Assessment of Municipal Population and Water Demand Projections in Texas Regional and State Water Supply Planning

TWDB Contract Agreement 2500012881
Progress Report 2

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Submitted by:

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Submitted to: Amanda Covington – Contract Manager, TWDB

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Project Goals

1) Better understand how other states, major water providers, and organizations assess or project future municipal water demands for their long-range water supply planning processes, including for water uses not served by utilities (i.e. exempt domestic and other use), including whether/how they use scenarios and why.
2) Assess the accuracy (quantified error) of Texas regional water supply plans' previous *population and municipal water demand* projections (as negotiated and modified through the planning process via TWDB and the Regional Water Planning Groups (RWPGs)) and compare to the accuracy of the Texas Demographic Center's population projection accuracy over the same time period (2000 – 2020). Accuracy of population projections should also be measured against actual population counts by the U.S. Census Bureau in the decennial Censuses in 2000, 2010, and 2020 at various geographic levels, including the county and municipal WUG level.
3) From the accuracy assessment, determine a reasonable quantified uncertainty of the projections and recommend how to apply that quantified uncertainty to future projections developed using TWDB's current projection methodologies.
4) Assess whether different projection methodologies, such as land use modeling for utility population projections, would increase the accuracy of future projections.
5) The project should result in implementable recommendations including, but not limited to:
    a) determining whether TWDB's current population and municipal water demand projection methodologies are still appropriate for future projections or if the methodologies should be changed.
    b) assessing what type of flexibility, if any, could be directly incorporated into draft TWDB population projections to allow RWPGs and TWDB to more efficiently and quickly assess and arrive at an agreeable but credible set of population projections – especially for the later planning decades.
    c) comparing the margin of error in the population projections versus the municipal water demand projections for same geographic area.

PROJECT PROGRESS DISCUSSION

Summary

- We have made substantial advances in the following areas since the previous progress report:
- Finalization of web and literature review of other state water planning process
- Detailed analysis of draft and final population projections at state, regional water planning area (RWPA), county, and WUG level, with particularly emphasis on the **WUG level**.
- Completion of five county area analysis, including predominantly rural and urban counties.
- Evaluation of water demand projections, including GPCD and water use, with comparison of draft and final projections at state, RWPA, and county level and WUG level.
- Evaluation of city projections of population and GPCD, based on discussions and report review for City of Austin and San Antonio
- Uncertainty analysis with relative contributions from uncertainties in populations and GPCD

Subtask 1. Projection Methodology Literature and Data Review

Status: We consider Subtask 1 50% complete.

Subtask 1a. Literature Review

We have started writing up the results of the literature review on projection methodologies from other states. The level of detail in each of the state plans is highly variable and some plans are very dated. We met with TWDB, Austin Water, and San Antonio Water System on June 23rd to discuss the reliability of their population projections and water water demand projections. City of Austin and San Antonio have their own demographers to support their work. The discussion emphasized the large water losses linked to drought and importance of considering those in water demand projections. Talk+Water had valuable water podcasts with Todd Votteler interviewing Marisa Flores-Gonzales at Austin Water and Gilbert Trejo and Christina Montoya-Halter at El Paso Water Utilities.

Subtask 1b. Data Review

This subtask focuses on analysis of municipal WUGs to be included in the study. However, we have analyzed all the municipal WUGs at this stage.

Next Steps:

We will continue the literature review and reach out to more state agencies to determine details about their planning process. We will emphasize the states of California, Arizona, and New Mexico.
We will also discuss further details with the Texas agencies listed in the proposal to develop more detailed analysis of their projections using city demographers, GPCD data, and water loss data during droughts.

Subtask 2. Accuracy of both the draft and final, where available, population projections in regional water plans, and accuracy of Texas Demographic Center's population projections

Status: We consider Subtask 2 to be 60% complete.

Subtask 2.1:

Comparison of TDC projected population to population counts in 2000, 2010, and 2020 by the U.S. Census Bureau in the decennial Censuses for the whole state and each county.

TDC project population was compared to population counts in 2000, 2020, and 2020 by the US Census Bureau for the state and each county. Results at the state level show that for 2020 (2017 projection) that TDC population underestimates census population with migration scenarios of 0.0 (6%) and 0.5 (1%) but overestimates for migration scenario of 1.0 (5%). Comparison at the county level shows that the best comparison was found with migration scenario of 0.5 with the recent data. The county populations were ranked, and comparisons were conducted using percentiles. Most of the analyses show divergence between TDC and the census when percentiles exceeded ~60th percentile. Uncertainties in projections increase with the length of the projection time.

