Chapter 1: Academic Buildings

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1.1 Introduction

This chapter of the 2014 Audit focuses specifically on Chapman University's water usage in academic buildings and landscaping on the academic campus. Due to the growth in Chapman's student body, water has become a resource of high use throughout the academic campus. This growth in population, paired with California's recent drought, makes it important to examine Chapman's current water use trends so the university can apply more efficient and sustainable water use practices. Specifically, this chapter will examine:

- Water usage in academic buildings
  - Water use and costs for Beckman Hall, Dodge College, Kennedy Law School, and the Cypress Street Schoolhouse
  - Water use practices in on-campus eateries
  - Water use associated with current bathroom fixtures
- Analysis of the 2014 Campus Environmental Audit Survey: Water Use and Landscaping
- The current HVAC (Heating, Ventilation, and Air Conditioning) water treatment system
- Water use associated with landscaping on the academic campus

This chapter revisits some of the findings from the 2013 Environmental Audit and aims to expand on this information in greater detail. Ultimately, the contents of this chapter will provide key information and recommendations for implementing more efficient and environmentally conscious water usage procedures.

1.2 History of Water Use in Academic Buildings at Chapman

1.2.1 Overview

Water usage at Chapman had not been examined in detail until it was the focus of one chapter of the 2013 Environmental Audit. The 2013 Audit provided some basic information regarding water usage in academic buildings. The most recent data examined was from the 2011 academic year, where:

- Water usage per person was around 6 hundred cubic feet (hcf).
- All academic buildings used 50,518 hcf of water, or ~37,800,000 gallons.
- Academic campus water cost per person was around $15/person.
- Total academic campus cost was $127,067.

The water usage of each academic building and water meters from least to greatest in 2009, 2010, and 2011 can be examined in **Figure 1.1**, which comes from the 2013 Audit. Not all buildings on campus are individually metered. Thus, water usage in buildings with no individual meter is compiled and measured as an aggregate of all buildings under these "consolidated meters". One of these meters is located behind Argyros Forum, one by the Bert C. Williams Mall, and the other in the Zee Allred Aquatics Center.

The 2013 Audit also stated that water consumption in academic buildings is highest during the warmer months (around 66% more water was used from June to September than from December to

March in 2010-2011), most likely due to the increase in the usage of the air conditioning system and increased irrigation.

There was some difficulty gathering data for each individual building not listed above due to the consolidated water meters; however the authors of the 2013 Audit determined that all academic buildings combined consumed 50,518 hcf of water in 2011. One hcf is the equivalent of 748 gallons, therefore total water used in academic buildings in 2011 amounts to almost 38,000,000 gallons of water.

The total academic campus water cost for 2011 was $127,067 (total academic and residential water cost was $311,500). This cost may not seem to represent a major expense in relation to Chapman's other utility expenses, such as energy: Chapman spent close to $2,000,000 in the 2011 academic year on electricity and natural gas (2013 Environmental Audit). However, water costs might become a larger expenditure in the future due to the unpredictable weather conditions California experienced in 2013. The authors of the 2013 audit predicted that if the city of Orange were to raise the water rates in the future (because of potential drought) by 14% per year (instead of the current 7% per year), Chapman's water cost in 10 years could exceed $1 million per year. Therefore, it seems imperative to reduce water consumption through reforming water use practices and installing more efficient infrastructure.

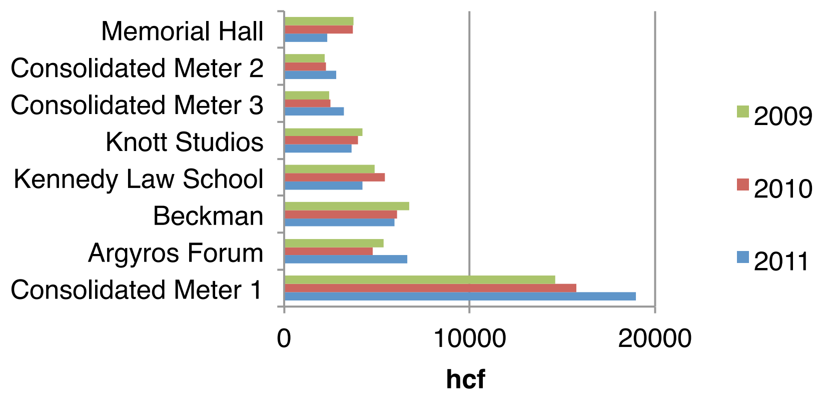

Figure 1.1. *Water usage of academic buildings each academic year sorted from least to greatest based on 2011 data.*

1.3 Current Status of Water Use in Academic Buildings at Chapman

Due to limited time and the abundance of data, this section of the chapter focuses on the total water usage and costs for four buildings on the academic campus: Beckman Hall, Marion Knott's Studio (Dodge College), Cypress Street Schoolhouse, and Kennedy Hall. Beckman, Dodge, and Kennedy were examined because there was a fair amount of data associated with these buildings, as many classes are hosted in these buildings and each one has an individual water meter. Beckman and Kennedy were built in 1998, while Dodge was built in 2004. The Cypress Street Schoolhouse, built in 1928, was chosen to compare the relative efficiency of water fixtures to that of other buildings as it was remodeled in 2013 as a LEED (Leadership in Energy and Environmental Design) Gold certified building. LEED is a certification program based off of a point system that recognizes and rewards sustainable construction approaches and practices. The Cypress Street Schoolhouse is currently the only LEED certified building on the Chapman campus. Because the Cypress Street Schoolhouse was re-opened in early 2013, there is currently only water usage and cost data associated with the building for one year.

1.3.1 Water Use in Academic Buildings

1.3.1a Individual Building Usage

Individual building use has had an overall increasing trend from year to year. Due to Chapman's increasing student population there is a subsequent increase in water usage. **Figure 1.2** shows how the amount of water used by the four buildings have generally increased year to year.

Cypress Street School House only has one data point because it was re-opened in 2013. The reason for the drop in water usage between 2011 and 2012 for Beckman, Knott Studios, and Kennedy could be attributed to the different cooling degree days of those years.

A cooling degree day is a measurement of how much energy is used to cool a building (The Weather Guys, 2012). “A cooling degree day is every degree that the mean temperature is above 65 degrees during a day. So, if the high temperature for the day is 95, and the minimum is 51, the average temperature for the day is 73. That would be 8 cooling degree days (73-65)” (The Weather Guys, 2012). The total cooling degree days of 2011 and 2012 were 1150 and 1019, respectively (Weather Data Depot, 2014). Because 2012 had fewer total cooling degree days, this indicates that temperatures were cooler, and thus air conditioning was used less. The lower number of total cooling degree days could therefore account for the drop in water used in Beckman, Knott Studios, and Kennedy between 2011 and 2012. Although total academic campus water usage increased from 2011 to 2012 (**Table 1.1**), it is most likely due to the increase in student body between those years as the percent increase was relatively small in comparison to the 2012-2013 percent increase.

