WATER SUPPLY EVALUATION STUDY

ConnectMenlo – General Plan and M-2 Area Zoning Update
Menlo Park, California

Prepared for:
City of Menlo Park

Prepared by:
Erler & Kalinowski, Inc.

3 February 2016

EKI B50071.00

Water Supply Evaluation Study
ConnectMenlo – General Plan and M-2 Area Zoning Update
Menlo Park, California

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

FIGURES

TABLES

APPENDICES

1 INTRODUCTION

Erler and Kalinowski, Inc. ("EKI") is pleased to present this water supply evaluation study ("WSE Study") in support of the proposed update to the Menlo Park General Plan Land Use & Circulation Elements and the M-2 Area Zoning, collectively known as "ConnectMenlo," for the City of Menlo Park, California (the "City"; see Figure 1).

The City's current General Plan Land Use and Circulation Elements were last updated in 1994 and include outdated land use and traffic projections. The purpose of ConnectMenlo is to update the Land Use and Circulation Elements of the City's General Plan, with a particular geographical focus on the Bayfront Area (also known as the "M-2 Zoning Area"; see Figure 2), and to update the zoning provisions to reflect the proposed land use changes within the Bayfront Area. These updates to the General Plan are being analyzed in the ConnectMenlo Program Environmental Impact Report ("PEIR"; PlaceWorks, 2015).

Changes in land use within the Bayfront Area are the subject of this WSE Study. For the purposes of this WSE Study and per the PEIR, the "proposed Project" includes a maximum potential net increase in new development north of Highway 101 in the Bayfront Area of approximately:

- 2.3 million non-residential square feet, including offices, life-sciences buildings, and other commercial uses;
- 400 hotel rooms;
- 4,500 multi-family residential units;
- Two transit centers; and
- Up to 61 acres of landscaped open space.

As described in Section 2, a Water Supply Assessment ("WSA") is not required for the proposed Project pursuant to the California Water Code ("CWC" or "Water Code") §10910-10915. However, for informational purposes, specifically with respect to the proposed changes to the Bayfront Area, the City has voluntarily elected to prepare a WSE Study for the proposed Project that is modeled after, and in general conformance with, WSA requirements and the information requested within the California Department of Water Resource's ("DWR's") *Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001: To Assist Water Suppliers, Cities, and Counties in Integrating Water and Land Use Planning*, dated 8 October 2003. The text of specific sub-sections of the Water Code is included in indented and italicized font at the beginning of specific sections of this WSE Study. The information presented in those respective sections, and the associated tables and figures, respond directly to Water Code requirements.

Water service within the Bayfront Area is provided by the Menlo Park Municipal Water District ("MPMWD")[1]. The purpose of this WSE Study is to evaluate whether the MPMWD has sufficient water supply to meet the current and planned water demands within its service area, including the demands associated with the proposed Project, during normal and dry hydrologic years over a 20-year time horizon. More specifically, this WSE Study includes:

- A summary of the WSA requirements articulated in Water Code §10910-10915 and a description of how they have been addressed in the WSE Study prepared for the proposed Project;
- A description and analysis of the current and projected future water demands of the proposed Project through the year 2040;
- A description and analysis of the historical, current, and projected future water demands for the MPMWD service area through the year 2040;
- A description and analysis of the current and projected future water supplies for the MPMWD service area through the year 2040; and
- A comparison of the water supplies and demands for MPMWD's water service area, including the projected water demands associated with the proposed Project.

The information contained in this WSE Study is based primarily on MPMWD's 2010 Urban Water Management Plan ("UWMP"), MPMWD's draft 2015 UWMP (which is in development), information provided by the City staff, and information specific to the proposed Project (i.e., square footage of specific land uses; PlaceWorks, 2015).

This WSE Study has been prepared for the sole use and benefit of the City of Menlo Park and MPMWD. Unless specifically authorized in writing in an agreement acceptable to EKI, reliance on this WSE Study by any other entity or third party is not permitted or authorized.

[1] A portion of the Bayfront Area bounded by Highway 101, Marsh Road, and the Dumbarton Rail is served by California Water Service Company. The proposed land use changes in this area would generally reflect the same uses and intensity that is permitted under the current regulations.

2 GENERAL REQUIREMENTS FOR THE PREPARATION OF A WATER SUPPLY ASSESSMENT

The purpose of this section is to outline what types of projects require WSAs, who is responsible for their preparation, and the necessary components of a WSA.

2.1 APPLICABILITY OF SENATE BILL 610 TO THE PROJECT

Water Code Section 10910

(a) Any city or county that determines that a project, as defined in Section 10912, is subject to the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) under Section 21080 of the Public Resources Code shall comply with this part.

Water Code Section 10912

For the purposes of this part, the following terms have the following meanings:

(a) "Project" means any of the following:
- *(1) A proposed residential development of more than 500 dwelling units.*
- *(2) A proposed shopping center or business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space.*
- *(3) A proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space.*
- *(4) A proposed hotel or motel, or both, having more than 500 rooms.*
- *(5) A proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area.*
- *(6) A mixed-use project that includes one or more of the projects specified in this subdivision.*
- *(7) A project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500 dwelling unit project.*

As described in Section 1, the proposed Project includes an update to the City's current General Plan that would allow a net increase in allowable new development in the Bayfront Area. As such, this Project does not strictly meet the project definitions included in Water Code §10910(a) and 10912(a)(3). However, the City has determined that the proposed Project is subject to the California Environmental Quality Act ("CEQA") and is voluntarily preparing a WSE Study evaluation as part of the PEIR that is modeled after, and in conformance with, all WSA requirements.

2.2 RESPONSIBILITY FOR PREPARATION OF THE WSA

Water Code Section 10910

(b) The city or county, at the time that it determines whether an environmental impact report, a negative declaration, or a mitigated negative declaration is required for any project subject to the California Environmental Quality Act pursuant to Section 21080.1 of the Public Resources Code, shall identify any water system that is, or may become as a result of supplying water to the project identified pursuant to this subdivision, a public water system, as defined in Section 10912, that may supply water for the project. If the city or county is not able to identify any public water system that

may supply water for the project, the city or county shall prepare the water assessment required by this part after consulting with any entity serving domestic water supplies whose service area includes the project site, the local agency formation commission, and any public water system adjacent to the project site.

Water for the proposed Project will be supplied by the MPMWD public water system and therefore, in accordance with Water Code §10910(b), the City would be the entity responsible for completing a Project-specific WSA. However, as noted previously, a WSA is not required for the proposed Project by the Water Code. However, the City voluntarily elected to prepare this WSE Study for the proposed Project that is modeled after, and in conformance with, all WSA requirements.

2.3 COMPONENTS OF A WATER SUPPLY ASSESSMENT

Water Code Section 10910

(c) (4) If the city or county is required to comply with this part pursuant to subdivision (b), the water supply assessment for the project shall include a discussion with regard to whether the total projected water supplies, determined to be available by the city or county for the project during normal, single dry, and multiple dry water years during a 20-year projection, will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses, including agricultural and manufacturing uses.

As listed above in Water Code §10910(c)(4), the primary purpose of a WSA is to evaluate whether sufficient water supply is available to meet all future demands within the water supplier's service area, including those associated with the proposed Project, during normal and dry hydrologic years for a 20-year time horizon. In order to complete an equivalent assessment, the following information is included in this WSE Study:

- A description and analysis of the current and projected future water demands of the proposed Project through the year 2040;
- A description and analysis of the historical, current, and projected future water demands for the MPMWD service area through the year 2040;
- A description and analysis of the current and projected future water supplies for the MPMWD service area through the year 2040; and
- A comparison of the water supplies and demands for MPMWD's water service area, including the projected water demands associated with the proposed Project.

3 PROJECT DESCRIPTION

The Bayfront Area is located in the northern-most portion of the City of Menlo Park (Figure 1). Water service within the Bayfront Area is provided by MPMWD[2]. Other water suppliers within the City of Menlo Park include California Water Service Company - Bear Gulch District, O'Connor Tract Co-Operative Water Company, and Palo Alto Park Mutual Water Company.

Current land uses within the Bayfront Area include industrial and business park uses. Figure 2 shows the location of the Bayfront Area, which is generally bounded by San Francisco Bay to the north; Redwood City to the west; East Palo Alto to the southeast; and the Menlo Park neighborhoods of Belle Haven, Flood Triangle, Suburban Park, and Lorelei Manor to the south. Existing water use within the Bayfront Area is associated with office- and industrial-type activities (e.g., restrooms, process, cooling, and landscape irrigation). The proposed Project's future water demand will reflect a mixed land use and be associated with residential and commercial activities.

The proposed Project includes a maximum potential net increase in new development north of Highway 101 within the Bayfront Area of approximately:

- 2.3 million non-residential square feet, including offices, life-sciences buildings, and other commercial uses;
- 400 hotel rooms;
- 4,500 multi-family residential units;
- Two transit centers; and
- Up to 61 acres of landscaped open space[3].

As above, as part of the increase in new development, the proposed Project is anticipated to add 61 acres of landscaped open space to the Bayfront Area. Approximately 15 acres of landscaped area will be within residential lots and the remaining 46 acres of landscaped area will be dedicated to non-residential land uses including the commercial land uses, transit centers, and open space areas. However, it is noted that the City is currently in the process of drafting new zoning regulations for the Bayfront Area that may reduce the minimum required open space area in residential lots from what was analyzed, thus reducing the outdoor water demand associated with the proposed Project.

Project buildout is planned over a 25-year horizon through 2040. Water demands associated with the proposed Project are anticipated to increase in phase-specific increments between 2020 and

---

[2] A portion of the Bayfront Area bounded by Highway 101, Marsh Road, and the Dumbarton Rail is served by California Water Service Company. The proposed land use changes in this area would generally reflect the same uses and intensity that is permitted under the current regulations.

[3] Information regarding landscaped areas within the proposed Project was provided by PlaceWorks on 13 August 2015.

2040. This WSE Study presents water demands for the proposed Project at buildout and at intermediate phases of development.

4 HISTORICAL AND CURRENT WATER USE WITHIN THE BAYFRONT AREA

Water use at each existing account within the Bayfront Area is metered and recorded by MPMWD on a monthly basis. Water use data for the period from April 2010 through December 2014 for the active water accounts within the Bayfront Area were provided by the City on 15 and 24 September 2015. A summary of the total historical water use for the Bayfront Area is included in Table 1.

Average annual water use within the Bayfront Area from 2010 through 2014 was approximately 195 million gallons ("MG"), with annual water use ranging from 162 MG in 2012 to 224 MG in 2010. The trends observed in historical water use within the Bayfront Area are generally consistent with those observed throughout MPMWD's service area, as discussed in Section 6.3, and likely reflect the influence of the recent droughts and vacancies in this area during the economic downturn.

It is expected that some or all of the existing demand within the Bayfront Area will be subsumed as part of the redevelopment plan for this area, as actual buildout of the proposed Project may replace some existing land uses. However, since the exact nature and location of the future development is unknown (i.e., whether it will add to or replace the existing land uses) we have conservatively assumed that all demands associated with the proposed Project are additive to the existing demands.

5 PROJECT WATER DEMAND

The City requires that all new residential and non-residential construction comply with the mandatory CALGreen Requirements.[4] The City also requires that new and rehabilitated landscapes on projects subject to city review and approval comply with the City's Water Efficient Landscaping Ordinance ("Landscaping Ordinance"), which was updated on 26 January 2016 to reflect recent changes to the State's Model Water Efficient Landscape Ordinance ("MWELO"; DWR, 2015). As such, at a minimum, future developments within the Bayfront Area are expected to include a number of water-efficiency features, including, but not limited to:

- Use of low-flow lavatory faucets, kitchen faucets, toilets, and urinals in accordance with CALGreen Code; and
- Inclusion of low-water use landscaping and high-efficiency irrigation systems to minimize outdoor water use in accordance with the Landscaping Ordinance.

In addition, the City is considering the adoption of recycled water requirements as part of new projects that meet certain criteria and are within the M 2 Zoning (Bayfront) Area. As part of the proposed Menlo Park General Plan Land Use & Circulation Elements and the M-2 Area Zoning Update, several new zoning district categories, including Office ("O"), Life Science ("LS"), and Mixed Use Residential ("MU-R"), are being proposed to the General Plan land use designations. Corresponding zoning district regulations could potentially include requirements for recycled water use, such as provide dual plumbing, use recycled water for landscape irrigation, and / or evaluate alternative water sources, including on-site recycling, for toilet and cooling water uses.

As described below, the proposed Project's average annual water use was estimated based on: (1) the application of well-established methodologies for estimating indoor and outdoor water use, and (2) assumptions regarding water efficiency for certain end uses based on conformance with the City requirements described above. As shown in Table 2, the annual water use associated with the proposed Project is conservatively estimated to be 343 MG at buildout.

5.1 RESIDENTIAL WATER USE

5.1.1 Residential Indoor Water Use Factors

The residential indoor water use factors were developed using a predictive model of residential water use developed for the United States Environmental Protection Agency ("U.S. EPA") and several large water utilities (DeOreo, 2011). The U.S. EPA model is based on residential indoor water use data collected over the years 2006 through 2010 at 300 single family homes[5] constructed since 2001 in nine American cities, including one city in California.

---

[4] As described on the City's website: http://www.menlopark.org/DocumentCenter/Home/View/93

[5] End uses for indoor water use in single family homes are similar to those in multi-family homes, so we have assumed that the formulas developed in this study also apply to multi-family homes.

Because the U.S. EPA model reflects actual water use patterns observed in recently-constructed and occupied homes, it represents a sound basis for predicting indoor water use in new developments, which would be required to meet even higher standards of efficiency such as the CALGreen Code. The results of this model also compare well with recent residential per capita data being published for similar communities throughout California by the State Water Resources Control Board ("SWRCB", 2015) and residential water use factors within other Bay Area Water Supply and Conservation Agency ("BAWSCA") cities (BAWSCA, 2014a).

The U.S. EPA predictive model allows the projected total residential indoor use to be calculated from these demographic and water conservation inputs:

$$\text{INDOOR} = [71.2 \times \text{RESIDENTS}^{0.63} \times (1 + 0.91 \times \text{LEAK}) \times (1 - 0.23 \times \text{H.EFF.CW}) \times (1 + 0.12 \times \text{SOFTENER})] + 11.8$$

where:

INDOOR =	indoor water use in gallons per home per day
RESIDENTS =	number of residents in household
LEAK =	the fraction of homes with a significant leak greater than 50 gallons per day
H.EFF.CW =	the fraction of homes with a high-efficiency clothes washer that uses less than 30 gallons per load
SOFTENER =	the fraction of homes with a water softening system

Residential indoor water use factors were developed using the above model to reflect the proposed Project's water efficiency design standards and based the following assumptions:

- Home water softening systems (e.g., regenerating ion exchange units or reverse osmosis units) are not installed.
- A total of 75% of clothes washers installed in residential units would use less than 30 gallons per load.[6]
- Leaks greater than 50 gallons per day would occur in at most 9% of the residential units, which represents a conservative assumption (i.e., likely higher than would actually be encountered based on empirical data from existing residential developments; DeOreo, 2011).
- Based on the planned population and residential units of the proposed Project, the average household size is assumed to be 2.57 people (PlaceWorks, 2015).

---

[6] For context, approximately 39% of existing homes in the United States have clothes washers that use less than 30 gallons per load (DeOreo, 2011) and the majority of commercially-available home washing machines today use under 30 gallons per load.

Based on the above methodology and assumptions, indoor water use for each residential unit is estimated to be 127 gallons per day. Annual indoor water use for residential land use is estimated to be 209 MG, or 49.4 gallons per capita per day ("GPCD"). The estimated indoor residential water use calculations are shown in Table 3a.

5.1.2 Residential Outdoor Water Use Factors

The outdoor water use factors were estimated using the landscape irrigation demand model described in the recently-updated MWELO (DWR, 2015), which the City recently adopted and is implementing as part of its Landscaping Ordinance. The MWELO requires that the annual estimated total water use for landscape irrigation not exceed the Maximum Applied Water Allowance ("MAWA"). As shown below, the MAWA is calculated based on the regional reference evapotranspiration rate, an evaporation adjustment factor, the total landscaped area, and the area of "special landscaped area".[7] For the proposed Project we have conservatively assumed that outdoor water use will be equal to the MAWA, which is the upper limit of annual applied water for the established landscaped area. For the residential portion of the proposed Project, it was assumed that a total of 15 acres would be irrigated (PlaceWorks, 2015[8]).

The MAWA is calculated using the following equation:

$$MAWA = ETo \times [(ETAF \times LA) + (1 - ETAF) \times SLA]$$

where:

ETo = The regional reference evapotranspiration rate[9]

ETAF = Evapotranspiration Adjustment Factor

= For residential areas = 0.55

= For non-residential areas = 0.45

LA = Total landscape area (including SLA)

SLA = Special Landscape Area

Based on the above methodology and assumptions, outdoor water use for residential units is estimated to be 10 MG per year, or 2.3 GPCD. The estimated outdoor residential water use calculations are shown in Table 4. However, it is noted that the City is currently in the process of

[7] Special Landscaped Area includes landscaping dedicated solely to edible plants, recreational areas, areas irrigated with recycled water, or water features using recycled water. No Special Landscaped Area is included in the proposed Project.

[8] Information regarding landscaped areas within the proposed Project was provided by PlaceWorks on 13 August 2015.

[9] Location-specific reference evapotranspiration ("ETo") data is required for calculating the the MAWA. Reference evapotranspiration data were obtained from Appendix A of the MWELO (DWR, 2015) based on values for Redwood City, which is the closest available City to the Bayfront Area. The total annual reference evapotranspiration is 42.8 inches as shown in Table 4.

drafting new zoning regulations for the Bayfront Area that may reduce the minimum required open space area in residential lots from what was analyzed, thus reducing the outdoor water demand associated with the proposed Project.

5.1.3 Total Residential Water Use

As shown in Table 2, based on the current land use assumptions, the total annual residential water use at Project buildout is estimated to be 219 MG, or 52 GPCD.

5.2 COMMERCIAL, INSTITUTIONAL, AND INDUSTRIAL WATER USE

5.2.1 Commercial, Institutional, and Industrial Indoor Water Use Factors

The Commercial, Institutional, and Industrial ("CII") indoor water use factors were developed using the data and methodology included in the Pacific Institute's *Waste Not, Want Not: The Potential for Urban Water Conservation in California* (2003), also referred to as the "Pacific Institute Study". This study developed indoor "employee water use factors" for wide range of commercial and industrial facilities based on statewide averages of (1) measured water use data, and (2) the number of employees for each type of facility. To account for implementation of more-stringent water efficiency standards since the study was completed, and the anticipated water-efficient design of the proposed Project, the "best" potential "conservation saving factors"[10] estimated in Appendices E and F of the Pacific Institute Study were applied to the employee water use factors. For reference, additional detail regarding the derivation of the Pacific Institute's water conservation factors is included in Appendix A to this WSE Study.

The CII indoor water use factors for the proposed Project were estimated for the assumed mix of specific CII land uses that are contemplated in the Bayfront Area, including office space, life science buildings, hotels and other commercial space.

Table 3b summarizes the CII land use parameters that were used to estimate the CII indoor water use factors. Each of these parameters is discussed in the following sections.

Number of Employees

The number of employees for office and hotel land use as shown in Table 3b for the proposed Project was based on information provided by City staff on 20 November 2015. The number of employees for life science buildings and other commercial land uses was estimated using the

---

[10] As shown in Appendix A, the Pacific Institute Study presented conservation saving factors for "high," "low," and "best" potential savings for each type of land use, and for specific end-uses. According to the Pacific Institute, the "best" potential conservation saving factors represent the most accurate estimate of likely conservation potential based on the source of the data, age of the data, and/or sample size.

average number of employees per floor area by CII category reported by the Federal Energy Information Administration in a 2006 study (EIA, 2006).[11]

Employee Indoor Water Use Factors

The employee water use factors discussed in the Pacific Institute Study identified the average indoor water consumption per employee per working day for each type of CII land use and normalized for a 225-day work year. For example, if the applicable employee water use factor is 100 gallons per employee per work day, each employee within the applicable CII land use category would consume 225 multiplied by 100, or 22,500 gallons per year.

It should be noted that the employee water use factors were derived from the Pacific Institute Study for comparable facilities based on water use data collected during or prior to the year 2000.[12] The water use efficiency for new commercial construction has generally improved since this these data was were collected. As a result, the employee water use factors developed as part of the Pacific Institute Study provide a conservative (i.e., high) estimate of CII water use for new buildings, a fact that was anticipated in the study and addressed through the development of conservation savings estimates, as discussed below.

Conservation Savings

The Pacific Institute Study was based on water use data that predated the adoption of the current CALGreen Code and other applicable water efficiency standards. Anticipating improved future water-efficiency, the Pacific Institute Study developed conservation saving factors, which can be applied to the employee water use factors to account for the implementation of more-stringent water efficiency standards. Specifically, the Pacific Institute Study estimated that the implementation of water conservation measures, such as those required by the current CALGreen Code and similar regulations, could reduce water demands by 26% to 42% compared with the water use factors developed in their study, depending on the conservation scenario, land use type, and type of water fixture or appliance. The water conservation measures accounted for in the Pacific Institute Study that would be implemented by the proposed Project include:

---

[11] The Commercial Buildings Energy Consumption Survey is a comprehensive national survey that collects information on the stock of U.S. commercial buildings, including their energy-related building characteristics, energy usage data, and how many employees there are per square foot for different CII land uses.

[12] According to the Pacific Institute study (2003), CII employee water use factors were estimated from data gathered from CII water users around California in several surveys (DWR, 1995 and 2000; Davis et al., 1988; Dziegielewski et al., 1990; and Dziegielewski et al., 2000). To estimate statewide CII water use, these employee water use coefficients were then applied to statewide employment data to project the total water use for each sector. These estimated water usages were then compared with water-delivery data by sector, as reported by nearly 150 water districts across the state. The difference between CII water use estimates developed using these two methods was less than 10%.

- Installation of ultra-low flush toilets and urinals, plus low-flow faucet aerators and showerheads[13];
- Improvements to mechanical cooling systems by installation of conductivity controllers, addition of chemical treatments to improve the concentration ratio, and improved energy efficiency of other mechanical components; and
- Other technologies appropriate for kitchens, laundries, and industrial processes such as water-efficient dishwashers and washing machines and industrial water reuse.

Based on assumed implementation of these water-efficiency measures within the proposed Project, conservation saving factors for indoor water uses were estimated based on the "best" potential savings[14] identified in the Pacific Institute Study, as shown in Appendix A. These estimated conservation saving factors were incorporated into the proposed Project demand calculations for all CII categories, as shown in Table 3b.

However, it should be noted that these conservation savings factors do not directly account for the water savings associated with use of high-efficiency toilets required by the CALGreen Code (i.e., those that use 1.28 gallons per flush or less), or the increased efficiency of other water fixtures relative to the assumptions imbedded in the Pacific Institute Study. Nor do they account for the potential conversion of the proposed Project's landscape irrigation or other non-potable demands to recycled water, or other non-potable sources. As such, to the extent that actual water use at the proposed Project is less than what has been conservatively estimated herein (for the reasons stated above, or other reasons), the resultant impacts to MPMWD's water supply and demand projections (as discussed in Sections 5 and 6), will likewise be reduced.

5.2.2 Transit Centers

Indoor water use for the proposed transit centers is calculated separately from other CII land uses based on an end-use approach. The end-use approach assumes that indoor water uses in the transit centers are only associated with restroom visits and that restroom fixture efficiencies meet CALGreen requirements.

The estimated transit center indoor water use calculations are shown in Table 3c.

---

[13] Effective January 2014, only high-efficiency toilets that use 1.28 gallons per flush will be available for purchase in California. The water savings estimates assumed in the Pacific Institute study only reflected installation of 1.6 gallon per flush toilets. Therefore, these CII conservation savings estimates may be conservative (i.e., underestimate the water savings potential).

[14] As shown in Appendix A, the Pacific Institute Study presented conservation saving factors for "high," "low," and "best" potential savings for each type of land use, and for specific end-uses. According to the Pacific Institute, the "best" potential conservation saving factors represent the most accurate estimate of likely conservation potential based on the source of the data, age of the data, and/or sample size.

5.2.3 Commercial, Institutional, and Industrial Outdoor Water Use Factors

As with the residential elements of the proposed Project, the CII outdoor water use factors were estimated using the landscape irrigation demand model described in the recently-updated MWELO (DWR, 2015), which the City has adopted and is implementing as part of its Landscaping Ordinance. For the proposed Project we have conservatively assumed that outdoor water use will be equal to the MAWA, which is the upper limit of annual applied water for the established landscaped area, which was estimated to be 46 acres (PlaceWorks, 2015). The estimated outdoor water demand calculations are shown in Table 4.

5.2.4 Total Commercial, Institutional, and Industrial Water Use

Based on the above methodologies and assumptions, the estimated annual total CII water use at Project buildout is estimated to be 124 MG, as shown in Table 2.

