Review of Amador Water Agency's Long-Term Needs and Water Supply Study

Prepared for Foothill Conservancy

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The Pacific Institute is a global water think tank that provides science-based thought leadership with active outreach to assist local, national, and international efforts in developing sustainable water policies. The Institute has worked with numerous state agencies, utilities, communities, businesses and communities advance sustainable water policies and deliver meaningful results such as:

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- Creating the first assessment and warning to policy makers of the dangers of climate change for fresh water supplies.
- Pioneering and promoting the "soft path" to water concept, which calls for a new and comprehensive approach for managing water infrastructure, demands, and institutions.

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Introduction

Portions of the Mokelumne River are being considered for a Wild and Scenic River designation as part of California Assembly Bill 142 (AB 142, 2015). As required by the Bill, the California Natural Resources Agency (CNRA) is collecting information on the "potential effects of the proposed designation on future water requirements." In July 2017, the Amador Water Agency (AWA) submitted a Long-Term Needs and Water Supply Study (LTNS) for the Agency's service area to the CNRA to inform the Wild and Scenic decision-making process. The LTNS concluded that AWA's future water demand would likely require additional resources from the Mokelumne River. The Foothill Conservancy, a 501(c)(3) nonprofit corporation focusing on preserving Amador and Calaveras County environments, asked Pacific Institute to review AWA's LTNS and provide recommendations to improve their long-term demand forecasting. This report provides that review.

AWA serves two large areas with water from the Mokelumne River: the Amador Water System (AWS), which provides treated and untreated (raw) water to cities and customers in the "down-country" communities of Amador County, and the Central Amador Water Project (CAWP), which provides both wholesale and retail water within the "up-country" communities of Amador County. There are two additional service areas, La Mel Heights and Lake Camanche Village, which are much smaller and primarily served by groundwater.

Through its retail and wholesale water service, AWA provides water to approximately three-quarters of Amador County's population, or about 28,000 people in 2015 (14,000 people through retail service and an additional 14,000 people through wholesale service). In 2010, prior to drought restrictions, AWA used 8,400 AF of its 16,150 acre-feet per year (AFY) water rights to serve its retail and wholesale customers. While water demand declined to 5,976 AF in 2015 due to drought restrictions, it may have experienced some rebound since restrictions were lifted.

AWA conducted an analysis of its long-term water needs, defined in the LTNS as water demand in Amador County at complete buildout, which they estimated to occur in the year 2100. The study used a basic extrapolation method based on land use designations and applied correction factors to account for the impacts of water conservation and efficiency improvements and climate change on future demand.

To forecast demand, the county area was separated into three categories: (1) current areas of service, (2) future areas of service within CAWP, and (3) remaining county areas. Land-use designations in each area were compiled from City and County general plans to calculate water use per acre within the major classes of water users: residential; commercial, industrial, institutional (CII); and agriculture. Projected water system losses were then added as a percent of total demand for the major classes of water users. Analytical methods for each of these classes will be discussed in more detail below and are summarized in Appendix A.

Based on this analysis, AWA estimated that the population served would increase from 28,000 people in 2015 to between 77,000 and 96,000 people at buildout. Without conservation measures, water use is forecasted to rise from 8,400 AFY in 2010 to 34,000 AFY at buildout (Figure 1). The study projects that conservation is expected to reduce annual demand at buildout by approximately 5,000 AFY, while climate change is expected to increase annual demand by 4,000 AFY, such that total demand at buildout is estimated at 30,000 – 33,000 AFY.