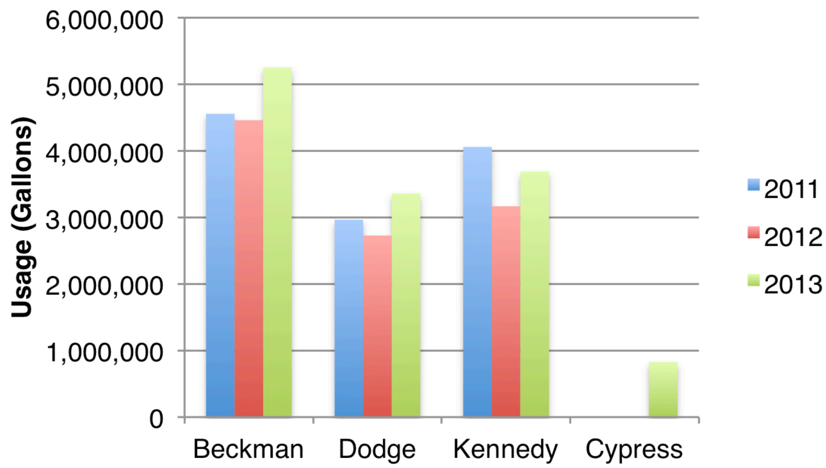

Figure 1.2. *Total water usage for the 2011, 2012, 2013 academic school years in Beckman Hall, Dodge College, Kennedy Hall, and the Cypress Street Schoolhouse.*

Table 1.1. *Total Academic Campus Water Usage.*

	Total Academic Campus Usage (gallons)	% Increase
2011	43,559,780	-
2012	45,636,976	4.7%
2013	53,508,180	17.3%

In order to more directly compare the usage of water between the four buildings the data can be normalized using square footage and building occupancy. **Table 1.2** shows the differences in gallons used after normalization. Cypress has the highest use per square foot and occupant because even though its size and occupant counts are low, the building is used as a research facility, using proportionally more water than other academic buildings. Kennedy is the most efficient building in regards to use per square foot due to its larger size and Beckman is most efficient in regards to occupants because it is the building with the largest daily occupancy, largely due to the variety and number of classes held in the building.

Table 1.2. *2013 water usage normalized by square footage and daily building occupancy. See* ***Appendix 1.8.1*** *for Daily Building Occupancy Calculations.*

	Gallons	Square Footage	Gallons/ Square Foot	Daily Building Occupancy	Gallons/ Occupant/ Year
Cypress	826540	9532	87	27	30613
Knott Studio	3363008	76193	44	694	4846
Beckman	5255448	112809	47	2054	2559
Kennedy	3689136	136962	27	488	7560

1.3.1b Water Fixtures

According to the 2014 Chapman Environmental Audit Survey: Water Use and Landscaping, 96% of the Chapman community uses the restroom on campus at least once a day, and 44% use the restroom 3 times a day or more. Because the restrooms are used by almost every person on campus, (**Figure 1.3)** it is important to examine the efficiency of all water fixtures in the restrooms, including faucet aerators and toilets.

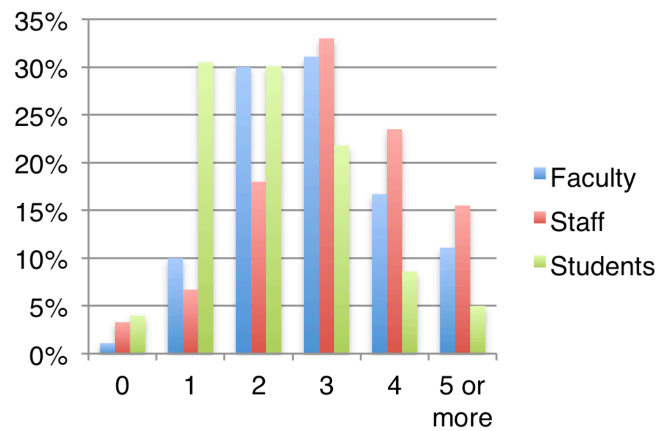

Figure 1.3. *Restroom use on campus.*

Water fixtures and the payback periods to update those features were covered in Chapter 10: Water of the 2013 Audit. Since these values have not changed since 2013, this section of the audit will provide an overview of the fixtures present in Beckman, Knott Studios, Kennedy, and Cypress. All of the faucet aerators and toilets in those four buildings are in accordance with Federal and California state standards of 1994 at 1.6 gpf (gallons per flush) for toilets and 0.5 gpm (gallons per minute) for faucet aerators (Appliance Standards Awareness Project, 2009). However, there is no standard brand that is installed in all campus restrooms. The brands in these buildings include Symmons, Kohler, Sloan, American Standard and Crane.

According to the 2013 Audit, in 2014 the new California state regulation for aerators is not changing, but for toilets, flow rates are changing to 1.28 gpf instead of the current 1.6 gpf (San Luis Obispo County Public Works Department, 2012). This means that any new construction projects from 2014 forward must meet these standards. In order to accomplish this, the 2013 Audit recommended a toilet with a 0.8 gpf toilet. This is the most efficient model on the market and will put Chapman ahead of any new regulations. However, the payback period for this is over 53 years, according to the 2013 Audit, which is a very long time period that would require a large initial investment. This measure will be necessary in new construction buildings but would not pay off as a retrofit for all current toilets.

1.3.2 Water Costs in Academic Buildings

Figure 1.4 displays the water costs per academic year for the four examined buildings. As the figure demonstrates, water costs have generally been increasing every year (except for Kennedy, which experienced approximately a $1000 decrease from 2011 to 2012, possibly due to the weather patterns discussed in section 1.3.1a). This growth is due to the increase in student body, and therefore water usage, paired with the increasing water cost rates (average of 7% each year in the city of Orange). There is only one data point for Cypress Street School because it has only been occupied as a LEED certified building since 2013.

In the 2013 academic school year, the total water cost for all academic buildings was $206,176. The combined water cost for Beckman, Dodge, Kennedy, and Cypress Street School in 2013 was $50,631. This value makes up almost 25% of total water costs in academic buildings for 2013. Total costs of water per person for 2011, 2012, and 2013 are listed in **Table 1.3.**

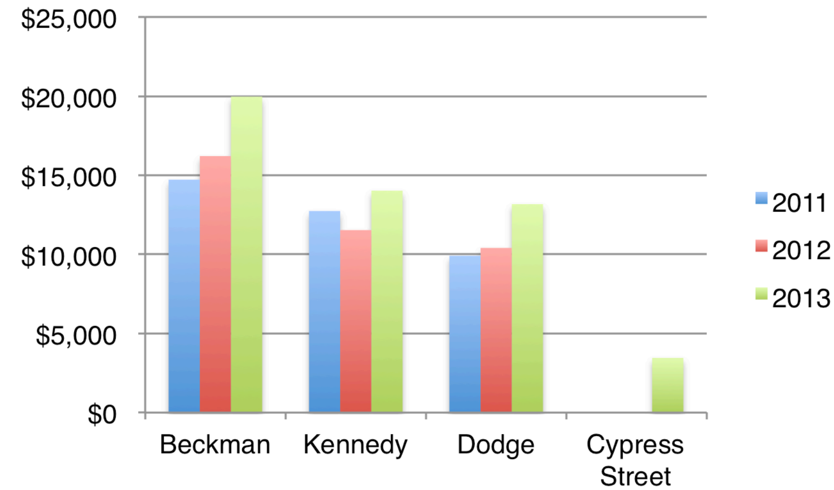

Figure 1.4: *Total water usage for the 2011, 2012, 2013 academic school years in Beckman Hall, Dodge College, Kennedy Hall, and the Cypress Street Schoolhouse.*

Table 1.3. *Water costs on the academic campus for 2011-2013.*

	2011	**2012**	**2013**
Cost	$141,879.63	$175,922.10	$206,176.35
Population	5559	5884	6268
Cost/Person	$25.52	$29.90	$32.89
% Increase	-	17%	10%

From 2011-2012, there was a 17% increase in cost/person, and a 10% increase from 2012-2013 (**Table 1.3)**. The percentage increase in cost may have been smaller from 2012-2013 than from 2011-2012 due to the larger increase in student body population from 2012-2013 (8.2%) than from 2011-2012 (5.8%). It is important to note that the discrepancy in data regarding the 2011 cost/person between the 2014 audit and the 2013 audit (where cost was $15/person) is due to the variances in data that was used to analyze total costs. The 2013 Audit examined data from eight building meters, three of which were consolidated meters (the buildings and meters examined for total cost in the 2013 Audit can be seen in **Figure 1.1**). The 2014 Audit examined costs for all 34 buildings and meters associated with Chapman's academic campus, therefore accounting for the higher cost.