6 MPMWD WATER DEMAND

Water Code Section 10910

(c) (1) The city or county, at the time it makes the determination required under Section 21080.1 of the Public Resources Code, shall request each public water system identified pursuant to subdivision (b) to determine whether the projected water demand associated with a proposed project was included as part of the most recently adopted urban water management plan adopted pursuant to Part 2.6 (commencing with Section 10610).

(c) (2) If the projected water demand associated with the proposed project was accounted for in the most recently adopted urban water management plan, the public water system may incorporate the requested information from the urban water management plan in preparing the elements of the assessment required to comply with subdivisions (d), (e), (f), and (g).

(c) (3) If the projected water demand associated with the proposed project was not accounted for in the most recently adopted urban water management plan, or the public water system has no urban water management plan, the water supply assessment for the project shall include a discussion with regard to whether the public water system's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses, including agricultural and manufacturing uses.

As part of the development of its 2015 UWMP, the City has estimated the current and projected future water demand for MPMWD water system service area based on buildout of the City's current General Plan and approved projects. In accordance with the UWMP Act (Water Code §10610-10656), MPMWD's projected future water demand is estimated in five year increments, between the years 2015 and 2040, and is subdivided between the following six customer sectors: (1) residential single family, (2) residential multi-family, (3) commercial and institutional, (4) industrial, (5) landscape, and (6) other.[15]

The proposed Project was not accounted for in the water demand projections of the current General Plan buildout. Therefore, although the proposed Project will likely supplant some existing demands within the Bayfront Area, we have considered the demand attributed to the proposed Project to be wholly additive to the current water demands (i.e., to existing conditions) and have conducted our analysis accordingly.

6.1 HISTORICAL AND CURRENT USE WITHIN THE MPMWD SERVICE AREA

Water use within the MPMWD service area is measured using water meters that are installed at each customer account and is summarized in Table 5. Records of current and historical water use at each account are maintained by the City Public Works Department. According to information provided by City staff on 30 September 2015, total annual water use for MPMWD was approximately 1,030 MG in 2014, which was a decrease relative to 2013 and a departure from the increase in water use observed between 2011 and 2013. Prior to 2011, water use had decreased

[15] System water loss is also included in the future water demand listed in the UWMP (Menlo Park, 2015). Losses were assumed to be approximately 4.5 percent of the total system water use.

since 2007; this decrease is thought to reflect impacts of the 2007-2009 drought and the economic downturn that resulted in lower residential and non-residential water use. The rebound in water use in 2011 and 2013 are thought to reflect improved economic conditions. Despite the economic rebound in the Bay Area, the resultant calls for water use cutbacks locally and mandatory state-wide restrictions[16] in response to the recent historic drought led to another decline in water use in 2014.

6.2 Population and Employment Projections

Future water demands for MPMWD's service area were projected by BAWSCA on behalf of MPMWD in the 2014 *Regional Water Demand and Conservation Projections Report* (BAWSCA, 2014b). Future water demands were projected using the Demand Management Decision Support System Model ("DSS Model") and based on population and employment projections within MPMWD's service area, which were in turn developed using Association of Bay Area Governments ("ABAG") 2013 data.

In 2015, MPMWD's DSS Model was revised to account for several changes since the demand projections completed by BAWSCA. The 2015 DSS Model update includes revised population and employment projections developed by the City's Planning Division based on information related to the City's recently-approved projects and the current General Plan.

Specifically, future population within MPMWD's water service area is projected within the draft 2015 UWMP and 2015 DSS Model based on buildout of the current General Plan. The current General Plan estimates that there will be 18,614 residents within MPMWD's service area in 2040, an increase of 2,548 relative to the current 2015 population of 16,066.

The MPMWD also supplies water to its CII customers, which were collectively estimated to provide 12,443 jobs within MWMPD's water service area in 2015. Based on the current General Plan and the City's approved projects, the number of jobs within MWMPD is anticipated to grow to 17,143 in 2020, and to 20,543 in 2040. Anticipated job growth within MPMWD is a combined effect of growth in the commercial sector and decline in the industrial sector. Specifically, commercial jobs are expected to increase by 8,796 while industrial jobs are expected to decrease by 696 between 2015 and 2040 (Menlo Park, 2015b).

6.3 Water Demand Projections - Current General Plan Buildout

The projected future water demand within MPMWD's service area was reported in the draft 2015 UWMP, and is summarized below and in Table 6. As described above, projected water demand

[16] On 28 July 2014, the SWRCB adopted emergency regulations to mandate water agencies, including the MPMWD, to implement their Water Shortage Contingency Plan and minimum actions to reduce outdoor water use. On 5 May 2015, SWRCB adopted Resolution 2015-0032 to mandate further minimum actions by water suppliers and their customers to reduce potable water use into 2016 and assigns a mandatory water conservation savings goal to each water supplier based on their residential water use. MPMWD has a SWRCB-mandated reduction target of 16%.

within the MPMWD service area is the sum of water use in each sector and water that is projected to be lost during distribution ("system losses" or "non-revenue water").

Projected water demands within MPMWD are provided in Table 6 in five-year increments for 2020 through 2040. It is estimated that annual water demands associated with the City's current General Plan buildout are approximately 1,310 MG in 2020 and 1,240 MG in 2040. The anticipated decline in water demands between 2020 and 2040 in spite of growth in total population and jobs is largely due to:

- Decreasing projected water use in the industrial sector; and
- Increased water efficiency in the residential and non-residential sectors as a result of plumbing code changes and planned MPMWD conservation efforts.

6.4 Other Planned Projects within MPMWD's Water Service Area

Table 7 identifies other planned projects within MPMWD's water service area that are included in the draft 2015 UWMP and the 2015 DSS Model. These projects were identified on the basis of information provided by the City's Planning Division.[17]

There are two projects that are pending City's approval that are not accounted for in the water demand projections of the City's current General Plan buildout or in the 2015 DSS Model. These projects and their potential annual water demands are included in Table 7. The total annual demand of these projects is approximately 31 MG.

6.5 Total Projected MPMWD Water Demand

Total projected MPMWD water demand, as shown in Table 8, is the sum of water demands associated with the City's current General Plan buildout (i.e., as reflected in the 2015 DSS Model), the planned projects within the MPMWD service area in addition to the current General Plan, and the proposed Project. It is estimated that annual water demand will be approximately 1,271 MG in 2040 within MPMWD's service area (i.e., 1,240 MG for buildout of the current General Plan plus 31 MG for other planned projects), excluding the proposed Project. Including the estimated water demand for the proposed Project (i.e., 343 MG per year), approximately 1,614 MG of water demand is expected in 2040 within MPMWD's service area.

---

[17] Projects were identified from the City of Menlo Park Planning Division on 9 September 2015.

7 MPMWD SUPPLY

This section identifies MPMWD's water supplies and discusses the vulnerability of the various supplies to drought and other factors affecting water reliability.

7.1 IDENTIFICATION OF WATER SUPPLY RIGHTS

Water Code Section 10910

(d) (1) The assessment required by this section shall include an identification of any existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project, and a description of the quantities of water received in prior years by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), under the existing water supply entitlements, water rights, or water service contracts.

Pursuant to Water Code §10910(d)(1), a WSA is required to include identification of all water supply entitlements, water rights, and water service contracts relevant to the identified water supply for the Project. In accordance with these requirements, this WSE Study includes a summary of MPMWD's water supply sources and the agreements between MPMWD and its wholesale supplier.

7.1.1 SFPUC Regional Water System

MPMWD receives water from the City and County of San Francisco's Regional Water System ("Regional System"), which is operated by the San Francisco Public Utilities Commission ("SFPUC"). This supply originates predominantly from the Sierra Nevada and is delivered through the Hetch-Hetchy aqueducts. The supply also includes treated water produced by the SFPUC from its local watersheds and facilities in Alameda and San Mateo Counties. Approximately 85% of the Regional System supply comes from the Tuolumne River and the Hetch-Hetchy Reservoir. The remaining 15% comes from local watersheds through the San Antonio, Calaveras, Crystal Springs, Pilarcitos and San Andreas Reservoirs.

The business relationship between San Francisco and its wholesale customers (including MPMWD) is largely defined by the Water Supply Agreement between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County and Santa Clara County ("Agreement") entered into in July 2009. The Agreement, which has a 25-year term, addresses water supply availability for the Regional System as well as the methodology used by the SFPUC in setting wholesale water rates. This agreement supersedes an earlier 25-year agreement signed in 1984.

The Agreement provides 184 million gallons per day ("MGD") to the wholesale customers during normal water years. This volume, referred to as the "Supply Assurance" is subject to reduction during periods of water shortage due to drought, emergencies, or other scenarios resulting in a water shortage. Each wholesale customer's share of the 184 MGD is referred to as their Individual Supply Guarantee ("ISG"). The MPMWD's ISG is 4.465 MGD (approximately 1,630 MG per year). Although the Agreement expires in 2034, the Supply Assurance and ISG continue in perpetuity.

The Agreement also recognizes the SFPUC's decision made in October 2008 to (a) defer any consideration of an increase to the 184 MGD Supply Assurance until 2018, (b) place an interim limit on sales of 184 MGD for all wholesale customers, including San Jose and Santa Clara, (i.e., those customers who do not have ISGs), (c) establish interim supply allocations ("ISAs") for each wholesale customer through 2018, and (d) develop an environmental enhancement surcharge to be applied to wholesale agencies that exceed their ISA, if total use by SFPUC's retail customers and wholesale customers exceeds 265 MGD.

However, these ISAs are entirely distinct from the permanent ISGs as they will last only until 2018 and will only be used as basis for applying the surcharge. Therefore, although the establishment of the ISAs may potentially increase the cost of water supplied by SFPUC to MPMWD if MPMWD exceeds its ISA at a time when collective deliveries from the Regional System exceed 265 MGD, the ISAs will not affect MPMWD's ISG of 4.465 MGD. Therefore, projected water supplies to MPMWD from SFPUC that are identified in the 2010 UWMP and rely on MPMWD's ISG have not been modified based upon the provisions of the new Agreement.

Currently MPMWD purchases 100% of its potable water supply from the SFPUC. The MPMWD's current and projected purchase quantities are approximately equal to an average of 2.79 MGD in 2014 (1,017 MG per year, Table 9) and 4.42 MGD based on projected demands in 2040 (1,614 MG per year), respectively. Both current and projected purchase quantities are less than MPMWD's ISG of 4.465 MGD.

7.1.2 Other Water Supplies

The MPMWD does not currently operate any potable groundwater wells for water supplies, but plans to construct approximately three to four emergency wells to provide water supply reliability to its northern service area, which includes the Bayfront Area. The wells will be designed to operate following a major earthquake or other emergency. The MPMWD is currently preparing environmental documents for the first well at the Corporation Yard and continues to review potential sites for the remaining wells.

The MPMWD is also assessing the feasibility of delivering recycled water to its southern service area in collaboration with the West Bay Sanitary District ("WBSD"). In November 2015, WBSD certified a *Mitigated Negative Declaration for the West Bay Sanitary District Recycled Water Project – Sharon Heights* (WBSD, 2015). The subject of this document is a proposed satellite wastewater treatment plant and recycled water treatment facility in the Sharon Heights area to serve irrigation demands to the Sharon Heights Golf and Country Club and potentially other customers in its vicinity. The MPMWD is also considering options related to service of recycled water to the entire Bayfront Area, or options related to onsite recycling and reuse. These and other options will be developed in more detail as part of the update to MPMWD's *Water System Master Plan*, that has an estimated completion date in 2017.

In addition, the City is considering the adoption of recycled water requirements as part of new projects meeting certain criteria and are within the Bayfront Area. As part of the proposed Project, several new zoning district categories are being added to the General Plan land use designations. Corresponding zoning district regulations for these zoning districts have been drafted and propose requirements regarding recycled water use such as provide dual plumbing, use recycled water for landscape irrigation, and / or evaluate alternative water sources, including on-site recycling, for toilet and cooling water uses.

7.2 TOTAL SUPPLY IN NORMAL, SINGLE DRY, AND MULTIPLE DRY YEARS

Water Code Section 10910

(c) (3) If the projected water demand associated with the proposed project was not accounted for in the most recently adopted urban water management plan, or the public water system has no urban water management plan, the water supply assessment for the project shall include a discussion with regard to whether the public water system's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses, including agricultural and manufacturing uses.

As shown in Table 10, the MPMWD's current and planned future water supply for normal hydrologic years is assumed to be equal to its ISG of 4.465 MGD, or 1,630 MG per year. The anticipated dry-year supply estimates presented below are based on the delivery estimates provided by BAWSCA and SFPUC as part of the 2015 UWMP update process (SFPUC, 2016; BAWSCA, 2016) and per application of the Tier 1 and Tier 2 allocation processes described in the City's Water Supply Agreement[18] and the BAWSCA Drought Implementation Plan ("DRIP").

During single dry years, the MPMWD draft 2015 UWMP estimates that annual deliveries from SFPUC will be reduced to 1,281 MG (Menlo Park, 2015b). Supply shortfalls relative to total demands during single dry years are estimated to range between 4.5% in 2020 and 21% in 2040 (see Table 11).

During multiple dry years, the MPMWD draft 2015 UWMP estimates that annual deliveries from SFPUC will be reduced to 1,108 MG during a multi-year drought (Menlo Park, 2015b). Supply shortfalls relative to total demands during the second and third year of a drought are estimated to range between 17% in 2020 and 31% in 2040 (see Table 12).

Projected supply shortfalls will be met through the implementation of MPMWD's Water Shortage Contingency Plan. As described in the 2010 UWMP and the draft 2015 UWMP, MPMWD has developed a Water Shortage Contingency Plan that systematically identifies ways in which MPMWD can reduce water demands during dry years. The most recent update to the Water Shortage Contingency Plan was completed in May 2015. The overall reduction goals in the Water

[18] The Water Supply Agreement between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County and Santa Clara County entered into in July 2009.

Shortage Contingency Plan are established in five drought stages and for water demand reductions up to 50%.

As customers within the MPMWD service area, future development within the proposed Project would be obligated to comply with the demand reduction efforts imposed by MPMWD through implementation of the Water Shortage Contingency Plan. Therefore, the proposed Project would contribute a proportionate share of the reduction in water demands during dry years.

8 COMPARISON OF SUPPLY AND DEMAND

Water Code Section 10910

(c) (3) If the projected water demand associated with the proposed project was not accounted for in the most recently adopted urban water management plan, or the public water system has no urban water management plan, the water supply assessment for the project shall include a discussion with regard to whether the public water system's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses, including agricultural and manufacturing uses.

As shown in Tables 8, 10, and 13, MPMWD is expected to have adequate water supplies during normal years to meet its total annual projected demands including the proposed Project demand (i.e., 343 MG per year) based on MPMWD's 2010 UWMP and draft 2015 UWMP.

During single-dry years, MPMWD's total annual water demand is expected exceed the total annual supply by approximately 50 MG, which results in a total water supply shortfall of 4.5%, either with or without the proposed Project demand (0 MG in 2020) based on MPMWD's draft 2015 UWMP. By 2040, MPMWD's total annual water demand, including the proposed Project demand, is estimated to exceed total single-dry year supply by approximately 333 MG, which results in a total water supply shortfall of 21% (Table 11). Without the proposed Project, there is sufficient supply to meet the anticipated demand during single dry years in 2040. Therefore, the proposed changes to the Bayfront Area creates an incremental shortfall of approximately 21% in 2040 compared to the without-Project conditions (Table 13).

During multiple-dry years in 2020, MPMWD's total annual water demand, either including or excluding the Project demand (0 MG in 2020), is projected to exceed the total annual supply by approximately 233 MG, which results in a total water supply shortfall of 17%. In 2040, MPMWD's total annual water demand, including the Project demand, is projected to exceed the total annual supply by approximately 506 MG, which results in a total water supply shortfall of 31% (Table 12). Without the proposed Project, the multiple dry year shortfall in 2040 is projected to be 13%. Therefore, the proposed Project creates an incremental shortfall of approximately 18% compared to the without-Project conditions (Table 13).

As described in Section 6, in response to anticipated future dry-year shortfalls, MPMWD has developed a Water Shortage Contingency Plan that systematically identifies ways in which MPMWD can reduce water demands and augment supplies during dry years. It is expected that, even without the proposed Project, the City would have to rely on implementation of its Water Shortage Contingency Plan during dry years to reduce demands. The MPMWD would likely have to implement higher stages of its Water Shortage Contingency Plan in response to a drought after the proposed Project is completed, however, it is not expected that MPMWD would have to change its operations or the general implementation of its Water Shortage Contingency Plan.

Further, this WSE Study has been prepared based on several very conservative assumptions. Firstly, it has been assumed that all of the proposed Project demands will be additive to the current demands in the Bayfront Area; in reality, the proposed Project will likely supplant some or all of the existing demands.

Secondly, as stated in Section 5.2.1, the water demand estimates for the proposed Project did not explicitly account for the increased water efficiency of toilets and other fixtures that are required for new construction per the CALGreen Code. Nor did they account for future zoning district regulations for the Bayfront Area that may reduce open space requirements on residential lots, and thus residential outdoor water use (Section 5.1.2).

Thirdly, as above, this WSE Study does not explicitly account for the fact that the City is considering the adoption of recycled water requirements within the Bayfront Area. To the extent that the City develops recycled water, or individual projects within the Bayfront Area implement on-site water recycling, the total future potable demands of the proposed Project would be expected to be less and therefore the resultant supply shortage will likely to be smaller. The MPMWD is developing these and other supplemental supply options as part of its 2017 *Water System Master Plan* update to minimize future dry year impacts.

9 CONCLUSIONS

As listed in Water Code §10910(c)(4), the primary purpose of this WSE Study is to evaluate whether sufficient water supply is available to meet all future water demands within the water supplier's service area, including those associated with the proposed Project, during normal and dry hydrologic years for a 20-year time horizon. This WSE Study has been prepared based on the following conservative assumptions:

- All of the proposed Project demands will be additive to the current demands in the Bayfront Area; in reality, the proposed Project will likely supplant some or all of the existing demands;
- The proposed Project demand estimates to do not account for future zoning district regulations for the Bayfront Area that may reduce the minimum requirement of open space on residential lots from what was analyzed, and thus reduce residential outdoor water use;
- The proposed Project demand estimates to do not directly account for the water savings associated with use of high-efficiency toilets (i.e., those that use 1.28 gallons per flush or less), or the increased efficiency of other water fixtures relative to the assumptions imbedded in the Pacific Institute Study; and
- The Project demand estimates to do not account for the potential conversion of the Project's landscape irrigation or other non-potable demands to recycled water, which may be required by the City's future zoning district regulations for the Bayfront Area.

Even with these conservative assumptions, based on the results of this WSE Study, MWMPD expects to have sufficient water supply to meet its planned demands, plus the demands of the proposed Project, during normal years through 2040.

During the 2040 worst-case drought scenario, MPMWD projects a water supply shortfall of 13% without the proposed Project, wherein it would implement its Water Shortage Contingency Plan. Using well-established methodologies for estimating water use and the conservative demand assumptions noted above, buildout of the proposed Project is estimated to increase this shortfall by approximately 18% in 2040, resulting in a total shortage of 31%.

Therefore, this study concludes that MPMWD has sufficient water supply to meet all future demands within its service area, including those associated with the proposed Project, during normal years for a 20-year time horizon. During dry years, MPMWD expects to experience some supply shortfalls over a 20-year time horizon and plans to meet these shortfalls through implementation of its Water Shortage Contingency Plan. Buildout of the proposed Project is conservatively estimated to increase the severity of these shortfalls by 18% in the 2040 worst-case drought scenario.

Based upon this increase in water supply shortfalls, MPMWD may have to implement higher stages of its Water Shortage Contingency Plan in response to a drought after the proposed Project is completed. However, it is not anticipated that MPMWD would need to change its operations or the general implementation of its Water Shortage Contingency Plan after Project buildout.

Further, to the extent that the City adopts recycled water requirements for the Bayfront Area and develops recycled water, or that individual projects within the Bayfront Area implement on-site water recycling, the total future potable demands of the proposed Project would be expected to be less and therefore the resultant supply shortage will likely to be smaller. The MPMWD is developing plans for recycled water and other supplemental supplies as part of its the 2017 *Water System Master Plan* update to minimize future dry year impacts.

10 REFERENCES

BAWSCA, 2014a. *Annual Survey, FY 2013-14,* Bay Area Water Supply & Conservation Agency, dated May 2014.

BAWSCA, 2014b. *Regional Water Demand and Conservation Projections*, Bay Area Water Supply & Conservation Agency, dated September 2014.

BAWSCA, 2016. UWMP Tier 2 Drought Implementation Plan Scenarios, Message to BAWSCA Member Agencies, dated 6 January 2016.

California Building Standards Commission. CAL Green Code, effective 2014 with supplements effective 2015: http://www.bsc.ca.gov/Home/CALGreen.aspx

DeOreo, William B., 2011b. *Water Efficiency Benchmarks for New Single-Family Homes - Final Report*, Salt Lake City Corporation and the United States Environmental Protection Agency, dated 24 March 2011.

DWR, 2015. Department of Water Resources Model Water Efficient Landscape Ordinance (California Code of Regulations, Title 23, Division 2, Chapter 2.7), dated July 9, 2015.

EIA, 2006. *2003 Commercial Buildings Energy Consumption Survey: Building Characteristics Tables*, Energy Information Administration, revised June 2006.

PlaceWorks, 2015. *ConnectMenlo: General Plan Land Use & Circulation Elements and Bayfront Area Zoning Update Program Environmental Impact Report*. City of Menlo Park, in development.

Menlo Park, 2010. 2010 *Urban Water Management Plan*, amended November 2014.

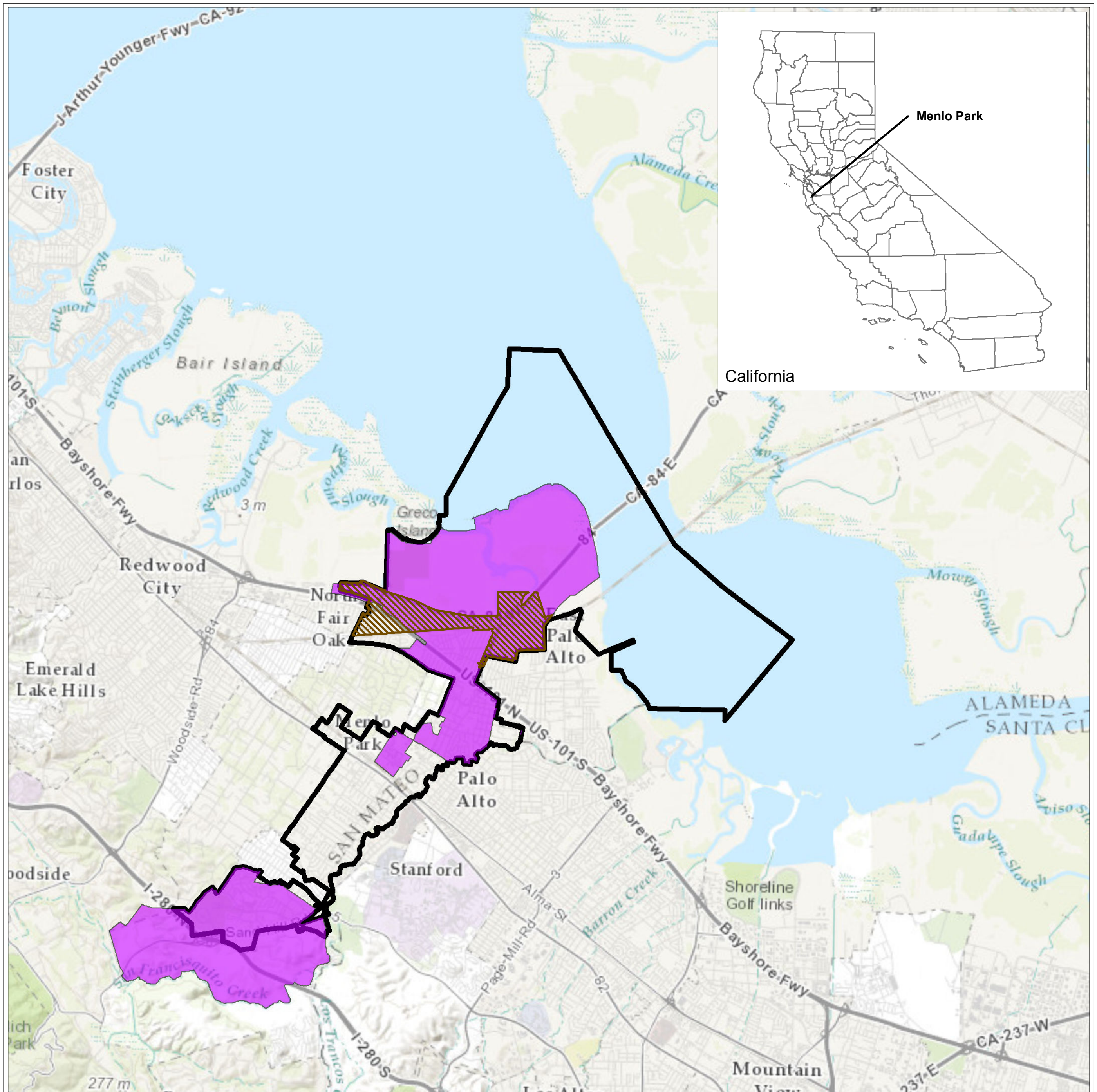
Menlo Park, 2015. *Draft 2015 Urban Water Management Plan*, in development.