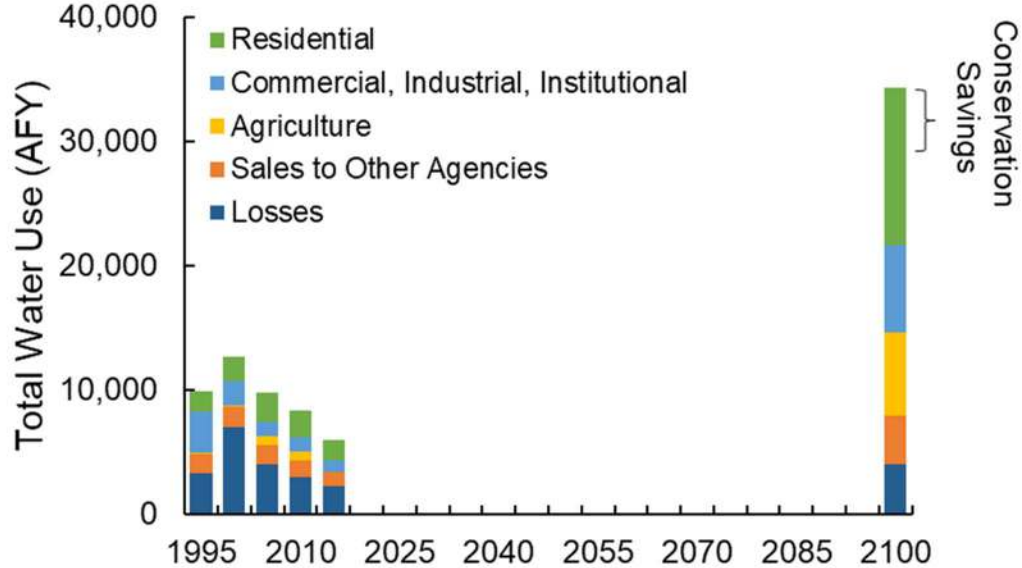

Figure 1. Total annual water use, in acre-feet per year (AFY), by sector within the Amador Water Agency (AWA) service area
Note: Residential, CII, and agricultural uses are defined within the AWA service area. Sales to other agencies are primarily residential but may include water for each of the other uses as well. Data Source: Data compiled from LTNS 2017 and the 2015 UWMP, Amador Water Agency (2016).

In our review of AWA's demand forecast, we examined the LTNS as well as AWA's 2005, 2010, and 2015 Urban Water Management Plans (UWMPs). We identified several inconsistencies within these documents with respect to the methodologies used, water deliveries reported, and past and future population reported. These inconsistencies, along with a lack of supporting information, made it difficult to carefully examine all elements of the demand forecast. Despite this limitation, our analysis finds several critical deficiencies that affect the assessment of future water demand and availability of additional supplies to meet that demand. These include:

1. The LTNS estimates population and growth beyond what is reasonably likely to occur, using a time horizon (forecasting to the year 2100) that is far beyond what is considered commonly-accepted practice by demand forecasters.

2. For the residential sector, the LTNS underestimates the effects of existing standards and codes, as well as utility conservation programs, which will greatly reduce indoor and outdoor water demand beyond what is captured in the conservation analysis.

3. For the nonresidential sector, the water demand factors used for agricultural crops are too high for Amador County, resulting in an overestimate of future water demand. In addition, the LTNS fails to include opportunities for water conservation and efficiency improvements for agricultural, commercial, institutional, and industrial customers.

These deficiencies are discussed in more detail below.

Key Issue 1: Forecasting to Buildout

The LTNS forecasts population and land use to 2100, when they estimate buildout is likely to occur. The LTNS uses a population estimate of between 77,000 and 96,000 people at buildout in 2100. It is unclear if this population is defined in the LTNS as the total county population or the population served. Regardless, AWA assumes that they will serve 95% of the new Amador County population in the future and thus at buildout, AWA predicts they will serve nearly all of the residential water needs in the County (Amador Water Agency 2016).

While Amador County experienced rapid population growth between 1970 and 2000, population growth has slowed over the past 15 years. The population even declined between 2010 and 2015. The Department of Finance (DOF) expects growth in Amador County to increase by between 0.2 and 0.7% per year through 2060 (Ca DOF, 2017; Figure 2).

The projected population at buildout (between 77,000 and 96,000 people) is significantly higher than estimates from other sources (Figure 2). For example, extrapolating the 2017 Department of Finance (DOF) projections for the county would result in a county-wide population of 48,000 in 2100. Likewise, extrapolating AWA's 2015 UWMP projection for 2040 UWMP would yield a population of 61,000.

