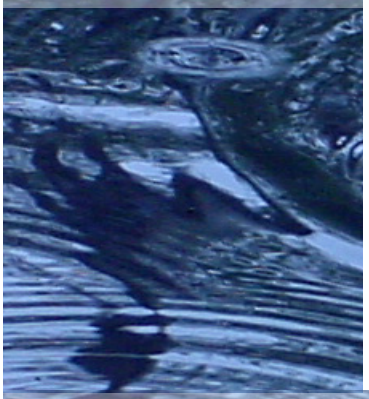

June 2007

Benchmarking Task Force Collaboration for *Industrial, Commercial & Institutional (ICI) Water Conservation*

A Collaborative Effort of Participants from:

Aurora Water
City of Boulder
City of Fort Collins
City of Greeley
City of Loveland
City of Thornton
City of Westminster
Colorado Springs Utilities
Colorado State University
Denver Water
Northern Colorado Water Conservancy District
The Brendle Group, Inc.

Benchmarking Task Force

Collaboration for Industrial, Commercial & Institutional Water Conservation

A Task Force For:

A Collaborative Effort of:

City of Aurora
City of Boulder
City of Fort Collins
City of Greeley
City of Loveland
City of Thornton
City of Westminster
Colorado Springs Utilities
Colorado State University
Denver Water
Northern Colorado Water Conservancy District

With Funding from:

The Colorado Department of Public Health and Environment's Pollution Prevention Advisory Board

Prepared By:

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July 2007

Executive Summary

Goal: Inform conservation efforts for industrial, commercial, and industrial sectors

Process:

- Determine high-priority ICI sectors
- Gather water use data for these sectors
- Analyze and normalize data
- Develop useful water use benchmarks for priority sectors
- Disseminate benchmarks to water providers and users

Why benchmarks are important:

- The issues of water quality and supply reflect the State's top environmental priority
- ICI sectors in Colorado present an area of particular need for conservation programs
- Benchmarks inform conservation policy/decision making related to water budgeting/ allocation
- Few reliable benchmarks exist for assessing performance and conservation in ICI sectors

ICI benchmarks:
95% confidence interval for annual water consumption

- Restaurants: 0.17-0.21 thousand gallons (kgal)/square foot; 10.6-14.3 kgal/seat
- Schools: 0.012-0.019 kgal/square foot; 1.7-2.7 kgal/student
- Hotel/motels: 0.079-0.165 kgal/square foot; 30.2-39.5 kgal/room
- Nursing homes/assisted living: 0.062-0.101 kgal/square foot; 32.8-40.7 kgal/bed; 25.4-39.6 kgal/apartment

Benchmark evolution:
Collaboration among regional partners participating on an ICI task force whose goals include a robust, standardized water benchmark database containing relevant data for providers and consumers in many regions and industries

- City of Aurora
- City of Boulder
- City of Fort Collins
- City of Greeley
- City of Loveland
- City of Thornton
- City of Westminster
- Colorado Springs Utilities
- Colorado State University
- Denver Water
- Northern Colorado Water Conservancy District

Project sponsor:
Grant sponsorship by the Colorado Department of Public Health and Environment's Pollution Prevention Advisory Board (PPAB)

Website: water.brendlegroup.com

1.0 Background

Water conservation on a significant level is challenging given the complex and fragmented system of water providers, especially for programs that target industrial, commercial, and institutional (ICI) business sectors. Based on the findings of a Northern Colorado regional group funded in 2005 by the Pollution Prevention Advisory Board (PPAB), useful benchmarks are key in addressing these challenges.

The goals of this project were:

- Convene/facilitate a Task Force through the Colorado Water Wise Council (CWWC), a statewide organization, to develop quantitative ICI water benchmarks.
- Collect/analyze water use data and identify consistent normalization factors for application to priority sectors.
- Disseminate benchmark results to inform conservation efforts and policy-making decisions regarding water allocation and budgeting.

The project was led by a Task Force of Colorado water providers, including members of an existing group of providers from Colorado's northern front range that participated in the 2005 PPAB-funded project. Mr. Paul Lander, Co-Chair of CWWC, was the executive project manager. The Brendle Group provided technical staff support to the Task Force as well as grant reporting and project accountability to the PPAB.

The project culminates in this report and accompanying materials to support disseminating the benchmarks for priority sectors to water providers throughout the state.

1.1 Problem Statement

Water conservation on a significant and state-wide level is challenging given the complex and fragmented system of water providers. Moreover, water conservation to ICI organizations is even more challenging due its specialized nature, as reflected by the low number of existing programs targeting these organizations. Through funding from the PPAB, a group of Northern Colorado water providers convened to address these issues and determined that developing relevant water use benchmarks is the top priority in creating effective ICI water conservation programs and informing policy regarding water allocation and budgeting. Quantitative ICI benchmarks for water use are not readily available nationally, let alone regionally, making prioritizing customers and program targets difficult. To be relevant, consistent data collection standards are pivotal, including how businesses are categorized and which normalization factors are the most appropriate (e.g., square feet or gallons per user).

1.2 Existing Benchmarking Studies

A number of organizations have undertaken benchmarking studies involving ICI sectors in support of water conservation program development. These resources are potentially valuable for comparison with benchmarking efforts undertaken through this grant.

In 2003, the Office of Government Commerce in the United Kingdom produced the Watermark study[1] focusing primarily on institutional sectors. This study establishes median and high performance (top quartile) benchmarks for various institutions. It was completed using a combination of utility bill analysis and end-user surveys. Normalizing factors of per person and per floor space were used as appropriate. It should be noted that this study has been used by a number of water providers in this country (e.g., State of Georgia[2]) to develop water conservation programs, despite its international origins.

In 2000, the AWWA sponsored and published a study entitled Commercial and Institutional End Uses of Water[3]. This study provides a fairly comprehensive review of existing resources, presents the results of field studies in five urban areas, and develops efficiency benchmarks based on a number of normalizing factors. This study focuses on restaurants, hotels and motels, supermarkets, offices, and schools.