Pacific Institute, 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, November 2003.

SFPUC, 2016. Regional Water System Long-Term Supply Reliability 2015-2040. Letter to BAWSCA, dated 5 January 2016.

SWRCB, 2015. Drought Actions and Information Webpage: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/

WBSD, 2015. *West Bay Sanitary District Recycled Water Project – Sharon Heights, Draft Mitigated Negative Declaration*, West Bay Sanitary District, November 2015.



Legend

- Bayfront Area
- MPMWD Service Area
- Menlo Park City Limit

Abbreviation

MPMWD = Menlo Park Municipal Water District

Note

1. All locations are approximate.
2. The proposed Project is located within the Bayfront Area and north of Highway 101.

Source

World Topographic base map provided by ArcGIS Online (ESRI, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBease, IGN, Kadaster NL, Ordinance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, OpenStreetMap contributors, and the GIS User Community), obtained 9 November 2015.

N

0 2 4

(Approximate Scale in Miles)

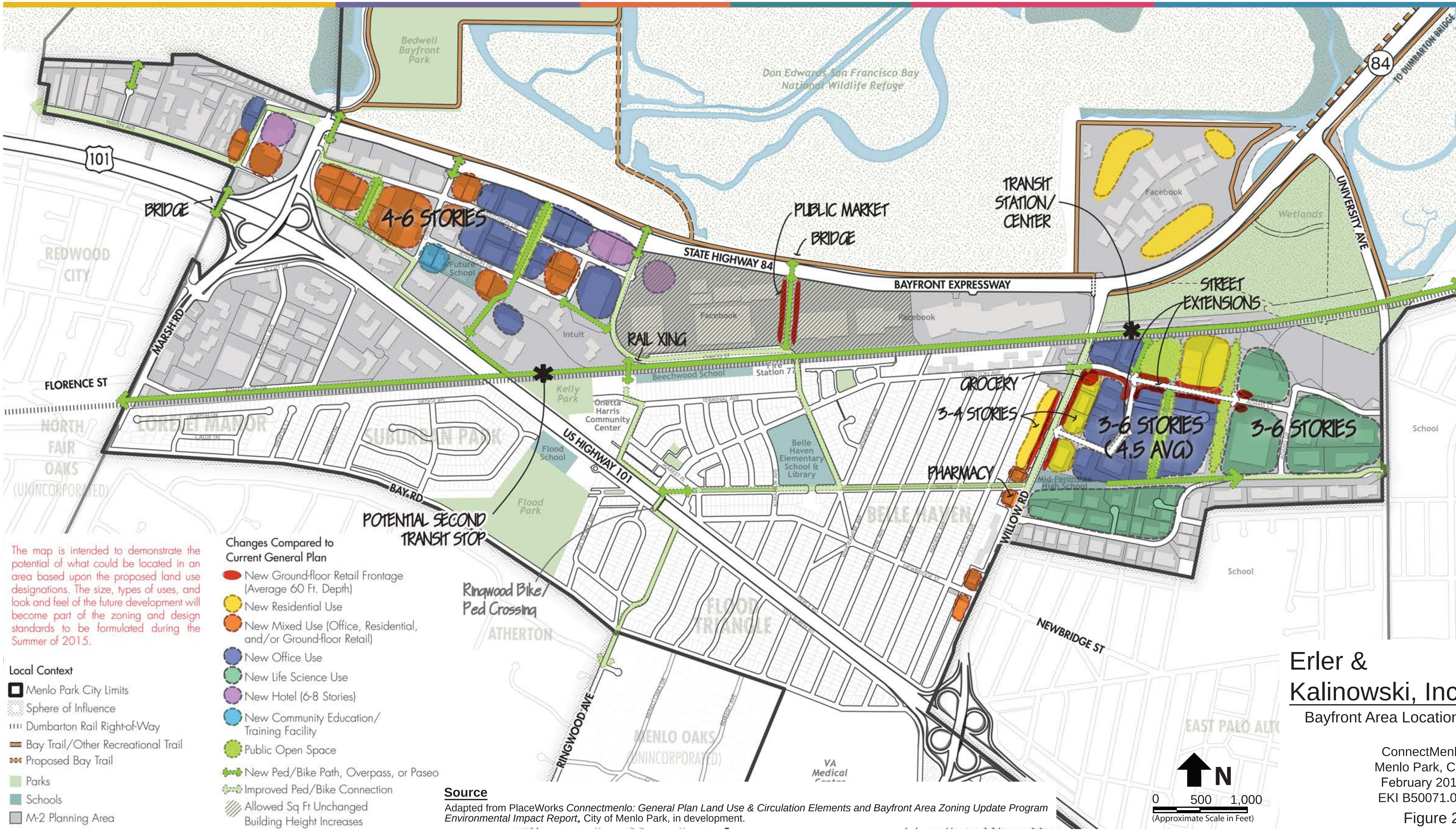
Erler & Kalinowski, Inc.

Regional Map

ConnectMenlo
Menlo Park, CA
February 2016
EKI B50071.00

Figure 1

Path: X:\B50071\Maps\11\Fig1_BayfrontAreaLocation_TW.mxd



Erler & Kalinowski, Inc.

Bayfront Area Location

ConnectMenlo
Menlo Park, CA
February 2016
EKI B50071.00

Figure 2

Table 1
Historical Annual Water Use
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Year	Total Annual Water Use within the Bayfront Area (MG) (a)
2010 (b)	224
2011	199
2012	162
2013	200
2014	191
Average Annual Water Use (2010 - 2014)	**195**

Abbreviations:

"MG" = million gallons

"MPMWD" = Menlo Park Municipal Water District

Notes:

(a) Total annual water use is based on MPMWD's metered water use data, provided by City staff on 15 and 24 September 2015 for 318 accounts within the Bayfront Area north of Highway 101.

(b) Actual water use in 2010 was only available from April through December and was interpolated to estimate water use for the whole year.

Table 2
Summary of Estimated Project Water Demand at Buildout (2040)
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Project Component	Annual Water Demand at Buildout			
	Indoor (MG) (a)	Outdoor (MG) (b)	Total (MG) (c)	Total (GPCD) (d)
Residential				
Multi-family Residential	209	10	219	52
Non-Residential				
CII (Excluding Transit Center)	99	24	124	--
Transit Center	0.4			
Total Project Water Demand			**343**	**81**

Abbreviations:
"CII" = Commercial, Industrial, and Institutional
"MG" = million gallons
"GPCD" = gallons per capita per day

Notes:
(a) The estimated annual indoor water demand at buildout for each project component is calculated in Tables 3a through 3c.
(b) The estimated annual outdoor water demand at buildout for each project component is calculated in Table 4.
(c) The estimated total annual water demand for residential and non-residential land uses, in MG, is calculated as the sum of indoor and outdoor water demands. Totals may not sum exactly due to rounding.
(d) The estimated total water demand, in GPCD, is calculated for residential land uses and the Project total. It is calculated as the sum of indoor and outdoor water demands divided by the estimated population for the project (see Table 3a) and the days per year. Total water demand in GPCD is not calculated for non-residential land uses.

Table 3a

Estimated Project Annual Indoor Water Demand, Residential Land Use

ConnectMenlo - General Plan and M-2 Area Zoning Update

Menlo Park, California

Land Use	[A] Number of Dwelling Units (a)	[B] Population (a)	[C] C = B / A Average Household Size (people/du)	[D] Household Water Use Factor (gphd) (b)	[E] E = A × D Average Daily Indoor Water Use (gpd) (c)	[F] F = E × 365 / 1,000,000 Total Annual Indoor Water Demand (MG) (d)
Multi-family Residential	4,500	11,570	2.57	127	572,985	209
					Total Indoor Water Demand, Residential Land Use	**209**

Abbreviations:

"du" = dwelling unit

"gpd" = gallons per day

"GPCD" = gallons per capita per day

"gphd" = gallons per household per day

"MG" = million gallons

Table 3a
Estimated Project Annual Indoor Water Demand, Residential Land Use
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Notes:

(a) Number of residential dwelling units and population are based on project information included in Reference 1.

(b) Residential indoor water use factor was estimated using a model of total indoor water use developed in Reference 2. The statistical model is based on single family homes that meet the standards for the Federal Energy Policy Act of 1992. The following assumptions were used for estimating project residential water uses:

1. The average household size (i.e., number of residents per home) is 2.57 persons/dwelling unit.
2. Home water softening systems (e.g., regenerating ion exchange units or reverse osmosis units) are not installed.
3. High-efficiency clothes washers that use less than 30 gallons of water per load are installed in 75% of the dwelling units
4. Significant leaks (i.e., leaks greater than 50 gallons per day) occur at approximately 9% of the dwelling units.

Based on the above assumptions, the residential indoor water use factor is estimated to be 127 gphd, or 49.4 GPCD.

(c) The average daily indoor water use is estimated by multiplying the number of dwelling units and the household water use factor.

(d) Total annual indoor water demand for residential land uses, in MG, is calculated as the product of daily indoor water use and the days per year. The product is then divided by the number of gallons per MG (1,000,000).

References:

1. ConnectMenlo: General Plan Land Use & Circulation Elements and Bayfront Area Zoning Update Program Environmental Impact Report, City of Menlo Park, in development.
2. DeOreo, 2011. *Analysis of Water Use in New Single-Family Homes,* 20 July 2011.

Table 3b
Estimated Project Annual Indoor Water Demand, CII Land Use (Excluding Transit Center)
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

	[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]
			C = A × B / 1,000			F = D x (1 - E)	G = C x F	H = G x 225 / 1,000,000
	Area	**Employee Density**	**Employees**	**Employee Indoor Water Use Factor**	**Indoor Conservation Factor**	**Employee Water Use After Conservation**	**Average Daily Indoor Water Use**	**Total Annual Indoor Water Demand**
Land Use	(sq ft) (a)	(emp/1,000 sq ft) (b)	(emp) (c)	(gpd/emp) (d)	(%) (e)	(gpd/emp) (f)	(gpd) (g)	(MG) (h)
Office	700,000	3.33	2,333	79	33%	53	123,034	28
Life Science (R&D)	1,400,000	2.12	2,963	148	40%	89	263,429	59
Commercial/Retail	200,000	0.80	161	109	34%	72	11,517	3
Hotel	350,000	0.86	300	216	32%	147	43,999	10
Total Indoor Water Demand, CII Land Use (Excluding Transit Center)								**99**

Abbreviations:

"CII" = Commercial, Industrial, and Institutional
"MG" = million gallons
"emp" = employees
"gpd" = gallons per day
"R&D" = Research and Development
"sq ft" = square feet

Table 3b
Estimated Project Annual Indoor Water Demand, CII Land Use (Excluding Transit Center)
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Notes:

(a) Areas of proposed land uses are based on project information included in Reference 1.

(b) Employee densities of office and hotel land uses were provided by City staff on 20 November 2015. Employee densities of life science and commercial/retail land uses are based on Table B1 of Reference 2.

(c) The number of employees was estimated by multiplying the floor area ratio, expressed in 1,000 square feet, by the employees per 1,000 square feet.

(d) The employee indoor water use factors are based on information contained in Appendices E and F of Reference 3, which are each based on a 225-day work year.

(e) The employee water use factors reported in Reference 3 represent water use in older buildings; they do not incorporate the benefits of more recent water saving technologies or account for the CALGreen standards. Therefore, to account for reductions in water use associated with the installation of water-efficient plumbing fixtures, appliances, and other recent technologies, conservation savings, based on the "best" conservation savings potential presented in Appendices E and F of Reference 3, were calculated in Appendix A and applied to each land use.

(f) Daily employee water use after conservation is calculated by multiplying the employee indoor water use factor by 100% minus the conservation potential.

(g) The total daily indoor water use for each land use is estimated by multiplying the number of employees by the land use-specific employee daily water use.

(h) Total annual indoor water use is calculated by multiplying the daily indoor water use by the 225-day work year from Reference 3 for the employee water use factors, then dividing by 1,000,000 gallons per MG.

References:

1. ConnectMenlo: General Plan Land Use & Circulation Elements and Bayfront Area Zoning Update Program Environmental Impact Report, City of Menlo Park, in development.
2. U.S. Energy Information Administration, 2006, *2003 Commercial Buildings Energy Consumption Survey* .
3. Pacific Institute, 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California* , November 2003.

Table 3c
Estimated Project Annual Indoor Water Demand, Transit Center
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Water Use (a)	[A] Daily Usage of the Transit Center (b)	[B] Average # of Restroom Visits per Usage (c)	[C] Fixture Rate (d)	[D] Average # of Fixture Uses per Restroom Visit (e)	[E] E = A x B × C x D Average Daily Indoor Water Use (gpd) (f)	[F] F = E x 365 / 1,000,000 Total Annual Indoor Water Demand (MG) (g)
Restroom						
Water Closet (male)	10,000	0.1	1.28 gpf	0.1	128	0.05
Water Closet (female)	10,000	0.1	1.28 gpf	0.5	640	0.2
Urinal	10,000	0.1	0.5 gpf	0.4	200	0.07
Lavatory	10,000	0.1	0.5 gpm	0.5	250	0.09
Total Indoor Water Demand, Transit Center						**0.4**

Abbreviations:

"gpd" = gallons per day
"MG" = million gallons
"gpf" = gallons per flush
"gpm" = gallons per minute

Table 3c
Estimated Project Annual Indoor Water Demand, Transit Center
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Notes:

(a) Indoor water use in the transit center is assumed to be associated with restroom visits of transit center users.
(b) Daily usage of the transit center is based on project information included in Reference 1.
(c) The average number of restroom visits assumes one restroom visit occurs in every ten person-usages of the transit center.
(d) Fixture rates are based on requirements of the CalGreen standards in Reference 2.
(e) The average number of fixture uses per restroom visit are estimated based upon the following assumptions:
1. Usage of the transit center restroom is from 50% male and 50% female;
2. On average each restroom visit consists of one toilet use and one 30-second lavatory use; and
3. On average males use the urinal in four out of five toilet uses.
(f) The daily indoor water use for each fixture is estimated by multiplying the fixture rate by the number of restroom visits per day and the number of fixture uses per visit.
(g) Total annual indoor water demand, in MG, is calculated as the product of daily indoor water use and the days per year. The product is then divided by the number of gallons per MG (1,000,000).

References:

1. ConnectMenlo: General Plan Land Use & Circulation Elements and Bayfront Area Zoning Update Program Environmental Impact Report, City of Menlo Park, in development.
2. 2013 California Green Building Standards Code (Effective January 1, 2014).

Table 4
Estimated Project Annual Outdoor Water Demand
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

	[A]	[B]	[C]	[D] D = B / 12 x C x A * 0.326
Land Use	**Total Landscaped Area** (acres) (a)	**Reference ET (ETo)** (inches/year) (b)	**ET Adjustment Factor** (c)	**Total Annual Outdoor Water Demand** (MG) (d)
Residential	15.3	42.8	0.55	10 (e)
Non-residential	46.2	42.8	0.45	24
			Total Project Outdoor Water Demand	**34**

Abbreviations:

"ET" = evapotranspiration
"MG" = million gallons
"GPCD" = gallons per capita per day
"CII" = commercial, industrial, and institutional
"MAWA" = Maximum Applied Water Allowance
"MWELO" = Model Water Efficient Landscape Ordinance

Table 4
Estimated Project Annual Outdoor Water Demand
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Notes:

(a) Areas dedicated to landscaping are based on project information included in Reference 1. Non-residential land use includes CII spaces, transit center, and public spaces.

(b) The reference ET is based on values for Redwood City in Appendix A of Reference 2. Redwood City is the closest available City to the project area.

(c) Per the California MWELO (Reference 2), ET adjustment factors of 0.55 and 0.45 were used to calculate the MAWA for residential and nonresidential areas, respectively. The project does not include any Special Landscape Areas, which include recreation areas, areas permanently and solely dedicated to edible plants, and areas irrigated with recycled water.

(d) Total annual landscaping water demand, in MG, is calculated based on the MAWA formula in Reference 2. Total annual landscaping water demand is conservatively assumed to be equal to the MAWA, which is the upper limit of annual applied water for the established landscaped area based upon the area's reference evapotranspiration, the ET Adjustment Factor, and the size of the landscape area.

(e) The residential outdoor water demand of 10 MG is equivalent to 2.3 GPCD based on the proposed number of residential units and population (see Table 3a).

References:

1. ConnectMenlo: General Plan Land Use & Circulation Elements and Bayfront Area Zoning Update Program Environmental Impact Report, City of Menlo Park, in development.
2. California Model Water Efficient Landscape Ordinance, 2015 Update.

Table 5
Historical Water Use for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Customer Category	Measured Annual Water Use (MG) (a)										Percent of Total 2014 Use
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	
Single Family Residential	473	408	485	483	456	382	376	386	402	354	34%
Multi-family Residential	72	71	76	79	70	108	115	119	118	106	10%
Commercial	156	173	193	189	191	162	141	153	206	183	18%
Industrial	360	347	362	298	244	234	240	217	231	215	21%
Public Facility	92	76	90	88	81	49	52	66	63	50	5%
Landscape Irrigation (b)	110	109	122	128	119	117	108	137	167	117	11%
Other (c)	4	3	1	1	1	0	0	1	3	4	0.42%
Total Water Use (d)	**1,268**	**1,187**	**1,329**	**1,267**	**1,163**	**1,052**	**1,033**	**1,079**	**1,189**	**1,030**	**100%**

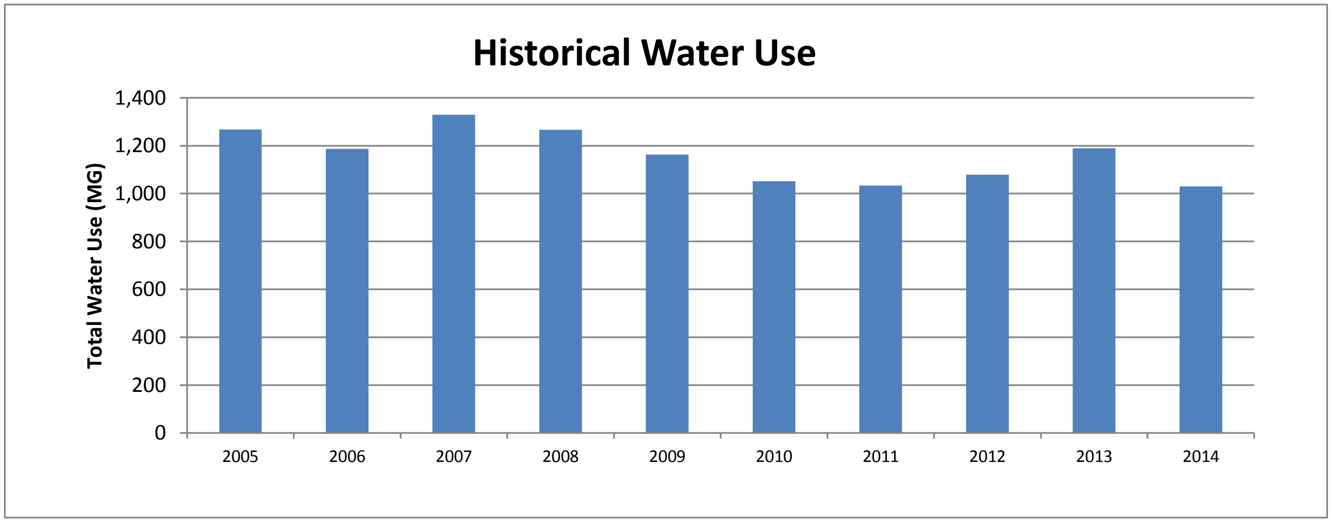


Table 5
Historical Water Use for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Abbreviations:

"MG" = million gallons

"MPMWD" = Menlo Park Municipal Water District

"UWMP" = Urban Water Management Plan

Notes:

(a) The measured annual water use for years 2005 through 2010 was from MPMWD's 2010 UWMP (Reference 1). The measured annual water use for years 2011 through 2014 was obtained from City staff on 30 September 2015. Totals may not sum exactly due to rounding.

(b) Irrigation water use includes water use for irrigation meters of accounts that are sub-metered. For most accounts, indoor and outdoors water use are measured by one meter and are shown in other categories. Therefore, irrigation water use shown here does not represent all of the outdoor irrigation water use within MPMWD.

(c) Other water use includes water used for temporary meters.

(d) "Non-revenue water" is defined herein as the difference between the MPMWD's customers' metered use and the MPMWD's metered supply. The total water use shown here does not include non-revenue water.

References:

1. 2010 Urban Water Management Plan, prepared by the City of Menlo Park, amended November 2014.

Table 6
Projected Future Water Demands of Current General Plan Buildout for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Customer Category	Projected Annual Water Demand of Current General Plan Buildout (MG) (a)				
	2020	**2025**	**2030**	**2035**	**2040**
Single Family Residential	447	438	430	425	422
Multi-family Residential	119	117	115	114	113
Commercial/Institutional	150	158	166	174	182
Industrial	315	289	264	241	221
Institutional/Governmental	86	86	87	87	88
Landscape Irrigation (b)	128	133	139	145	151
Other (Temporary Meters) (c)	3	3	3	3	3
Total Water Use	1,248	1,224	1,204	1,189	1,179
Non-Revenue Water (d)	*62*	*62*	*61*	*61*	*61*
Total Water Demand (e)	**1,310**	**1,286**	**1,265**	**1,251**	**1,240**

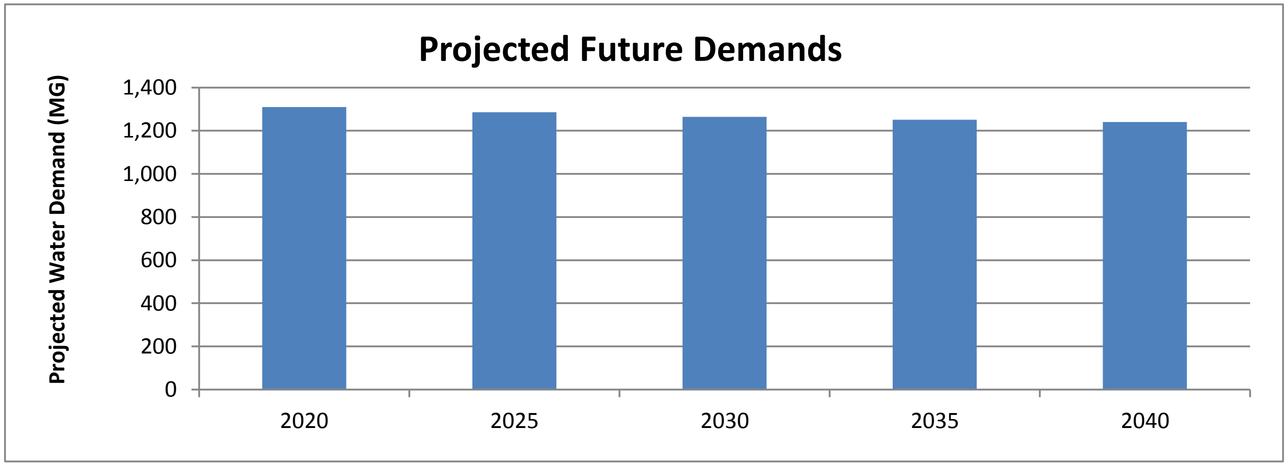


Table 6
Projected Future Water Demands of Current General Plan Buildout for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Abbreviations:

"MPMWD" = Menlo Park Municipal Water District
"MG" = million gallons
"UWMP" = Urban Water Management Plan

Notes:

(a) The projected future water demands of current General Plan buildout are from the MPMWD's draft 2015 UWMP (Reference 1).
(b) Irrigation water use includes water use for irrigation meters of accounts that are sub-metered and does not represent all of the outdoor irrigation water use within MPMWD.
(c) Other water use includes water used for temporary meters.
(d) "Non-revenue water" is defined herein as the difference between the MPMWD's customers' metered use and the MPMWD's metered supply. Thus, non-revenue water includes apparent losses such as customer metering inaccuracies, real losses such as distribution main leakage, and authorized unmetered uses such as fire hydrant flow testing. The values for non-revenue water were from MPMWD's draft 2015 UWMP and are assumed to be approximately 4.5% of the total water use.
(e) The total water demand is the sum of total water use and non-revenue water. The projected water demands include savings from plumbing code updates and conservation efforts the City plans to undertake.

References:

1. 2015 Urban Water Management Plan, prepared by the City of Menlo Park, in development.

