Chapter 10

The Hospitality Sector

10.1 Introduction

Tourism plays a very important role in the world economy. The World Tourism Organisation estimates that there were more than 633 million international travellers in 1999 [1]. World international arrivals are expected to grow at a rate of 4.1% a year through the first two decades of the new millennium [1]. Asian tourism industry has the highest growth rates. The hospitality sector is one of the largest employers. For example according to the 2007 survey conducted by the National Restaurant Association there are over 12.8 million people employed in over 935 000 locations generating sales of US$ 537 billion.

This rapid growth in tourism will have a significant detrimental impact on the environment. In the United States alone, US$185 billion is spent on travel and of this US$37 billion is spent on accommodation [2]. More and more hotels will need to be built to cater for the increased tourist arrivals. On the other hand, operationally hotels are also large users of water per square area. Therefore, through water conservation, hoteliers can save money and the environment.

Some hotel resorts are located in remote areas where town water supply is non-existent and hotels depend on alternate supply sources such as bore water and tankers from nearby sources. Especially for these establishments security of supply is a critical issue and the financial benefits of water conservation are most compelling. In some of these locations such as in the Caribbean the cost of water can be as high as US$3.50/m^3 (US$13/1000 US gal.) and if the water is delivered by tankers the cost of water can be as high as US$20/m^3 (US$75/1000 US gal.).

Water conservation also provides other benefits, such as reduced infrastructure costs to store water, pumps, and reduced volumes of wastewater that need to be treated and discharged to the sewer or to the environment. In particular, remote locations can incur significant costs.

Some large hotel chains such as the Inter-Continental Hotel Group, Starwood, Hilton and Marriott participate in the UK-based International Hotel

Environmental Initiative (IHEI) to foster sustainable tourism practices within the tourism industry. Organisations such as the Green Hotels Association, the Coalition for Environmentally Responsible Economies (CERES) and the Green Hotels Initiative are spreading the benefits of *green hotels*. Hotel certification programmes such as Green Globe 21 provide hoteliers with marketable certifications. Not withstanding, water consumption per room still remains high in many hotels.

This chapter discusses water conservation opportunities in the hospitality sector which includes hotels, stand-alone restaurants and other food-preparation establishments.

10.2 Benchmarking Water and Energy Consumption

10.2.1 Benchmarking Water Consumption

Hotel water consumption can be benchmarked based on

- m^3/bed space/yr (Thames Water, UK)
- Water consumption per guest night (International Hotel Environment Initiative (IHEI))
- Water consumption per hotel per day (Sydney Water).

To gauge the factors that contributed to water consumption in hotels, UK water utility Thames Water carried out a survey in 1999 of 597 hotels located within its area of operations [3, 4]. The survey included information on the age of the building, catering facilities, the presence of swimming pools, leisure clubs, large gardens and air-conditioning systems. The study concluded that the main elements which affect water use in hotels are

- occupancy
- age of buildings
- hotel category (star rating)
- how efficiently water is used.

Occupancy has the largest bearing on hotel water consumption. A hotel category determines the type of facilities available, such as swimming pools and number of restaurants. Using the first two categories, Thames Water established benchmark figures based on water usage in *m^3/bed space/yr*. The study also concluded that ***three quarters of hotels*** used more water than the benchmark and about ***half of all the hotels in the area*** could save at least a quarter of their water bills by implementing some water-saving measures. Hotels with a very high consumption might save 50% or more. These results are shown in Figure 10.1.

The Thames Water benchmarks given in Table 10.1 provide a guide to water usage.

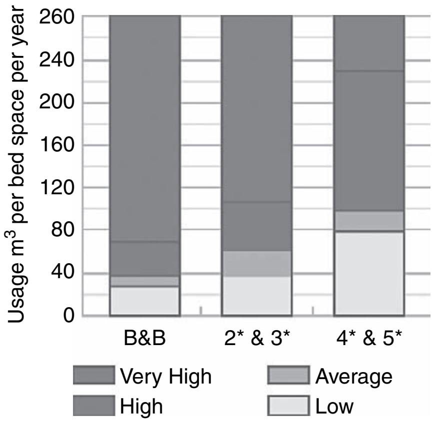


Figure 10.1 Water-use benchmarks for hotels

Courtesy of Thames Water, UK.

Table 10.1 Hotel water-usage benchmarks for water efficiency

Hotel category	Water usage per bed space per annum
Bed and breakfast	30 m^3
2 and 3 star	40 m^3
4 and 5 star	80 m^3

Courtesy of Thames Water, UK.

The IHEI benchmarks are based on *litres per guest night*. The water usage is categorised under hotels less than 50 rooms, 50–150 rooms and greater than 150 rooms [5].