Amy Vickers' Handbook of Water Use and Conservation[4], published in 2001, summarizes benchmarks from a number of sources, including Dewberry and Davis (gal/customer/day), IWR-MAIN Water Demand Analysis Software (gal/employee/day), and the Greater Vancouver (British Columbia) Regional District (gal/connection/year). Beyond just benchmarks, The Handbook is a valuable resource for ICI water conservation technologies and implementation strategies.

Additional benchmarks have also been developed by Exergy, of Australia, for offices and public buildings and by Santa Clara for a number of sectors.

It was not possible to directly compare all the benchmarks produced by these studies because of the different benchmarking approaches. With the few exceptions where categories overlapped, the normalization factor of choice was often different. This emphasizes the importance of standardizing data collection methods in order to facilitate sharing and comparing benchmarks, as discussed in the forward looking statements at the end of this report.

This study seeks to develop regionally applicable benchmarks for sectors that are considered high priority by participating water providers. These benchmarks utilize factors that are widely available to these providers and therefore are more easily utilized than some existing benchmarks.

2.0 Methodology

The following sub-sections document the methodology used in this study. This methodology covers the full process of the study from sector selection to data collection and analysis.

2.1 Sector Selection

Participating water providers considered two potential approaches for this benchmarking study. The first was a top-down model: take all available water consumption data, categorize accounts by type (e.g. restaurant, school, office, etc.), and then pursue normalizing data for each account from other resources. The second approach was bottom-up: choose priority sectors, identify just the accounts in those sectors, and pursue appropriate normalization factors.

While the former approach would have addressed more sectors it was determined to be infeasible because it is extremely difficult to classify all of the numerous ICI accounts from data available in existing water provider databases. Furthermore, tracking down normalization data for that many accounts was also problematic because it was not readily associated with the accounts through information available in the provider databases. In other words, it would have been an extremely labor intensive prospect to individually identify accounts and track down normalization data for this large a data set. The forward looking discussion at the end of the report touches on potential improvements to provider databases that might facilitate more efficient benchmark development using a top-down approach.

For the purpose of this study, participants elected to focus on producing high quality data for four ICI sectors using the bottom-up approach. The four sectors that were found to be high priority were:

- Restaurants with seating and dishwashing facilities (not including fast food)
- Schools (K-12)
- Hotels and motels
- Nursing, assisted living, and independent care facilities

These four sectors were selected through a voting process based on the following criteria:

1. Ease and accuracy of classification
2. Accessibility of water usage data
3. Results from 2005 PPAB effort
4. Number of customers in sector
5. Water intensity of sector
6. Opportunity for water conservation
7. Availability of logical normalization factor(s)

2.2 Normalization Factors

Normalization factors were selected for each sector based on the following considerations:

1. Availability of data from another source that can be easily associated with the account
    - Square footage from municipal or county records, sometimes GIS systems
    - Seating capacity from fire marshal
    - Student count from school district
    - Room count from hotel/motel association

2. Availability of data to the account holder for direct solicitation, if it not otherwise attainable
3. Usefulness of the factor in quickly evaluating facilities against the benchmark

In general, access to a broader selection of data through the water provider database and/or better connectivity between the provider database and other sources of information would facilitate more efficient benchmark development.

2.3 Categorization

Under a top-down approach, categorization of accounts becomes challenging. Barriers include, but are not limited to, fine distinctions between water use even within identifiable sectors, account names that reference billing entity but do not indicate use type, etc. Under this approach, using a formalized system such as the NAICS would be highly recommend, but still presents challenges. Ideally, water provider databases will move toward collection of use type information when a new account is opened.

By taking a bottom-up approach, providers largely solved the categorization problem for the purpose of this study. A list of accounts can be compiled from the local phone book as a starting point. Using available information in provider databases, it was reasonable to identify and pull consumption data for the finite number of accounts in the selected sectors.

2.4 Data Collection and Handling

Providers participating in the data collection efforts for this study agreed on 2005 as the preferred data year. Compared to previous years, 2005 was more typical from a climate and water resource standpoint. Additionally, 2005 was the most recent year with complete data when collection efforts were initiated.

The following data were collected, where available, for accounts in all four sectors:

- Description – An identifying reference for the account. Depending on confidentiality policy at the water provider, this ranged from an account name to a simple identifying number. All results in this report are reported in aggregate to assure confidentiality for the account and provider.
    - Where multiple accounts existed under a single entity, water use and normalization factors were totaled into a single line item. The exception to this was accounts that were clearly serving irrigation use based on summer only consumption. These accounts were deleted.
- Address – Similar to description, some data was provided with addresses to distinguish accounts.
- Building Age
    - In some cases more than one year was indicated representing renovations that have taken place since the building's initial construction. The oldest date was kept for the purpose of this study.
- Year Account Established
- Meter Size
- Square Footage
- Other Normalizing Factors
    - Complete description in Results section
    - Accounts not reporting any normalizing factors were excluded

- Water Consumption by Month
    - Accounts deleted if more than 3 months of consumption data were missing
- Other Notes

2.5 Calculation of Benchmarks

The purpose of these benchmarks is to address annual indoor water consumption in the priority sectors. Therefore, efforts were undertaken to normalize the data for the impact of irrigation water use or water-based cooling that may not be representative of the sector. Therefore, all benchmarks are calculated based on winter water consumption as determined by the monthly average billed in the months December through April.

The winter monthly average was extrapolated to twelve months to determine average annual consumption based on winter use rates. This average annual consumption was then divided by the normalizing factors to determine the reported benchmarks.

2.6 Impact of Drought Restrictions

Among the many factors that may influence the quality of the data used to determine these benchmarks are the lingering impacts of drought in the years prior to 2005. Many of the water providers involved in this study had enforced water use restrictions that may have impacted the sectors under consideration. In some cases, these restrictions may still have been in effect; in others the behaviors instilled in previous years may have continued into 2005.

As an illustrative example, the City of Aurora, which provided data for this study, maintained a Water Management Plan Stage IB Moderate Drought rating and had restrictions still in place in 2005.