Table 7
Preliminary Water Demand Estimates for Planned Projects within the MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Project Name (a)	Type of Use	Size		Status	Project Location	Included in General Plan Water Demand Projections?	Estimated Annual Water Demand (MG)
Facebook Campus Expansion (b)	Office Hotel	962,400 200	sq ft rooms	Pending	North of U.S. 101	No	30
New Magnate High School (c)	School	400	students	Pending	North of U.S. 101	No	0.6
333 Ravenswood Ave	R&D Campus	3,000	employees	Pending	West Menlo/Downtown/El Camino Real	Yes	--
1283 Willow Rd (Police/City Service Center)	Office Retail	3,800 5,096	sq ft sq ft	Approved	North of U.S. 101	Yes	--
100-155 Constitution Dr & 100-190 Independence Dr (Menlo Gateway)	Office Health Club Restaurant Hotel Hotel	694,664 41,000 6,947 250 197,050	sq ft sq ft sq ft rooms sq ft	Approved	North of U.S. 101	Yes	--
Facebook West (Building 20) (d)	Office	433,656	sq ft	Approved	North of U.S. 101	Yes	--
Commonwealth Corp. Center	Office	259,920	sq ft	Approved	North of U.S. 101	Yes	--
VA/Core 605 Willow Rd	Residential	60	du	Approved	South of U.S. 101	Yes	--
Anton Menlo	Residential	394	du	Approved	North of U.S. 101	Yes	--
777 Hamilton Ave	Residential	195	du	Approved	North of U.S. 101	Yes	--
3645 Haven Ave	Residential	146	du	Approved	North of U.S. 101	Yes	--

Table 7
Preliminary Water Demand Estimates for Planned Projects within the MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Project Name (a)	Type of Use	Size		Status	Project Location	Included in General Plan Water Demand Projections?	Estimated Annual Water Demand (MG)
Sequoia Belle Haven	Residential	90	du	Approved	North of U.S. 101	Yes	--
Facebook Building 23	Office	180,108	sq ft	Approved	North of U.S. 101	Yes	--
German American School	School	400	students	Approved	South of U.S. 101	Yes	--
Water Demands for Planned Projects not Included in Current General Plan Buildout Demand Projections (MG)							**31**

Abbreviations:
"Cal Water" - California Water Service Company
"du" = dwelling units
"MG" million gallons
"MPMWD" = Menlo Park Municipal Water District
"R&D" = Research and Development
"sq ft" = square feet

Notes:
(a) Projects were identified by City staff based on applications received before or near June 18, 2015 Notice of Preparations. Table includes all projects within MPMWD's service area (and not those within Cal Water's service area) that have filed a complete development application for five (5) or more net new residential units or 5,000 sq ft or more of net new commercial space.
(b) Water demand for the Facebook Expansion Project was estimated in Reference 1.
(c) Water demand for the New Magnate High School was provided by City staff on 21 December 2015. The annual water demand was estimated using 7.9 gallons per day per student for 400 students and 180 school days per year.
(d) Facebook West (Building 20) was completed early 2015 but is included in the approved project list because 2015 City water meter data are not yet available.

References:
1. Water Supply Assessment Study, Facebook Campus Expansion, Menlo Park, California, prepared by the City of Menlo Park, in development.

Table 8
Total Projected Future Water Demands for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Water Demand Estimate	**Projected Future Water Demand (MG)**				
	2020	**2025**	**2030**	**2035**	**2040**
Water Demand of Current General Plan Buildout (a)	*1,310*	*1,286*	*1,265*	*1,251*	*1,240*
Water Demand for Other Planned Projects (b)	*31*	*31*	*31*	*31*	*31*
Total Water Demand without Project	**1,341**	**1,317**	**1,296**	**1,282**	**1,271**
Project Water Demand (c)	0	86	172	257	343
Total Water Demand with Project	**1,341**	**1,403**	**1,468**	**1,539**	**1,614**

Abbreviations:

"MG" = million gallons

"MPMWD" = Menlo Park Municipal Water District

"UWMP" = Urban Water Management Plan

Notes:

(a) The total projected MPMWD-wide water demand between 2010 and 2040 is based on water demand projections within the MPMWD's draft 2015 UWMP (Reference 1) (see Table 6).

(b) The total estimated water demand for currently planned projects is 31 MG (see Table 7).

(c) The proposed project is expecting buildout by 2040 over a 25-year horizon, based on information provided by City staff on 3 November 2015. Therefore, project water demands at buildout (Table 2) are phased from 2020 to 2040 to reflect phased buildout.

References:

1. 2015 Urban Water Management Plan, prepared by the City of Menlo Park, in development.

Table 9
Historical Water Supply for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

	Historical Water Supply (MG) (a)									
Water Supply Source	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
SFPUC (b)	1,259	1,185	1,314	1,267	1,159	1,085	1,084	1,190	1,344	1,017
Total Water Supply	1,259	1,185	1,314	1,267	1,159	1,085	1,084	1,190	1,344	1,017

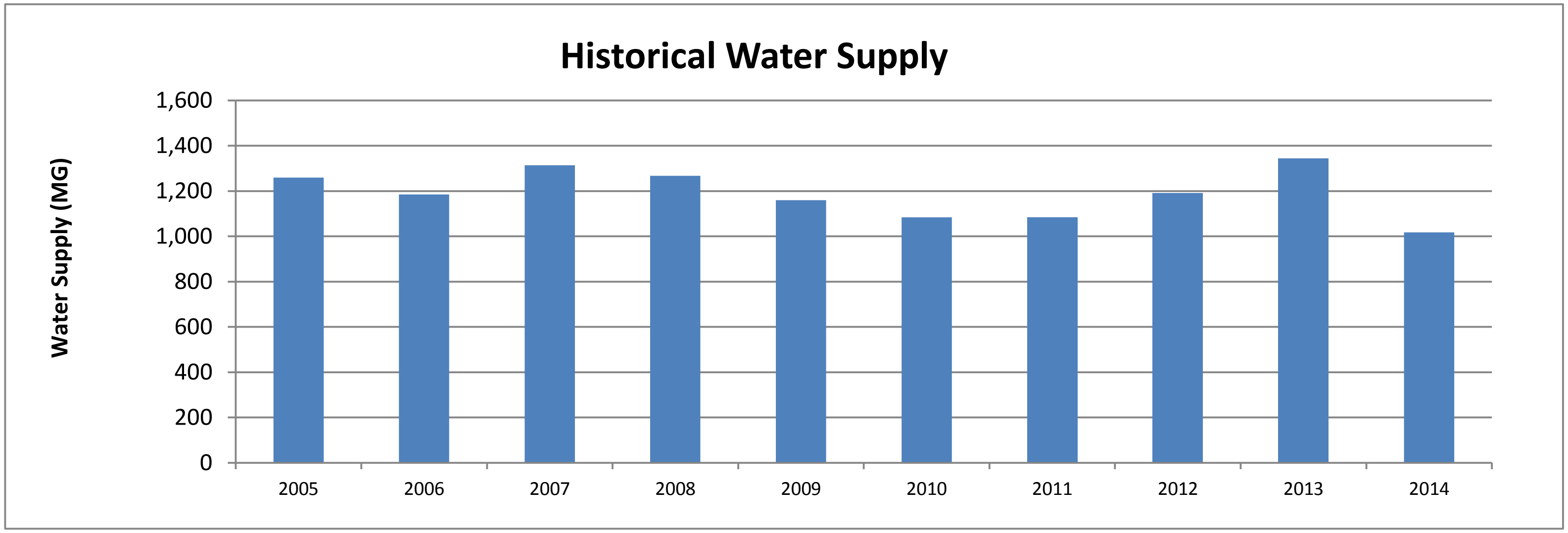


Table 9
Historical Water Supply for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Abbreviations:

"MG" = million gallons
"MGD" = million gallons per day
"MPMWD" = Menlo Park Municipal Water District
"SFPUC" = San Francisco Public Utilities Commission

Notes:

(a) The annual water supply values for 2005 through 2014 are based on monthly wholesale water meter readings provided by City staff on 13 and 16 October 2015.

(b) The MPMWD has a SFPUC individual supply guarantee of 4.465 MGD, or approximately 1,630 MG per year (Reference 1).

References:

1. 2010 Urban Water Management Plan, prepared by the City of Menlo Park, amended November 2014.

Table 10
Projected Future Normal Year Water Supply for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Water Supply Source	Projected Normal Year Supply (MG) 2020	2025	2030	2035	2040
Primary Supply Sources					
SFPUC (a)	*1,630*	*1,630*	*1,630*	*1,630*	*1,630*
Groundwater	*0*	*0*	*0*	*0*	*0*
Total Normal Year Potable Supply	1,630	1,630	1,630	1,630	1,630
Recycled Water	0	0	0	0	0
Total Normal Year Water Supply (b)	1,630	1,630	1,630	1,630	1,630

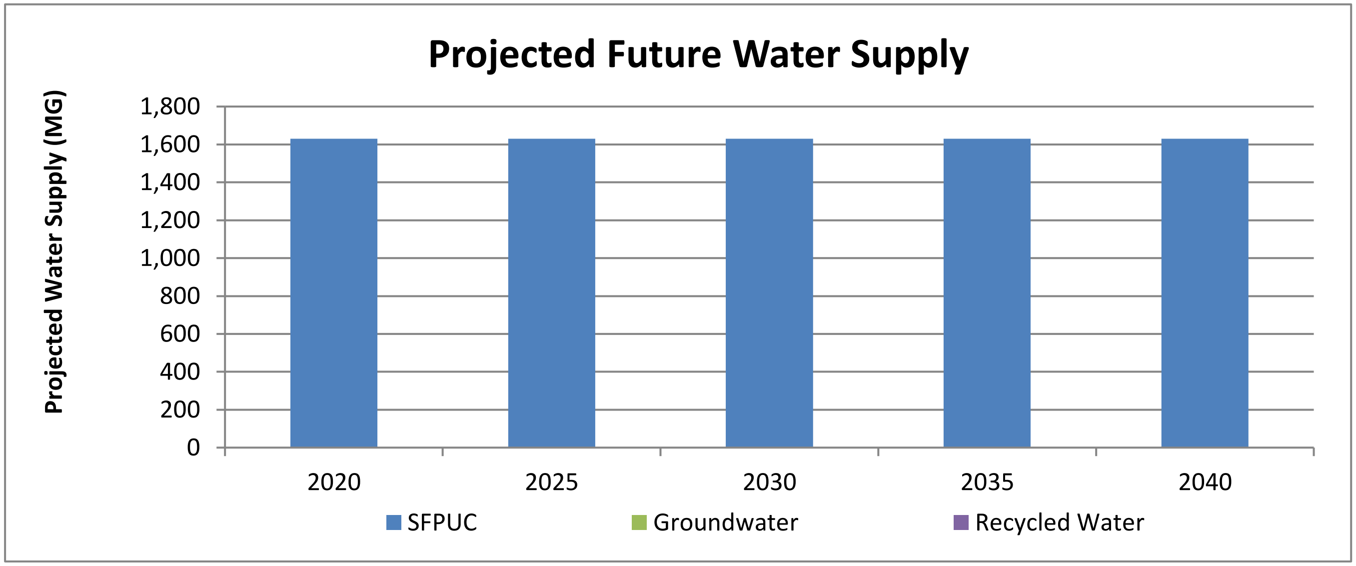


Table 10
Projected Future Normal Year Water Supply for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Abbreviations:

"ISA" = Interim Supply Allocation
"MG" = million gallons
"MGD" = million gallons per day
"MPMWD" = Menlo Park Municipal Water District
"SFPUC" = San Francisco Public Utilities Commission

Notes:

(a) The MPMWD has a SFPUC individual supply guarantee of 4.465 MGD, or approximately 1,630 MG per year. The MPMWD's ISA through 2018 is 4.4 MGD, or approximately 1,607 MG per year, but this ISA is only triggered when the demand of the Regional System as a whole exceeds 265 MGD, and then it only means that MPMWD would be charged a surcharge for any incremental use over the ISA amount (Reference 1).

(b) Total supply is the sum of the potable and recycled water supplies.

References:

1. 2015 Urban Water Management Plan, prepared by the City of Menlo Park, in development.

Table 11
Comparison of Single Dry Year Water Supply and Demand for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Water Supply Source	Projected Water Supply and Demand (MG)				
	2020	**2025**	**2030**	**2035**	**2040**
Primary Supply Sources (a)					
SFPUC	*1,281*	*1,281*	*1,281*	*1,281*	*1,281*
Groundwater	*0*	*0*	*0*	*0*	*0*
Total Dry Year Potable Supply	1,281	1,281	1,281	1,281	1,281
Potable Demand	1,341	1,403	1,468	1,539	1,614
Supply Shortfall	60	122	187	258	333
Supply Shortfall (% demand)	4.5%	8.7%	13%	17%	21%

Abbreviations:

"MG" = million gallons
"UWMP" = Urban Water Management Plan
"MPMWD" = Menlo Park Municipal Water District
"SFPUC" = San Francisco Public Utilities Commission

Notes:

(a) Projected available water supplies and demand during multiple dry years are from the MPMWD's draft 2015 UWMP (Reference 1).

References:

1. 2015 Urban Water Management Plan, prepared by the City of Menlo Park, in development.

Table 12
Comparison of Multiple Dry Year Water Supply and Demand for MPMWD
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Supply Source	Projected Water Supply and Demand During Mutiple Dry Years (MG)														
	2020			2025			2030			2035			2040		
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Primary Supply Sources (a)															
SFPUC	*1,281*	*1,108*	*1,108*	*1,281*	*1,108*	*1,108*	*1,281*	*1,108*	*1,108*	*1,281*	*1,108*	*1,108*	*1,281*	*1,108*	*1,108*
Groundwater	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total Dry Year Potable Supply	1,281	1,108	1,108	1,281	1,108	1,108	1,281	1,108	1,108	1,281	1,108	1,108	1,281	1,108	1,108
Potable Demand	1,341	1,341	1,341	1,403	1,403	1,403	1,468	1,468	1,468	1,539	1,539	1,539	1,614	1,614	1,614
Supply Shortfall	60	233	233	122	295	295	187	360	360	258	431	431	333	506	506
Supply Shortfall (% demand)	4.5%	17%	17%	8.7%	21%	21%	13%	24%	24%	17%	28%	28%	21%	31%	31%

Abbreviations:

"MG" = million gallons
"MPMWD" = Menlo Park Municipal Water District
"SFPUC" = San Francisco Public Utilities Commission
"UWMP" = Urban Water Management Plan

Notes:

(a) Projected available water supplies and demand during multiple dry years are from the MPMWD's draft 2015 UWMP (Reference 1).

References:

1. 2015 Urban Water Management Plan, prepared by the City of Menlo Park, in development.

Table 13
Incremental Impact of the Project on MPMWD's Water Supply and Demand in Normal and Dry Years
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Year			[A] Total Potable Supply (MG) (a)	Without Project: [B] Potable Demand (MG) (b)	Without Project: [C] C = (A - B) / B Supply Shortfall (% of Demand)	With Project: [D] Potable Demand (MG) (b)	With Project: [E] E = (A - D) / D Supply Shortfall (% of Demand)	With Project: [F] F = E - C Incremental Shortage (c)
2020	Normal		1,630	1,341	No Shortfall	1,341	No Shortfall	0%
	SDY		1,281	1,341	4.5%	1,341	4.5%	0%
	MDY	Year 1	1,281	1,341	4.5%	1,341	4.5%	0%
		Year 2	1,108	1,341	17%	1,341	17%	0%
		Year 3	1,108	1,341	17%	1,341	17%	0%
2025	Normal		1,630	1,317	No Shortfall	1,403	No Shortfall	0%
	SDY		1,281	1,317	2.7%	1,403	8.7%	6%
	MDY	Year 1	1,281	1,317	2.7%	1,403	8.7%	6%
		Year 2	1,108	1,317	16%	1,403	21%	5%
		Year 3	1,108	1,317	16%	1,403	21%	5%
2030	Normal		1,630	1,296	No Shortfall	1,468	No Shortfall	0%
	SDY		1,281	1,296	1.1%	1,468	13%	12%
	MDY	Year 1	1,281	1,296	1.1%	1,468	13%	12%
		Year 2	1,108	1,296	14%	1,468	24%	10%
		Year 3	1,108	1,296	14%	1,468	24%	10%
2035	Normal		1,630	1,282	No Shortfall	1,539	No Shortfall	0%
	SDY		1,281	1,282	0.1%	1,539	17%	17%
	MDY	Year 1	1,281	1,282	0.1%	1,539	17%	17%
		Year 2	1,108	1,282	14%	1,539	28%	14%
		Year 3	1,108	1,282	14%	1,539	28%	14%
2040	Normal		1,630	1,271	No Shortfall	1,614	No Shortfall	0%
	SDY		1,281	1,271	No Shortfall	1,614	21%	21%
	MDY	Year 1	1,281	1,271	No Shortfall	1,614	21%	21%
		Year 2	1,108	1,271	13%	1,614	31%	18%
		Year 3	1,108	1,271	13%	1,614	31%	18%

Table 13
Incremental Impact of the Project on MPMWD's Water Supply and Demand in Normal and Dry Years
ConnectMenlo - General Plan and M-2 Area Zoning Update
Menlo Park, California

Abbreviations:

"MG" = million gallons
"MDY" = Multiple Dry Year
"MPMWD" = Menlo Park Municipal Water District
"SDY" = Single Dry Year
"UWMP" = Urban Water Management Plan

Notes:

(a) Projected available water supplies during normal, single dry and multiple dry years are from MPMWD's draft 2015 UWMP (Reference 1), and are documented in Tables 10, 11, and 12.
(b) Values for projected water demand with and without project are calculated in Table 8.
(c) Values are subject to rounding.

References:

1. 2015 Urban Water Management Plan, prepared by the City of Menlo Park, in development.

Appendix A

Summary of Conservation Saving Factors for Indoor Water Uses

and

Appendices E and F to the Pacific Institute's *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, November 2003.

Savings potential for each end use in specific CII land uses are listed in Appendices E and F of the Pacific Institute Study. Using data from the Pacific Institute Study, the conservation factor for indoor water use is calculated in Tables A-1 through A-4 below.

Table A-1: Indoor Conservation Factor for Office Buildings

End Use	**Water Use (TAF)** (a) (b)	**Conservation Potential** (c)		
		Best	**Low**	**High**
Restroom	88	49%	49%	49%
Cooling	77.9	26%	9%	41%
Kitchen	10.2	20%	20%	20%
Other	33.9	10%	0%	25%
Indoor Total (d)	**210**	**<u>33%</u>**	**25%**	**41%**

<u>Notes and Abbreviations:</u>

(a) TAF = Thousand Acre-Feet
(b) Total water use in sampled office buildings obtained from Table E-1 of the Pacific Institute Study.
(c) Conservation potential for each end use in office buildings are obtained from Table E-3 of the Pacific Institute Study.
(d) The indoor total conservation potential is calculated as the weighted average of the conservation potential for each end use based on their water use.

Table A-2: Indoor Conservation Factor for Life Science Buildings

End Use	**Water Use (TAF)** (a) (b)	**Conservation Potential** (c)		
		Best	**Low**	**High**
Process	52.5	43%	29%	53%
Cooling	15.0	26%	9%	41%
Restroom	3.8	49%	49%	49%
Indoor Total (d)	**71.3**	**<u>40%</u>**	**26%**	**50%**

<u>Notes and Abbreviations:</u>

(a) TAF = Thousand Acre-Feet
(b) Total water use in sampled high tech industry obtained from Table F-33 of the Pacific Institute Study.
(c) Conservation potential for each end use in the high tech industry are obtained from Table F-33 of the Pacific Institute Study.
(d) The indoor total conservation potential is calculated as the weighted average of the conservation potential for each end use based on their water use.

Table A-3: Indoor Conservation Factor for the Commercial / Retail Industry (a)

End Use	**Grocery Stores**		**Other Retail**	
	Water Use (TAF) (b) (c)	**"Best" Conservation Potential** (d)	**Water Use (TAF)** (b) (c)	**"Best" Conservation Potential** (d)
Restroom	5.9	51%	30.7	N/A
Cooling	16.9	26%	24.8	N/A
Other	7.6	10%	13.0	N/A
Kitchen	3.1	20%	4.7	N/A
Indoor Total (e)	33.5	26%	83.2	37%
Indoor Total for the Commercial / Retail Industry (f)				**34%**

Notes and Abbreviations:

(a) Conservation factors were determined separately for grocery stores and other retail stores in the Pacific Institute Study. These factors were combined to obtain the indoor total conservation factor for the commercial / retail industry.

(b) TAF = Thousand Acre-Feet

(c) Total water use in sampled grocery and retails stores obtained respectively from Tables E-23 and E-24 of the Pacific Institute Study.

(d) Conservation potential for each end use in grocery stores are obtained from Table E-23 of the Pacific Institute Study. Conservation potential for each end use in other retail stores are likely to have printed erroneously in Table E-24, therefore, the indoor conservation potential is assumed to be the total conservation potential.

(e) The indoor conservation potential for grocery stores is calculated as the weighted average of the conservation potential for each end use in grocery stores based on their water use.

(f) The indoor total conservation factor is calculated as a weighted average of conservation potential in grocery stores and other retail stores based on their water use.

Table A-4: Indoor Conservation Factor for Hotels

End Use	**Water Use (TAF) (a) (b)**	**Conservation Potential**		
		Best	**Low**	**High**
Restroom	16.7	31%	31%	31%
Laundry	4.2	54%	42%	66%
Cooling	3	26%	9%	41%
Kitchen	2.4	20%	20%	20%
Other	0.9	0%	0%	0%
Indoor Total	**27.2**	**32%**	**28%**	**36%**

Notes and Abbreviations:

(g) TAF = Thousand Acre-Feet

(h) Total water use in sampled hotels obtained from Table E-4 of the Pacific Institute Study.

(i) Conservation potentials for each end use in hotels are obtained from Table E-6 of the Pacific Institute Study.

The indoor total conservation potential is each calculated as the weighted average of the conservation potential based on total water use for “best”, “high”, or “low” potential.

Appendix E

Details of Commercial Water Use and Potential Savings, by Sector

Office Buildings
(SIC codes 60–64, 67, 73, 81, 87, and 90)

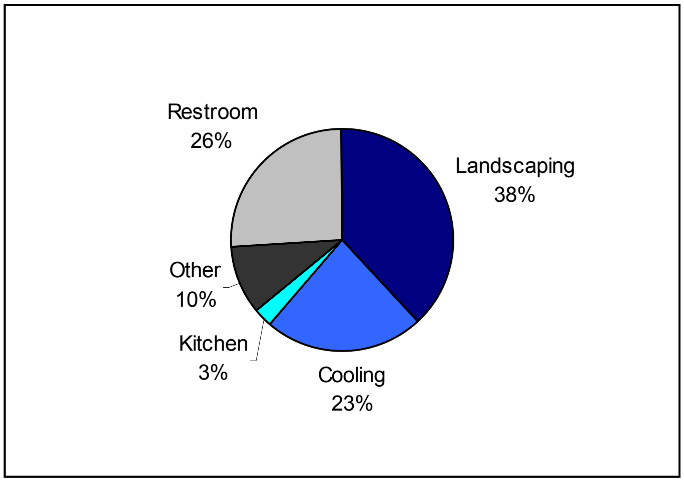
Offices buildings house a wide variety of companies ranging from insurance brokers to law offices. Although the types of offices differ, their employees are usually engaged in similar activities and can therefore be aggregated under one category. We did not, however, include SIC code 65 (real estate) or SIC code 86 (membership organizations) in our analysis, because the GEDs estimated were unreasonably high; indicating problems with either the data or the categorization. For example, we suspect that SIC code 65 includes multi-family housing in addition to real estate offices because it includes in its description "apartment building operators," and rental offices are often located within apartment complexes, where water is used for residential purposes.

Table E-1
Employment and Water Use in Office Buildings (2000)

Sub-industry	SIC code	Gallons per Employee Day (GED)[1,2]	Employees	Annual Use, Thousand Acre-Feet (TAF)
Depository	60	58	198,500	7.9
Non-Depository	61	135	84,700	7.9
Security, Broker	62	176	75,100	9.1
Insurance	63	169	136,300	15.9
Insurance	64	129	83,400	7.4
Holding/Investment	67	176	39,680	4.8
Business	73	129	1,350,530	120.1
Legal	81	99	123,204	8.4
Engineering	87	113	472,069	36.7
Government	90	136	1,279,745	120.3
Office Buildings Total		**127 (average)**	**3,843,303**	**338.5**

[1] Based on a 225-day year.
[1] Note that the GED coefficients estimated for 1995 were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector. See the write-up on correcting GED Estimates for 2000 in the report.

Figure E-1
Water Use, by End Use, in Office Buildings



Source: Calculated from MWD audit data of selected office buildings (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled water use in office buildings, using published estimates of restroom visits by employees, irrigated turf area, cooling requirements etc. We compared our GED-derived estimate of water use per employee to that predicted by the model Table E-2. The end-use calculations in the GED-derived estimate are from Figure E-1 and the model's assumptions are derived from the end use data in Appendix D.