In order to more directly compare the cost of water between the four buildings the data can be normalized using square footage and building occupancy. **Table 1.4** shows the differences in cost after normalization. The reason that Cypress has such a high cost is because it has a very small square footage and building occupancy in comparison to its total water use. Cypress is a research facility which explains its larger than proportionate cost per square foot and cost per occupant. Beckman is the most cost efficient building in terms of occupants and Kennedy is the most efficient in terms of square footage.

Table 1.4. *2013 water cost normalized by square footage and daily building occupancy. See* ***Appendix 1.8.1*** *for Daily Building Occupancy Calculations.*

	Cost	Square Footage	Cost/Square Foot	Daily Building Occupancy	Cost/ Occupant/ Year
Cypress	$3,456	9532	$0.36	27	$128
Knott Studio	$13,179	76193	$0.17	694	$19
Beckman	$19,968	112809	$0.18	2054	$10
Kennedy	$14,029	136962	$0.10	488	$29

1.3.3 Water Use in On-Campus Eateries

To get an idea of how much water is used in the on-campus eateries such as Jamba Juice, WOW! and Jazzman's Café, the General Manager of Sodexo, Eric Cameron, was interviewed. Some general information gathered about the kitchen in Argyros Forum included:

- A Champion Dishwasher (**Figure 1.5)**
    - There is no information available regarding the model of this dishwasher.
- Three compartmental sinks are used
    - Rinse sink
    - Sanitizer sink
    - Hand washing sink
- The rinse and sanitizer sinks are filled and drained approximately twice a day, once in the morning at opening and once in the afternoon/evening at closing.
- To conserve water and to keep the water from continuously running, only two of the three compartmental sinks are filled when dishes are washed

One concern regarding on-campus eateries is the fact that the sinks at the Jamba Juice in the Student Union are always running. When asked why this was the case, Mr. Cameron responded: "One of the reasons why we have the faucets running at Jamba Juice throughout the day is for sanitary and health conditions. Being aware that many customers could potentially be allergic to some fruits and/or dairy we have to continuously wash down scoops" (Eric Cameron, 2014).

Figure 1.5. *Champion DualRinse Dishwasher. This is a newer model of the dishwasher in the AF kitchen.*

Figure 1.6. *Low flow aerators.*

To reduce water usage without compromising sanitation, the staff at Jamba Juice should consider keeping the faucets running only during peak business hours, and turn off the faucets when business is slower. If the faucets ran only during the busiest hours during the school week, from around 9:30

AM to 4:00 PM, around 94,500 gallons of water could be saved every year (see **Appendix 1.8.2a** for calculation). This equates to almost 77,000 flushes of a standard bathroom toilet (Mueller, 2012). This data demonstrates that simple modifications to water use practices can result in abundant water savings.

If cross-contamination of kitchen supplies is a concern that cannot be compromised, an alternate option would be to install low-flow aerators (**Figure 1.6**) on all the faucets at Jamba Juice (to our knowledge no aerators are currently present). Low flow aerators typically have a flow rate between 0.5-1.0 gpm (gallons per minute), compared to the standard commercial faucets used in on-campus eateries, with flow rates of 1.5 gpm. If low-flow aerators were installed at Jamba Juice, only 60,750 gallons (with 1.0 gpm aerator) would be used, meaning that 121,500 gallons of water could be saved per year (see **Appendix 1.8.2b** for calculations). It is important to note that these calculations do not account for weekend hours or Interterm. If those days were also taken into consideration, even more water savings would be realized.

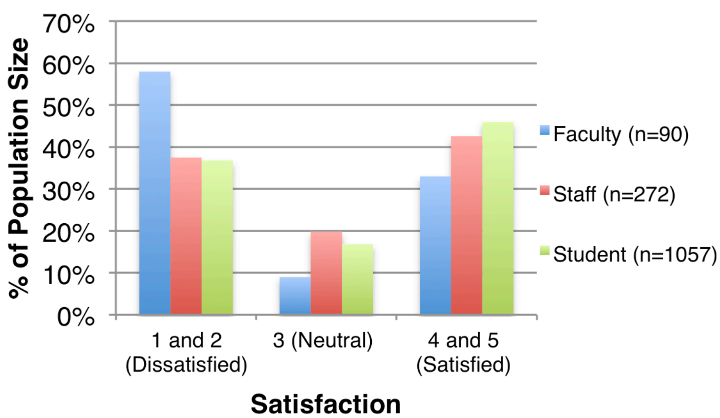

Figure 1.7. *Faculty, staff, and student satisfaction with building temperatures.*

1.3.4 Survey Analysis

For this chapter of the audit, the 2014 Environmental Audit Survey: Water Use and Landscaping provided information that was used to better understand water usage on the academic campus and willingness to integrate more sustainable water use practices into the current system. To gauge the general building temperature preferences of students, faculty, and staff, one question asked: “On a scale from 1-5 (1 being Very Dissatisfied, 5 being Very Satisfied), how satisfied are you with Chapman’s academic building temperatures?” **Figure 1.7** demonstrates the results as a percentage of the total population size (n) of each respondent group. Responses of 1 and 2 were grouped in the table to gauge general dissatisfaction, while responses of 4 and 5 were grouped to gage the general satisfaction. **Figure 1.7** shows that the percentage of students and staff that are generally satisfied with the building temperatures (around 45%) is slightly greater than those that are dissatisfied (around 38%). However, the proportion of dissatisfied faculty is almost 25% more than the number of those that are satisfied with building temperatures. This discrepancy in satisfaction could be attributed to the fact that faculty may spend more extended periods of time in the buildings due to back-to-back classes and office hours, thus increasing the possibility of feeling too hot or too cold. The next question asked was to determine the willingness of the Chapman population to vary the thermostat temperatures to save energy and water. The question was: “Are you supportive of raising the temperature in academic buildings by 2-3 degrees in the hotter months to save water and energy?” As **Figure 1.8** shows, the greater percent of the Chapman population would be supportive of varying the building temperatures to save water and energy. Just about two-thirds (66-67%) of all survey groups (faculty, staff, and students) were in support of increasing building temperatures. These results provide insightful information that can be referenced as Chapman integrates more sustainable practices onto the campus. Although many survey responses show relative satisfaction with the current building temperatures (see **Figure 1.7**), the general attitude of the Chapman

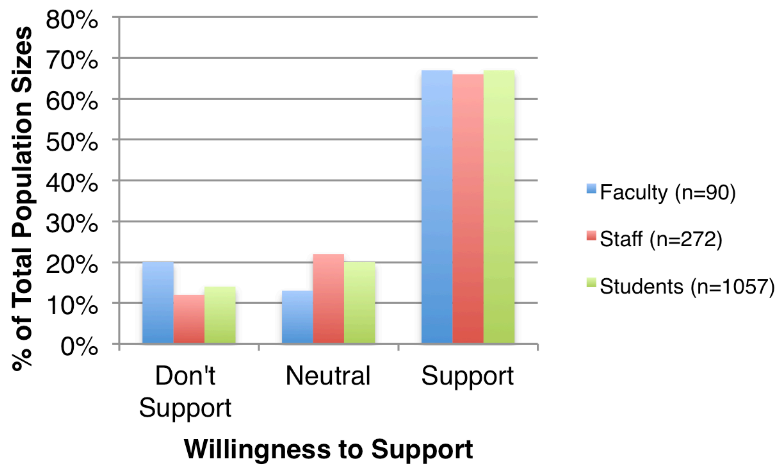

Figure 1.8: *Willingness to support a 2-3 degree increase in building temperatures to reduce water costs and use.*

population seems willing to make changes that would help Chapman progress towards a more environmentally conscious campus.