For hotels:

1. Outdoor watering was restricted to 3 days per week; could not water between 10 am and 6 pm, trees/shrubs, etc. could be hand- watered.
2. Indoor and outdoor pools were allowed to operate under best management practices.
3. Place information providing customers with the option of having their linens (sheets and towels) changed less frequently.
4. Wasting of Water Ordinance in effect: water cannot spray sidewalks and fences, cannot pool and run down the street, etc.

For schools:

1. Athletic fields could be watered any day as per pre-designated water allotment.
2. Trees/shrubs, etc. could be hand- watered at any time.
3. Indoor and outdoor pools were allowed to operate under best management practices.

For restaurants:

1. Outdoor watering was restricted to 3 days per week; could not water between 10 am and 6 pm, trees/shrubs, etc. could be hand- watered.
2. Water could only be served on request.

2.7 Outliers

Participants submitting data for this study were asked to review outlying data after the initial analysis. In some cases, corrections were made that brought these outliers into compliance with the rest of the data. Otherwise, outliers are included in the analysis except where other indications led to their deletion. For example, some accounts were identified by the submitting

provider as being property management firms that operated a whole set of properties that shared a single meter. In these cases, differentiating the portion of use for the account of interest was not possible and the data was excluded. It is very probable that this circumstance still exists in the data set and it may account for some of the lingering outliers.

3.0 Resulting Benchmarks

Among the cities participating in this project, six generously aggregated and submitted data for analysis including Aurora, Boulder, Denver Water, Fort Collins, Thornton, and Westminster. Participants from these providers invested significant effort in tracking down normalizing data for these accounts, in some cases calling the account holders directly to obtain data. Their efforts are much appreciated.

In total, data from 631 accounts including 302 restaurants, 184 schools, 97 hotels/motels, and 48 nursing/assisted living facilities was analyzed.

3.1 Restaurants

Restaurants are a prevalent ICI water user and were considered a high priority by the participants in this study based on the previously identified criteria.

For the purpose of this study a restaurant was defined as an eating establishment with indoor seating and dishwashing facilities. Breweries, bars, and fast-food establishments were not included in this analysis.

Seating capacity was a particular normalizing factor collected for this sector. Participants found that fire marshals typically maintained a database of seating capacity or could apply a rule-of-thumb estimation based on square footage. If the fire marshal was not able to provide the data, the restaurant usually could based on signage provided by the fire marshal.

In one data set, small restaurants had seating capacity indicated as "<50". In these cases the value of 25 was used in place of the "<50". Also, seating specifically identified as outdoor was not included in the seating count.

Table 1. Restaurant Study Summary

Consumption (number of accounts)	302
Square footage (% of accounts)	78%
Seating capacity (% of accounts)	93%
Summer (May- November) to winter (December-April) variation of greater than 10% (% of accounts)	61%

The characteristics of the data set used to determine benchmarks for restaurants are summarized in Table 1. A large percentage of accounts reported both square footage and seating capacity. Also, a decent percentage of the accounts had greater than a 10% variation between summer and winter use, suggesting that some irrigation use may be included in many of the accounts. Therefore, the application of winter average based consumption was appropriate in this sector.

3.1.1 Results

A profile of the average restaurant in the study is provided in Table 2.

Table 2. Restaurant Account Summary

Average building age (years)	40
Median meter size (inches)	1.5
Average square footage (ft^2)	12,294
Average seating capacity (indoor seats)	149

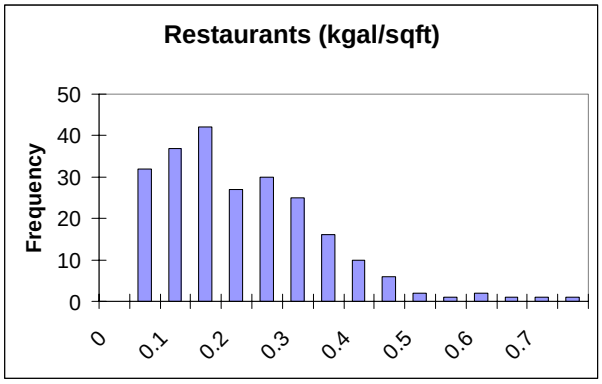
The resulting benchmarks for the restaurant sector are provided in Table 3. The annual consumption per connection result corresponds moderately well with similar benchmarks from other sources. Unfortunately, this benchmark is not particularly useful since it does nothing to account for the size, operational characteristics, or efficiency of the account.

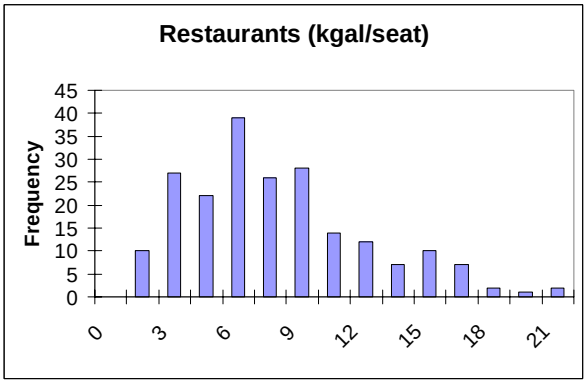
Table 3. Restaurant Benchmarks

Benchmark	Annual Average	95% Confidence Interval	Comparison to Existing Benchmarks
Consumption per connection (thousand gallons)	1,276	n/a	1,635 (1) 2,616 (2)
Consumption per square foot (thousand gallons/ft^2)	0.192	0.173-0.211	
Consumption per indoor seat (thousand gallons/seat)	12.45	10.58-14.31	10.8-12.7 (2)

[1]Amy Vickers, Handbook of Water Use and Conservation, Waterplow Press, 2001
[2]AWWA Research Foundation, Commercial and Institutional End Uses of Water, http://www.awwarf.org/research/topicsandprojects/execSum/241b.aspx

The benchmark for consumption per indoor seat corresponds very well to the results from the AWWA study. The AWWA study used a smaller sample size which may account for the reduced variability in their benchmark. The histograms for consumption per square foot and per seat are provided to indicate the distribution of restaurant performance.