Table E-2
Modeled Water Use in Office Buildings (2000)

End Use	Unit	Rate	Number	Modeled Water Use (GED)	GED-derived (GED)
Toilets[1]					
Employee use	gpf	3.00	2.60 flushes/day	7.8	
Visitor use	gpf	3.00	0.33 flushes/day	1.0	
Urinals[1]					
Employee use	gpf	1.60	1.25 flushes/day	2.0	
Visitor use	gpf	1.60	0.17 flushes/day	0.3	
Faucets[1]					
Employee use	gpf	0.11	3.85 flushes/day	0.4	
Visitor use	gpf	0.11	0.50 flushes/day	0.1	
Total restroom				11.6	33.0
Cooling	gal/sq ft/day	0.07[2]	350[3] sq.ft/employee	23.3	29.2
Landscaping	gal/sq ft	0.08[4]	547[5] sq. ft/employee	20.7	48.3
Kitchen	gal/meal	10.1[6]	0.33 meals/employee/day	3.3	3.8
Other				12.7	12.7
Total				**72**	**127**

[1] See Appendix D.

[2] Two case studies estimated 15 and 34 gal/sq ft./year. The average is about 25 gal/sq.ft/year. We estimate that only 60 percent of office buildings have cooling towers so this works out to 15 gal/sq ft/year on average or 0.07 gal/sq ft/day (Dziegielewski et al. 2000).
[3] Statistical average of 67 office buildings (Dziegielewski et al. 2000).
[4] See Appendix D.
[5] MWD 2002.
[6] See Appendix D.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of end use, we estimated potential water savings (shown in Table E-3).

Table E-3
Potential Water Savings in Office Buildings (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Landscaping	128.6	38%	53%	50%	48.3	68.0	64.2
Restroom	88.0	49%	49%	49%	43.4	43.4	43.4
Cooling	77.9	9%	41%	26%	7.4	32.3	20.0
Kitchen	10.2	20%	20%	20%	2.0	2.0	2.0
Other	33.9	0%	25%	10%	0.0	8.5	3.4
Total	**338.5**	**30%**	**46%**	**39%**	**101.1**	**154.1**	**133.0**

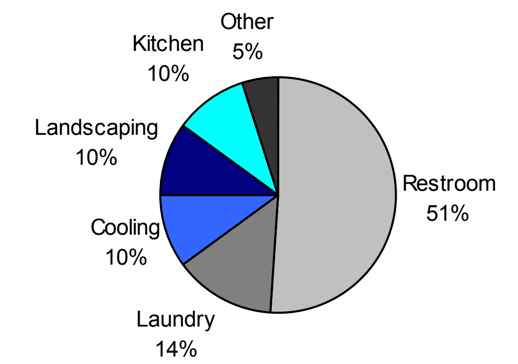
Hotels (SIC codes 701 and 704)

Sub-industries under SIC code 70 include hotels, motels, rooming and boarding houses, recreational vehicle parks, camp sites, and a variety of other types of lodging establishments. Because the literature focuses primarily on water use in hotels, motels, and bed and breakfasts (SIC codes 701 and 704), we limited our focus to these three types of lodging establishments, which we refer to collectively as hotels.

Table E-4
Employment and Water Use in the Hotel Industry (2000)

Industry	SIC codes	GED	Employees	Annual Use (TAF)
Hotels	701,704	240	182,640	30.3

Figure E-2
Water Use, by End Use, in the Hotel Industry



Source: Calculated from MWD audit data of 93 hotels (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled the water use in hotels, using published estimates of restroom visits, showers, faucet use by guests and employees, irrigated turf area, cooling requirements etc. We converted our GED-derived estimate of water use per employee into water use per occupied room per day and then compared it to that predicted by the water use model. The end use calculations in the GED-derived estimate are from Figure E-2 and the model's assumptions are based on the end use data in Appendix D and a study of water use in the hotel industry (Redlin and deRoos 1990).

Table E-5
Modeled Water Use in Hotels (2000)

		Typical Use/Occupied Room/Day			
	Measurement Unit	**Rate/Unit**	**Number of Units**	**Water Use (gal/day)**	**GED-derived Use (gal/day)**
Showers[1]	gal/minute	2.2	16.0	35.2	
Faucets[1]	gal/minute	1.3	0.4	0.6	
Toilets[1]	gal/flush	3.0	4.0	12.0	
Laundry[2]	gal/lb.	2.5	8.0[3]	20.0	
Kitchen	gal/meal	7.6[4]	2.2[5]	17.0	
Icemakers	gal/meal	0.5[6]	2.2[5]	1.1	
Misc.	gal			25.0	

INDOOR				**111.0**	
Cooling[7]	gal/CDD	5.6	1.4	8.0	
COOLING				**8.0**	
Irrigation[8]	gal/sq. ft.	0.2	50.0	10.0	
Pool				0.5	
OUTDOOR				**10.5**	
TOTAL				**130**	**117**[9]

[1] See Appendix D.
[2] See Appendix D.
[3] Pounds/occupied room/day of laundry is obtained from the average of the 12 hotels in Redlin and de Roos (1990). Eighty-nine percent of hotels have in-house laundries (Redlin and de Roos 1990).
[4] Average gal/meal is obtained from the restaurant sector. Seventy-six percent of hotels have restaurants (Redlin and de Roos 1990).
[5] Meals/occupied room (Redlin and de Roos 1990)
[6] 0.5 lbs/meal * 1 gal/lb : lbs/meal taken from 1994 ASHRAE Refrigeration Handbook, 1 gal/lb estimated from Pike 1995.
[7] Nearly 50 percent of the hotels surveyed in Redlin and de Roos (1990) had central cooling. Average annual Cooling Degree Days (CDD) in California was 1035. Therefore Cooling Degrees per day = 1035*50%/365 = 1.4 gal/CDD obtained from Redlin and de Roos (1990).
[8] See Appendix D.
[9] We used information on the total number of occupied hotel rooms and total water used by the hotel sector in 2000. When we divided 2000 water use (30.3 TAF) by 350,000 rooms times the average occupancy rate for the year (66%), the water use/occupied room/day was about 117 gallons.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-6).

Table E-6
Potential Water Savings in the Hotel Industry (2000)

End Use	**Water Use (TAF)**	**Conservation Potential (percent)**			**Conservation Potential (TAF)**		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Restrooms	16.7	31%	31%	31%	5.3	5.3	5.3
Laundry	4.2	42%	66%	54%	1.8	2.8	2.3
Cooling	3.0	9%	41%	26%	0.3	1.3	0.8
Landscaping	3.0	47%	53%	50%	1.1	1.6	1.5
Kitchen	2.4	20%	20%	20%	0.5	0.5	0.5
Other	0.9	0%	0%	0%	0.0	0.0	0.0
Total Savings	**30.3**	**30%**	**38%**	**34%**	**9.0**	**11.4**	**10.3**

Golf Courses (SIC code 7992)

SIC code 79 includes various recreational establishments such as theaters, amusement parks, movie studios, and golf courses. Because water use in these industries varies tremendously, we included only golf courses (SIC code 7992), which comprise a very water intensive sub-industry, in our analysis. Indeed, in 2000, there were nearly 900 golf courses in the state, covering close to 89,000 acres (Horton, 2002), and using 342 TAF of water annually.

Table E-7
Employment and Water Use at Golf Courses (2000)

Industry	SIC	GED	Employees	Annual Use (TAF)
Golf Courses	7992	7,718	34,100	341.8[1]

[1] Freshwater comprised 229 AF of 2000 use and the remaining water was reclaimed water (California State Water Resources Control Board 2002).

Although we do not know the exact breakdown of water use at golf courses, we do know that water is used primarily for landscaping. Without published data, we assumed that 95 percent of golf course water use is used for irrigating turf while the remaining 5 percent is used in restrooms, kitchens, and cooling, which we consolidated as "other." Golf courses tend to use high amounts of reclaimed water in addition to self-supplied and agency-supplied water.[1]

Comparison of GED-derived Estimate to Modeled Water Use

Since landscaping comprises nearly all of a golf course's water use and little or no information was available on restroom, kitchen, or cooling uses, we modeled only the irrigation component to crosscheck our GED-derived estimate. First, we totaled the number and acreage of golf courses by hydrological region and then applied what we know about turf water use in different regions to these acreages to determine total water use in 2000.[2]

[1] According to the National Golf Foundation, in 1998, about 33% of the water supply to golf courses in Region 8 (which includes So Cal, W.AZ and So NV) was supplied from reclaimed water. This percentage was assumed to apply to California. The rest of the water supply to golf courses was from freshwater sources: lakes and streams (22%), wells (32%), public supply(9%), and other (5%). (Thompson, 2002).

Table E-8
Modeled Irrigation Water Use at Golf Courses

Hydrologic Region	Percentage Golf Acreage[1]	Acreage 2000[2]	EV Ratio w.r.t Central Coast[3]	Annual Water Use (AF/Acre)	Modeled Total Irrig. Use (TAF)	GED-derived Estimate of Total Use (TAF)
North Coast	3%	2,945	1.01	2.02	**5.9**	
San Francisco	15%	13,394	1.26	2.52	**33.8**	
Central Coast	7%	6,126	1.00	2.00	**12.3**	
South Coast	46%	41,012	1.37	2.74	**112.4**	
Tulare Lake	5%	4,082	1.80	3.60	**14.7**	
San Joaquin	6%	5,687	1.80	3.60	**20.5**	
Sacramento River	13%	11,211	1.80	3.60	**40.4**	
North Lahontan	1%	544	1.56	3.12	**1.7**	
South Lahontan	4%	3,412	2.08	4.16	**14.2**	
Colorado River	0%	360	2.53	5.06	**1.8**	
Total Irrigation		**88,773**			**258**	**324.6**
Total All End Uses						**341.8**

[1] The number of golf courses was reported by county and we translated this into hydrologic region (California Golf Owners Association 2002). We then converted the number of golf courses in each region into a percentage of the state's total golf course acreage.
[2] The total acreage of golf courses was reported by the California Golf Owners Association (2002) and then distributed among regions based on the percentage of golf courses in each region.
[3] see Appendix D.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-9).

Table E-9
Potential Water Savings at Golf Courses (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Irrigation (Freshwater)	211.9[1]	26%	100%	39%	60.1	211.9[2]	88.7
Irrigation (Reclaimed)	112.8[1]	0%	0%	0%	0	0	0
Other	17.1	0%	0%	0%	0	0	0
Total	**341.8**	**26%**	**100%**	**39%**	**55.6**	**82.1xx**	**211.9xx**

[1] According to the National Golf Foundation, in 1998, about 33% of the water supply to golf courses in Region 8 (which includes So Cal, W.AZ and So NV) was supplied from reclaimed water. (Thompson, 2002)
[2] The low and best estimates coincide with the findings in Appendix D while the high estimate includes potential freshwater savings if all freshwater currently used in golf course irrigation (229 AF/year) was replaced with reclaimed water.

Hospitals (SIC code 806)

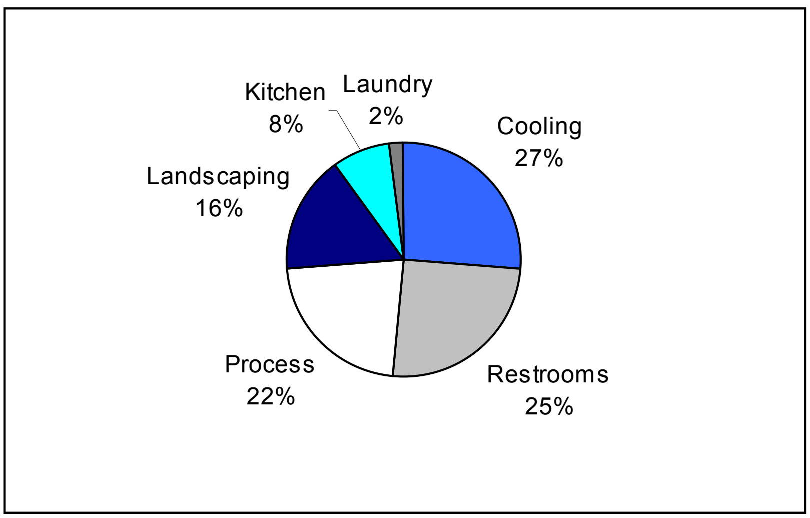
Hospitals are classified under SIC code 80, which also includes physicians' offices (SIC codes 801, 802, and 804), nursing homes and special care facilities (SIC code 805), laboratories and dental clinics (SIC code 807), and outpatient clinics and blood banks (SIC codes 808 and 809). Because the water use in these facilities varies considerably, we focused solely on hospitals (SIC code 806), which are the largest single sub-industry in SIC code 80. Table E-10 and Figure E-3 show water use in hospitals by end-use.

Table E-10
Employment and Water Use in the Hospital Industry (2000)

Industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Hospitals	806	124	428,450	36.7

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

Figure E-3
Water Use, by End Use, in the Hospitals



Source: Calculated from MWD audit data of regional hospitals (MWD 2002).

Process Water Description

Hospitals use process water to operate the following equipment:

- X-ray machines (as part of the film development process);
- Steam sterilizers (for sterilizing equipment);
- Washers;
- Autoclaves (for sterilizing equipment);
- Laboratories;
- Boilers;
- Vacuum pumps (for sterilizing environments); and

- Other, misc. processes.

Potential Process Water Savings

Table E-11
Potential Process Water Savings in the Hospital Industry (2000)

Sub-end Use	Water Conservation Measure	Sub-end Use (x) [1]	Technology Savings (c)	Penetration Rate (p)	Conservation Potential (s) [2]
		(percent)			
X-ray	Recirculating x-ray machines[3]	22%	90%[3]	5%[4]	90%
Steam sterilizers	Replace steam sterilizers with ozone based ones; recirculate water where replacement is not possible	23%	70%[5]	50%[6]	65%
Washers	None				
Autoclave	None				
Laboratories	Improve efficiency of reverse osmosis units; install ultrasonically controlled sinks; retrofit sterilizers	1%	20%	30%[6]	20%
Boilers	Recycle boiler condensate	1%	50%	85%[6]	50%
Vacuum pumps	Replace with oil-ring pumps	4%	100%[7]	95%[8]	100%
Other			0%	50%	30%
Total			**52%**		

[1] Estimated from data in three case studies (B&V 1991 (c&d), MWD 1996, B&M, 1995).
[2] Percent Savings Potential = Savings * (1-Penetration)/ (1- Savings*Penetration Rate)
[3] Water Saver/Plus ™ units can save 98 percent of water used for x-ray machines (CUWCC 2001). Because this technology is relatively new, only a handful of machines have been retrofitted and we assumed that 95 percent of x-ray machines in California are yet to be replaced.
[4] Estimated from data in CUWCC (2001).
[5] The typical conservation recommendations for sterilizers include installing auto-shutoff valves, running the sterilizer or autoclave with full loads only, and recycling steam condensate and non-contact cooling water from sterilizers as make-up water in cooling towers or boilers. These conservation measures could result in savings up to 60 percent (LADWP 1991). However, more recently a few hospitals have replaced steam sterilization with chemical-based sterilizers, saving both water and energy. Almost 70 percent of a hospital's sterilizing needs can be met without steam (Scaramelli and Cohen 2002).
[6] Estimate based on how many years the technology has been around
[7] Converting from water ring pumps to oil ring pumps eliminate water use altogether. Where steam must be used, recirculation is increasingly becoming common (Scaramelli and Cohen 2002).
[8] Oil-ring vacuum pumps currently dominate 80 percent of the market, about 17 percent are oil-less, and roughly 3 percent are still water-ring pumps (Britain 2002).

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) and Table E-11 to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-12).

Table E-12
Potential Water Savings in the Hospital Industry (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Cooling	9.6	9%	41%	26%	0.9	4.0	2.5
Restrooms	9.2	47%	47%	47%	4.3	4.3	4.3
Process	8.1	39%	57%	52%	3.1	4.6	4.2
Landscaping	5.9	38%	53%	50%	2.2	3.1	2.9
Kitchen	2.9	20%	20%	20%	0.6	0.6	0.6
Laundry	0.7	42%	42%	42%	0.3	0.3	0.3
	36.7	**31%**	**46%**	**40%**	**11.4**	**16.8**	**14.8**

Laundries (SIC code 721)

SIC code 721 consists of a range of facilities that include carpet and upholstery cleaners, large linen rental companies, and a variety of laundries, including industrial laundries that clean rags used to wipe inks and solvents off equipment. We include all laundries except SIC code 7215, coin laundries. Table E-13 shows employment and gallons per employee per day coefficients. Figure E-4 shows laundry end-use estimates. As expected, most water use in this industry goes to washing clothes, though about 15% goes to other end uses.

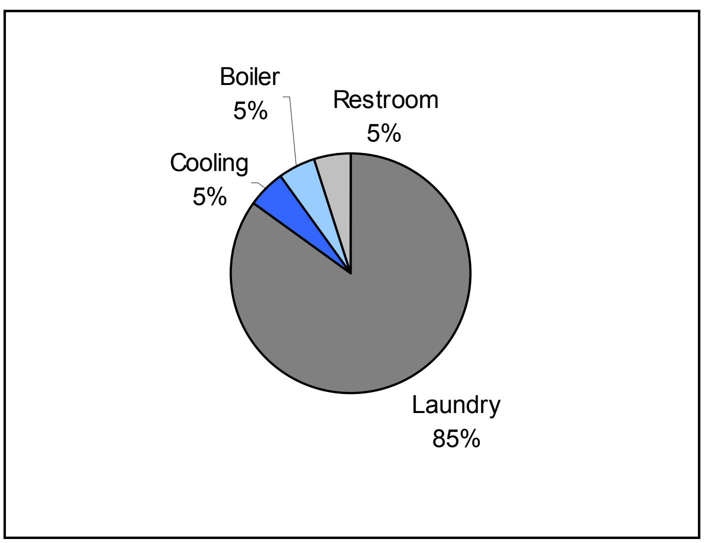
Table E-13
Employment and Water Use in the Laundry Industry (2000)

Sub-industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Dry cleaning & laundry	7216	981	21,410	14.5
Linen supply	7213	977	7,860	5.3
Carpet & upholstery	7217	984	5,890	4.0
Industrial launderers	7218	981	9,150	6.2
Total	**49,965**		**44,310**	**30.0**

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

In the laundry industry, water is used primarily to remove soil and odors from textiles through laundering and very little water (<15 percent) is used for other purposes.

Figure E-4
Water Use, by End Use, in the Laundry Industry



Source: Based on average of two laundry case studies (AWWARF 2000)

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (as shown in Table E-14).

Table E-14
Potential Water Savings in the Industrial Laundry Industry (2000)

	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
End Use		**Low**	**High**	**Best**	**Low**	**High**	**Best**
Laundry	25.5	42%	66%	54%	10.8	16.9	13.8
Cooling	1.5	9%	41%	26%	0.1	0.6	0.4
Boiler[1]	1.5	0%	25%	10%	0.0	0.4	0.2
Restroom	1.5	34%	34%	34%	0.5	0.5	0.5
Total	**30.0**	**38%**	**61%**	**49%**	**11.4**	**18.4**	**14.8**

[1] Assumed Range

Restaurants (SIC code 58)

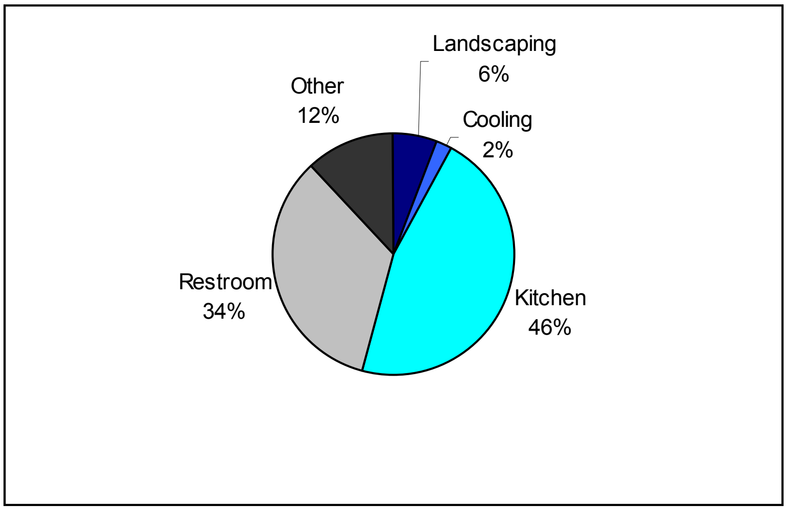
Water is used in restaurants primarily for kitchen purposes, such as washing dishes, making ice, and preparing food (see Appendix D for a description of these uses). A significant amount of water is also used for restrooms. Table E-15 and Figure E-5 provide our estimates of total water use in the restaurant industry by end use.

Table E-15
Employment and Water Use in the Restaurant Industry (2000)

Industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Restaurants	58	265	890,600	163.0

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

Figure E-5
Water Use, by End Use, in the Restaurant Industry



Source: Calculated from MWD audit data of 89 restaurants (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled water use in restaurants using published estimates of restroom visits by employees and customers, irrigated turf area, cooling requirements, dishwashing water use etc. We converted our GED-derived estimate of water use per employee into water use per meal and then compared it to that predicted by the water use model. To convert the GED-derived estimate, we first divided the amount of water used in the restaurant sector in 2000 by the number of meals eaten to calculate the average gallons/meal/day.

Because the number of meals eaten at California restaurants per day was not available, we estimated this number with two different methods (see Tables E-16 and E-17).

Table E-16
Number of Meals Served in California (2000), Method One

Data	Source	Value (2000)
A) Employees in California	US Census Bureau	895,000
B) Meals/employee/day	Average of restaurants[1]	15
C) Total meals/day in California	A*B	13,500,000
D) Percentage of drive-through meals	Restaurant USA	18%
E) Take out meals/day	C*D	2,400,000
F) Sit down meals/day	C-E	11,100,000

[1] Average of data from several case studies (LADWP, 1991 (a & b), MWD, 1992, MWRA, 1990)

Table E-17
Number of Meals Served in California (2000), Method Two

Data	Source	Value (2000)
A) Population in California in 2000	US Census Bureau	33,800,000
B) Meals eaten out/week	Restaurant USA	4.2
C) Total meals/day in California	A*B/7	18,200,000
D) Fraction of meals eaten at cafeterias (not in SIC code 58)	Fraction of establishments not included in SIC code 58	25%[1]
E) Meals in SIC code 58	C*(1-D)	13,700,000
F) Percentage of drive-through meals	Restaurant USA	18%
G) Number of drive-through meals	D*E	2,500,000
H) Sit-down meals/day in restaurants	D-F	11,200,000

[1] We used the number of establishments (74,000) published by the California Restaurants Association (www.calrest.org). The number listed under SIC code 58 (57,000), is about 77 percent of the total restaurants.

To model the water use in a medium-sized restaurant, we considered a food establishment with 25 employees and 60 seats. The meal turnover industry average of 5 meals/seat/day (or 250 meals/day) (LADWP, 1991 (a & b), MWD, 1992, MWRA, 1990) was applied to end-use data from Appendix D.

Table E-18
Modeled Daily Water Use in Restaurants (2000)

Water End Use	Volume[1]	Times Per Day[1]	Use Gal/Day	Use Gal/Meal/Day	Use Efficient Gal/Meal/Day[2]
Dishwasher					
Pre-rinse nozzles	2.5 gpm	60 min	150	0.6	0.40
Pot and pan sink	40 gal	3 sinks * 2 fills[3]	300	1.20	1.20
Garbage disposal	4.5 gpm	30 min	135	0.54	0.20
Dishwasher	2.4 gal/rack	0.5 racks/meal, 70 percent capacity[4]	429	1.71	0.79
Restrooms[5]					
Employee use restrooms	2.8 gal/visit	25 employees * 4.6 visits/day gal/day	322	1.3	0.72
Customer use restrooms	2.7 gal/visit	250 customers *50 percent of customers	338	1.4	0.79
Food Prep					
Preparation sink	15 gal	2 fills/day	30	0.12	0.12
Water used in food	0.5 gal/meal	250 meals/day	125	0.50	0.50
Icemaker					
Ice maker	1 gal/lb[6]	1.5 lb/meal[7]*250 meals	338	1.5	1.2
General Sanitation					
Floor wash	12 gal/clean	3 cleans[8]	36	0.14	0.14
Other[9]	30 gal		125	0.50	0.50
Miscellaneous	100 gal		100	0.40	0.40
Total			**25,607**	**9.91**	**6.96**

[1] Volume and use were estimated from data in several case studies (LADWP, 1991 (a & b), MWD, 1992, MWRA, 1990), except where otherwise noted.
[2] See Appendix D
[3] Three pot sinks of 50 gallons capacity are filled and emptied twice daily.
[4] The amount of dishes generated was assumed to be 2.5 racks/guest (Bohlig 2002).
[5] See Appendix D.

[6] Ice used per meal was about 1.5 lbs and icemaker water use of 1 gal/lb was assumed (note that one gallon of water produces only one pound of ice because, during the process, several gallons are lost to bleed-off.
[7] ASHRAE 1994
[8] Assuming the restaurant uses about 25 gallons each time it cleans the floor and counters and it does this twice daily.
[9] The restaurant uses 100 gallons daily in other uses including laundry and landscaping (about 5 percent of total use). The restaurant does not have a cooling tower.

Our comparison of the GED-derived and modeled estimates is shown in Table E-19 below.