Subtask 2.2:

Comparison of draft Regional Water Plan projected population to population counts in 2000, 2010, and 2020 by the U.S. Census Bureau in the decennial Censuses for the whole **state**, **regional water planning area**, **county**, and **select WUGs**.

Results at the **state** level show low percentage errors between draft and census population data (~ 1%). Differences between projected and census data range from -3 to 14% at the scale of the **RWPAs** for 2017 projection of 2020 census data. Projection uncertainties are similar or increase with the length of the period projected.

Analysis of the **WUG** data indicates that the population projections diverge from the census population with increasing county WUG population with greater divergence about the 90th percentile (with projections above and below actual WUG populations). WUG population projections are generally overestimated relative to the census data.

Subtask 2.3

Comparison of final Regional Water Plan projected population to population counts in 2000, 2010, and 2020 by the U.S. Census Bureau in the decennial Censuses for the whole state, regional water planning area, county, and select WUGs.

The final population projections are similar to the draft projections and census data at the **state** level with differences of ~ 1% for 2020 data.

The draft and final **RWPA** population projections appear identical. It is not clear if there were any draft projections for RWPAs.

Comparison at the **county** level shows that the final population projections generally differ more than the draft population projections relative to the census data, particularly as the county population percentiles increase(Fig. 1). Most final projections overestimate census populations between ~40th and 95th county population percentiles and some underestimate at the highest county population percentile.

Results for the **WUGs** show similar variations as the county data with increasing differences from draft to final projections, particularly with increasing WUG population percentiles.