3.1.2 Comparison to Case Studies

A case study is presented from an onsite assessment to illustrate how water conservation practices in the field correspond to performance against the benchmark.

Restaurant A	
Description of Operation • Building age >100 years • Employees 100 • Approximately 7,000 square feet • Seating capacity of 252 • Hours of operation about 8 a.m. to midnight seven days a week	Water Consumption Status • Most of the toilets are 3.5 gallon per flush (gpf) models • Most urinals are 1.6 gpf models • Restroom faucet aerators in excess 1.0 gallons per minute (gpm) • Two toilets were damaged and running during the assessment • Some kitchen faucets lacked aerators, others were rated in excess of 2.0 gpm • A low-flow pre-rinse spray nozzle was not installed • Alternative controls were not in place for kitchen faucets (e.g. foot control) • Two faucets in the kitchen were leaking • Two water cooled ice machines rated at 1,300 lbs/24 hours were in place
Performance 0.136 thousand gallons/square foot 3.368 thousand gallons/seat	

The case study indicates that Restaurant A performs well against the benchmarks developed in this study scoring in the 40th percentile by consumption per square foot and 18th percentile by consumption per seat. However, Restaurant A's water consumption status indicates that there are many opportunities for improved practices including:

- Replacing toilets with 1.6 gpf models
- Replacing urinals with 1.0 gpf or waterless urinal models
- Replacing restroom faucet aerators with ones that use 0.5-1.0 gpm
- Repairing toilet leaks
- Install or replace kitchen sink aerators with 2.5 gpm models where higher flow is needed and 1.5-2.0 gpm models elsewhere
- Install a 1.6 gpm pre-rinse spray nozzle
- Install foot-activated faucets where appropriate to save water and for hands-free convenience
- Repair leaking faucets
- When replacing water-cooled ice machines consider air-cooled alternatives

Despite respectable performance against the benchmark Restaurant A has a number of opportunities for improved water conservation. This may suggest that even more significant opportunity exists at those establishments that do not perform well against the benchmarks.

3.2 Schools

Like restaurants, schools are a pervasive ICI account among the participating water providers and considered a similarly high priority for conservation.

For the purpose of this study schools include any public or private school serving the grades of kindergarten through 12th. The study differentiates between elementary, middle, and high

school. In some districts, middle school is defined as grades 6-8, in others it is grades 7-9. For the purpose of this study, both of these classifications are labeled as middle schools.

In addition to the data collect for all accounts, the number of students enrolled was also determined for each school. This data was typically readily available from the school district. Also, the presence of a swimming pool was indicated.

Table 4. School Study Summary

Consumption (number of accounts)	184 total 35 high schools 42 middle schools 107 elementary schools
Square footage (% of accounts)	78.8%
Student enrollment (% of accounts)	99.5%
Summer (May- November) to winter (December-April) variation of greater than 10% (% of accounts)	82.1%

The characteristics of the data set used to determine benchmarks for restaurants are summarized in Table 4. A large percentage of accounts reported both square footage and nearly all accounts reported student enrollment. Also, a majority of the accounts had greater than a 10% variation between summer and winter use, suggesting that some irrigation use may be included in many of the accounts. Therefore, the application of winter average based consumption was appropriate in this sector.

3.2.1 Results

A profile of the average school in the study, across all types, is provided in Table 5.

Table 5. School Account Summary

Average building age (years)	37
Median meter size (inches)	2
Average square footage (ft^2)	69,016
Average number of students (count of students)	638

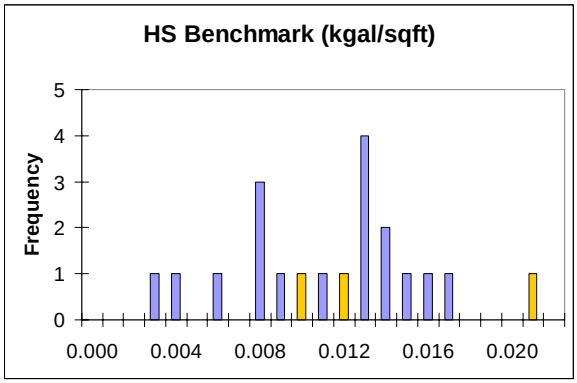
The resulting benchmarks for schools are provided in Table 6. The annual consumption per connection result corresponds poorly with similar benchmarks from other sources demonstrating that this metric is not particularly useful since it does nothing to account for the size, operational characteristics, or efficiency of the account.