1.3.5 HVAC Water Treatment Program

A water treatment audit for Chapman conducted by Capture H_2O in March of 2014 provided significant details regarding the university's water treatment practices for the HVAC (heating, ventilation, and air conditioning) system. Capture H_2O is a LEED Green Associate water treatment company dedicated to providing efficient and sustainable treatment services. Currently, Chapman uses a chilled water system paired with cooling towers for air conditioning throughout the academic campus. Although water use is said to be the most efficient resource for cooling systems (Capture H_2O), Chapman's current system has encountered a few issues commonly associated with chemical water treatments:

- Scale formation
- Corrosion

These issues can be combated through steady monitoring on behalf of staff members and specific chemical additions to the water system. Two processes make up such chemical additions, termed *cycles of concentration* and *bleed off.* When pure water evaporates from the cooling system, the natural minerals of the water remain in the system and recirculate as the water continues to evaporate, increasing the mineral concentration of the water. *Cycles of concentration* compares the level of solid mineral buildup in the recirculating tower water to the level of minerals in the original freshwater. If the recirculating water has two times the concentration of dissolved minerals compared to the concentration in the original freshwater, the cycle of concentration is determined to be *2.0*. *Bleed off* refers to the process of manually extracting some of the highly concentrated recirculating water and replacing it with fresh water. This process is monitored by setting a certain concentration level for the circulating water to be set, which in turn controls the cycles of concentration.

At the moment, Chapman treats its water with chemicals provided by Supply Energy Chemicals. All of the sites examined for this audit operate at cycles of concentration below 3.0 (estimate made by Capture H_2O after data collection, visiting cooling tower sites, and meeting with Chapman's water treatment staff). Lower cycles of concentration require more freshwater due to more frequent "bleedings" of concentrated water. Thus, it would be more beneficial to maximize the allowed number of cycles of concentration to reduce water use and cost. Capture H_2O stated that the Chapman system could increase the allowed cycles of concentration from below 3.0 to above 6.0 if the current system was updated. This increase could decrease the amount of freshwater needed for replacement by 20%, and reduce the “bleeding” of the concentrated water by 50%. Because the current cooling towers lack individual meters, it is difficult to determine how much water is used throughout the system on a daily basis. Therefore, Capture H_2O bases these savings upon a well-educated approximation based upon the expertise and knowledge of the Capture H_2O associates.

If Chapman wanted to implement a treatment that uses no chemicals, Capture H_2O has suggested implementing the “Zero Bleed” Program. This water treatment system uses no chemicals, but rather a water softener containing sodium to control corrosion, scale formation, and biological activity. With this type of treatment, the valves draining the chemically concentrated water to the sewer system are closed, which diminishes the need to replenish the system with fresh water, therefore reducing overall water usage and cost.

Again, because the current cooling towers lack individual meters, and each building has a different tower model the exact savings from upgrading the system are difficult to specify. However, Tom Rosales, a water treatment specialist from Capture H_2O, was able to make some payback and savings estimates based upon his and assessment of Chapman’s current system and his experience in the field:

Figure 1.9. *Capture H_2O’s dry chemical feed system (Capture H_2O, 2014).*

- The efficiency of the entire system would improve by 10-15% if solid chemicals replaced the current liquid chemicals being used (**Figure 1.9)** displays Capture H_2O’s solid chemical feed system)
    - Solid chemistry costs are estimated to be around $8500 per location for the equipment
    - This includes the costs of two dry chemical feeders, two water meters, installation, corrosion probes and new monitor, a monitor rebate of $1750, and taxes
- Installation of sub-meters on all individual cooling towers and solid chemical treatment would experience a payback period of 1-2 years
    - The costs associated with the meter and monitor provided by Capture H_2O amount to around $1,800 (this cost is included in the $8500):
        - Meter: $500
        - Monitor: $3,000 with $1,700 rebate
- Installing a Zero Bleed system in Knott Studio would cost around $20,000 (for equipment, installation, and taxes)
    - Total annual savings from water costs, the rebate from the monitoring system, and the decrease in service costs from upgrading the system is approximated to be $7000, which amounts to a payback period of around 36 months for the Zero Bleed system.

1.3.5a Geothermal Heating and Cooling

For future construction projects, Chapman may want to consider installing alternate HVAC systems that use minimal freshwater and energy, such as a geothermal system. “[Geothermal systems] use the constant temperature of the earth as the exchange medium instead of the outside air temperature. This allows the system to reach fairly high efficiencies (300% to 600%) on the coldest winter nights, compared to 175% to 250% for air-source heat pumps on cool days" (Department of Energy, 2012).

A geothermal unit is more than twice as efficient, at cooling, than any regular heat pump or air conditioner (WaterFurnace).

- Installing a single geothermal unit is the environmental equivalent of planting 750 trees or removing two cars from the road (WaterFurnace)
- This method is highly recommended by the Environmental Protection Agency (EPA) as the most environmentally friendly and cost-effective heating/cooling system (WaterFurnace)

WaterFurnace, a geothermal heating and cooling system supply company, uses systems that tap into this underground energy with an earth loop, a method of circulating a water-based solution through a "loop system":

- In a closed-loop system, a water-based liquid solution is circulated through underground pipes; this system can be installed vertically, horizontally, or in a pond.
- Vertical loops would be the most effective system for Chapman as this system is used when adequate surface land is limited (Department of Energy, 2012). These systems are used in most commercial buildings and schools.
    - With a vertical system, geothermal heat pumps can cool a building by reverting the natural direction of heat flow from above to below ground: the cooled water circulates, absorbing the heat in the air above ground, then releasing the heat underground.
    - "Holes (approximately four inches in diameter) are drilled about 20 feet apart and 100 to 400 feet deep. Into these holes go two pipes that are connected at the bottom with a U-bend to form a loop. The vertical loops are connected with horizontal pipe (i.e., manifold), placed in trenches, and connected to the heat pump in the building" (Department of Energy, 2012). See **Figure 1.10**.
- WaterFurnace systems emit no carbon dioxide, carbon monoxide, or other greenhouse gases that contribute to climate change.

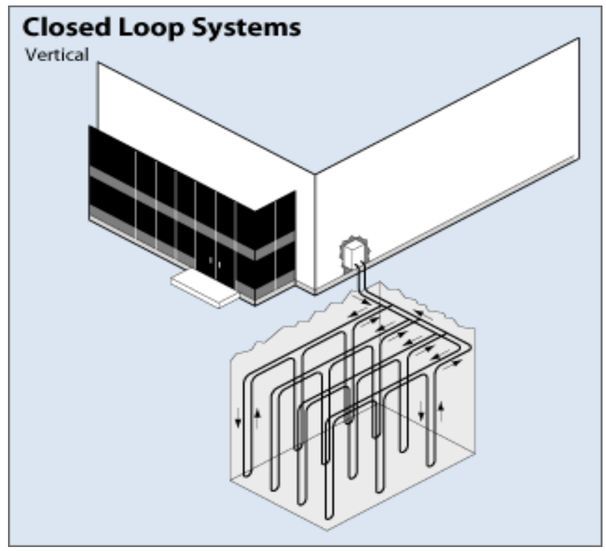

Figure 1.10. *Vertical geothermal loop system (Department of Energy, 2012).*

According to the Department of Energy and the EPA, geothermal heating/cooling systems have the lowest environmental impact compared to other systems (WaterFurnace), therefore this could be a system for Chapman to apply when considering HVAC systems for new construction.