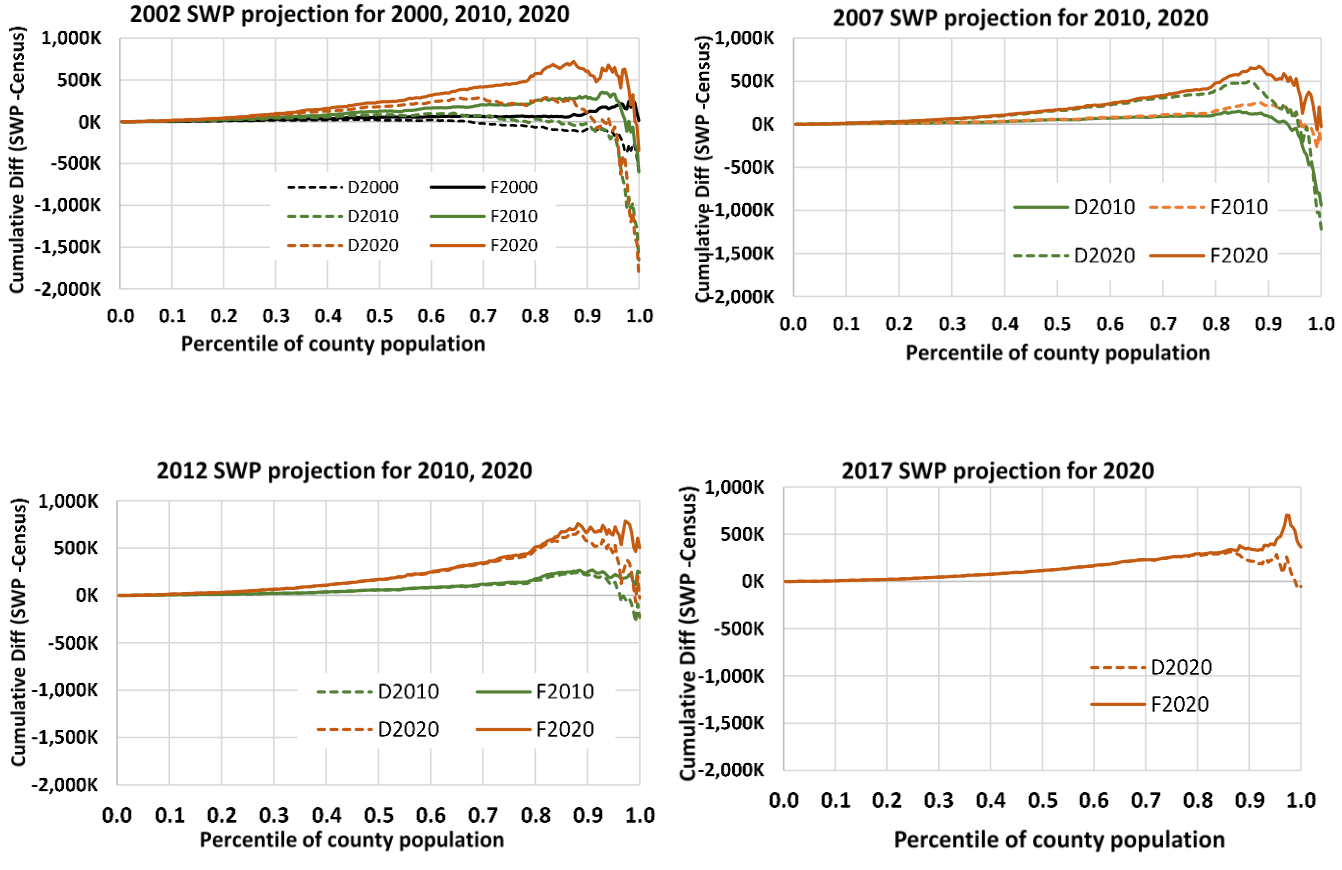

Figure 1. The graphs illustrate the cumulative difference of draft (D) and final (F) population projection minus Census for the **counties**. It also includes the percentile distribution of county populations, providing insight into how projections align with actual demographic data across different population scales. A similar analysis and set of graphs have been developed for Water User Groups (WUGs), offering a comparative view of projection accuracy and population distribution at that level.