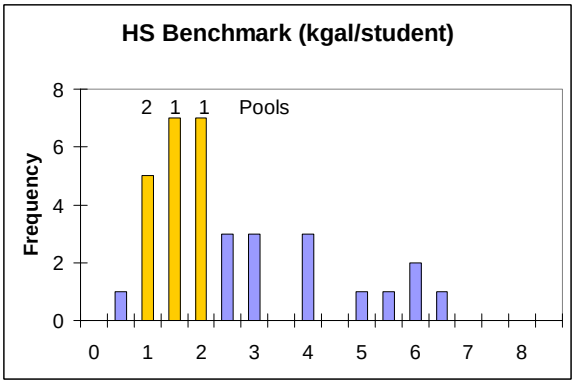
Table 6. School Benchmarks

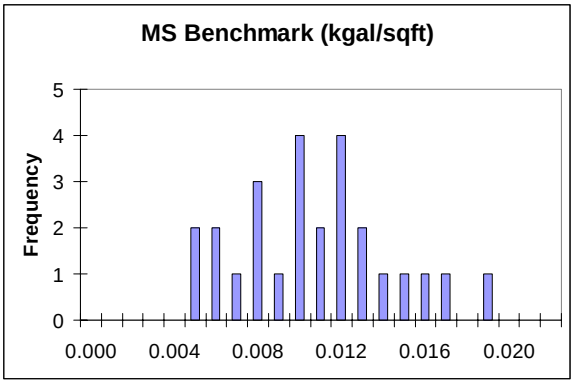
Benchmark	Annual Average	95% Confidence Interval	Comparison to Existing Benchmarks
ALL SCHOOLS			
Consumption per connection (thousand gallons)	3,424	n/a	1,639 (1) 11,592 (2)
Consumption per square foot (thousand gallons/ft²)	0.0155	0.0121-0.0189	0.030 xx
Consumption per student (thousand gallons/student)	2.23	1.73-2.73	n/a
HIGH SCHOOLS			
Consumption per square foot (thousand gallons/ft²)	0.0122	0.0102-0.0143	0.0244 (2)
Consumption per student (thousand gallons/student)	2.89	1.72-4.07	1.03 (3) 3.54 (2)
MIDDLE SCHOOLS			
Consumption per square foot (thousand gallons/ft²)	0.0132	0.0084-0.0181	0.0244 (2)
Consumption per student (thousand gallons/student)	1.95	1.56-2.34	n/a
ELEMENTARY SCHOOLS			
Consumption per square foot (thousand gallons/ft²)	0.0169	0.0124-0.0214	n/a
Consumption per student (thousand gallons/student)	2.13	1.38-2.87	1.00 (3)

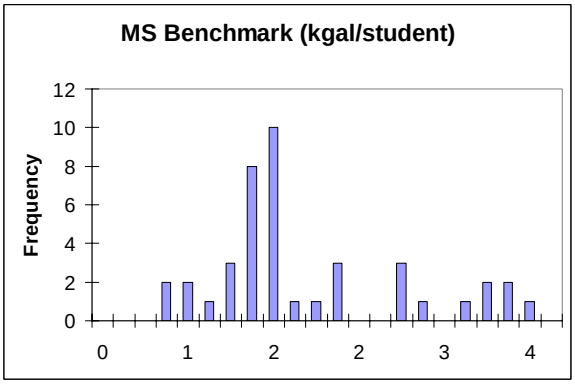
[1]Amy Vickers, Handbook of Water Use and Conservation, Waterplow Press, 2001
[2]AWWA Research Foundation, Commercial and Institutional End Uses of Water, http://www.awwarf.org/research/topicsandprojects/execSum/241b.aspx
[3]ADSM and WatermarkPLUS, Final Watermark Project Report, http://www.adsm.com/docs/Final%20Report_version%202_short.pdf

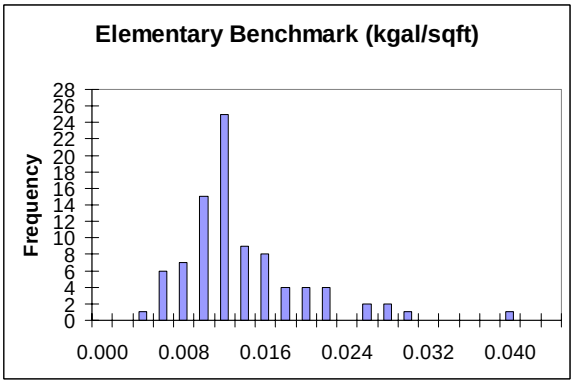
The benchmarks are generally on the same order of magnitude as corresponding benchmarks from other studies. The histograms for consumption per square foot and per student are provided to indicate the distribution of school performance by school type. Schools with swimming pools are highlighted in yellow. There is not an obvious correlation between swimming pools and overall water consumption performance.

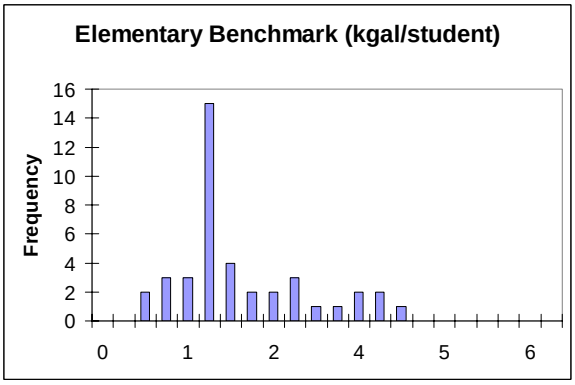












3.2.2 Comparison to Case Studies

A case study is presented from an onsite assessment to illustrate how water conservation practices in the field correspond to performance against the benchmark.

3.3 Hotels and Motels

For the purpose of this study, no particular restrictions were placed on the definition of hotels/motels. However, lodging such as bed & breakfasts are not included in this analysis.

Additional data collected for hotels/motels beyond that collected for other accounts included number of rooms, occupancy, and the presence of a swimming pool, restaurant or conference facility. In most cases, the hotel was contacted directly to collect this data. Occupancy data is often proprietary and was provided for only a small fraction of accounts. Therefore, occupancy does not figure into the calculation of the benchmarks, though it would no doubt impact water use.

Table 7. Hotel and Motel Study Summary

Consumption (number of accounts)	97
Square footage (% of accounts)	68%
Room count (% of accounts)	100%
Summer (May- November) to winter (December-April) variation of greater than 10% (% of accounts)	78%

The characteristics of the data set used to determine benchmarks for hotels/motels are summarized in Table 7. A large percentage of accounts reported square footage and all of the accounts reported room count. Also, majority of the accounts had greater than a 10% variation between summer and winter use, suggesting that some irrigation use may be included in many of the accounts. Therefore, the application of winter average based consumption was appropriate in this sector.

3.2.1 Results

A profile of the average hotel/motel in the study is provided in Table 8.

Table 8. Hotel and Motel Account Summary

Average building age (years)	28
Median meter size (inches)	2
Average square footage (ft^2)	48,516
Average number of rooms (count of rooms)	97
Swimming pools (accounts having)	53
Restaurants (accounts having)	24
Conference facilities (accounts having)	34

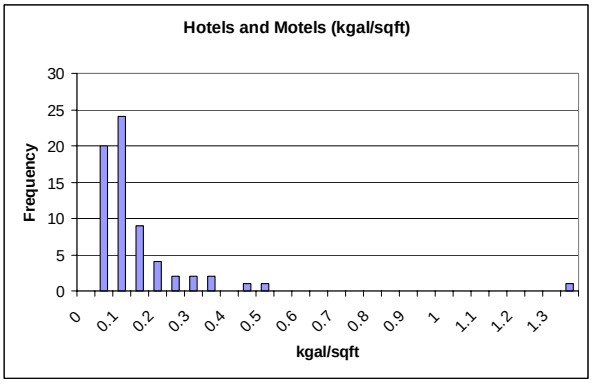
The resulting benchmarks for the restaurant sector are provided in Table 8. The annual consumption per connection result corresponds moderately well with similar benchmarks from other sources. Unfortunately, this benchmark is not particularly useful since it does nothing to account for the size, operational characteristics, or efficiency of the account.