1.3.6 Water Use for Academic Landscaping

A large part of Chapman's aesthetic comes from the landscaping design of campus. In order to protect the beauty and appeal of campus the landscaping must be constantly monitored and maintained. A large part of keeping the plants around campus healthy is frequent watering. In the 2012-2013 academic year irrigation required 8,582,652 gallons of water (**Figure 1.11**), which cost $27,145. While this is only 16% of the total water used on campus, it is still significant because water costs may continue to increase as water becomes scarcer due to changing weather patterns. Water costs have already increased in the past four years (**Figure 1.12)**.

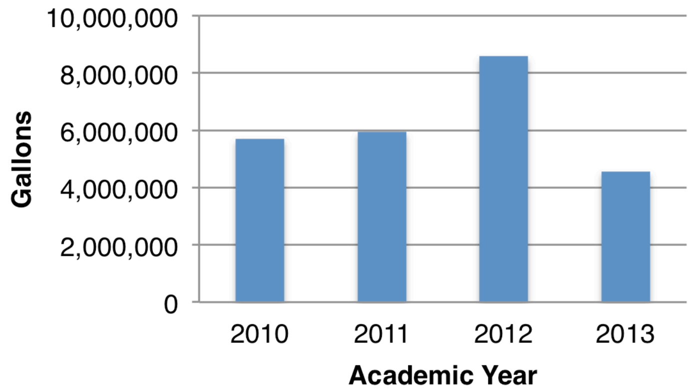

Figure 1.11. *Total water usage for irrigation for the past four academic years.*

It is important to note that for the 2013 academic year the data is only available until 3/25/14, whereas all other years have information through July. The 2013 academic year is missing 6 months of data because they have not occurred yet, however the current cost for the 6 months of water usage is $15,816. By the end of the 2013 academic year the cost will be approximately double, at around $31,631, which is a $4,500 increase from the 2012-2013 academic year.

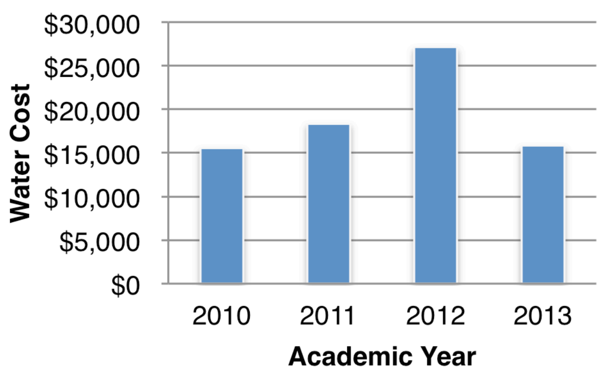

Figure 1.12. *Total cost for irrigation for the 2010-2013 academic years (2010 = 2010-2011 year, etc.).*

Figure 1.13. *Rain Bird 1806 Pop-up.*

Currently, Chapman uses a sprinkler system to water most of the plants on campus. The sprinklers installed on campus are Rain Bird 1806 pop-ups (**Figure 1.13)**, which use an average of 3 gallons per minute (gpm). According to Joe Cotroneo, Valley Crest Operations Manager, there are approximately 19,250 sprinkler heads throughout the main campus (See **Appendix 1.8.3** for calculations). These sprinklers are used for different durations due to varying water requirements for plants and grass based on the season (See **Appendix 1.8.3** for calculations). An estimate of the total number of gallons of water used by these sprinklers per year can be used as a basis of the amount of water used for landscaping (**Table 1.5**).

Table 1.5. *Amount of water used by Rain Bird sprinklers on main campus. Estimates perfromed with information provided by ValleyCrest Operations Manager.*

Gallons of Water	Summer (April – September)	Winter (October – March)	Entire Year
Grass	6,570	3,285	9,855
Planters	3,285	1,632.5	4,917.5
Total	9,855	4,917.5	14,772.5

The Rain Bird sprinklers are on a manual system, meaning that every time it rains a member of the Valley Crest landscaping staff has to shut off the sprinklers by hand, which wastes man hours, time and resources. This inefficient system also means that all changes in the duration of watering times as the seasons change must be done manually.

There are also drip irrigation systems on campus, an alternative system to pop-up sprinklers. Because ValleyCrest only began installing them in 2013, as of spring 2014 they make up less than 5% of all watering systems on campus. Drip systems deliver water directly to the root of the plant, making it a more efficient watering system. They also have increased flexibility, reduced costs over time, reduced water quality problems from runoff, and may improve the health of plants. The drawbacks of this system include a high initial investment cost, increased monitoring needs, and potential plant and root development problems (Lamm). Mr. Cotroneo also states that drip systems work best for potted plants, and all of Chapman's drip systems are only present in some planters. Unfortunately, there is no way to determine the difference in the amount of water used by the drip systems versus the sprinklers systems because the water meters for landscaping are all consolidated. See Chapter 5 for more detailed information.

Chapman's manual sprinkler system requires excess manual labor hours from the Valley Crest staff to change the duration of the sprinklers from season to season as well as turn off the systems any time there is rain. However, Chapman is currently in the process of installing a weather based irrigation system. (See Chapter 2: Residential Buildings for more information). This system includes sensors that detect the amount of water each plant needs based on soil moisture and ambient temperature. Then a signal is sent to each sprinkler to run for the appropriate amount of time. This system will also automatically shut off the sprinklers in the case of rain. This will save manual labor for Valley Crest as well as water by reducing excess watering and consequently yield monetary savings for Chapman. Installing the weather-based sprinkler system on main campus as well would further reduce water usage and costs. According to Mackenzie Crigger, Chapman's Sustainability Manager, this system has plans to be installed once a budget has been found for the project. The actual savings from this system cannot be determined because there are many variables, including weather, which must be taken into account.

1.4 Concluding Assessment

1.4.1 Areas of progress

- Capture H_2O is currently working with Chapman's Facilities Department in organizing a preliminary plan to install a Zero Bleed water treatment program in Knott Studio.
    - Although an official plan is still currently being assembled, Capture H_2O has predicted an approximate payback period of 20 months after installing the Zero Bleed program.

- A weather based irrigation system is in the process of being selected for implementation on Chapman's campus. This will decrease the amount of water used for landscaping.
- A new dishwasher is being installed in the kitchen in Argyros Forum. The Hobart FT900S is a flight-type dishwasher (**Figure 1.14)** and is replacing the current product. This dishwasher will save water and energy through its ratio of water flow to pressure. The flow rate of the machine is 292 gpm offers "excellent wetting and flooding over ware" according to the information provided by Hobart in **Appendix 1.8.4.** The dishwasher also has insulated doors to reduce heat loss. This unit has the lowest gallons per hour rinse rate in the industry for a standard machine at 114 gallons per hour.
- Chapman has many separate water meters for academic buildings, which makes analysis of water use easier to locate and analyze.