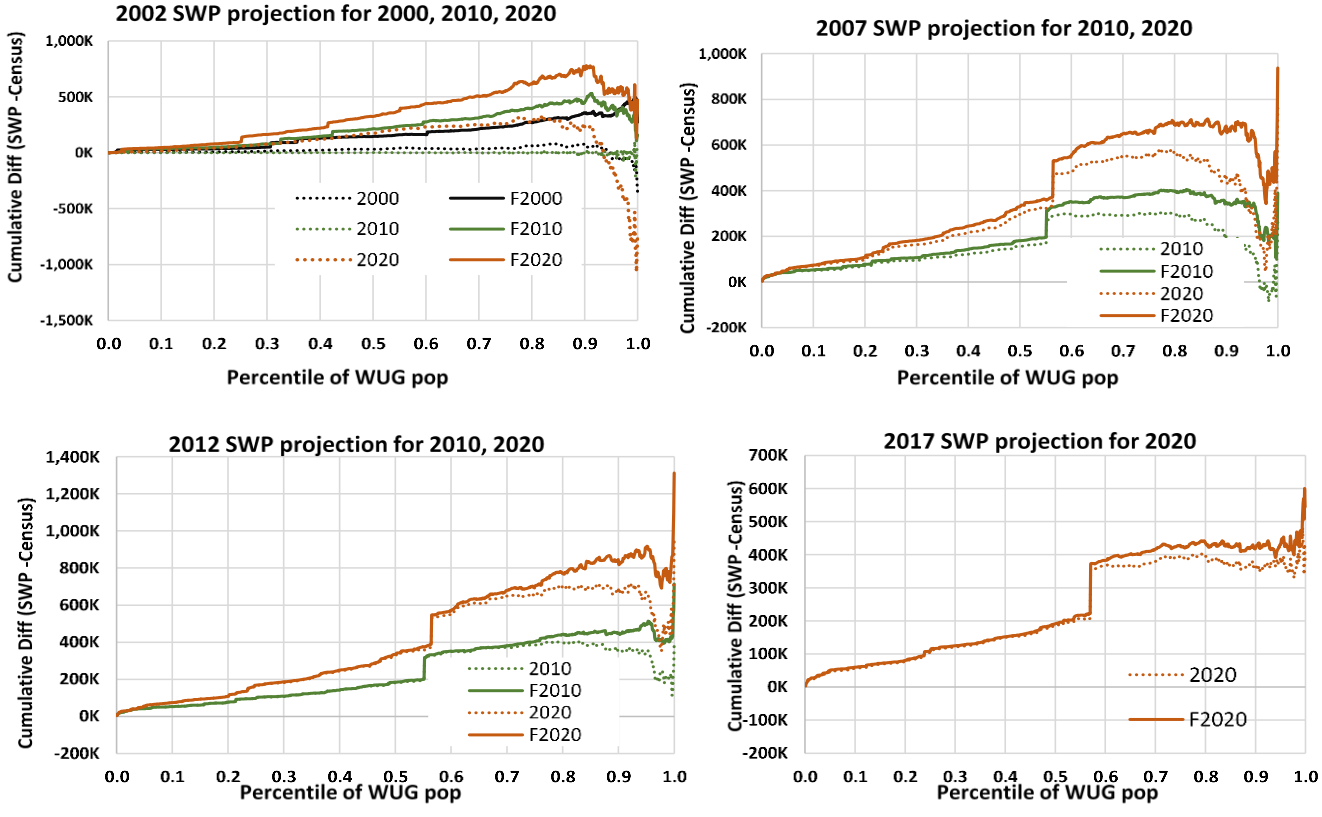

Figure 2. The graphs illustrate the cumulative difference between draft (D) and final (F) population projections minus Census for the WUGs against the percentile distribution of WUG populations. Note: There is an inconsistency in WUG data between the draft/final figures and the Census population, resulting in an apparent abrupt change at about 56% (NORTH ALAMO WSC).

Subtask 2.5:

Accuracy of urban versus rural populations per TWDB's definition Texas Water Code Ch. 15.001(14):

a) Counties where the population is less than 50,000.

b) WUGs where the population is 10,000 or less and does not overlap an urban area, as defined by the U.S. Census Bureau in 41 CFR 102-83.80.

c) Other utility size thresholds as determined appropriate and in line with uniform reporting requirements across the state (small, medium, medium-large, large, and metropolitan categories[1]).

Data were analyzed Brown, Guadalupe, Jim Wells, Lubbock, and Rockwall counties. WUGs in these counties were classified as urban or rural. Population and water demand projections were compared. Percentage differences in population projections were greater in rural WUGS than in urban WUGs.

Special focus on County-Other WUG population projections.

We have not initiated this work.

Subtask 3. Accuracy of state and regional water plans' municipal demand projections (with consideration of drought supply planning)

Status: We consider Subtask 3 to be 40% complete.

[1] https://www.twdb.texas.gov/publications/reports/special_legislative_reports/doc/Water-Use-of-Texas-Water-Utilities-87th-Legislative.pdf?d=7743.300000071526

Subtask 3.1

Temporal analysis of projected municipal demand considering the various factors of municipal water use:

a) Residential

b) Per capita

We have assessed municipal demand projections at state, RWPA, county, and WUG levels.

Subtask 3.2:

2) Analysis results from various geographic levels: State, regions, counties, select WUGs.

Analysis of Texas water demand projections revealed variations between projected and net-use estimates across planning periods. At the scale of the **RWPAs**, the absolute differences were generally highest for Region C for most planning periods but percent differences were greater for many other regions. The differences increased with the projection period length. For example, the difference for Region C increased by a factor of 10 for projections for 2000 to 2020 based on 2002 projected population and demand. Percent differences were < 40% for all RWPAs for the 2017 projection of 2020.

At the **county** level, water demand was overestimated for all the projections with the level of cumulative overestimation increasing with the length of the projection period (Fig. 4). The reliability of the water demand projections improved with time as seen from the 2002 versus 2017 projections (Fig. 4).

The water demand projections followed a pattern similar to the population projections. In the 2002 planning period, estimates for the year 2000 were relatively close to observed values, while projections for 2020 showed much larger deviations (Fig. 4). This trend indicates that the uncertainty observed in long-term population forecasts was carried over into water demand projections