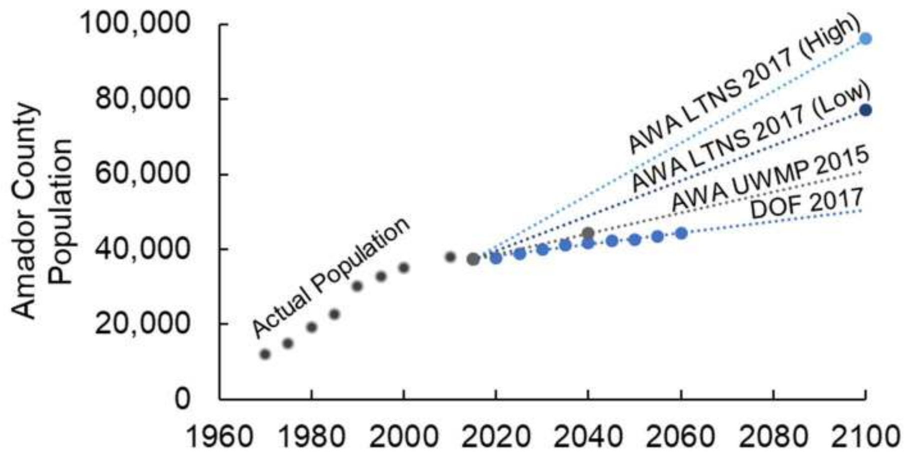

Figure 2. Amador County Population and projections from the LTNS (high projection and low projection), AWA's 2015 UWMP, and the Department of Finance (DOF).
Data Sources: AWA (2015) and Ca DOF (2017)

Further, other agencies in Amador County are not planning for the growth projected in the LTNS, but rather all rely on the DOF population projections for planning. In their 2015 regional transportation plan, Amador County Transportation Commission is currently planning for a 2035 population of only 43,150 people in Amador County, based on the California DOF projections (ACTC 2015). Similarly, according to the Amador County General Plan, the County is focused on ensuring community services and education based on the DOF's projected 2030 population (Amador County General Plan, 2016). It is unreasonable for AWA to forecast their demand at more than double the growth rate that is being planned for by other agencies.

The American Water Works Association suggests that population forecasts for water demand forecasts should include the following characteristics:

- include high, medium, and low variants or a confidence interval;
- be based on information from sources such as birth and death records, school enrollment, and utility connections;
- be consistent with other regional and national forecasts, and acknowledge demographic changes, such as aging of the population or projected changes in migration or birth rates;
- if the forecast does not include these above elements, it should explain why; and
- acknowledge the higher potential for variability, if the forecast is for a small area.

While the LTNS was based on the assumption that "ultimate demand will occur at buildout regardless of the date," the most recent Amador County General Plan (2016) states that "full build-out of the land use designations in the General Plan is not likely to occur" for several reasons. These include:

- existing development is not likely to be replaced by new, more dense development;
- there is low likelihood that population will continue to grow by historic growth rates; and
- water system constraints, including limitations on water treatment, conveyance, wastewater collection, and wastewater treatment systems.

Based on our analysis, we conclude that buildout is not likely to occur in Amador County and is very unlikely to occur within a reasonable planning horizon. **The combination of high population projections in 2100 or at buildout in addition to errors in estimating future per capita demand (described in more detail in the following section) has led to a vastly overestimated future water demand.** AWA should forecast population growth (and associated water use) based on existing planning documents and population growth projections from reputable sources. If the population was extrapolated based on the DOF population (48,000 people) as opposed to buildout population (97,000), the total residential demand in 2100 would be 8,000 AFY, half of what is reported in the LTNS.

Finally, the time horizon selected for this study (forecasting to the year 2100) is far beyond what is considered commonly-accepted practice by demand forecasters. Long-term demand forecasts typically focus on 20 to 30-year time horizon, rather than the 85 years modeled in the LTNS. It is not feasible to accurately predict water demand beyond a 20- to 30-year time horizon due to a variety of factors, including changing technologies, population growth, and economic activities. As an example, imagine estimating today's water demand based on the uses of water in 1930.

