel centroids (yellow points) used in summarizing parcels (yellow polygons) to utility service area boundaries (blue polygons)

PROJECTION DELIVERABLES

The final population projections were delivered in multiple formats, including:

1. GIS – Esri's file geodatabase, with individual feature classes for each county containing parcel-level results, and a single feature class with all counties aggregated.
2. Tabular – Excel spreadsheet summaries by utility service area

The GIS outputs are useful for quality assuring the results and inputs, for maintaining the projection inputs over time, and for graphically depicting projected patterns of future population growth. Figure 6 on the following page is a graphical depiction of these deliverables.

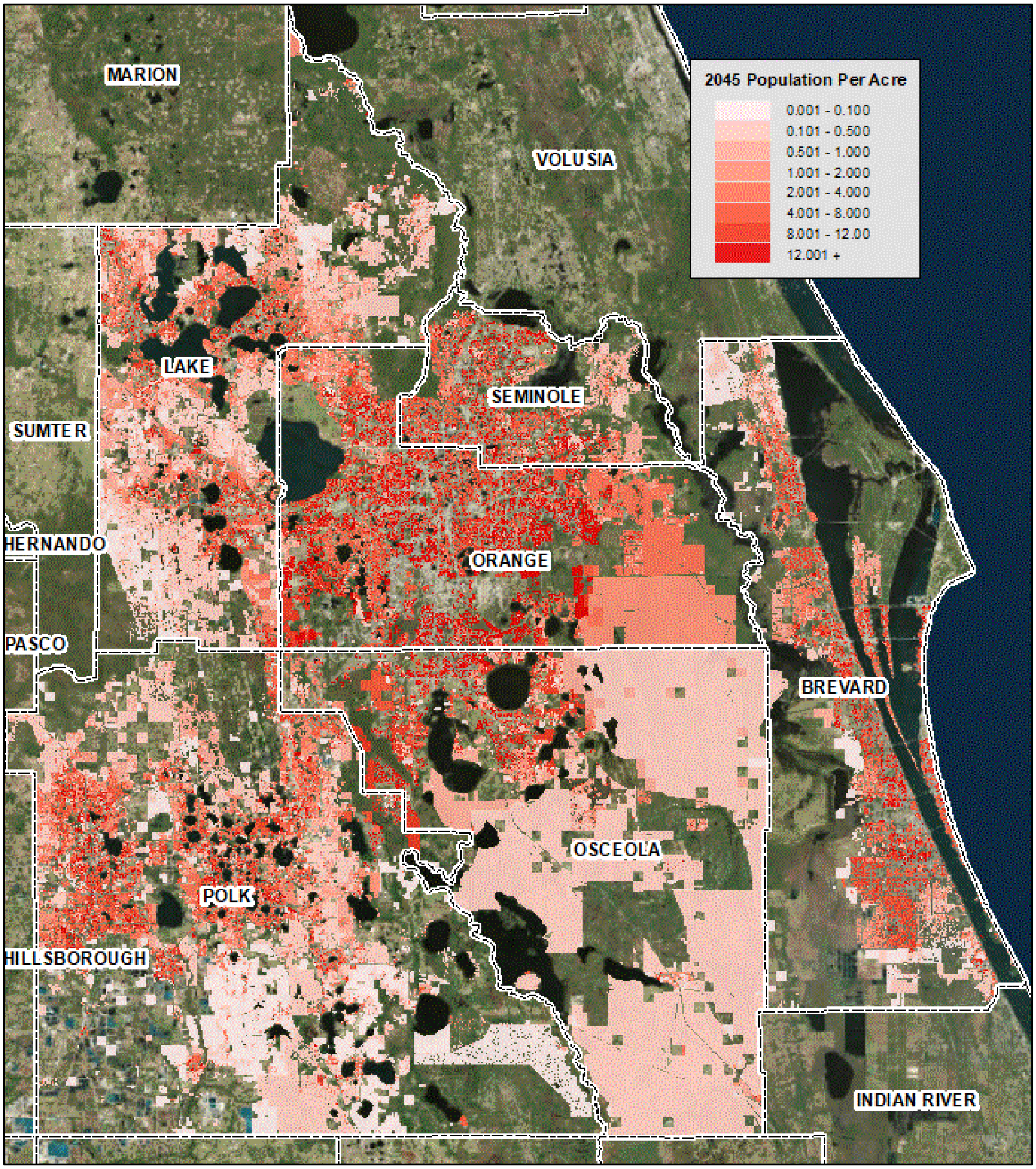

Figure 6. CFWI parcels shaded by 2045 projected population density (pink is low and red is high)

The tabular deliverables were provided in a spreadsheet with utility summary tabs for each CFWI county. Tables 3 and 4 on the next page show the service area population estimate and projection summaries by county and water management district. The population outside of service areas include population with private wells for potable use (considered to be domestic self-supply) or small utilities without a service area boundary mapped by the water management districts. Small utilities are generally defined as those utilities permitted for less than 100,000 gallons per day (gpd). However, there are some small utilities in that category that are included here because their service area boundaries were mapped. Note that these service area population summaries may include some self-supplied populations (or populations with private wells) that reside within the service areas.