According to the US EPA the average hotel in the United States uses 791 L/room/day (209 US gal./room/ day). Studies done by the Seattle Public Utilities Board established that the median water usage in Seattle hotels is 545–719 L/room/day (144–190 US gal./day/room). Larger and more luxury hotels use 946 L/room/day (250 US gal./day/room) [6].

Sydney Water carried out 24 water audits in hotels in the Central Business District and developed benchmarks published in *Water Conservation Best Practice Guidelines for Hotels* [7]. The chart shown in Figure 10.2 gives best practice water usage for three different types of hotels based on occupancy and takes into account the presence of cooling towers and laundries (top line). Figure 10.3 shows the water-usage breakdown in each type of hotel.

10.2.2 Benchmarking Energy Consumption

The Australian Department of Industry Tourism and Resources carried out a survey of 50 hotels to gauge their energy consumption and develop

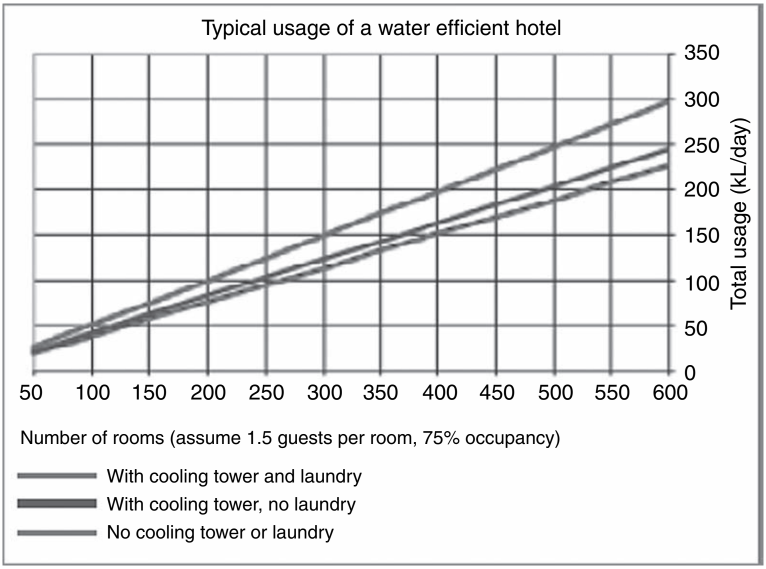


Figure 10.2 Charts to benchmark water usage

Courtesy of Sydney Water – Water Conservation Best Practice Guidelines for Hotels.

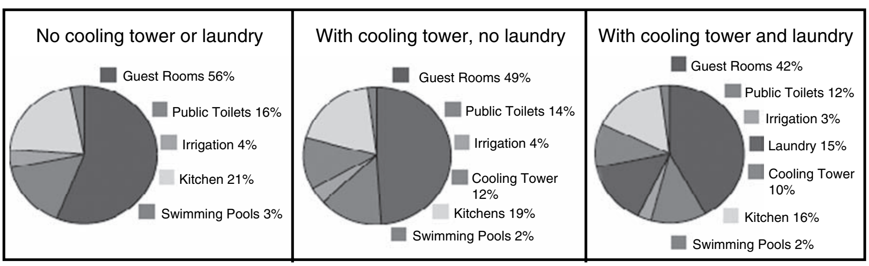


Figure 10.3 Typical water distribution in hotels [5]

Courtesy of Sydney Water – Water Conservation Best Practice Guidelines for Hotels.

benchmark indicators of best practice performance within the survey hotels [8]. The proposed benchmarks are as follows:

	MJ/Room (MM Btu/room)	MJ/m^2 (Btu/ft^2)
Accommodation hotels	35 000 (33 MM Btu/room)	750 $MJ/m^2/yr$ (66 $MBtu/ft^2/yr$)
Business hotels	95 000 MJ/room (90 MM Btu/room)	1050 $MJ/m^2/yr$ (92.4 $MBtu/ft^2/yr$).

The survey found that the average energy consumption was 1313 $MJ/m^2/yr$ (115 $MBtu/ft^2/yr$) which is similar to the energy consumption for US hotels at 1250 $MJ/m^2/yr$ (110 $MBtu/ft^2/yr$) [8]. The report confirms that especially for business hotels, energy consumption is a function of floor area and is relatively independent of the location or climate zone in which it operates. For accommodation hotels the number of rooms was more important than floor area.

The report not surprisingly also identifies a linear relationship between water consumption and energy consumption.

The UK Energy Efficiency Best Practice Programme presents the findings of a survey of more than 300 hotels and recommendations for best practice energy efficiency in the report *Energy Efficiency in Hotels – A Guide to Owners and Managers* [9].