Key Issue 2. Residential Water Demand

Residential water demand accounts for nearly half of the total projected future water needs for AWA in 2100. In the LTNS, residential water demand was forecasted using basic extrapolation, i.e., multiplying per capita water usage in the baseline period (2008-2013) in each service area by future population within that service area. Baseline water usage was between 124 and 191 gallons per capita per day (gpcd) (Table 1). This was then multiplied by the projected population in each area, yielding a total expected residential demand of 16,500 AFY. By comparison, residential water use between 2005 and 2010 was approximately 4,000 AFY, including single family, multi-family, and sales to other agencies (Amador Water Agency 2016, Table 4-1).

Table 1. Baseline per capita water usage and projected population for each service area.

	Average Baseline GPCD (2008 – 2013)[a]	LTNS Projected Population in 2100[b]	Water Demand (AFY)[c]
AWS Retail and Wholesale	161	40,000	7,000
CAWP Retail and Wholesale	132	23,000	3,400
La Mel Heights	191	60	12
Lake Camanche Village	124	3,000	460
Remaining County Area (Weighted Average of 2008 –2013 GPCD)	155	31,000	5,400
		97,000	16,500

Data Source: (a) LTNS 2017, Appendix A, Table 2, Pg 9; (b) Projected population calculated based on reported gpcd and water demand (AFY); (c) LTNS 2017, Appendix A, Table 3, Pg 10.

The basic extrapolation method is a simple analysis that requires little data and provides only a very cursory understanding of future demand. To account for future conservation savings, AWA applied a correction factor to the projected total water demand in 2100. The correction factors for residential indoor and outdoor water uses were based on estimates developed by the state agencies on expected savings in the year 2020 from the fulfillment of SBx7-7. The analysts calculated the difference between the 2008 – 2013 baseline water usage from the land use analysis (152 gpcd) and their expected residential per capita water use target in 2020 under SBx7-7 (107 gpcd). This difference of 45 gpcd (152 gpcd -107 gpcd) was then multiplied by the expected future population (97,000 people) and resulted in an expected savings of approximately 5,000 AFY. Using this approach, in 2100, residential per capita water use is projected to be 107 gpcd, of which indoor usage is 52.5 gpcd and outdoor usage is 54.5 gpcd. As described below, the estimates for both future indoor and outdoor water use are too high, inflating future residential water demand.

Indoor Residential Water Conservation

According to the LTNS, indoor residential water usage in 2100 is estimated at 52.5 gpcd. This estimate fails to adequately account for the impact of existing statewide and federal standards requiring more efficient appliances and fixtures. Due to existing California codes and standards, new homes must be equipped with water-efficient devices, such as toilets that use 1.28 gallons per flush (gpf) or less and showerheads that use 2.0 gallons per minute (gpm) or less. As devices in existing homes wear out, they must be replaced by more efficient models that meet these new standards. By 2100, it is reasonable to assume that all homes within Amador County will be equipped with devices that meet current standards. Based on our calculations, indoor water use for someone living in a home equipped with appliances and fixtures that meet current California standards would be less than 40 gpcd (Table 2).

Table 2. Estimated indoor water usage with California standard appliances and fixtures.

End Use	Use Behavior[a]	California Standard	Total Water Use (gpcd)
Toilets	5.6 flushes pcd	1.28 gpf	6
Showers	0.7 showers pcd x 8 minutes	2.0 gpm[b]	11
Faucet	20 uses pcd x 0.5 minutes per use	1.2 gpm	12
Clothes Washer	0.3 uses pcd	30 gal per cycle[c]	6
Dishwasher	0.1 uses pcd	5.0 gal per cycle	1
Baths	0.06 uses pcd	20 gal per event[d]	1
Total			**38**

Note: Units are per capita per day (pcd), gallons per flush (gpf), gallons per minute (gpm), and gallons per capita per day (gpcd)
(a) Use behavior determined as median uses in the Residential End Uses of Water (REUWS) 2016 study (DeOreo et al. 2016);
(b) Showerhead standard is currently 2.0 gpm, but will be reduced in July 2018 to 1.8 gpm;
(c) Standard front-loading clothes washers require 4.7 gallons per cubic feet, and we assumed an average clothes washer size of 4.5 cubic feet based on available clothes washer market sales data.
(d) No bathtub volume standard exists so median water usage was used from the REUWS 2016.