Table E-19
Comparison of Estimates of Water Use in a Typical Restaurant

	GED-derived (gallons/meal)	Model 1 (typical use)	Model 2 (efficient use)
Total	12.9[1]	9.9	7.0

[1] Using 163 TAF in 2000 for SIC code 58 and dividing this by the number of meals per day and then by 365 days in a year, we got about 12.9 gal/meal.

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-20).

Table E-20
Potential Water Savings in the Restaurant Industry (2000)

	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
End Use		**Low**	**High**	**Best**	**Low**	**High**	**Best**
Landscaping[1]	9.8	38%	53%	50%	3.7	5.2	4.9
Cooling	3.3	9%	41%	26%	0.3	1.4	0.8
Kitchen	75.0	20%	20%	20%	14.9	14.9	14.9
Restrooms	55.4	46%	46%	46%	25.2	25.2	25.2
Other[2]	19.6	0%	25%	10%	0.0	4.9	2.0
Total	**163.0**	**27%**	**32%**	**29%**	**44.0**	**51.5**	**47.7**

[1] Based on our modeled landscaping use, we assumed that about 18 TAF, or 4 percent, of total restaurant use is used for landscaping. The remaining 13 TAF, or 6 percent, of the other/landscaping category was used for other purposes. See Appendix D for more information on landscaping.
[2] Range assumed

Retail Stores (SIC codes 53, 54, 55, 56, 57, 59)

Retail stores include grocery stores, department stores, gas stations, and non-store retailers (i.e., retailers who work from home). In 2000, there were nearly 800,000 retail stores in the state. Due to known differences in water use, we categorize retail establishments as grocery stores or "miscellaneous retail" stores. These are shown in Table E-21 and Figure E-6 and Figure E-7.

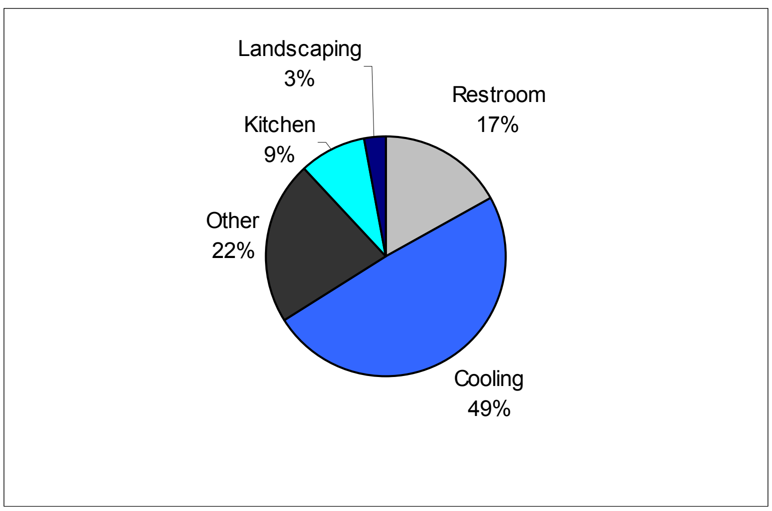
Table E-21
Employment and Water Use in the Retail Industry (2000)

Sub-industry	SIC code	GED[1,2]	Employees	Annual Use (TAF)
Grocery	540	170	293,224	34.5
Misc. Retail	53,55,56,57,59	152	1,128,210	118.1
Total			**1,421,434**	**153.0**

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

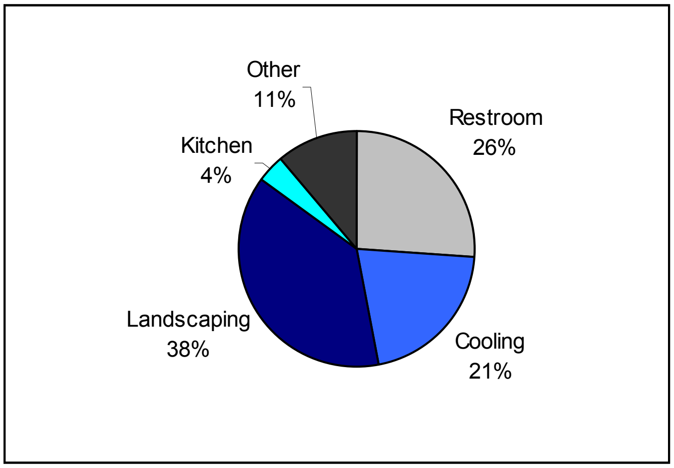
Retail stores use water in kitchens and restrooms and for cooling and irrigation. Although no process water is typically used in the Retail industry, water use varies considerably among the different types of retail stores. For example, grocery stores use water more intensively than other retail stores because they have sinks and dishwashing nozzles in meat and deli departments, misters to keep produce moist, and ice makers. In contrast, department and other retail stores use water mostly for restrooms and space cooling.

Figure E-6
Water Use, by End Use, in the Grocery Sub-industry



Source: Calculated from MWD audit data of 45 grocery stores (MWD 2002).

Figure E-7
Water Use, by End Use, in Misc. Retail Sub-industries



Source: Calculated from MWD audit data of 38 miscellaneous retail stores (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We could not create a complete model of typical water use because of data insufficiency on kitchen and cooling water use in retail establishments. However, we did compare our GED-derived estimates to some of the various end uses that were calculated in Appendix D, as shown in Table E-22.

Table E-22
Comparison of Estimates of Annual Water Use in the Retail Industry

End Use	Modeled End Use	GED-derived Use
	(TAF)	
Kitchen	n/a	7.8
Restrooms	22.5	36.6
Cooling	n/a	41.7
Landscaping	33.7	45.9
Other	n/a	20.6
Total		**153**

Estimate of Potential Savings

By applying the conservation potential calculated in the end use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-23).

Table E-23
Potential Water Savings in Grocery Stores (2000)

Grocery End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Restroom	5.9	51%	51%	51%	3.0	3.0	3.0
Cooling	16.9	9%	41%	26%	1.6	7.0	4.3
Landscaping	1.0	38%	53%	50%	0.4	0.5	0.5
Other	7.6	0%	25%	10%	0.0	1.9	0.8
Kitchen	3.1	20%	20%	20%	0.6	0.6	0.6
Total	**34.5**	**16%**	**38%**	**27%**	**5.6**	**13.1**	**9.2**

Table E-24
Potential Water Savings in the Other Retail Stores (2000)

Misc. Retail End Use	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Restroom	30.7	44%	51%	51%	51%	15.7	15.7
Cooling	24.8	7%	9%	41%	26%	2.4	10.3
Landscaping	44.9	47%	38%	53%	50%	16.9	23.7
Other	13.0	0%	0%	25%	10%	0.0	3.2
Kitchen	4.7	20%	20%	20%	20%	0.9	0.9
Total	**118.1**	**28%**	**43%**	**37%**	**33.2**	**50.9**	**43.4**

Schools (SIC codes 8219, 9382)

There are 8,330 public and 4,370 private schools in California, including elementary, middle, high, continuing, and vocational schools. Total enrollment (public and private) was 4.73 million in elementary and middle schools, 1.85 million in high schools, and 2.20 million in other[3] types of schools (CDE 2002, California Postsecondary Education Commission 2002).

Table E-25
Employment and Water Use in Schools (2000)

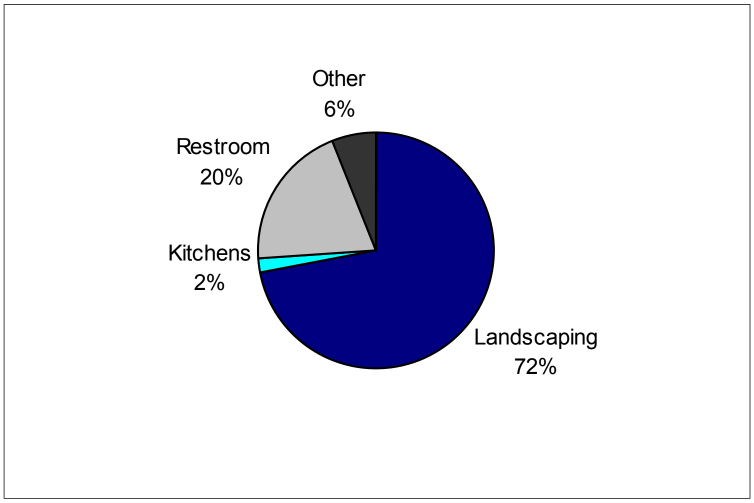
Sub-industry	SIC	GED[1,2]	Employees	Annual Use (TAF)
K-12		308	1,009,130	214.6
Other		190	280,200	36.7
Total			**1,289,300**	**251.3**

[1] Based on a 225-day year.
[2] Note that the GED coefficients estimated for 1995, were decreased by 20% to obtain the GED coefficients for 2000 for the commercial sector.

Although most schools use water for restrooms, cooling and heating, irrigation, and kitchens, the percentage of water consumption devoted to different end uses varies among schools. The most significant difference appears to result from the large use of irrigation water in schools with athletic fields. High schools generally have more irrigated athletic field area per student than elementary schools or other types of schools. Because the end use percentages can vary greatly among the different types of schools, we analyzed water use in elementary/middle schools, high schools, and other schools separately (see Figures E-8 and E-9).[4]

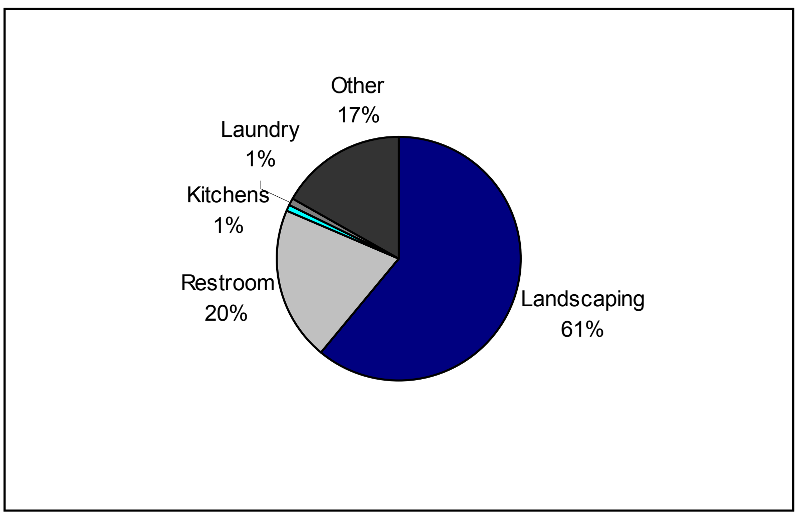
[3] Other types of schools, as referred to herein, include colleges, universities, trade schools, and other non-K-12 schools.
[4] In some cases we had enough data to also analyze elementary and high schools separately.

Figure E-8
Water Use, by End Use, in K-12 Schools



Source: Calculated from MWD audit data of 149 schools (MWD 2002).

Figure E-9
Water Use, by End Use, Other Schools



Source: Calculated from MWD audit data of selected non-K-12 schools (MWD 2002).

Comparison of GED-derived Estimate to Modeled Water Use

We modeled water use in schools using published estimates of restroom visits by students and staff, irrigated turf area, cooling requirements, etc. We converted our GED-derived estimate of water use per employee into water use per student per day and then compared it to that predicted by the water use model. The end use calculations in the GED-derived estimate are from Figures E-8 and E-9 and the model's assumptions are derived from the end-use data in Appendix D. Table E-26 shows the results.

Table E-26
Modeled Water Use per Student

End Uses	Unit Measuring Area or Volume of Use	Area or Volume	Unit Measuring Frequency of Use	Frequency of Use	Total gal/ student/ day
Elementary and Middle Schools					
Irrigation[1]	irrigated acres/student	0.004	gal/acre/school day	varies	24.3
Toilet[2]	gpf	3.00	visits/day	2.11	6.3
Urinal[3]	gpf	1.60	visits/day	1.01	1.6
Faucet Use[4]	gpf	0.11	flushes/day	3.12	0.3
Kitchen	gal/meal	9.91[5]	meals/day/student	0.4[6]	4.0
Other[7]					2.0
Total					**38.5**
High Schools					
Irrigation[1]	irrigated acres/student	0.008	gal/acre/school day	varies	55.6
Toilet[2]	gpf	3.00	visits/day	2.11	6.3
Urinal[3]	gpf	1.60	visits/day	1.01	1.6
Faucet Use[4]	gpf	0.11	flushes/day	3.12	0.3
Kitchen	gal/meal	9.91[5]	meals/day/student	0.4[6]	4.0
Other[7]					4.0
Total					**71.8**
Other Schools					
Irrigation	irrigated acres/student	0.002	gal/acre/school day	varies	6.9
Toilet[8]	gpf	3.00	visits/day	1.03	3.1
Urinal[9]	gpf	1.60	visits/day	0.39	0.6
Faucet Use	gpf	0.11	min/day	0.96	0.1
Kitchen	gal/meal	9.91	meals/day/student	0.4	4.0
Other					1.0
Total					**15.7**

1

2 Assuming that each K-12 student and staff uses the toilet 1.95 times per day (see Appendix D) and a student-staff ratio of about 11.8 (based on student enrollment obtained from the Educational Demographics Office (2002) and employment data from California Employment Development Department (2002), we calculated 2.11 daily toilet visits per K-12 student.

3 Assuming that each K-12 student and staff uses urinals 0.94 times per day (see Appendix D) and a student-staff ratio of about 11.8 (Based on Student Enrollment obtained from the Educational Demographics Office (2002) and Employment Data from California Employment Development Department (2002)), we calculated 1.01 daily urinal visits per student.

4 Faucet use was based on the number of daily toilet and urinal flushes reported above.

5 Average gal/meal was obtained from the model in Appendix D.

6 The USDA estimated that there were about 489 million school meals served in 2000 (about 2.7 million meals per day). The total enrollment in California's public and private schools is about 6.6 million, implying about 40 percent of students have cafeteria meals.

7 Other use is estimated at 5 percent of total use and includes cooling, pools, etc.

8 Assuming that each non K-12 student uses the toilet 0.86 times per day and staff uses the toilet 1.95 times per day and a student-staff ratio of 11.8, we calculated 1.03 daily visits per non K-12 student.

9 Assuming that each non K-12 student uses urinals 0.31 times per day and staff uses them 0.94 times per day and a student-staff ratio of 11.8, we calculated 0.39 daily visits per student.

Table E-27
Comparison of Estimates of Water Use in Typical Schools

	GED-Based Estimate[1]	Modeled Estimate
	(gal/student/day)	
Elementary and middle schools	48.1	38.5
High schools	87.4	71.8
Other schools	30.5	15.8

[1] Based on the assumption that elementary and middle school students use 55 percent of the water used by high schools students (see Table E-26), we converted elementary and middle students into 2.60 million "additional" high school students. We then divided total K-12 water use (215 TAF) by the number of high school students plus the "additional" high school students to yield 87.43 gallons/high school student/school day. Then, we took 55 percent of the high school use in gal/student/day to get gallons/K-8 student/day. For gallons/other student/day, we divided total other use by the number of other students and then by the number of school days.

Estimate of Potential Savings

By applying the conservation potential calculated in the end-use studies (see Appendix D) to our GED-derived estimates of water use, we estimated potential water savings (shown in Table E-28 and E-29).

Table E-28
Potential Water Savings in K-12 Schools (2000)

K-12 End Uses	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Landscaping	154.5	38%	53%	50%	58.1	81.6	77.1
Kitchens	4.3	20%	20%	20%	0.9	0.9	0.9
Restroom	42.9	45%	45%	45%	19.4	19.4	19.4
Other	12.9	0%	25%	10%	0.0	3.2	1.3
Total K-12	**214.6**	**36%**	**49%**	**46%**	**78.3**	**105.1**	**98.6**

Table E-29
Potential Water Savings in Other Schools (2000)

Other Schools End Uses	Water Use (TAF)	Conservation Potential (percent)			Conservation Potential (TAF)		
		Low	High	Best	Low	High	Best
Landscaping	26.4	38%	53%	50%	9.9	14.0	13.2
Kitchens	8.8	45%	45%	45%	4.0	4.0	4.0
Restroom	0.4	20%	20%	20%	0.1	0.1	0.1
Laundry	0.4	42%	66%	54%	0.2	0.2	0.2
Other	0.7	0%	25%	10%	0.0	0.2	0.1
Total Higher and Special-Ed.	**36.7**	**39%**	**50%**	**48%**	**14.1**	**18.4**	**17.5**

Appendix F

Details of Industrial Water Use and Potential Savings, by Sector

Meat Processing (SIC code 201)

The Meat Processing industry includes establishments primarily engaged in packing meat, manufacturing sausages and other prepared meat products, and poultry slaughtering and processing. Table F-1 shows water-use coefficients and total estimated water use in this sector in 2000. Figure F-1 shows water use in this sector by end use. Most water goes to processing meat, though a substantial amount is also used for cooling.

Table F-1
Employment and Water Use in the Meat Processing Industry (2000)

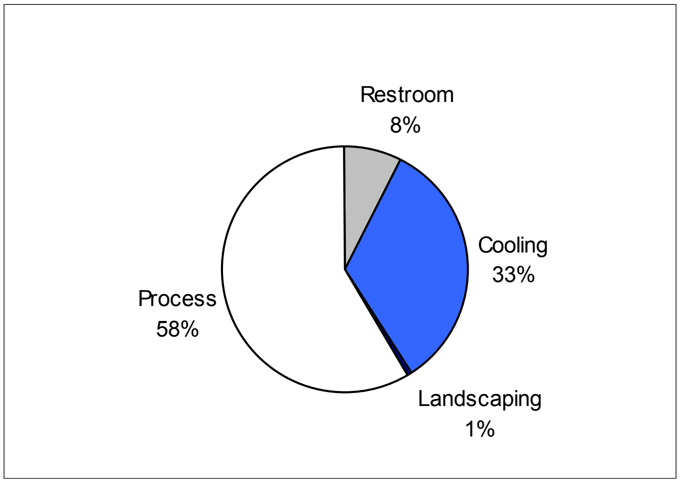
Sub-industry	SIC code	Employees	GED[1,2]	Water Use (TAF)
Poultry processing	2015	7,110	1,365	6.7
Animal (except poultry) slaughtering	2011	4,170	1,477	4.3
Seafood (estimated)	2011	2,790	772	1.5
Meat processed from carcasses	2013	4,930	772	2.6
Total	**201**	**19,000**	**1,149**	**15.1**

[1] Based on a 225-day year.
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector.

Water Use

Meat Processing plants use water primarily for sanitizing animal holding areas, scalding, meat washing, chilling, waste fluming, and cleaning and disinfecting equipment. The industry is heavily regulated and in 1998 it implemented new regulations, called Hazardous Analysis Critical Control Points (HACCPs), which specify the minimum amount of water required for specific operations, such as scalding and chilling. Due primarily to these regulations, water-use intensity (gallons of water per animal or bird processed) has actually increased since the late nineties (Woodruff 2000).

Figure F-1
Water Use, by End Use, in the Meat Processing Industry



Source: Calculated from MWD audit data of two meat-processing plants (MWD 2002).

Process Water Conservation Potential in Poultry Processing

While qualitative information on process water use and potential savings in the Meat Processing industry was available, quantitative data on water use for sanitation, chilling, and scalding and penetration rates were limited.

Sanitation

Information on potential sanitation savings in poultry processing included:

- Poultry plants in California are largely located in the Central Valley where water and sewer charges are comparatively low. Data from one case study indicated that while significant savings are possible from basic improvements in housekeeping techniques, these are not economical in the absence of higher wastewater charges (North Carolina Cooperative Extension 1999).
- Some plants are still using water extremely inefficiently because plant managers do not want to risk implementing water conservation measures at the expense of having the plant shut down under the 1998 HACCP regulations (Woodruff 2000). Consequently, the productivity of water use in this sector has actually declined in recent years.
- Potential savings from good housekeeping appear to be moderate in California's Meat Processing Industry (Lelic, personal communication, 2002).

Based on the information listed above, we assumed that potential savings from various sanitation measures could range anywhere from 20 to 80 percent, although the sources seemed to point toward the lower end of this range. Consequently, we chose 40 percent as our best estimate of typical savings per site.

Chilling and Scalding

In addition to savings from sanitation, some poultry processing plants are using bubbled accelerated floatation (BAF), ultra-filtration, ozone treatment, and recycling for the clean up and recycling of poultry chilling and scalding water. Chilling and scalding water use can be decreased by up to 80 percent with these techniques and (Carawan and Sheldon 1989), to remain conservative in our estimates; we assumed 70 percent per site. The penetration rate of these technologies was estimated at 30% based on the results of the 1997 CIFAR Survey (Pike 1997). The survey indicated that water reuse technologies averaged about 25% in the "All" Category. Since Fruit and Vegetable Processors had much higher penetration rates, meat and poultry were estimated to have lower penetration rates.

Process Water Savings in the Meat Processing Industry

We used the above information about poultry processing to calculate potential process water savings in the Meat Processing industry as a whole, as shown below in Table F-2

Table F-2
Potential Process Water Savings at a Meat Processing Plant (2000)

Process Sub-end Use	Measure	Sub-end Use (x percent)[2]	Site Savings (c percent)	Penetration Rate (p percent)	Savings Potential (s percent)[5]
Sanitation	Good housekeeping	(60%)	40%[3]	(40%[3,4])	29%
Chilling	Recirculate water	(10%)	70%[6]	(20%[7])	65%
Scalding	Recirculate water	(10%)	No Savings	N/A	N/A
Utility		(20%)	No Savings	N/A	N/A
Total process savings potential		**100%**	**23%[8]**		

[1] Note that savings in the a meat processing plant are taken from our estimate of savings in a poultry processing plant.
[2] This breakdown is a guess – no data was available.
[3] Estimated from conversations with Lelic (2002).
[4] Estimated from the general industry feeling (conveyed by Woodward (2002) and the industry literature) that HACCP regulations are preventing the implementation of some of these measures.
[5] Percent Savings Potential = Savings * (1-Penetration)/ (1- Savings*Penetration Rate)
(See Appendices C and D for derivation)
[6] Estimated from data presented by the North Carolina Cooperative Extension (1999).
[7] Estimated based on overall application of reuse of cooling water, rinse, wash water etc. from the 1997 CIFAR Survey
[8] Σx% * s%. (See Appendices C and D for derivation)

Estimate of Potential Water Savings

The conservation potential for common end uses was calculated in the end use studies (see Appendix C) and then applied to our GED-derived estimate of water use to get potential water savings for these end uses. To get the conservation potential for the Meat Processing industry's process water use, we used data from poultry processing (see Table F-1 above). A sensitivity analysis was applied to our best guess penetration rates to obtain a high and low estimate.

Table F-3
Potential Water Savings in the Meat Processing Industry (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Potential Savings (TAF)		
		Low	High	Best	Low	High	Best
Process	8.8	14%	29%	25%	1.2	2.5	2.2

Cooling	5.0	9%	41%	26%	0.5	2.1	1.3
Restroom	1.1	49%	49%	49%	0.6	0.6	0.6
Landscaping	0.1	38%	53%	50%	0.0	0.1	0.1
Total	**15.1**	**15%**	**35%**	**27%**	**2.3**	**5.2**	**4.1**

Comparison with Industry Benchmarks

To crosscheck our estimate of conservation potential, we estimated the amount of water necessary to process one animal and compared it to industry efficiency benchmarks from the North Carolina Department of Environment and Natural Resources (NCDENR et al. 1998). Unfortunately, we had benchmarks for only cattle and broilers and we had to estimate water requirements for processing hogs, sheep, and turkeys. We made the following assumptions[1]: processing a hog required about one-fifth the water used to process one head of cattle; processing a sheep required about one-eighth the water used to process one head of cattle; and processing turkeys required twice as much water per bird as broilers. When we compared our calculated use to what is considered efficient water use industry-wide (see Table F-4 below), we found that total water use in California's Meat Processing industry could be reduced by 33 to 50 percent if all plants operate at the maximum level of efficiency.

Table F-4
Comparison of Estimated Water Use to Efficient Water Use in Meat Processing

Sub-industry	Water Use in 1995 (TAF)	Production [1]	Efficient Water Use (gal/head)	Estimated Water Use (gal/head)
Poultry	Broiler – 6.5 Turkey – 1.2 Chicken – 0.4	22 Mn Turkey 235 Mn Broilers 13 Mn Chicken	Gal / Bird [2] Broiler – 6.0 Turkey – 12.0	Gal / Bird Broiler – 9.0 Turkey – 18.0
Animal Slaughter	Beef Cattle – 1.8 Hogs/Pigs – 0.25 Sheep – 0.05	1.9 Mn Cattle 1.2 Mn Hogs 0.38 Mn Sheep	Gal/ Head 150 [3]	Gal/Head Cattle –300 Hogs – 60 Sheep – 40

[1] California Agricultural Statistical Services 1995
[2] Woodruff (2000) states that under the new health guidelines it is unlikely that water use can return to the 4 gal/bird efficiency benchmark mentioned in the North Carolina CII Water Efficiency Manual (1998) and that a benchmark of 6 gal/bird is more realistic
[3] NCDENR et al. 1998

---

[1] We based these assumptions on the ratio of their average weights (National Agricultural Statistics Service 2000).