Figure 1.14. *Hobart FT900S Dishwasher* ***(Appendix 1.8.4)***

1.4.2 Areas in which to improve

- Adding sub-meters to all of buildings in the consolidated water meters on campus would allow for more accurate analysis of water usage on campus.
- Capture H_2O's audit concluded by stating that Chapman has a water treatment system that is not performing at maximum efficiency. A few areas where the University could improve are:
  - More efficient water metering equipment to allow for verification of cycles of concentration, detecting leaks, overflows, etc.
  - Capture H_2O suggested installing sub-meters on individual cooling towers that can be viewed online, which allows staff to easily monitor how the cooling towers are operating anytime of day. Currently, no sub-meters are present, therefore tower efficiency and performance are difficult to measure.
  - Better chemical feed system. Currently, Chapman allocates a fair amount of manpower towards conducting water treatment, with individual staff members monitoring and treating each cooling tower separately on a daily basis (sub-meters would help combat this issue).
  - Capture H_2O also discovered that there are a number of cooling towers on campus with issues contributing towards their inefficiencies, including corrosion and scale formation. These issues not only impair the functionality of the cooling system, but also increase water use and therefore cost, as inefficient systems use more energy.

1.4.3 Existing gaps in knowledge

- Exact water and cost savings from increasing building thermostat temperatures during warmer months were not calculated for this audit, as the spec sheets (documents that provide manufacturing information) for the related equipment were unable to be located. Thus, exact energy and water usages could not be verified to determine water and energy savings.
- The costs associated with installing a geothermal unit were not able to be verified for this audit

- There are missing landscaping bills from the year 2010 and 2011. Roughly half of the bills from 2010 and one billing period from 2011 are missing. This may cause the totals to be skewed.
- The consolidated water meters for some academic buildings make it impossible to determine the amount of water used by those buildings.
- There is no information on the current dishwasher in the Argyros Forum kitchen. Therefore we cannot calculate the potential savings of the new dishwasher being installed in the AF kitchen.

1.5 Recommendations

1.5.1 Low cost/effort

- Install more efficient bathroom fixtures (toilets, sinks) for future construction projects.
- Keep sinks at Jamba Juice running only during peak hours
    - Water savings of 94,500 gallons/year could be realized
- Install low flow aerators on on-campus eatery faucets
    - Water savings of up to 121,500 gallons/year could be realized
- Raise the thermostat temperatures of the academic buildings by 2-3 degrees in warm months to save on water and costs

1.5.2 Moderate cost/effort

After reviewing the information collected and suggestions made by Capture H_2O, some recommendations regarding Chapman's water treatment system have been developed:

- Install sub-meters on waterlines that allow staff members to monitor cycles of concentration and easily check for leaks and water loss. Sub-meters will give better information regarding the specific water use for individual meters.
- Switch from a liquid chemical treatment to solid chemicals. Solid chemical use would:
    - Facilitate the treatment system
    - Generate a smaller carbon footprint:
        - An upgraded system increases the overall efficiency of the program. A more efficient system uses less energy overall, therefore reducing the carbon footprint
        - Elimination of large bins that store the liquid chemicals reduces plastic use, which in-turn lowers the carbon footprint of the system as well
    - Reduce the risk of injury associated with the liquid feeding system.
        - The current liquid treatments require individual staff members to transport 120-500 pound barrels of these liquid chemicals.
        - Switching to solid chemicals would reduce the risk of exposure to these hazardous chemicals via potential leaks or spills.
    - Additionally, solid chemicals provide additional water and labor savings, as the EPA requirement to triple wash the barrels that house the chemicals before disposing of them would no longer be relevant.
- Organize an immediate cleaning program for cooling towers to improve entire system's efficiency
- Create performance metrics and goals to help confirm the system is performing properly and to better monitor corrosion, scale and bacterial growth by:
    - Installing sub-meters to monitor water use
    - Installing probes that measure corrosion rates
    - Measuring biological activity by periodically collecting samples and sending them to a lab for testing

Capture H_2O stated they are willing to provide Chapman's water treatment staff with training to ensure that all of these stated tasks are completed successfully.

1.5.3 High cost/effort

- Install Geothermal HVAC systems for future construction projects, such as the new Center for Science and Technology
  - Expected to have an approximate 100,000 square footage, a unit such as the Envision® Series NXW Chiller could be installed in the new science center.
- Replace Chapman's manual sprinkler system with a weather-based system
  - This change is already in progress in the dorms with a weather-based system. This system will be installed on main campus as well once there is funding for the project.

1.5.4 Future areas of research

- Geothermal Energy for future construction projects
- Exact water and cost savings from increasing building thermostat temperatures
- Once the weather-based system is installed the reduction seen in the water bills for landscaping can be used to calculate the savings of a weather-based irrigation system.

1.6 Contacts

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12. Jillian Wood, Operations Administrator, The George L. Argyros School of Business and Economics (jryan@chapman.edu, 714-289-2026

1.7 References

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1.8 Appendices

1.8.1 Building Occupancy Calculations

- Total Student Occupancy = Number of Classrooms x Average Capacity x Average Number of Classes Taught Per Day
- Total Occupancy = (Total Student Occupancy x 0.3) + (Faculty x 1.0)
- Student occupancy is multiplied by 0.3 because students are not in each building for as long a period of time as faculty/staff and therefore they have less of an impact on water usage. Faculty/Staff are usually in their building all day so they are counted as one whole person.
- For Cypress there are 4 faculty and 45 part time faculty. In this case the part time faculty are multiplied by 0.5 because it is estimated that they are there half of the time of a full time faculty or staff member.
    - Cypress = (4 x 1.0) + (45 x 0.5) = 27
- For Kennedy the actual capacity was 43, however according to WebAdvisor most of the classes were only at half capacity so this average was halved to 22 to reflect this.
- Knott Studios occupancy may also be higher due to the usage of the various labs in the building. This student use is not scheduled, it is open to students when the building is open so this cannot be factored into the calculations, but the actual occupancy may be higher due to this.

Table 1.6. *2013 building occupancy. All adjunct faculty were counted as full time faculty because this distinction was not made in the information provided be the building managers. Numbers of classrooms, average number of classes per day, and room capacity were estimated using information from WebAdvisor and 25Live.*

	Number of Classrooms	Average Capacity	Average Number of classes taught/day	Total Student Occupancy	Total Faculty/ Staff Occupancy	Total Occupancy
Cypress	n/a	n/a	n/a	n/a	49	27
Knott Studio	12	25	6	1800	154	694
Beckman	18	40	9	2054	110	2054
Kennedy	12	22	5	1320	92	488

1.8.2 Potential Water Savings in Jamba Juice

1.8.2a Water Savings from Turning Off Sinks

- Business hours Monday-Friday: 8:30 AM-10:00 PM (equates to 13.5 hours/day, or **810 minutes**)
- Peak business hours: 9:30 AM – 4:00 PM (6.5 hours, or **390 minutes**)
- Slow business hours: 810 minutes – 390 minutes = **420 minutes**
- Faucet flow rate = **1.5 gpm** (gallons per minute)
- 1 semester = 15 weeks = 75 school days (Monday – Friday)
    - (75 days/semester) x (2 semesters/year) = **150 school days/year**
- Gallons of water to be saved each day if water was turned off during slow hours:
    - (1.5 gpm) x (420 minutes/day) = **630 gal/day**
- Water savings per year (630 gal/day) x (150 days/yr) = **<u>94,500 gallons/yr</u>**