Furthermore, there are numerous devices on the market that exceed current standards, and additional technological improvements are likely. Manufacturers in the water sector use the term “ultra-high efficiency” to refer to devices that are more efficient than the minimum product criteria of WaterSense or ENERGY STAR. Table 3 provides flow rates for devices meeting current California standards and more stringent WaterSense or ENERGY STAR criteria; it also includes the next generation of ultra-high efficiency devices. Most notably, residential ultra-high efficiency clothes washers use 30% less than ENERGY STAR-labeled front-loading clothes washers and 40% less than California standard top-loading models.

Moreover, there are new, emerging water technologies that can dramatically improve water-use efficiency beyond what was previously thought possible. In 1957, the *National Plumbing Code Handbook* suggested a theoretical minimum for toilet efficiency of 2.6 gallons per flush (Manas 1957; Whitford 1972). The standard toilet in California now uses 1.28 gpf. We have obviously surpassed this "theoretical minimum" and continue to improve device efficiencies beyond expectations. Devices that represent the cutting-edge technology of today are likely to become tomorrow's standards and be present in homes in the year 2100.

Table 3. Comparisons of ultra-high efficiency, high efficiency, and current California Standard water use rates for indoor residential devices.

	Units	California Standards	WaterSense or ENERGY STAR minimum efficiency requirement [(a)]	Ultra-high efficiency [(b)]
Single-flush toilets	gpf	1.28	1.28	0.8
Showerheads [(c)]	gpm	2.0	2.0	0.75
Bathroom faucets	gpm	1.2	1.5	1.0
Residential clothes washers [(d)]	gallons per cycle per ft^3	4.7 (front- load) 6.5 (top-load)	3.7 (front-load) 4.3 (top-load)	2.6
Residential dishwashers [(e)]	gallons per cycle	5.0	3.5	1.95

Notes: Units are in gallons per flush (gpf) and gallons per minute (gpm), and cubic foot (ft^3).
(a) Data on high efficiency devices are based on the minimum criteria of WaterSense (i.e., toilets, urinals, showerheads, faucets, and pre-rinse spray valves) and Energy Star (i.e., clothes washers, dishwashers, and ice makers);
(b) Ultra-high efficiency device flow rates are based on the most efficient WaterSense or Energy Star certified devices, provided by WaterSense Product Search (https://www.epa.gov/watersense/product-search);
(c) ultra-high efficiency showerheads use atomized water spray;
(d) Federal standards for residential top-loading washers, and commercial top-loading and front-loading washers are effective beginning January 1, 2018; front loading capacity is > 2.5 cu.ft.;
(e) standard, ≥ 8 place settings;

Outdoor Residential Water Conservation

In the LTNS, outdoor water usage with efficiency savings is estimated to be 54 gpcd, based on a 20% reduction in current outdoor water use for existing developments. This factor is applied to current and future developments. However, outdoor water usage is likely to decline beyond this level due, in part, to changes in the model Water Efficient Landscape Ordinance, or MWELO, that were adopted in 2015.

California has been a leader in developing water efficiency standards for lawns and landscapes, beginning in 1990 with the passage of the Water Efficient Landscape Ordinance (AB 325). The current version of this law, adopted in 2006 and amended in 2015, requires cities and counties to set water-efficiency requirements for landscapes over a certain size threshold. The ordinance discourages large areas of lawn and encourages water-efficient plants by limiting the amount of water that can be applied to the landscape based on the region's climate (DWR 2016). It also requires water-saving measures, including high-efficiency sprinklers and pressure regulators. MWELO initially targeted larger landscapes greater than 2,500 square feet. However, it was updated in 2015 to apply to all new construction for residential and non-residential landscapes that are greater than 500 square feet and require a building or landscaping permit, as well as rehabilitated landscapes that are greater than 2,500 square feet and require a permit. To comply with the MWELO, new and large rehabilitated landscapes must meet a water budget that is based on a 0.55 ETo standard for residential landscapes and a 0.45 ETo standard for non-residential landscapes. Using this standard, the allowable water for future residential developments can be calculated by the following equation:

$$\text{Max allowable water usage (gal/yr)} = 0.55 * \text{ETo (ft/yr)} * \text{Landscape Area } (\text{ft}^2) * 7.48 \text{ ft}^3/\text{gal}$$