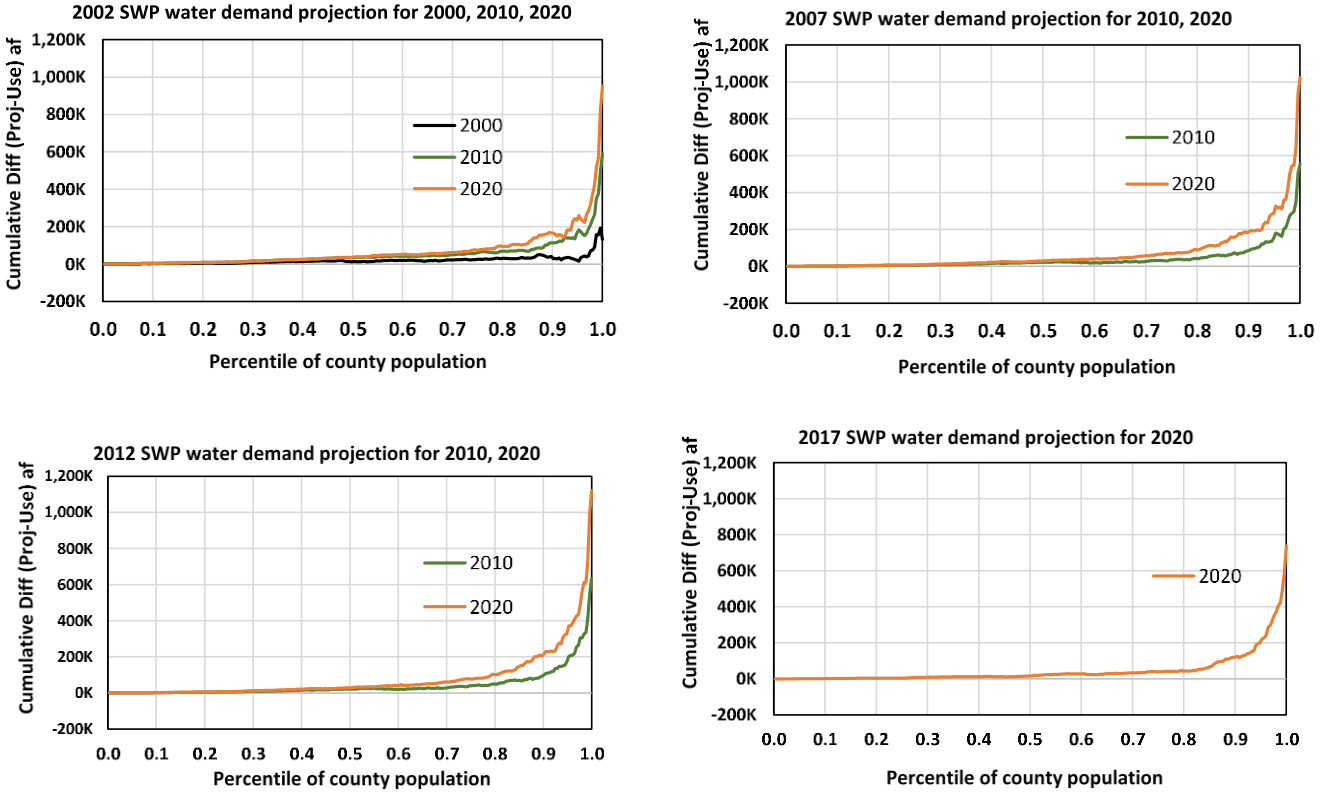

Figure 4: The graphs display the cumulative differences between projected water demand and actual net water use across counties against the percentile distribution of county populations. A similar set of analyses and visualizations has been developed for Water User Groups (WUGs) to identify projection accuracy and usage trends at WUG level.

Subtask 3.3: Evaluation of urbanization and impacts on GPCD using USGS land use change data.

This subtask has not been initiated.

Subtask 3.4: Accuracy of urban vs rural water use.

a) Counties where the population is less than 50,000.
b) WUGs where the population is 10,000 or less and does not overlap an urban area, as defined by the U.S. Census Bureau in 41 CFR 102-83.80.
c) Other utility size thresholds as determined appropriate and in line with uniform reporting requirements across the state (small, medium, medium-large, large, and metropolitan categories).

Data were analyzed Brown, Guadalupe, Jim Wells, Lubbock, and Rockwall counties. WUGs in these counties were classified as urban or rural. Water demand projections were compared. There was no systematic variation in water use projections for urban vs rural WUGs.

We selected six major cities and conducted a time-series analysis of actual population, GPCD, and total water use. This approach allowed us to explore the relationships among these three components and identify trends and patterns in urban water demand.