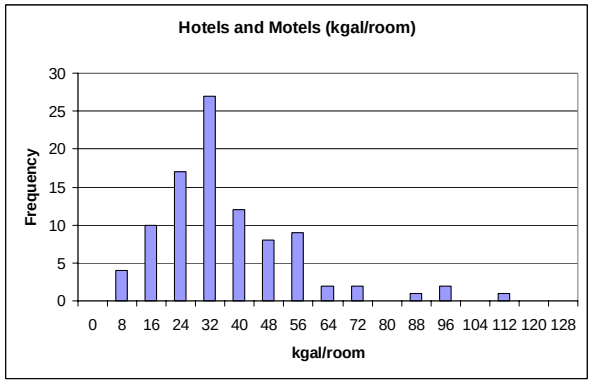
Table 9. Hotel and Motel Benchmarks

Benchmark	Annual Average	95% Confidence Interval	Comparison to Existing Benchmarks
Consumption per connection (thousand gallons)	4,035	n/a	5,234 (1) 7,018 (2)
Consumption per square foot (thousand gallons/ft^2)	0.12	0.079-0.165	0.063 xx
Consumption per room (thousand gallons/room)	34.83	30.19-39.47	21.9 (1) 42.6 (2)

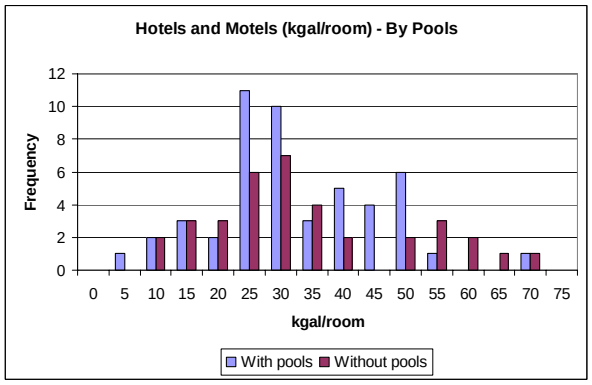
[1]Amy Vickers, Handbook of Water Use and Conservation, Waterplow Press, 2001
[2]AWWA Research Foundation, Commercial and Institutional End Uses of Water, http://www.awwarf.org/research/topicsandprojects/execSum/241b.aspx

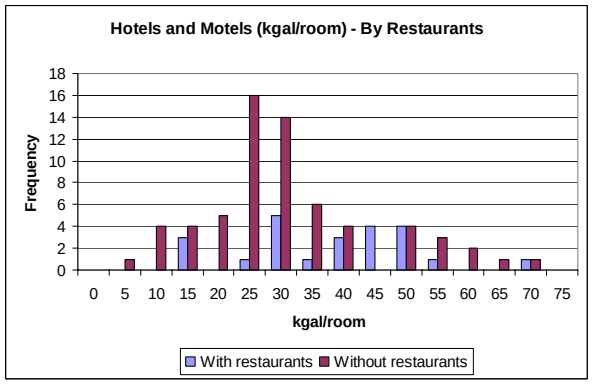
The benchmark for consumption per room is similar to the corresponding benchmark from the AWWA study. The histograms for consumption per square foot and per room are provided to indicate the distribution of hotel/motel performance.

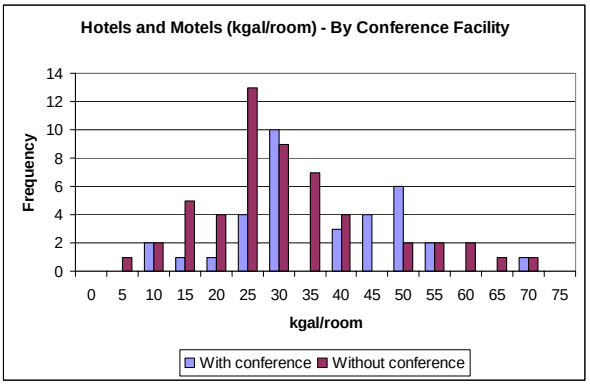




Distributions are also provided for accounts having swimming pool, restaurant, and conference room amenities versus those that do not. There is no clear correlation between consumption and any of these amenities. Further quantification that examines at the magnitude of the pool, restaurant or conference facility would enhance this analysis.







3.2.3 Comparison to Case Studies

Two case studies are presented of onsite assessments to illustrate how water conservation practices in the field correspond to performance against the benchmark.

Hotel/motel A	
Description of Operation • Building age 40 years • Employees 165 • Approximately 51,000 square feet • 269 rooms • Swimming pool • Restaurant • Conference facility	Water Consumption Status • Guest room faucet aerators rated at 2.2 gallons per minute (gpm) • A low-flow pre-rinse spray nozzle was not installed • Alternative controls were not in place for kitchen faucets (e.g. foot control)
Current Use 0.259 thousand gallons/square foot 49.3 thousand gallons/room	

The case study indicates that Hotel/motel A is below average in its performance relative to the benchmarks developed in this study scoring in the 91st percentile by consumption per square foot and 82nd percentile by consumption per room. While this performance could be partly attributed to the facility having a pool, restaurant and conference facility, it also indicates that there are many opportunities for improved practices including, at a minimum:

- Replacing restroom faucet aerators with ones that use 0.5-1.0 gpm
- Install a 1.6 gpm pre-rinse spray nozzle
- Install foot-activated faucets where appropriate to save water and for hands-free convenience