1.8.2b Water Savings from Installing Low-Flow Aerator

<u>Current Flow/Year (1.5 gpm)</u>

- Business hours Monday-Friday: 8:30 AM-10:00 PM (equates to 13.5 hours/day, or **810 minutes**)
- Faucet flow rate = **1.5 gpm** (gallons per minute)
- 1 semester = 15 weeks = 75 school days (Monday – Friday)
    - (75 days/semester) x (2 semesters/year) = **150 school days/year**
- Gallons of water used each day:
    - (1.5 gpm) x (810 minutes/day) = **1215 gal/day**
- Water used per year (1215 gal/day) x (150 days/yr) = **<u>182,250 gallons/yr</u>**

<u>Potential Savings with 1.0 gpm Aerator</u>

- Gallons of water used each day:
    - (1.0 gpm) x (810 minutes/day) = **810 gal/day**
- Water used per year (810 gal/day) x (150 days/yr) = 121,500 gallons/yr
- Water Savings: (182,250 gal/yr) – (121,500 gal/yr) = **<u>60,705 gal/yr</u>**

<u>Potential Savings with 0.5 gpm Aerator</u>

- Gallons of water used each day:
    - (0.5 gpm) x (810 minutes/day) = **405 gal/day**
- Water used per year (405 gal/day) x (150 days/yr) = 60,705 gallons/yr
- Water Savings: (182,250 gal/yr) – (60,705 gal/yr) = **<u>121,500 gal/yr</u>**

1.8.3 Sprinkler Calculations

- 35 timers x 22 stations = 770 valves x 25 sprinkler heads = **19,250 sprinkler heads.**
- Sprinklers are used five days a week with varying duration depending on the temperature and season. In the summer, grass is watered in 12 minute increments and planters (not on a drip system) are watered for 6 minutes. In the winter, these times are cut in half, to 6 minutes and 3 minutes respectively. Since only the rates for summer and winter are known, assume that summer is half the year and winter is the other half (182.5 days each).
- Summer grass: 12 minutes x 182.5 days = 2190 minutes x 3 gallons/minute = **6570 gallons**
- Summer planters: 6 minutes x 182.5 days = 2190 minutes x 3 gallons/minute = **3285 gallons**
- Winter grass: 6 minutes x 182.5 days = 2190 minutes x 3 gallons/minute = **3285 gallons**
- Winter planters: 3 minutes x 182.5 days = 2190 minutes x 3 gallons/minute = **1642.5 gallons**

1.8.4 Hobart FT900S Information

Quantity ____

C.S.I. Section 11400

HOBART
701 S Ridge Avenue, Troy, OH 45374
1-888-4HOBART • www.hobartcorp.com

FT900S FLIGHT-TYPE DISHWASHER

STANDARD FEATURES

- Opti-RinSe™ system
- Water usage 114 gph @ 20 psi (standard height)
- Microprocessor controls
- Low temperature alert
- Single point vent connection
- 42" access doors on power wash/final rinse chamber, 34" access doors on prewash chamber
- Variable speed conveyor 4-6.3 fpm
- Start and stop switches at both ends
- Doors open indicator
- Load end flush system
- Door interlocks
- 3 H.P. TEFC prewash and power wash pump motors
- Easy to remove wash arms
- Easy to remove scrap trays and baskets
- 30½" wide conveyor
- Insulated hinged access doors
- Front and rear panels

DIRECTION OF OPERATION

- ❑ Right to Left
- ❑ Left to Right

VOLTAGE

- ❑ 208/60/3
- ❑ 240/60/3
- ❑ 480/60/3
- ❑ Other options available, consult factory.

LA Research Report #M660004

MODEL

- ❑ FT900S – Flight-Type Dishwasher

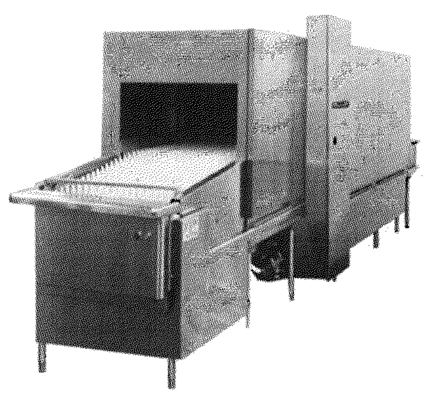
OPTIONS AT EXTRA COST

- ❑ Energy Recovery – advansys (will require a back draft preventer)
- ❑ Electric Tank Heat
- ❑ Steam Tank Heat
- ❑ Booster Heater
  - ❑ Electric
  - ❑ Steam
- ❑ 6" higher than standard - 120 gph @ 20 psi
- ❑ Prewash temperature control
- ❑ Insulated counterbalanced sliding doors option
- ❑ Multiple conveyor choices
- ❑ Circuit breakers
- ❑ Other options available, consult factory

ACCESSORIES

- ❑ Feet
  - ❑ Extended
  - ❑ Flanged
- ❑ Water hammer arrestor/PRV.

Specifications, Details and Dimensions on Inside and Back.



HOBART FT900S FLIGHT-TYPE DISHWASHER

FT900S
FLIGHT-TYPE DISHWASHER

HOBART
701 S Ridge Avenue, Troy, OH 45374
1-888-4HOBART • www.hobartcorp.com

DESIGN: Fully automatic, flight-type dishwasher machine consisting of a load section with power recirculating prewash, a 4 foot power wash, final rinse section and unload section. Included with each machine will be flexible plastic strip curtains to control over spray.

CONSTRUCTION: Stainless steel tank and chambers with No. 3 polish on appearance surfaces. Frame, legs and feet to be constructed of stainless steel. Inspection doors to be chamber width.

PUMPS: Recirculating stainless steel pumps with stainless steel impellers. Pump housing has easy to remove coverplate for access to impeller. All pumps are self-draining. 150 gpm prewash; 292 gpm power wash.

MOTORS: Totally enclosed fan cooled design, with inherent overload protection. Prewash and power wash to be 3 H.P. each, conveyor ½ H.P. Available in electrical specifications of 208-240/60/3 and 480/60/3.

CONTROLS: A stainless steel control center with electronic digital controls mounted at eye level. Power "On/Off" and "Start/Stop" switches integrated into keypad. Digital display indicates door(s) open, low temperature alert, tanks/final rinse temperatures, and other pertinent operating data. Additional "Start/Stop" switches are located at each end of machine.

FLIGHT-TYPE CONVEYOR: Stainless steel side links, tie rods and conveyor tracks. Injection molded, resilient Duraflex flight links.

VENT: Single built-in vent duct with dampers mounted in cleanable cross duct.

RECIRCULATING PREWASH SECTION: Prewash compartment is fitted with upper and lower wash arms. Prewash flush down for prewash tank bed. Large removable one piece perforated stainless steel screen sloped downward to deep stainless steel scrap basket.

TANK HEAT: Power wash water temperature is thermostatically controlled. Low water protection is provided. Specify either electric or steam heat.

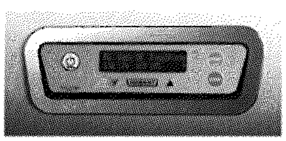
FINAL RINSE: Easily removed final rinse arms.

CONVEYOR DRIVE UNIT: Powered by a ½ H.P. motor. Trip mechanism provided on unload section. Jam protection is provided by load sensing switch at drive platform. Conveyor speed adjustment of 4 fpm to 6.3 fpm is provided in the main control box.

DRAINS: Manual, hand operated, located in each tank.

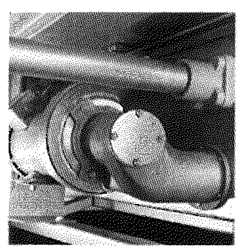
No other control system allows easier monitoring.