This standard should be used in the LTNS. However, as described above, the LTNS assumes that outdoor water use for *all* residential developments in 2100 would be 54 gpcd. We calculated allowable landscaped area for each household under the new MWELO requirements. Average ETo in the region is 55.65 inches (or 4.64 ft) annually (Amador Water Agency 2016, Table 3-1). We estimate that an average household with 2.2 people using 54 gpcd for outdoor landscaping would require a landscaped area of 0.05 acres. In medium-density areas in the county, however, maximum buildout would result in 25 dwelling units per acre, or approximately 0.04 acres per dwelling. Thus, in order to use 54 gpcd for outdoor landscaping, the total landscaped area would exceed the total area of the parcel. This suggests that a water use factor of 54 gpcd for new developments is too high and results in an overestimate of future water use. Analysts must consider how outdoor water use will change with increasing residential density and implementation of the MWELO.

All of the aforementioned corrections for both indoor and outdoor residential water usage only include passive conservation that will occur, regardless of AWA's intervention. There is also ample opportunity for active conservation in AWA's service area. For example, landscape conversions could be pursued in existing developments, thereby reducing water use further.

To improve demand forecasting within the residential sector, we recommend that AWA include the following:

- Given the long time horizon, the Agency can reasonably assume that all households will contain devices and appliances that, at a minimum, meet current standards. Indoor water demand in all developments should be projected using the water use rate for a home equipped with appliances and fixtures meeting current standards.
- The forecast should separately address outdoor water demand from future and existing developments. Outdoor water demand in developments built after 2015 should be based on the MWELO standard and consider increased residential density that is likely to occur at buildout.
- The forecasts should examine multiple scenarios that may affect total residential water demand, including for example, households that go beyond existing water efficiency codes and/or conversion of existing water-intensive irrigated landscapes with drought tolerant landscapes.

Key Issue 3: Agricultural Sector and Commercial, Industrial, and Institutional Sector

Agricultural Sector

To project future agricultural water demand, the LTNS estimates future water use for agricultural areas within the existing service area, as well as 10% of land uses designated as "Agricultural Transition" areas within the AWA and CAWP service areas.[1] Additional agricultural area within the CAWP service area and outside of the existing and CAWP extent were not considered. The proportion of land area devoted to each crop was based on the distribution of crops in Amador County in 2014. A water factor (AF/ac) for each crop, using DWR calculations of the statewide average amount of water applied for irrigated cropland in California in 2010, was then multiplied by the crop land area. The analysts acknowledged that not all agricultural plots are irrigated each year and therefore multiplied crop demand by 33% to account for non-irrigated lands.

Agricultural water demand does not currently represent a large portion of AWA's total water demand but is projected to grow dramatically. Between 1995 and 2015, AWA supplied, on average, 321 AFY to agriculture. These values vary widely, ranging from 14 AFY in 2015 to 697

[1] These agricultural transition areas represent a land use that is primarily rural residential but may also contain some small-scale agriculture.

AFY in 2005. In the 2015 UWMP, AWA projected that, agricultural water use in 2040 would reach 424 AFY.

At buildout, the total agricultural area is estimated at 7,930 acres (6,724 acres in agricultural areas and an additional 348 and 858 acres within agricultural transition areas in the AWA and CAWP service areas, respectively). By contrast, the LTNS projects that agricultural water demand (including agriculture within agricultural transition areas) at buildout would reach 6,700 AFY, more than 20 times average agricultural water demand over the past 20 years.