Dairy Products (SIC code 202)

Industry Description

The Dairy industry includes establishments primarily engaged in manufacturing: butter; cheese; dry, condensed, and evaporated milk;[2] ice cream and frozen dairy desserts; and special dairy products. SIC code 202 covers only milk processing plants and not dairy farms.

Table F-5
Employment and Water Use in the Dairy Products Industry (2000)

Sub-industry	SIC code	Employment	GED[1,2]	Water Use (TAF)
Creamery butter	2021	540	5,319	2.0
Cheese, natural and processed	2022	4,200	2,078	6.0
Dry, condensed products	2023	2,380	1,071	1.8
Ice cream and frozen desserts	2024	2,350	1,071	1.7
Fluid milk	2026	6,540	1,292	5.8
Total	**202**	**16,010**	**1,568**	**17.3**

[1] Based on a 225-day year.
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector.

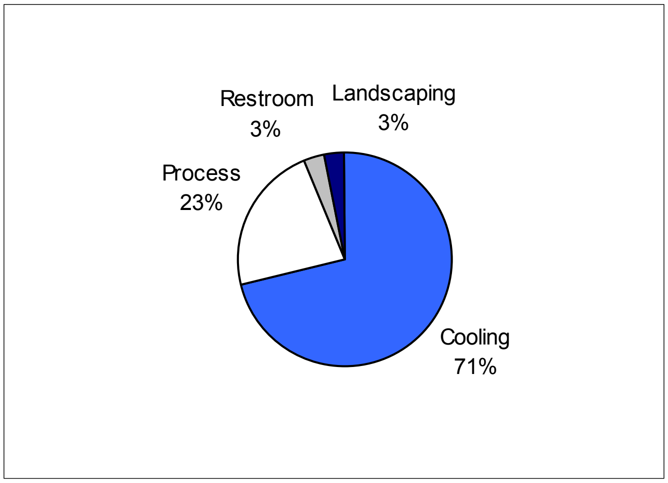
Water Use

The Dairy industry uses water primarily for cooling and, to a lesser degree, for the following process uses (see Figure F-2):

- Sanitize equipment and work areas (industry sanitation standards require that all equipment in contact with a fluid food product must be cleaned every 24 hours);
- Heat and boil milk and milk products;
- Product cooling.

[2] This includes plants that pasteurize, homogenize, add vitamins to, and bottle fluid milk for wholesale or retail distribution.

Figure F-2
Water Use, by End Use, in the Dairy Products Industry



Source: Calculated from MWD audit data of three dairy processing plants (MWD 2002).

Process Water Conservation Potential

California's Dairy industry has not been surveyed since the 1970s and, therefore, actual penetration rates of various water conservation technologies were not available. All penetration rate information obtained for the Dairy industry was estimated from discussions with industry experts and various reports (see Table F-6 below).

Table F-6
Process Water Savings in a Dairy Processing Plant

Measure	Process Water Saved (percent)	Penetration Rate
Eliminate continuous running of carton cleaning water		Most plants[1]
Recirculate carton cleaning water		
Recirculate carton cooling water		
Reverse osmosis of pre-rinse effluent to recover by-product and water	4%[2]	Potential for most plants[2]
Optimize process runs		Most plants[1]
Collect tank acid rinse water to use as pre-wash in next cleaning cycle		No plants (too expensive)[2]
Reuse cow water in nondairy operations like cooling towers and boilers	25%[3]	
Use a reverse osmosis system to upgrade the "cow water" to potable quality	50-60%[3]	Few plants (expensive)
Reverse osmosis to recover water from whey		Few plants

[1] Bruhn, personal communication, 2002.
[2] CIFAR (1995b).
[3] Estimated from data presented in Pequod Associates (1992).

Table F-7
Potential Process Water Savings in the Dairy Processing Industry (2000)

Sub-end Use	**Measure**	**Sub-end Use (x percent)**[1]	**Savings (c percent)**	**Best Est. Penetration Rate (p percent)**[2]	**Savings Potential**[3] **(s percent)**
Carton washing	Eliminate continuous flow, recirculate carton cleaning and washing water	7%	(30%)[4]	90%	4%
Cold storage	Use cow water	3%	25%	70%	30%
Utilities	Use cow water	35%	25%	70%	30%
Sanitation of equipment, filling room, receiving[6]	Recycle dilute rinses, optimize runs to clean less often, upgrade cow water through reverse osmosis to replace potable water	50%	(10%)[4] (10%)[4] 60%[5]	20% 70% 20%	28%
Consumptive	none	5%	0%		
Total process savings potential = Σ x% * s% [7]		**100%**	**25%**		

[1] Estimated from data presented in Carawan et al. (1979) and Danish EPA (1991)
[2] All penetration rates are developed from the qualitative information described in Table F-6. Thus 90% = "Very High/Most Plants", 70% = "High", 20% = "Low"
[3] Percent Savings Potential = Technology Savings * (1-Technology Penetration Rate)/ (1-Savings*Penetration Rate)
[4] Estimate from MnTAP 1994b.
[5] Calculated from data presented in Pequod Associates (1992).
[6] These technologies are complementary, so the overall savings are additive.
[7] see Appendices C and D for derivation

By applying penetration rates from various case studies, the range of the savings in process water was estimated to be between 19 and 28 percent.

Estimate of Potential Water Savings

The conservation potential for common end uses was calculated in the end use studies (see Appendix C) and then applied to our GED-derived estimate of water use to get potential water savings for these end uses. We used data from Table F-7 above for the estimate of potential process water savings (Table F-8).

Table F-8
Potential Water Savings in the Dairy Processing Industry (2000)

	Water Use (TAF)	**Conservation Potential (percent)**			**Potential Savings (TAF)**		
End Use		**Low**	**High**	**Best**	**Low**	**High**	**Best**
Cooling	12.3	9%	41%	26%	1.2	5.1	3.2
Process	4.0	20%	28%	25%	0.8	1.1	1.0
Restroom	0.5	49%	49%	49%	0.3	0.3	0.3

Landscaping	0.5	38%	53%	50%	0.2	0.3	0.3
	17.3	**14%**	**39%**	**27%**	**2.4**	**6.8**	**4.7**

Comparison with Industry Benchmarks

Our estimate of conservation potential in the Dairy industry was crosschecked against industry benchmarks of water use per gallon of milk produced (Table F-9).

Table F-9
Water Use per Gallon of Milk Produced

Water Use	**Gal/gal of Milk[1,2]**	
	1970's	**1990's**
Efficient	2.28	0.5-1.0[3]
Median	3.35	1.4-2.6
High	9.74	

[1] COWI 1991 (reported in liters)
[2] Using 1 gallon of water = 3.78 liters, 1 gallon of milk = 3.9 kg
[3] Bough and Carawan 1992; NC Division of Pollution Prevention and Environmental Assistance 1998 (http://www.p2pays.org/ref/01/0069206.pdf).

About 660 million gallons of milk were used to produce fluid milk in 2000 (California Dairy Forum 2000). From the GEDs we estimated that about 5,750 AF of water was used in fluid milk manufacturing in that year and this translates to roughly 2.8 gallons of water per gallon of milk produced. Given this water consumption, potential water savings could be as high as 65 percent, indicating that our estimate of 16 percent in 2000 is possibly a conservative estimate.

Preserved Fruits and Vegetables (SIC 203)

Industry Description

The Preserved Fruits and Vegetables industry includes processing fresh produce in the following ways: canning (SIC codes 2032 and 2033); dehydration (SIC code 2034); freezing (SIC codes 2037 and 2038); and pickling (SIC code 2035). Fruit and vegetable canning (SIC code 2033) accounts for half of the water used by SIC code 203. Tomato processors constitute the single largest sub-industry, using an estimated 30 percent of the industry's total water use. Peaches, olives, apricots, and pears are among the most important fruits and vegetables processed. Table F-10 shows water coefficients and total water use in SIC code 203. Figure F-3 shows water use by end use. Most water goes to process requirements.

Table F-10
Employment and Water Use in the
Preserved Fruits and Vegetables Industry (2000)

Sub-industry	SIC code	GED[1,2]	Employees	Water Use (TAF)
Preserved Fruit and Vegetables	203	2,487	40,500	69.5

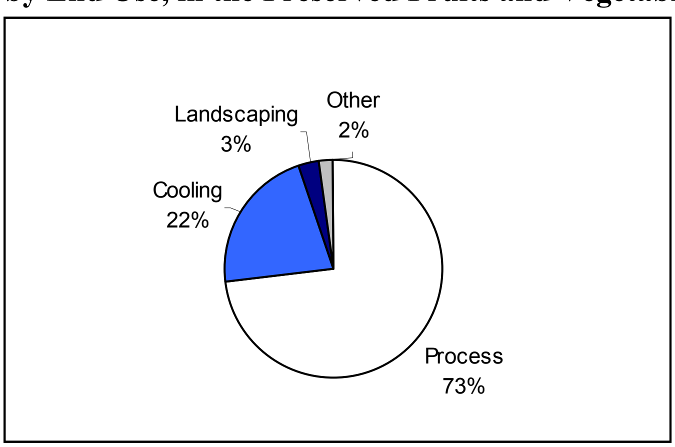
[1] Average across all regions, based on a 225-day year.
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector.

Water Use

Process water is used in the Fruit and Vegetables industry to:

- Clean fruits and vegetables;
- Move produce into the plant;
- Sanitize the peeling, dicing, and other equipment;
- Move waste into the sewers; and
- Sanitize floor and storage areas.

Figure F-3
Water Use, by End Use, in the Preserved Fruits and Vegetables Industry



Source: Calculated from MWD data of one fruit and vegetable processing plant (MWD 2002).

Process Water Conservation Potential

A 1997 report by the California Institute of Food and Agriculture appears to be the best and most recent indicator of penetration rates of water efficient technologies in this industry (Pike 1997). Although the survey is not a random sample, it presented the most comprehensive indicator of penetration rates.[3] The survey showed that fruit and vegetable canning plants have already implemented several conservation measures (see Table F-11).

Table F-11
Implementation of Process and Cooling Water Conservation Technologies at a Fruit and Vegetable Cannery

Measure	Percent Implementing Measure between 1994 and 1997
Process Water	
Self-closing nozzles	42%
Reuse non-contact cooling water	58%
Recycle steam condensate	48%
Reduce wastewater to recapture product	32%
Sanitize reconditioned water for contact use	18%
Reuse rinse water	25%
Cooling Water	
Eliminate single pass cooling	42%
Improve cooling tower efficiency	25%
Change to air cooling	8%

Source: Pike 1997

We applied the findings on conservation technologies in canneries, as shown in Table F-11, to the entire Processed Fruit and Vegetable industry (see Table 4.C.3.3 below).

Table F-12
Potential Process Water Savings in the Preserved Fruit and Vegetables Industry

Sub-end Use	Measure		Savings[1]	Penetration Rate[2]	Potential
Cleaning of produce and equipment	Self-closing nozzles	75%	(30%)	42%	20%
	Reduce wastewater to recapture product		(10%)	32%	7%
	Sanitize reconditioned water for contact use		(10%)	18%	8%
	Reuse rinse water		(10%)	25%	8%

[3] Response to the survey was low (six percent) which leads to the possibility of a self-selection bias. Also, a key survey question ("which efficiency measures have been implemented in the last three years?") would have excluded the plants that implemented measures subsequent or prior to the survey period.

	Membrane filtration of wastewater for reuse		(20%)	0%	20%
	Combined[3]				*22%*
Utilities/Boilers		25%			
Recycle steam condensate			(50%)	48%	34%
Combined		**100%**	**29%**		

[1] There were no reliable estimates available of amount of savings from the different technologies. This is our best guess based on information from similar technology in other sectors.
2 Pike 1997
[3] The first technology is complementary with the other technologies while the others are exclusive. Only some will be applicable at a given plant.

According to Yates (2002), penetration of the conventional technologies listed in the table above (except membrane filtration) is now as high as 90 percent. We performed a sensitivity analysis on the penetration rates to include this information and found that the overall savings vary between 9 and 35 percent using a reasonable range of penetration rates.

Estimate of Potential Water Savings

The conservation potential for common end uses was calculated in the end use studies (see Appendix C) and then applied to our GED-derived estimate of water use to get potential water savings for these end uses. We used data from Table F-12 above for the estimate of potential process water savings (Table F-13).

Table F-13
Potential Water Savings in the Preserved Fruit and Vegetable Industry (2000)

End Use	**Water Use (TAF)**	**Conservation Potential (percent)**			**Potential Savings (TAF)**		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Process	50.8	9%	35%	25%	4.5	17.6	12.8
Cooling	15.3	9%	41%	26%	1.5	6.3	3.9
Landscaping	2.1	38%	53%	50%	0.78	1.1	1.0
Other[1]	1.4	0%	25%	10%	0.0	0.3	0.1
	69.5	**10%**	**37%**	**26%**	**6.8**	**25.4**	**18.0**

[1] Assumed range

Beverages (SIC code 208)

Industry Description

The Beverage industry includes establishments primarily engaged in manufacturing: malt beverages; malt; wines, brandy, and brandy spirits; distilled and blended liquors; bottled and canned soft drinks and carbonated waters; and flavoring extracts and syrups.[4] There are 609 establishments under SIC code 208 in California and of these, 391 are wineries, 69 are malt breweries, 87 manufacture soft drinks, and the rest make flavored syrups. Table F-15 shows total water coefficients and use. Figure F-4 shows water by end use.

Table F-15
Employment and Water Use in the Beverage Industry (2000)

Sub-industry	SIC code	Employment	GED[1,2]	Water Use (TAF)
Malt beverages	2082	5,030	6,756	23.5
Malt	2083	60	204	0.0
Wines, brandy, and brandy spirits	2084	20,210	1,211	16.9
Distilled and blended liquors	2085	490	329	0.1
Bottled and canned soft drinks	2086	10,070	1,990	13.8
Flavoring syrups	2087	1,940	1,705	2.3
Total Beverage Industry	**208**	**37,800**	**2,169**	**56.6**

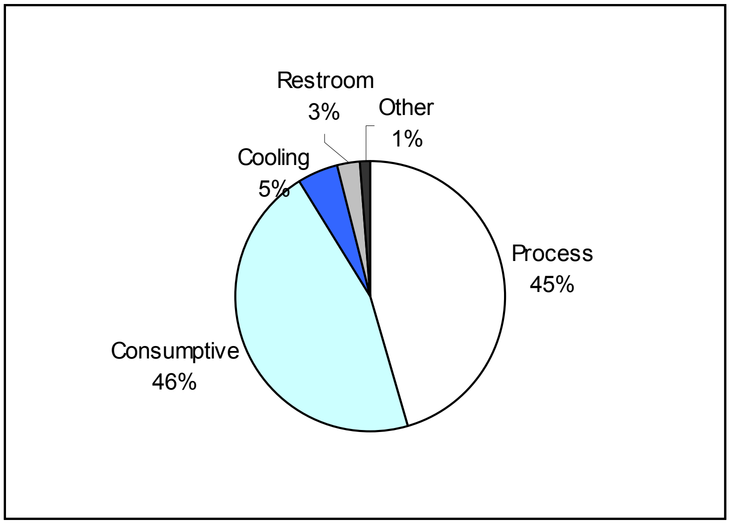
[1] Based on a 225-day year
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector.

Water Use

The Beverage industry uses process water use for:
- The final product;
- Bottle washing;
- Refrigeration;
- Equipment cleaning and cleaning-in-place (C-I-P); and
- Boilers (for pasteurization and sterilization).

[4] This industry does not include fruit juices, which are classified under Fruit and Vegetable Processing (SIC code 203).

Figure 4
Water Use, by End Use, in the Beverage Industry



Source: Calculated from MWD audit of five beverage plants (MWD 2002).

Process water use includes consumptive use, i.e. water included in the final product. We assume that half of the process water use is incorporated into the final product.

Process Water Conservation Potential

A 1997 report by the California Institute of Food and Agriculture Research was the best and most recent indicator of penetration rates (Pike 1997). Although the survey is not a random sample, it offers the only available indicator of penetration rates (Table F-16).[5] The survey showed that wineries have implemented only some conservation measures.

Table F-16
Implementation of Process and Cooling Water Conservation Technologies in Wineries

Measure	**Percent Implementing Measure between 1994 and 1997**
Process Water	
Separate wastewater streams	37%
Self-closing nozzles	18%
Reuse non-contact cooling water	9%
Reduce wastewater to recapture product	9%
Sanitize reconditioned water for contact use	--
Reuse rinse water	18%
Cooling Water	
Eliminate single pass cooling	10%

[5] See footnote 4 above.

Source: Pike 1997

While most of the earlier efforts were focused on efficiency improvements, such as the introduction of self-closing nozzles and adjusting nozzle flow to their rated capacity, reusing rinse water is gaining more popularity. Discharges that can potentially be reused in the beverage industry include: final rinses from tank cleaning; keg washers; fermenters; bottle and can soak and rinse water; cooler flush water; filter backwash; and pasteurizer and sterilizer water. Areas of possible reuse are: first rinses in wash cycles; can shredder; bottle crusher; filter backflush; caustic dilution; boiler makeup; refrigeration equipment defrost; equipment cleaning; and floor and gutter wash.

Table F-17
Potential Process Water Savings in the Beverage Industry

Measure	**Savings[1]**	**Penetration Rate[2]**	**Potential[3]**
Self-closing nozzles	(30%)	25%	24%
Separate wastewater streams	(5%)	40%	3%
Reuse non-contact cooling water	(20%)	10%	18%
Reduce wastewater to recapture product	(20%)	10%	18%
Reuse rinse water	(20%)	20%	17%
Combined			**27%**

[1] There were no reliable estimates for this figures, these are simply our best guess
[2] These penetration rates are the same rates shown in Table F-16, adjusted upwards to account for some increased penetration from 1997 to 2000
[3] The first technology is complementary with the other technologies while the others are exclusive, only some will be applicable at a given plant.

By performing a sensitivity analysis on the penetration rates we found that the potential for saving process water varied between 19 and 31 percent.

Estimate of Potential Water Savings

The conservation potential for common end uses was calculated in the end use studies (see Appendix C) and then applied to our GED-derived estimate of water use to get potential water savings for these end uses. We used data from Table F-17 above for the estimate of potential process water savings.

Table F-18
Potential Water Savings in the Beverage Industry

End Use	**Water Use (TAF)**	**Conservation Potential (percent)**			**Potential Savings (TAF)**		
		Low	**High**	**Best**	**Low**	**High**	**Best**
Consumptive	(25.8)	N/A	N/A	N/A	0.0	0.0	0.0
Process	(25.8)	19%	31%	27%	4.9	7.9	7.0
Cooling	2.8	9%	41%	26%	0.3	1.2	0.7
Restroom	1.7	49%	49%	49%	0.8	0.8	0.8

Other[1]	0.6	0%	25%	10%	0.0	0.1	0.1
	56.5	**11%**	**18%**	**15%**	**6.0**	**10.1**	**8.6**

[1] Assumed Range

Textile Industry (SIC code 22)

Industry Overview

The Textile industry is a relatively new industry in California. In the past three decades, the industry has grown into a $5 billion business located primarily in southern California. The industry is comprised of diverse, fragmented groups of establishments that receive and prepare fibers, transform the fibers into yarn, and then dye or finish the yarn into fabric. Table F-19 shows employment, water coefficients, and total use in the Textile sector.

Table F-19
Employment and Water Use in the Textile Industry (2000)

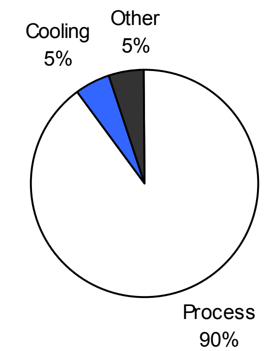
Sub-industry	SIC code	Employment	GED[1,2]	Water Use (TAF)
Broad, narrow, knit fabric mills	221, 224	3,180	299	0.7
Knitting mills	225	11,800	1,651	13.5
Textile finishing	226	4,020	910	2.5
Carpets	227	3,200	2,805	6.2
Yarn and thread	228	940	2,805	1.8
Misc. textile goods	229	4,060	2,328	6.5
	22	**27,200**	**1,660**	**31.2**

[1] Average across all regions, based on a 225-day year.
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector.

Water Use

Due to data constraints, an end use breakdown for the textile industry was unavailable. Based on our study of end uses, we assumed that since reasonable restroom and kitchen use would not exceed 50 gallons per employee per day, at least 90 percent of the water use must be for process and cooling. Conversations with Textile industry experts indicated that the residual hot water from the cooling process is reused in various processes (usually dye baths) (Demanyovich 1990). We assumed that only five percent of overall water is used in cooling (Figure F-5).

Figure 5
Water Use, by End Use, in the Textile Industry



Source: Estimate based on interviews

The stages of textile manufacturing that use the most water are the "wet processing" steps, which involve transforming undyed, unprocessed fabric known as "greige" into the finished product through four broad stages:

- Fabric preparation (chemically treating the greige to remove impurities, improve strength and dye uptake, and enhance the appearance of the fabric);
- Dyeing;
- Printing; and
- Finishing.

In each stage, water is used to either make chemical baths or to wash out excess chemicals after processing. The amount of water used varies greatly among mills and depends on each mill's specific processing operations and equipment.

Table F-20
Water Use by Processing Category in the Textile Industry

Processing Category	**Minimum (gal/lb)**	**Median (gal/lb)**	**Maximum (gal/lb)**
Wool	13.3	34.1	78.9
Woven	0.6	13.6	60.9
Knit	2.4	10.0	45.2
Carpet	1.0	5.6	19.5
Stock/yarn	0.4	12.0	66.9
Non woven	0.3	4.8	9.9
Felted fabrics	4.0	25.5	111.8

Source: NCDENR 1998

Process Water Savings

Because of the high variability in water use, calculating detailed penetration rates and savings from individual technologies for this sector proved nearly impossible. Instead, we used the case study information provided below in Table F-21 to estimate penetration rates.

Table F-21
Process Water Savings in the Textile Industry

End Use	Type	Technology	Savings	Penetration
Preparation: scouring[1]	Reuse	Reuse of bleach, mercerizing[2] rinse water		
Preparation: desizing[3]	Reuse	Reuse of scouring, jet-weaving, bleach, mercerizing rinse water		
		Membrane filtration of desizing water[4]		Pilot stage
Continuous dyeing	Recycling	Countercurrent washing	20-50% of dyeing water use[5]	
	Efficiency	Use of automatic shutoff valves	20% of dyeing water use[6]	Probably high[7]
	Reuse	Reuse of rinse water from dyeing for dye bath makeup	50%[8]	Only 2 out of 60 firms as of 2002.[9]
VAT dyeing	Efficiency	Avoiding overflow rinsing	20-70% of dyeing water use[6]	
Carpet dyeing	Reclaimed water	Use of reclaimed water in carpet dyeing		Only 3-4 mills in CA in 2000[10]
Sanitation	Reuse	Reuse of colored wash water for cleaning floors and equipment in the print shop		

1 Scouring: a cleaning process to remove impurities from fiber and yarn through washing with alkaline solutions.
2 Mercerizing: chemical treatment of cotton and cotton/polyester fabrics to improve dye uptake and luster of the fabric.
3 Desizing: sizing is the application of starches and materials, called sizes, to improve the quality of the fabric. Once sizing is completed, the fabric is desized, which involves treating the fabric with enzymes to breakdown the starches and then washed it.
4 Ministry of Environment and Energy, Danish Environmental Protection Agency 2001
5 Estimated from data presented in Asnes (1984).
6 Estimated from data presented in NCDNRCD (2002).
7 This technology has been around for a long time, but the textile industry is a relatively new industry in California (it emerged in the 1980s) so it is likely that most plants already have auto shut off valves in their continuous process lines.
8 Estimated from conversation with Templeton (2002).
9 Demanyovich 2002
10 State Water Resources Control Board 2002

Using our best judgment of the penetration rates and the breakup of water use between the different sub-end uses, we estimated savings potential for each sub-end use (as shown in Table F-22).

Table F-22
Potential Process Water Savings in the Textile Industry (2000)

Process Sub-end Use	Measure	Portion of Process Use (percent)[1]	Savings (percent)	Penetration Rate (percent)	Savings Potential (percent)
Preparation	Reuse of scouring, bleach and mercerizing water	15%			33%
Dyeing	Reuse of rinse water from dyeing for dye bath make-up; use of reclaimed water in carpet dyeing; avoiding bath overflow	52%	50%[2] 100% 50%[3]	5%[4] 5%[5] 50%[6]	56%[7]
Printing		6%			10%[8]
Washing	Counter current washing, spray rinsing	27%	30%[3]	50%[6]	18%
Total Process		**100%**		**39%**	

[1] Estimated from flow rates provided in NCDENR et al. (1998).
[2] Estimated from conversation with Templeton (2002).
[3] Estimated from data in Table F-21 above.
[4] Estimated from conversation with Demanyovich (2002).
[5] Estimated from State Water Resources Control Board data (CSWRCB 2002).
[6] No data on penetration rates were available, 50 percent assumed.
[7] Carpet mills account for about 15 to 20 percent of the water use (we assumed reclaimed water applied). The other technologies were assumed to be applicable to all fabric and yarn mills.
[8] This is an assumption. Similar technologies such as reusing equipment wash water are possible at the printing stage.