The controls are placed in a convenient panel that lets operators verify proper operation and temperatures at a glance.



Digital display indicates the unit is on, and confirms that the doors are closed. Automatic door interlocks prevent the pump and conveyor from operating if the doors are open. Easy-to-read digital display indicates accurate temperatures of the 160°F wash and 180°F final rinse — critical for proper HACCP system record-keeping.

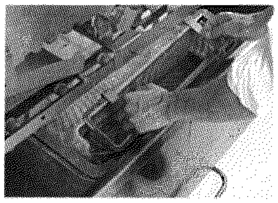
Stainless steel pump is built for long life.



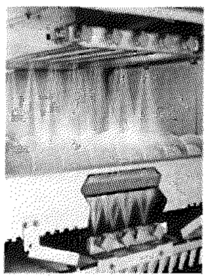
The stainless steel pump housing and impeller offer greater durability and long life. The pump motor is totally enclosed and fan cooled (TEFC) to protect it from water spray during dishroom clean-up. The pump is also externally mounted to the frame for added rigidity and easy access to the clean-out port.

HOBART
701 S Ridge Avenue, Troy, OH 45374
1-888-4HOBART • www.hobartcorp.com

FT900S FLIGHT-TYPE DISHWASHER



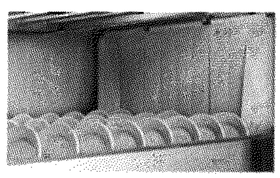
Scrap baskets capture food particles and are easy to clean.
The sloped screens that carry scraps to the scrap baskets are steeper, so less soil gets into the tanks. The basket opening is larger for easy cleaning and basket handles have been designed for easy lift-out access.

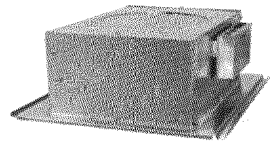


The FT900S saves water and energy.
The unit is designed to cut water and energy usage, yet provide effective cleaning and sanitizing that meet NSF International requirements.

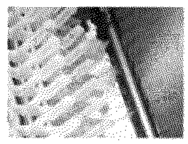
This is achieved through a carefully balanced ratio of water flow to pressure. At 292 gallons per minute (gpm), the machine offers excellent wetting and flooding over ware. Insulated doors also reduce heat loss. The unit's 1.9 gpm/114 gallons per hour rinse (the lowest in the industry on a standard machine) or 2.0 gpm/120 gallons per hour rinse (6" HTS) flow rate saves both water and the energy to heat it.

Wider, variable speed conveyor offers increased throughput.
The conveyor on the FT900S is wider so it can handle more ware. Result: more volume and versatility, quicker work. Its speed is servicer adjustable for the type of ware, soiled condition, or workforce requirements. It can be adjusted from 4 to 6.3 feet per minute.





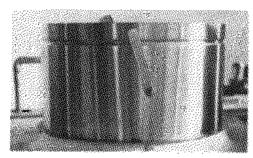
Optional Energy Recovery system.
The optional Energy Recovery system captures escaping heat and steam from the exhaust air and uses a heat exchanger to recycle it into energy. This free energy is used to preheat the incoming water supply before it enters the booster heater. The cold ground temperature water passes through a heat exchanger positioned directly in line with the machine's exhaust system to capture the energy from the exhaust air to elevate the temperature of the water to 128° before it enters the booster heater.



Flush arm keeps load end clean.
The load end also has a readily removable flush arm to rinse food scraps into the prewash area scrap basket.

Self-draining pumps help keep water clean.
Pumps are self-draining when the machine is shut down, so there is no residual water left in the pumps.

Installation is quick and easy with modular design, minimal wiring connections, and single point vent.
Modular design means the FT900S installs quickly, and reliably. Sections fit through 42" doors. The control panel is already in place, premounted to the power wash/final rinse section.



Wiring connections are minimal, and there is only a single vent connection, saving time and expense. The control box uses a "single plane" circuitry design for easy accessibility during installation and service. The FT900S is ready to run quickly.

1.8.5 Sample Water Bill

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CITY OF ORANGE
300 E. Chapman Avenue
Orange, CA 92866-1591
Ph 714-744-2233
www.cityoforange.org

Billing Detail
Review the back of this document for more information

PREVIOUS BALANCE	$4,372.21
PAYMENT 12-23-2013	-$4,372.21
BALANCE FORWARD	**$0.00**

Account Summary

Name:	CHAPMAN UNIVERSITY
Account Number:	
Service Address:	
Bill Date:	01-27-2014
Delinquent After:	02-24-2014
Amount Due:	**$2,803.42**

Water Usage *(1 unit = 100 CF = 748 Gallons)*

Billing Period 11-19-2013 to 01-23-2014

Meter No.	***Previous Read***	***Current Read***
0031844735	7402	7911
0031844736	6611	7118

	Total Usage	Average Per Day
Current Usage	1016	15.63
Prior Billing Period	1637	28.72
Same Period Last Year	1118	15.97

Water Charges	***QTY***	***RATE***	***TOTAL***
SERVICE CAPACITY CHARGE	1	123.230	$123.23
SERVICE CAPACITY CHARGE	1	50.180	$50.18
WATER CONSUMPTION TIER 1	20	1.185	$23.70
WATER CONSUMPTION TIER 1	20	1.221	$24.42
WATER CONSUMPTION TIER 2	50	2.040	$102.00
WATER CONSUMPTION TIER 2	50	1.981	$99.05
WATER CONSUMPTION TIER 3	658	2.135	$1,404.83
WATER CONSUMPTION TIER 3	218	2.199	$479.38
FIRE SERVICE CHARGE			$105.32
		Water Charges Total	**$2,412.11**

Sanitation Charges	***QTY***	***RATE***	***TOTAL***
SEWER MAINTENANCE	1016	0.112	$113.79
STORMWATER/ENV COMP	1016	0.128	$130.05
STREET SWEEPING	1016	0.142	$144.27
CITY-WIDE TREE PROGRAM	1	3.200	$3.20
		Sanitation Charges Total	**$391.31**

Message Center

CONCERNED ABOUT CRIME IN YOUR NEIGHBORHOOD? LIVE OR WORK IN ORANGE? HAVE AN E-MAIL ADDRESS? FOR FREE CRIME ALERTS SUBSCRIBE TO THE ORANGE POLICE DEPARTMENTS i-WATCH SYSTEM @ www.orangeiwatch.com
IF YOU USE "BILL PAY" SEE BACK OF BILL

Total Amount Due **$2,803.42**

C081494d
3110 510334
OK to pay
M.C. 2/4/14

Due upon receipt. A 10% Penalty will be assessed if payment is not RECEIVED on or before 02-24-2014 by 9:00 p.m PST.

PAYMENT COUPON Return this portion with your payment

CITY OF ORANGE
300 E. Chapman Ave.
Orange, CA 92866-1591
Temp-Return Service Requested

Account Number:	
Route Number:	
Service Address:	
Bill Date:	01-27-2014
Delinquent After:	02-24-2014
Call us to join the Paramedic Program	
Amount Due:	**$2,803.42**
Amount Enclosed:	2803.42

☐ Check here to update personal information and provide it on the reverse.
To pay by credit card go online at www.cityoforange.org or use our 24-HR payment line 855-894-2386.

Make checks payable to:

ORG0127B
2000000035 1/35

CHAPMAN UNIVERSITY
C/O FACILITIES MANAGEMENT
1 UNIVERSITY DR
ORANGE, CA 92866

CITY OF ORANGE
PO BOX 30146
LOS ANGELES, CA 90030-0146

000001000193880000000028034200002803420000