Hotel/motel B	
Description of Operation • Building age 47 years • Employees 50 • Approximately 72,000 square feet • 165 rooms • Swimming pool • Restaurant • Conference facility	Water Consumption Status • About 80% of the toilets are 3.5 gallon per flush (gpf) models • Showerheads are mostly original to building construction and rated at 2.5 gpm • Guest room faucet aerators are typically rated at 2.0 gallons per minute (gpm) • Pool and hot tub leaks
Current Use 0.086 thousand gallons/square foot 40.9 thousand gallons/room	

The case study indicates that Hotel/motel B demonstrates average to below-average performance against the benchmarks developed in this study scoring in the 57th percentile by consumption per square foot and 73rd percentile by consumption per room. While this performance could be partly attributed to the facility having a pool, restaurant and conference facility, it also indicates that there are many opportunities for improved practices including, at a minimum:

- Replacing toilets with 1.6 gpf models
- Replacing showerheads with 1.5 gpm models
- Replacing restroom faucet aerators with ones that use 0.5-1.0 gpm
- Repairing pool and hot tub leaks
- Recycling laundry rinse water

Despite respectable performance against the benchmark Hotel/motel B has a number of opportunities for improved water conservation. This may suggest that even more significant opportunity exists at those establishments that do not perform well against the benchmarks.

3.4 Nursing and Assisted Living Facilities

For the purpose of this study a nursing/assisted living facility was defined as a residential facility providing some level of care for the elderly. Initially, an attempt was made to differentiate between nursing, assisted living, and independent living. However, these categorical definitions were difficult to impose and many facilities had numerous levels of care metered on a single account. Therefore sub-categories were not analyzed.

In addition to the data collected for other sectors, the number of beds, number of apartments, occupancy, and presence of a swimming pool were collected for this sector. Differentiating number of beds from number of apartments was meant to accommodate the differences between nursing and assisted living facilities. All reporting accounts reported just one metric, number of beds or number of apartments, but not both. Occupancy was rarely obtained and is therefore not included in the analysis, but can be assumed to be uniformly high in this sector. Only one account reported a swimming pool.

Table 10. Nursing/Assisted Living Study Summary

Consumption (number of accounts)	48
Square footage (% of accounts)	63%
Number of beds (% of accounts)	46%
Number of apartments (% of accounts)	48%
Summer (May- November) to winter (December-April) variation of greater than 10% (% of accounts)	71%

The characteristics of the data set used to determine benchmarks for care facilities are summarized in Table 10. Reporting percentages for normalizing factors were generally lower than in other sectors. One contributing factor is that all facilities report either bed count or apartment count but not both. Also, a decent percentage of the accounts had greater than a 10% variation between summer and winter use, suggesting that some irrigation use may be included in many of the accounts. Therefore, the application of winter average based consumption was appropriate in this sector.

3.2.1 Results

A profile of the average care facility in the study is provided in Table 11.

Table 11. Nursing/Assisted Living Account Summary

Average building age (years)	20
Median meter size (inches)	3
Average square footage (ft^2)	59,920
Average number of beds (count of beds)	115
Average number of apartments (count of apartments)	106

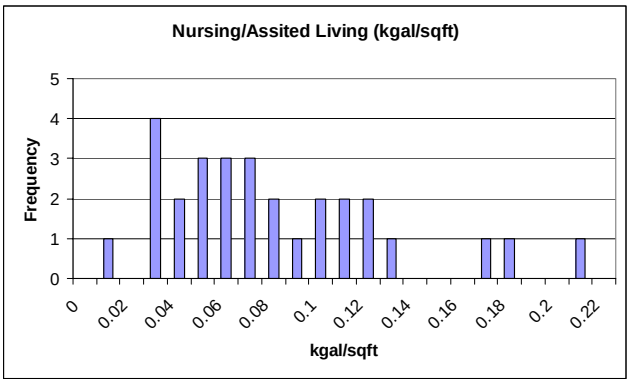
The resulting benchmarks for the care facility sector are provided in Table 12.

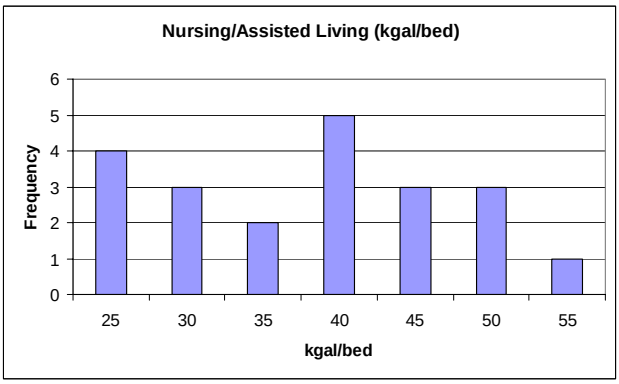
Table 12. Nursing/Assisted Living Benchmarks

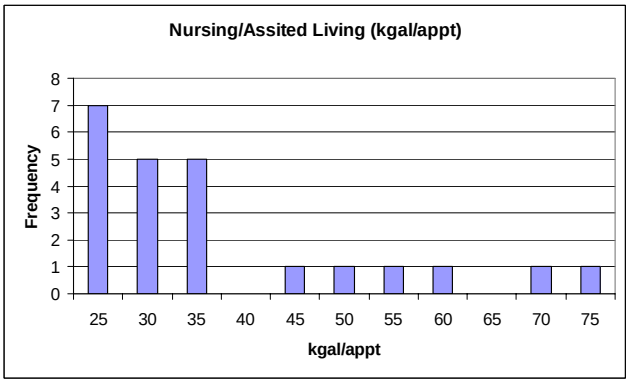
Benchmark	Annual Average	95% Confidence Interval	Comparison to Existing Benchmarks
Consumption per connection (thousand gallons)	5,185	n/a	n/a
Consumption per square foot (thousand gallons/ft^2)	0.08	0.062-0.101	
Consumption per bed (thousand gallons/bed)	36.8	32.8-40.7	21.3 per resident [3]
Consumption per apartment (thousand gallons/apartment)	32.5	25.4-39.6	

[1]Amy Vickers, Handbook of Water Use and Conservation, Waterplow Press, 2001
[2]AWWA Research Foundation, Commercial and Institutional End Uses of Water, http://www.awwarf.org/research/topicsandprojects/execSum/241b.aspx
[3]ADSM and WatermarkPLUS, Final Watermark Project Report, http://www.adsm.com/docs/Final%20Report_version%202_short.pdf

The benchmark for consumption per bed is on the same order as the per resident benchmark from another study. The histograms for consumption per square foot, per bed, and per apartment are provided to indicate the distribution of facility performance.