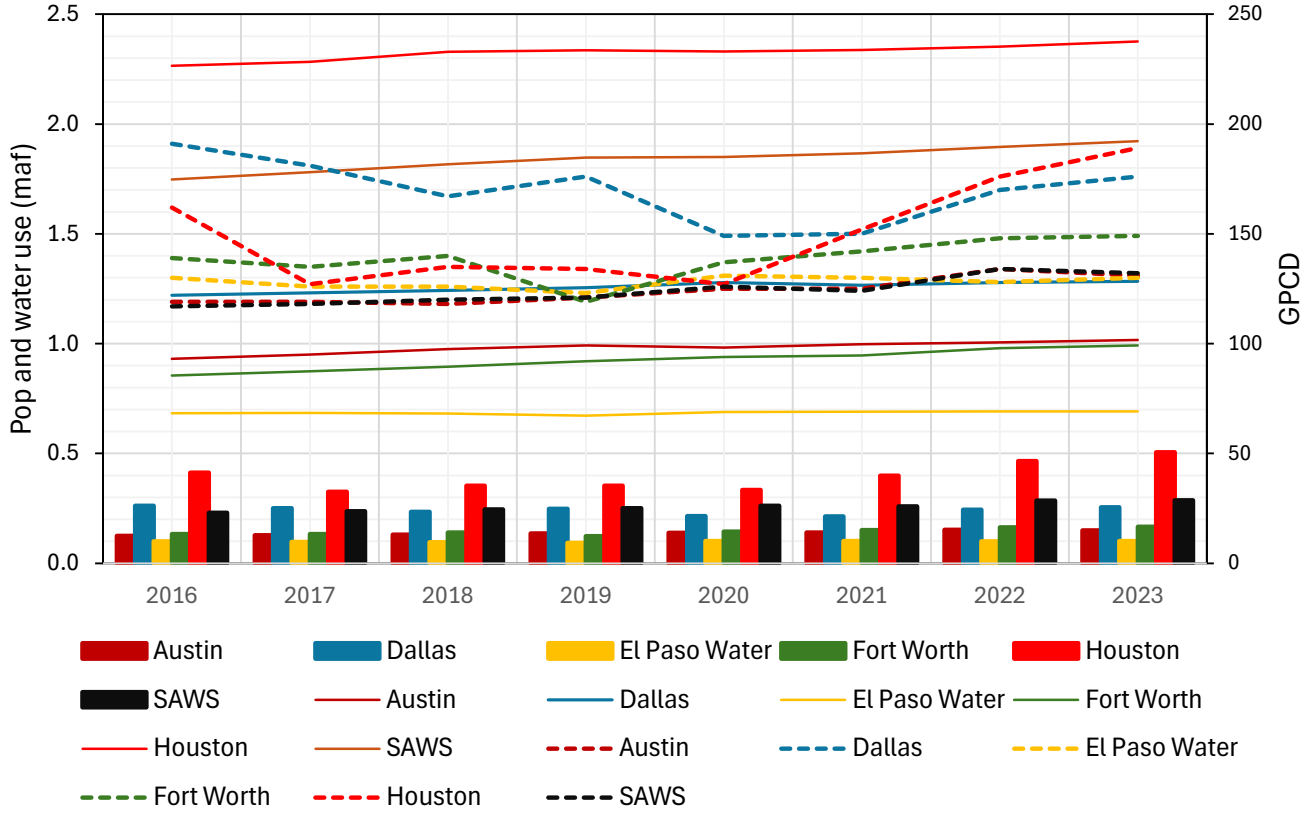

Figure 5. Population (millions, solid line), water use (maf, block), and GPCD (dashed line).
Data source: (https://www3.twdb.texas.gov/apps/reports/WU_REP/SumFinal_UtilityWUGSum)

There is no systematic pattern in GPCD over time in these cities. Houston shows a large increase from 2000 – 2023 and also a population increase.

Subtask 3.5: Special focus on the accuracy of the municipal water demand projections compared to the historical estimates for County-Other WUGs.
We have not initiated this subtask.

Subtask 3.6: Statistical analysis documentation and outcome: Degree/margin of error, confidence level in the accuracy of the projections at each geographic level.

The degree of uncertainty, margin of error, and confidence level in the accuracy of projections at RWPA, county, and WUG level have been analyzed and documented.

Subtask 3.7: Comparison to the margin of error identified in Subtask 2 for same geographic levels (i.e., compare margin of error in population projections to margin of error in municipal demand projections).
We have documented the margin error for water use and the next step will be to compare it with the population margin error.

We have not initiated this subtask.

Subtask 4. Quantifiable margin of error translated to reasonable degree of uncertainty:

This task has not been initiated.

Subtask 4. Recommendations to improve future accuracy of projections.

This task has not been initiated.