The assumptions made for the agricultural analysis overestimate future water use. First, the analysts selected average crop water demand factors for all of California rather than factors specifically for Amador County. The average statewide factors are higher than crop water demand factors for Amador County, thereby inflating the water required to support these crops. Table 4 compares average water demand factors for California and for Amador County. The area-weighted water demand factor for Amador County is 28% less than the statewide average. Using the correct water demand factors for Amador County would reduce total agricultural water demand by 28% at buildout.

Second, as was stated previously, buildout in any sector is not likely to occur. An increase in agricultural water use has not previously been included in AWA's demand forecasts. The LTNS forecasts a 16-fold increase in agricultural water usage at buildout compared to their 2040 projection. Yet, AWA stated in the 2015 UWMP: "there is not enough information currently available to include this potential future [agricultural] demand in this UWMP" (Amador Water Agency 2016). The uncertainty in agricultural demand should be acknowledged in the LTNS.

Finally, the percent of irrigated lands that is projected has not been adequately justified. Currently, 95% of Amador County agricultural lands are non-irrigated pasture. Yet, at buildout, AWA assumes that 33% of land will include irrigated crops that match the current distribution of irrigated crops in the wider region. No information is provided to justify the increase from 5% to 33% in irrigated cropland.

Table 4. Amador County crop acreage in 2014 and comparison of DWR water demand factors (AF/ac) from a statewide average and water demand factor (AF/ac) for Amador County.

2014 Amador Crop Type[a]	Current Acres (County-Wide)[a]	DWR Water Demand Factor – Ca State Average (AF/ac)[a]	DWR Water Demand Factor – Amador County (AF/ac)[b]
Wine Grapes	3,899	1.86	1.07
Walnuts	239	3.30	2.72
Misc (Olive Oil, Kiwis)	101	3.12	No Data Available
Hay, Alfalfa	451	5.05	3.36
Hay, Grain (Wheat For/Fod, Oats For/Fod)	903	1.39	0.87
Hay, Other (Dry Land Hay, Ryegrass For/Fod)	458	1.39	0.87
Pasture Irrigated	2,050	4.05	3.27
Misc Crops (Sudan Grass, Corn For/Fod)	316	2.72	No Data Available
Weighted Average		2.52 AF/ac	1.83 AF/ac

Source: (a) LTNS Appendix A, Table 8, Page 17; (b) Ca DWR 2016

Commercial, Industrial, and Institutional (CII)

The land uses within the commercial, industrial, and institutional (CII) sector vary widely and include parks and recreation, light industrial, mineral resource zone, and office commercial. Each of the land uses was categorized in the LTNS as either commercial, industrial, institutional, or irrigation. Water demand factors (AF/ac) were calculated for each category based on average consumption per acre for account types in the region. Because there was only one industrial account, a water demand factor from an alternate source was used. Additionally, an irrigation water factor was selected from the Calaveras UWMP 2015. The water demand factors were applied to the categorized land uses.

The LTNS does not include any conservation factors in the non-residential areas because, as the authors state, it is unknown and there are no current requirements at the State level. This is incorrect. There are state and federal requirements for the CII sectors that affect water usage, including standards for toilets, urinals, dishwashers, clothes washers, and pre-rinse spray valves. As efficient devices replace older, less efficient devices, the overall water usage from these water uses could decline. Additionally, as described previously, outdoor water usage in new CII developments in the region will be subject to the MWELO, which sets the total allowable water usage for outdoor landscapes at 0.45 x ETo.

Furthermore, newly proposed legislation will further reduce water usage in the CII sector. Per current legislation, a set of practices will be required for commercial, industrial, and institutional users. These include installing dedicated irrigation meters on landscapes over a certain size, developing water management plans for large water users, and applying an outdoor water budget to existing landscapes on dedicated irrigation meters. While not yet adopted, these requirements should be acknowledged within the LTNS.

To improve demand forecasting for the CII sector, CII water users should be examined independently to determine water use by specific industries and trends over time. For example, the Mule Creek State Prison (MCSP) is the only current industrial demand in AWA's service region. MCSP is a large water user in AWA's service area, but the LTNS does not examine changing water usage at this facility and its impact on overall water demand. In 2016, the MCSP completed an additional 1,584 bed complex located near its 2400-bed existing facility. The buildings were designed with LEED Silver certification, including low-flow water fixtures. Based on the Draft Environmental Impact Report (DEIR) for the project, water use at the facility at buildout will be 670 AFY (CDCR 2013). Existing information from the DEIR was not considered for forecasting water use within the CII sector.