3.2.3 Comparison to Case Studies

Two case studies are presented of onsite assessments to illustrate how water conservation practices in the field correspond to performance against the benchmark.

Nursing/assisted living A	
Description of Operation • Building age 7-40 years • Employees 240 • Approximately 580,000 square feet of assisted living apartments • 24 hour operations • Cooling towers, kitchen operations, and laundry operations	Water Consumption Status • About 60% of the toilets are 5.0 gallon per flush (gpf) models • Most showerheads are 2.5 gpm • Restroom faucet aerators rated to 2.0 gallons per minute (gpm)
Current Use 0.030 thousand gallons/square foot	

The case study indicates that nursing/assisted living facility A performs well against the benchmarks developed in this study scoring in the 14th percentile by consumption per square foot. However, Nursing/assisted living facility A's water consumption status indicates that there are many opportunities for improved practices including:

- Replacing remaining toilets with 1.6 gpf models
- Replacing showerheads with 1.5 gpm models
- Replacing restroom faucet aerators with ones that use 0.5-1.0 gpm

Despite solid performance against the benchmark nursing/assisted living facility A has a number of opportunities for improved water conservation. This may suggest that even more significant opportunity exists at those establishments that do not perform well against the benchmarks.

Nursing/assisted living B	
Description of Operation • Building age 18-42 years • Employees 50-60 • Approximately 229,000 square feet of independent living apartments and assisted living • 24 hour operations	Water Consumption Status • About 60% of the toilets are 5.0 gallon per flush (gpf) models • About 20% of the toilets are 3.5 gallon per flush (gpf) models • About 55% of showerheads are 2.5 gpm • Restroom faucet aerators rated in excess of 2.0 gallons per minute (gpm)
Current Use 0.057 thousand gallons/square foot 43.8 thousand gallons/apartment	

The case study indicates that nursing/assisted living facility B performs well against the benchmarks developed in this study scoring in the 37th percentile by consumption per square foot and 73rd percentile by consumption per apartment. However, Nursing/assisted living facility B's water consumption status indicates that there are many opportunities for improved practices including:

- Replacing remaining older toilets with 1.6 gpf models
- Replacing showerheads with 1.5 gpm models
- Replacing restroom faucet aerators with ones that use 0.5-1.0 gpm

Nursing/assisted living facility B has a number of opportunities for improved water conservation. This may suggest that even more significant opportunity exists at those establishments that do not perform as well against the benchmarks.

4.0 Future Work

The participating providers in this project have successfully developed usable benchmarks for four high priority ICI sectors that will help to inform conservation and water budgeting efforts. Future work in this area should seek to develop similar quality benchmarks across all ICI sectors. The bottom-up approach used in this effort does not scale well to comprehensive benchmarking. Other tools may be needed.

Water provider databases should be enhanced to include additional information that would facilitate benchmarking. Enhancements might include resident company name (instead of sometimes remote entities that handle billing), account categorization by a system such as NAICS, and the capacity to capture and/or readily connect with other databases for information such as square footage, number of employees, etc. Many water providers are or will soon undergo updates to billing database systems; upgrades such as these should be considered at that time.

Participants envision a national clearinghouse of water utility benchmarking data that would collect data from these billing database systems and aggregate it in a standardized database. This would enable the development of comprehensive regional and national benchmarks bringing these useful tools to water providers throughout the country.

Intermediate steps to this vision include the continued development of benchmarks using bottom-up methodologies to better understand the nuances of water use benchmarking and capturing this understanding in an evolving draft standard for water benchmarking data collection.

5.0 Dissemination of Results

A number of efforts will be undertaken to disseminate the results of this study. Accompanying this report will be a one page fact sheet on the project and a press release that will be targeted to water providers, newsletters related to water, and media outlets throughout the state. In addition, a public presentation will be prepared that will be suited to a number of opportunities. Some presentation opportunities that are being pursued or have already been scheduled include those summarized in Table 13.

Table 13. Presentation Plan

Presentation Opportunity	Date	Presenter
NCWCD Fall Session, Berthoud	TBD	TBG
AWWA Rocky Mountain Conference, Keystone	Sept. 9-12	TBG
Fort Collins Business Environmental Program Series	Sept. 11	TBG and Laurie D'Audney
CWWC/AWWA Luncheon Program, Westminster	Nov. 8	TBG
PPAB Meeting, Denver	TBD	TBG and participant?
ESAP, Greeley	TBD	Ruth?
Assist in preparation for AWWA International Water Sources Conference, Reno • Stu Feinglas' abstract • Paul Lander discussion panel	May 7, 2008	Stu Feinglas or Paul Lander

The results of this study and all of the above mentioned materials will be featured in an emerging ICI water conservation web resource, currently located at http://water.brendlegroup.com. With funding from the United States Bureau of Reclamation, The Brendle Group is currently working with water providers to develop a comprehensive resource to guide ICI users and water providers through some of the most basic and significant water conservation opportunities. This website will feature these benchmarks as a tool for end users to evaluate their facility's performance against similar entities.

Sources Cited

[1] ADSM and WatermarkPLUS, Final Watermark Project Report, http://www.adsm.com/docs/Final%20Report_version%202_short.pdf

[2] Department of Natural Resources, State of Georgia, Water Conservation Program: Water Conservation Plan Guidelines, http://www.georgiaplanning.com/environ/waterconservation/FinalPlan.htm

[3] AWWA Research Foundation, Commercial and Institutional End Uses of Water, http://www.awwarf.org/research/topicsandprojects/execSum/241b.aspx

[4] Amy Vickers, Handbook of Water Use and Conservation, Waterplow Press, 2001