Table 3. Population estimate summaries by county and water management district

POPULATION ESTIMATES BY COUNTY AND WATER MANAGEMENT DISTRICT								
COUNTY	DISTRICT	POP10	POP11	POP12	POP13	POP14	POP15	POP16
BREVARD	SJRWMD	543,376	545,184	545,625	548,424	552,427	561,714	568,919
LAKE	SJRWMD	296,008	297,225	298,639	302,274	308,683	315,510	322,940
LAKE	SWFWMD	1,039	1,040	1,038	1,043	1,053	1,059	1,045
ORANGE	SFWMD	326,097	329,371	336,209	346,894	357,483	367,636	381,957
ORANGE	SJRWMD	819,859	827,971	839,732	856,084	870,512	884,760	898,430
OSCEOLA	SFWMD	267,392	272,553	279,533	287,002	294,176	306,912	321,437
OSCEOLA	SJRWMD	1,293	1,314	1,333	1,359	1,377	1,415	1,425
POLK	SFWMD	32,713	32,907	33,027	33,513	34,240	35,071	36,251
POLK	SWFWMD	569,382	571,885	573,861	580,437	588,934	597,981	610,738
SEMINOLE	SJRWMD	422,718	424,587	428,104	431,074	437,086	442,903	449,124
DISTRICT SUM -	SFWMD	626,203	634,831	648,769	667,409	685,899	709,619	739,644
DISTRICT SUM -	SJRWMD	2,083,254	2,096,281	2,113,433	2,139,215	2,170,085	2,206,301	2,240,838
DISTRICT SUM -	SWFWMD	570,420	572,925	574,899	581,480	589,987	599,041	611,784
ALL DISTRICT TOTALS		3,279,877	3,304,037	3,337,101	3,388,104	3,445,971	3,514,961	3,592,266

Table 4. Population projection summaries by county and water management district

POPULATION PROJECTIONS BY COUNTY AND WATER MANAGEMENT DISTRICT							
COUNTY	DISTRICT	POP20	POP25	POP30	POP35	POP40	POP45
BREVARD	SJRWMD	595,700	625,500	649,200	666,300	681,700	696,100
LAKE	SJRWMD	354,004	390,021	420,947	449,178	476,017	500,977
LAKE	SWFWMD	1,296	1,579	1,853	2,122	2,383	2,623
ORANGE	SFWMD	419,942	469,188	522,596	583,359	645,266	649,637
ORANGE	SJRWMD	984,558	1,084,612	1,159,704	1,210,941	1,253,334	1,345,463
OSCEOLA	SFWMD	370,690	432,407	487,784	533,640	572,969	610,987
OSCEOLA	SJRWMD	2,110	2,793	3,416	3,960	4,631	5,313
POLK	SFWMD	39,717	43,199	46,472	49,423	51,969	54,236
POLK	SWFWMD	658,283	714,001	760,328	804,277	844,431	880,964
SEMINOLE	SJRWMD	474,700	504,000	528,400	550,700	570,300	588,000
DISTRICT SUM -	SFWMD	830,349	944,794	1,056,852	1,166,422	1,270,205	1,314,860
DISTRICT SUM -	SJRWMD	2,411,071	2,606,926	2,761,667	2,881,079	2,985,981	3,135,854
DISTRICT SUM -	SWFWMD	659,579	715,580	762,181	806,399	846,814	883,586
ALL DISTRICT TOTALS		3,901,000	4,267,300	4,580,700	4,853,900	5,103,000	5,334,300

CONCLUSIONS

Small area population estimates and projections provide an essential foundation for water supply planning, particularly in areas like Central Florida that are experiencing rapid growth. They are integral to understanding per capita water use and forecasting future demands. BEBR's implementation of this Geospatial Small-Area Population Estimation and Forecasting Model for the CFWI region provided reasonable and consistent estimates and projections for this purpose. Controlling to our own official estimates and projections provided consistency with other projections made by state and local governments, while at the same time providing the spatial precision needed for water supply planning.

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