AWA should separate the CII water usage into additional sub-categories, including schools, hotels, laundromats, retail, restaurants, and hospitals. Water uses can vary dramatically between these sub-categories and many of these have opportunities for improved water efficiency. By applying a generic water demand factor to broad land use categories, it is nearly impossible to examine how changing standards and efficiency can affect water demand.

To improve forecasting in non-residential water uses, we recommend the following:

- AWA must include available crop water demand factors that are appropriate for Amador County, rather than for California on average. This will lead to a 28% decrease in projected agricultural water use.
- AWA should examine trends in agricultural water use and multiple scenarios that include both the current buildout projection of water use for agriculture, as well as

changing crops and irrigation land over time. These scenarios should consider the impact of water price on use of agricultural lands.

- AWA should examine trends in CII water use within their service area, including the impact of standards and codes on existing and new development. AWA should incorporate available information on water use from their largest users (i.e., MCSP).

Conclusions

Amador Water Agency's demand forecast is inadequate, and several assumptions are likely to overestimate future water demand. The time horizon of the LTNS forecast is beyond what is considered commonly-accepted demand forecasting practice. In addition, the assumption that Amador County will reach buildout is unreasonable. Furthermore, for the residential sector, the LTNS underestimates the impact of conservation and efficiency on per capita water demand and ignores existing standards, codes, and ordinances that affect new development. For the nonresidential sector, the water demand factors used for agricultural crops are too high for Amador County and lead to a substantial overestimation of future agricultural demand. In addition, the LTNS does not include opportunities for conservation and efficiency improvements in the non-residential sectors.

Substantial work has been done in the Mokelumne region, especially through the Mokelumne Watershed Interregional Sustainability Evaluation (MokeWISE) Program. As part of MokeWISE, the AWA signed a Memorandum of Understanding (MOU) to examine and develop sustainable solutions to meet water supply and other regional water needs (MokeWISE Final Report, 2015). Supply and conservation projects to reduce future water demand from the Mokelumne River were discussed throughout the MokeWISE process and should be examined in more detail.

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Appendix A. Summary of Long Term Water Needs and Supply Study Methodology

Source: Data compiled from LTNS 2017

Sector and County Area Categories		Methodology	Total Demand at Buildout (AFY)
Residential			
	Existing Service Area	Area * Dwelling/Acre * People/Dwelling * R-GPCD; Dwelling/Acre defined in LNTS Appen A, Table 1; People/Dwelling determined from 2010 US Census Data; R-GPCD defined by service area in Appendix A, Table 2; County R-GPCD calculated as weighted average	9,694
	Future CAWP Development		1,385
	Remaining County Area		5,440
	Total		**16,519**
Commercial, Industrial, and Institutional			
	Existing Service Area	Land uses were reclassified as commercial, industrial, institutional, or agricultural; Water usage from current accounts was averaged to determine WF (AF/ac), Industrial WF from Sacramento Valley; Irrigation WF from Calaveras UWMP, 2015.	1,844
	Future CAWP Development		435
	Remaining County Area		4,799
	Total		**7,078**
Agricultural			
	Existing Service Area	Ag Land Area * 33% irrigated * Ca DWR WF (AF/ac); 6,724 acres, WF = 2.6	5,648
	Future CAWP Development	Not included	-
	Remaining County Area	Not included	-
	Total		**5,648**
Agricultural Transition			
	Existing Service Area	10% of land area assumed as agriculture and calculated with agricultural methodology. 3,478 ac in existing service area, 8,583 ac in future CAWP development; WF = 2.6	292
	Future CAWP Development		721
	Remaining County Area	Not included	-
	Total		**1,013**
Losses			
	Existing Service Area	Calculated as % of total demand	1,904
	Future CAWP Development		542
	Remaining County Area		1,609
	Total		**4,055**
Total			**34,313**