We estimate that process water use savings range between 32 and 44 percent. Membrane filtration of the various waste streams could further increase the conservation potential.

Estimate of Potential Water Savings

We used data from Table F-22 above for the estimate of potential process water savings and we assumed that restroom water use comprised the majority of other use (see F-23 for total savings).

Table F-23
Potential Water Savings in the Textile Industry (2000)

End Use	Annual Use (TAF)	Conservation Potential (percent)			Potential Savings (TAF)		
		Low	High	Best	Low	High	Best
Process	21.8	32%	44%	39%	8.5	11.7	10.4
Cooling	6.2	9%	41%	26%	0.1	0.6	0.4
Other	3.1	49%	49%	49%	0.7	0.7	0.7
	31.2	**32%**	**45%**	**39%**	**9.4**	**13.1**	**11.5**

Crosscheck

NCDENR et al. (1998) estimated that "a reduction of 10-30 percent can be accomplished by taking fairly simple measures" like fixing leaks, turning off running hoses, and saving cooling water when the machinery is shut down. Dr. Robert

Demanyovich (2002) of RJD technologies, an expert in the textile industry, judged the overall savings to be somewhere between 20 to 50 percent.

Paper and Pulp (SIC codes 261,262, 263)

Paper and Pulp mills are very water-intensive facilities. Pulp facilities (SIC 261) convert wood products to pulp, which is then transported via pipe or truck to another manufacturing facility to be transformed into paper or paperboard. Integrated facilities produce pulp and paper in the same facility.[6] Table F-24 shows estimated California water use in this sector. Figure F-6 shows end use of water in pulp and paper mills from representative plants out of state. We assume comparable water uses here and urge state-specific data be collected.

Table F-24
Employment and Water Use in the Paper and Pulp Industry (2000)

Sub-industry	SIC code	GED[1,2]	Employees	Water Use (TAF)
Pulp Mills	261	12,590	370	3.2
Paper Mills	262	5,260	2,240	8.1
Paperboard Mills	263	10,320	1,500	10.2
Total			**4,110**	**22.0**

[1] Average across all regions and based on a 225-day year.
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector.

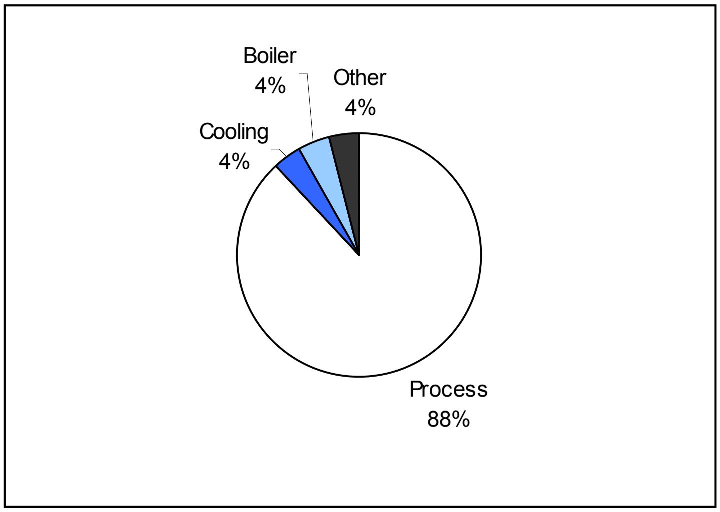
Water Use

The Paper and Pulp industry uses process water for the following purposes:

- **Pulping** – Digesting the raw material (wood) by chemical or mechanical means to release cellulose fibers by breaking the bonds that hold the fibers together;
- **Pulp Processing** – Removing impurities, preparing the fiber for manufacture of paper and bleaching the fiber to improve brightness; and
- **Paper/Paperboard Manufacturing** - Applying a watery suspension of cellulose fibers to a screen to drain the water and leave behind the fiber to form a sheet.

[6] Facilities that convert paperboard to boxes and cartons are also classified under SIC 26 but they are not included herein because they are significantly less water intensive.

Figure 6
Water Use, by End Use, in the Paper and Pulp Industry



Source: Texas Water Resources Control Board 1996

Process Water Savings

The average water use in the Paper and Pulp industry decreased from 15,000 gallons/ton of paper produced in the 1980s to about 2,500 gallons/ton today. Information about current conservation potential in this industry is relatively modest (see Table F-25).

Table F-25
Process Water Savings Paper and Pulp Plants

Technology	Process Water Saved (percent)	Penetration Information Available
Partial recycling of process water	20-40%	CDWR data (1995) indicate that between 40-50% of the plants surveyed practiced some kind of water recirculation.
Closed loop systems	80-90%	As far as we can determine, only one plant in 2000, Louisiana Pacific, had a closed-loop system, but there is an industry trend towards closed-loop systems.
Reclaimed water use	100%	The Pacific Crest Paper Mill in Southern California currently uses reclaimed water from the Irvine Ranch Water District for process water use.

This overall savings potential estimate was mostly based on the assumption that the Paper and Pulp industry can save considerable amounts of water by moving towards closed loop systems and increasing recycling of water. The development of new membrane filtration technologies is increasingly making this move a viable alternative. In the best case we assumed that a third of the plants will implement closed-loop systems and reduce water use by 70 percent. In the low conservation scenario, we assume that only 10 percent of the plants will be able to do so.

Estimate of Potential Water Savings

We used data from Table F-25 above for the estimate of potential process water savings (summarized in F-26).

Table F-26
Potential Water Savings in the Paper and Pulp Industry (2000)

	Water Use (TAF)	Conservation Potential (percent)			Potential Savings (TAF)		
End Use		**Low**	**High**	**Best**	**Low**	**High**	**Best**
Process	19.4	(16%)	(49%)	(34%)	3.1	9.5	6.6
Cooling	0.9	9%	41%	26%	0.1	0.4	0.2
Boiler	0.9	0%	10%	5%	0.0	0.1	0.0
Other	0.9	20%	40%	30%	0.2	0.4	0.3
	22.0	**(15%)**	**(47%)**	**(33%)**	**3.4**	**10.3**	**7.2**

Fabricated Metals (SIC code 34)

Industry Overview

The Fabricated Metals industry (SIC code 34) includes facilities that machine, clean, treat, coat, and paint metal parts. Machining operations involve using tools that travel on the surface of the metal to shear, etch, or cut it. Metal cleaning, a process found in virtually all fabricated metal industries, consists of chemically stripping the metal of old paint, oxidation, or plating. Water is used primarily for rinsing components after the various chemical processes and in preparing chemical baths.

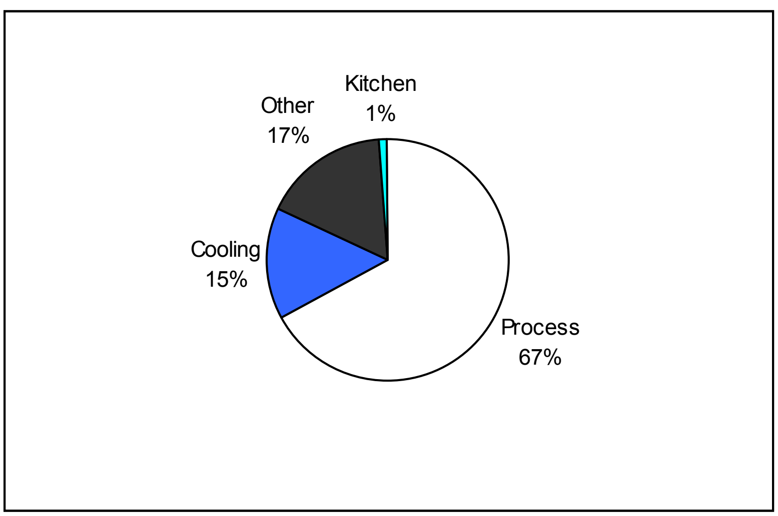
Individual facilities may perform one or more of these functions, either for third parties or as part of a larger manufacturing process. Southern California supports the largest Fabricated Metals industry in the United States due to the region's aircraft and electronics industries. Table F-27 shows total estimated water use in the Fabricated Metals sector of California in 2000. Figure F-7 shows water by end use in this sector; again, more extensive end use data should be collected.

Table F-27
Employment and Water Use in the Fabricated Metals Industry (2000)

Industry	SIC code	GED[1]	Employees	Water Use (TAF)
Fabricated Metals	34	215	132,600	19.7

[1] Average across all regions, based on a 225-day year.
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector. See earlier information.

Figure F-7
Water Use, by End Use, in the Fabricated Metals Industry



Source: This was calculated from MWD audit data of an aircraft parts manufacturer (MWD 2002).

Process Water Savings

A 1994 survey of 318 metal finishers across the U.S. provided background information on the penetration of water conservation technologies (NCDENR et al., 1998). We applied the national averages found in these studies to California (Table F-28).[7]

Table F-28
Process Water Savings in the Fabricated Metals Industry

Measure	Process Water Savings (percent)	Penetration Rate in 1994 (percent) [1]
Flow restrictors	n/a	70%
Counter current rinsing	50-60%[2]	68%
Manually turn of rinse water when not in use	n/a	66%
Agitated rinse tanks	n/a	58%
Spray rinses	60%[3]	39%
Reactive or cascade rinses	50%[3]	24%
Conductivity controllers	40%[3]	16%
Flow-meters	n/a	12%
Timer rinse controls	40%[3]	11%
Acid recovery systems	50%[4]	(40%)
Best Estimate of overall process water savings		**33%[5]**

[1] NCDENR et al. (1998).
[2] Estimated from data provided by the City of San Jose, 1992 (b).
[3] Estimated from data provided by the US EPA 1994.
[4] A case study from the Office of Technical Assistance (OTA 2002) shows a savings of more than 90 percent of process water. We assume that an average of 50 percent can be saved and a penetration rate of 40 percent for this technology.
[5] To obtain the best estimate we assumed that spray rinses and cascade rinses were complementary technologies with about 50 percent market share each. We also assumed that acid recovery systems could be applied to 50 percent of the metal finishing facilities and that timer rinse controls and conductivity controllers can be implemented at all facilities.

Estimate of Potential Water Savings

The conservation potential for common end uses was calculated in the end use studies (see Appendix C) and then applied to our GED-derived estimate of water use to get potential water savings for these end uses. We used data from Table F-28 above for the estimate of potential process water savings (Table F-29).

[7] Detailed 2001 resource recovery information, by state, can be purchased from the National Metal Finishers Association, but the cost of the data exceeded our resources.

Table F-29
Potential Water Savings in the Fabricated Metals Industry (2000)

End Use	Water Use (TAF)	Conservation Potential (percent)			Potential Savings (TAF)		
		Low	High	Best	Low	High	Best
Process	13.2	25%	42%	33%	3.3	5.5	4.4
Cooling	3.0	9%	41%	26%	0.3	1.2	0.8
Other	3.3	43%	51%	50%	1.5	1.7	1.7
Kitchen	0.2	20%	20%	20%	0.0	0.0	0.0
Total	**19.7**	**26%**	**43%**	**35%**	**5.0**	**8.5**	**6.8**

Crosscheck

The Fabricated Metals industry has created a National Metal Finishing Strategic Goals Program, which aims to reduce water use by 50 percent compared to 1992 levels. The status for California in 2000 indicates that 65 percent of the goal has been met for water efficiency (National Metal Finishing Strategic Goals Program 2000). These findings imply about a 25-percent reduction in current water use is possible.

High Tech Industry (SIC codes 357, 36, 38)

Industry Overview

There is no standard definition of the High Tech industry. In this report, we adopted the definition used by the Portland Water Bureau (Boyko et al. 2000) and included the following sub-industries: computers and office equipment (SIC code 57); electronic equipment and components (except computer equipment) (SIC code 36); and measuring, analyzing, and controlling instruments (SIC code 38). Table F-30 lists total employment and estimated water use in the High Tech industry in 2000.

Table F-30
Employment and Water Use in the High Tech Industry (2000)

Sub-industry	SIC code	GED[1]	Employees	Water Use (TAF)
Semiconductor devices	3674	356	61,540	15.1
PCB manufacture and assembly	3672, 3679	405	77,790	21.8
Computer and office equipment	357	88	95,000	5.8
Rest of high tech	Rest of 36,38	156	300,592	32.4
Total High Tech	**357,36,38**	**203**	**534,930**	**75.0**

[1] Based on a 225-day year
[2] The GEDs estimated for 1995, were decreased by 6% to obtain the GED coefficients in 2000, for the industrial sector. See earlier discussion.

Semiconductor devices (SIC code 3674) and printed circuit board manufacturing and assembly (SIC codes 3672 and 3679) use about half of the water used in the High Tech industry. Semiconductor manufacturing consists of growing silicon crystals and then cutting and polishing them into thin silicon wafers. Hundreds of integrated circuits are then etched onto the wafer in an ultra-clean environment. A printed wiring board (PWB) or printed circuit board (PCB) is a device that provides electrical interconnections and a surface for mounting electrical components. The production process consists of etching patterns of conductive material, usually copper, onto a non-conductive base. After each step of surface preparation, electroplating, pattern masking, and etching, water is used for rinsing. The rest of the High Tech industry includes facilities that manufacture and assemble various electrical, electronic, and communication components.

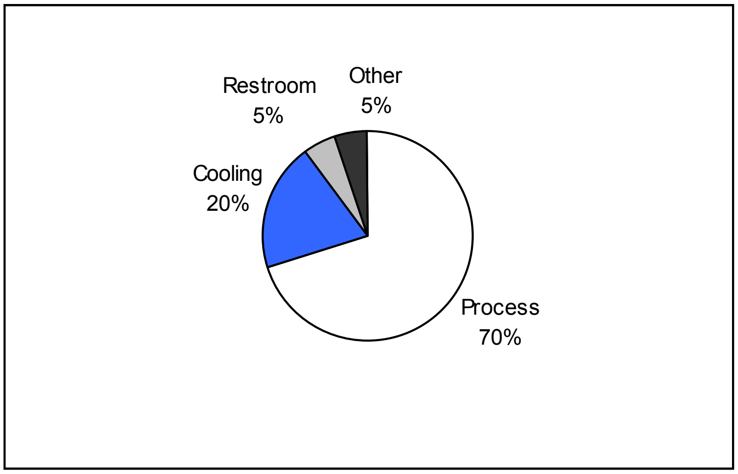
Water Use

Process water use comprises most of the High Tech industry's water use (60 to 80 percent), cooling uses 20 to 30 percent, and the rest is domestic and irrigation use (Figure F-8). Process water is used for:

- Passing potable city water through a reverse osmosis membrane to remove impurities, producing ultra-purified water (UPW)[8];
- Rinsing and tool cleaning (water of an extremely high purity is used to rinse components after they are treated with solvents and acids); and
- Scrubbing (water is used to remove polluting gases from exhaust air).

[8] Typically, 1,400 to 1,600 gallons of potable water produce 1,000 gallons of UPW.

Figure F-8
Water Use, by End Use, in the High Tech Industry



Source: City of San Jose 1992 (h)

Process Water Savings

In 1994, SEMATECH, a semiconductor industry association, conducted an assessment of the status of water conservation in the semiconductor industry, determined future requirements, and established standard terminology and metrics to characterize water consumption in the industry. This study was the best source of penetration rate information available.

Table F-31
Process Water Savings in the Semiconductor Industry

End Use	Process Water Saved (percent)[1]	Penetration Rate (percent)[1]	Penetration Data Year
Improve efficiency by modifying rinse tools	5-10%	80%	1994
Cascade rinsing/ spray rinses	Up to 60%[2]	50%[3]	
Rinse optimization	25-50%[4,5]	40%[5]	2000
Recycle UPW by selecting cleanest rinse streams	50%[6]	39%	1994
Reuse rinse effluent in wet scrubbers	5%[7]	70%	1994
Improve efficiency of UPW production unit	5-15%	20-30%	
Best Estimate of Overall Conservation Potential			**40-70%**

[1] Unless otherwise indicated, all water savings and penetration information were obtained from SEMATECH (1994).
[2] City of San Jose 1992(h)
[3] The SEMATECH (1994) survey reveals that about 50 percent of the facilities use wet decks with dump rinsers with the remaining evenly split between cascade rinsers and spray rinsers.
[4] Chiarello (2000) estimates savings of 25 to 80 percent in process water use using rinse optimization.
[5] Based on our conversation with Rosenblum (2002), typical savings appeared to be around 25 percent while the penetration rate was about 40 percent.
[6] The survey estimates that about half the facilities recycling water recover 70 percent of the UPW consumed and half recover about 30 percent. Topical Reports (2000) estimates UPW recovery at 40 to 50 percent.

[7] Scrubbers consume about 5 to 10 percent of process water in semiconductor fabrication. The SEMATECH (1994) survey also indicated that almost 70 percent of facilities surveyed reused wafer rinse water in cooling towers and scrubbers, replacing almost all the fresh water use in these applications.

The semiconductor industry has been a pioneer in water conservation and many technologies developed for this industry have been adopted by other High Tech industries. Indeed, recent studies indicate that comparable opportunities exist for the application of semiconductor industry water conservation technologies, such as rinse optimization, reuse of reverse osmosis backwash, and recycling UPW rinse water, to the Printing Wiring Board and Computer Components industries, yielding savings of 40 to 50 percent. Because data on conservation potential were not available for the other High Tech sub-industries, we assumed that the process water savings and penetration rates estimated for the semiconductor industry are applicable to the entire industry.

By varying the penetration rates from Table F-31 above, we obtained a range of 29 to 53 percent possible savings in process water Table F-32).[9]

Table F-32
Potential Process Water Savings in the High Tech Industry (2000)

Sub-end Use[1]	Portion of Process Use (percent)	Measure	Savings from Measure[2]	Best Est. Penetration Rates[3]	Potential Savings
Rinsing	80%	Improve efficiency by modifying rinse tools	10%	90%	1%
		Cascade rinsing/spray rinses	50%	60%	29%
		Rinse optimization	40%	50%	25%
		Recycle UPW by selecting cleanest rinse streams	50%	50%	33%
		Reuse rinse effluent in wet scrubbers	5%	80%	1%
Scrubbers	10%	Reuse rinse effluent in wet scrubbers	5%	80%	1%
UPW Production	10%	Improve efficiency of UPW production unit	10%	40%	6%
Total Conservation Potential[4]			**43%**		

[1] This break-up of sub-end uses is our best guess.
[2] See Table F-29 above for the ranges and sources from which these percentages were taken.
[3] SEMATECH 1994. Because the SEMATECH study is from 1994 and the High Tech industry adopts new technologies quickly, we increased the penetration rates slightly.
[4] In estimating the total conservation potential, rinse optimization is considered to be the same as recycling, since it involves recycling of selected rinses. The rinsing measures are assumed to be complementary, i.e. they can all be simultaneously applied.

[9] If dry cleaning technologies become feasible in the future, then reductions in water needs by as much as 50-80 percent of current use are possible. A high estimate of technical potential is based on the assumption that dry cleaning techniques become technically feasible in the next few years.

Estimate of Potential Water Savings

The conservation potential for common end uses was calculated in the end use studies (see Appendix C) and then applied to our GED-derived estimate of water use to get potential water savings for these end uses. We used data from Table F-32 above for the estimate of potential process water savings (Table F-33).

Table F-33
Potential Water Savings in the High Tech Industry (2000)

End Use	Water Use	Conservation Potential (percent)			Conservation Potential (TAF)		
	(TAF)	Low	High	Best	Low	High	Best
Process	52.5	29%	53%	43%	15.2	27.8	22.6
Cooling	15.0	9%	41%	26%	1.4	6.2	3.9
Restroom	3.8	49%	49%	49%	1.8	1.8	1.8
Other	3.8	0%	25%	10%	0.0	0.9	0.4
Total	**75.0**	**25%**	**49%**	**38%**	**18.6**	**36.6**	**28.7**

Crosscheck

The literature expects the semiconductor industry to significantly decrease water use over the next decade. Specifically, producing an 8-inch wafer disc, which used about 30 gal/in^2 in 1997, was expected to use 10 gal/in^2 in 2000 and 6 gal/in^2 by the end of 2003 (Allen and Hahn 1999, NRTS 2001, and SEMATECH 1994).[10] This expectation indicates that the savings of 37 percent that we have indicated are feasible. However, it is important to keep in mind that the benchmarks set by the NTRS are goals for the industry to strive to achieve, and not necessarily technically achievable at the current time.

Boyko et al (2000) estimate the overall savings to be much lower (about six percent), although specific case studies mentioned in the study achieved savings of 17 percent. Their estimates, however, include only simple low cost measures and exclude savings from rinse optimizations and recycling of UPW rinses.

[10] In the semiconductor industry, gallons per square inch (g/in^2) appears to be a standard metric of measuring water use. Typically wafer disc sizes are 8-inch/200mm for older versions or 12-inch/300mm for newer versions.

Petroleum Refining (SIC code 291)

Industry Description

SIC code 291 includes establishments primarily engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, and lubricants, through fractionation or straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking, or other processes.

In 2000, there were 22 operational refineries in California (Petroleum Supply Annual 2000) employing about 9,900 people. Data from 13 of these facilities were included in the 1995 CDWR survey (Table F-34).

Table F-34
Employment and Water Use in the Petroleum Refining Industry (2000)

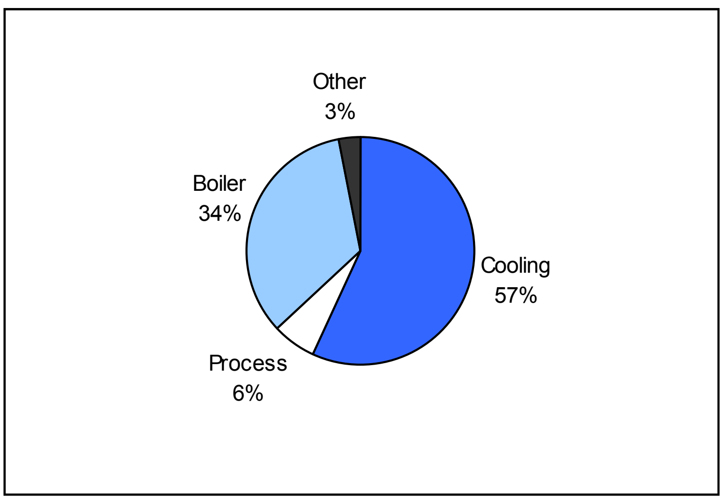
Industry	SIC code	GED	Employees	Water Use (TAF)
Petroleum Refining	291	14,676	9,890	84.1*

* Excludes 11.1 TAF of reclaimed water

Water Use

Refineries use water primarily in high and low-pressure boilers to produce steam and in cooling towers. Overall, water use in this industry has decreased considerably since the 1995 CDWR survey and six refining facilities from the survey are no longer operational.[11]

Figure F-9
Water Use, by End Use, in the Petroleum and Coal Industry



Source: AWWA Annual Conference Proceedings 1996

Process Water Savings

Recent water conservation efforts in the refining industry have focused on:

- Optimization using software algorithms;

[11] This finding is consistent with a national trend of moving refineries overseas.

- Reusing of secondary effluent; and
- Replacing freshwater for cooling tower makeup and boilers with treated reclaimed water.

The first two measures have typically reduced water use by 5 to 12 percent (estimated from Wilbur et al. 2002) but the primary trend for water conservation likely involves increasing the use of reclaimed water.

Of the 22 operational facilities in 2000, four facilities (the ARCO facility in Carson, the two Chevron facilities - El Segundo and Richmond, and the Exxon-Mobil facility in Torrance) use some reclaimed water for cooling. The Exxon Mobil facility also uses reclaimed water for boiler use and, consequently, has cut its freshwater use by 98 percent (Schaich 2001). The others have reduced water use by an estimated 40 to 60 percent (based on how much water was replaced by reclaimed water)

The refining sector is increasingly open to the idea of using highly treated reclaimed water in their cooling towers because of the added benefit of improved reliability of supply (and hence operations) during droughts. It is also a cost-effective option for both the refineries and local water agencies.

No industry-wide surveys of water use in this industry are available. While refineries could technically replace all cooling, process, and boiler water with reclaimed water, we assume a more realistic replacement estimate of 85 percent of cooling and boiler water and a penetration rate of 20 percent in 2000 (4 out of 22 refineries).

Estimate of Potential Water Savings

Table F-35
Potential Water Savings in the Petroleum and Coal Industry

End Use	Water Use (TAF)	Conservation Potential (percent)			Savings Potential (TAF)		
		Low	High	Best	Low	High	Best
Cooling	48.0	50%	100%	80%	24.0	48.0	38.4
Process	5.0	0%	0%	0%	0.0	0.0	0.0
Boiler	28.6	50%	100%	80%	14.3	28.6	22.9
Other	2.5	20%	50%	40%	0.5	1.3	1.0
Total	**84.1**	**46%**	**93%**	**74%**	**38.8**	**77.9**	**62.3**

Crosscheck

Water use in the refining sector varies considerably from 20 to 60 gallons/barrel of oil. This range probably indicates the potential magnitude for efficiency improvements.