For luxury hotels (number of rooms 100–500 with average floor area per bedroom between 70–90 m^2) total energy consumption of less than 1404 $MJ/m^2/yr$ was considered to be good. For business hotels (3–4 star, with 50–150 rooms with an average floor area of 40–60 m^2) good practice required that energy consumption be less than 1224 $MJ/m^2/yr$. For smaller hotels (2 star, 20–100 bedrooms with floor area of 60–70 m^2) good practice required energy consumption to be less than 1152 $MJ/m^2/yr$.

10.3 Steps to Achieve Water Savings

Gaining senior management commitment and support to develop water conservation policy is a prerequisite to achieve sustainable outcomes.

Both technical opportunities and behavioural approaches that are designed to improve cultural practices within the hotel should be given equal consideration. These aspects are discussed below.

The key steps are

1. Developing a water management policy
2. Gathering consumption and billing data and metering water consumption
3. Identifying the Best Opportunities
4. Staff training
5. Communicating to guests and staff
6. Communicating to the public.

10.3.1 Water Management Policy

Chapter 3 shows how a water conservation policy for the hotel can be undertaken. The policy needs to include commitment, responsibilities, guests, staff and procurement practices.

Hotels chains participating in the IHEI initiative would have a written environmental policy but it is not clear whether these hotels have a written *water management policy* and if so is communicated to the managers of individual hotels.

10.3.2 Gathering Consumption and Billing Data and Metering Water Consumption

What cannot be measured cannot be controlled. Therefore follow the guidelines in Chapter 3 to gather the required consumption and billing data and meter water usage. Ideally install sub-meters and preferably dataloggers so that each high water using area can be individually monitored.

10.3.3 Identifying the Best Opportunities

While there are many opportunities to save water it is important to start with the most cost-effective measures. This is discussed in Chapters 3 and 4. First, determine the water distribution profile for your hotel. In a series of audits undertaken by Sydney Water, it was demonstrated that there could be at least be a 30% reduction in water usage.

As Figure 10.3 shows guest rooms account for nearly half the water usage in all three types of hotels.

Consequently, the best opportunities for improving water use efficiency, in order of priority, are shown below:

(i) Guest rooms
(ii) Public amenities
(iii) Kitchens
(iv) Cooling tower
(v) Laundry
(vi) Swimming pools
(vii) Outdoor areas.

10.3.3.1 Guest Rooms

In a water-efficient guest room the water distribution profile [7] will look as follows.

Showers	56%
Toilet	25%
Basin	9%
Cleaning	10%

Showers. Replacing the shower with a water-efficient shower will have the greatest impact. A conventional showerhead is rated to use 11–27 L/minute (3–7 US gpm) at normal water pressure of about 550 kPa (80 psi). A 5-minute shower with a conventional showerhead typically consumes 60–130 L (15–35 US gal.) of water.

Table 10.2 Typical Savings available per room

Area	Best Practice	Conventional	Savings per room per year	$ savings per year	Supply and installation cost	Payback period
Showers	9 L/min (2.4 US gpm)	22 L/min (6 US gpm)	36 m^3 (9511 US gal.)	A$117	A$30 per showerhead. Installation cost – A$30	6 months
Toilet	6/3 dual flush (1.6/0.8 US gpf)	11 L per flush (2.9 US gpf)	17 m^3 (4500 US gal.)	A$40.80	A$400–600 for new dual flush toilet	>10 years
Basin	6 L/min (1.6 US gpm)	12 L/min (3.2 US gpm)	5.3 m^3 (1400 US gal.)	A$12.70	Aerator A$5 Labour A$10 = A$15	Approximately One year

Water-efficient showerheads are available rated at 9–12 L/minute (2.4–3.2 US gpm) at normal pressures. In Australia under the WELS scheme only water-efficient showerheads are available from July 2006. Refer to Chapter 3 for more details on the WELS scheme and Table 10.2 for a calculation of water savings.

Some hotels are not keen to replace the showerheads under the misconception that there might be guest complaints or that it will damage their brand name. If the message is clearly communicated, guests will not complain and in many cases they are happy to stay in environmentally friendly hotels.

Sometimes the concern is that the showerhead quality must match with the hotel's image. In this case, flow restrictors can be installed without impacting on the aesthetics of the showerhead. A 300-room hotel on the Gold Coast in Australia installed 'Gem-flo' restrictors and was able to reduce the water usage from 18 L/minute to 12 L/minute (4.75–3.2 US gpm) without impacting on guest comfort. It costs the hotel $30 000 to retrofit but recouped this investment in 10 months. However in areas of inadequate water pressure, in-flow restrictors may not perform well. A better solution is well engineered showerheads.

Toilets. Poorly maintained toilets can leak a lot of water. Toilets with leaking flapper valves, overflowing tanks and defective flushing mechanisms are the frequent cause of leaking toilets. More importantly leakage from toilets can go undetected.

Older style cisterns use 12–14 L/flush (3.2–3.75 US gpf). If this is the case, these need to be retrofitted with more water-efficient models.

In 1984 the Australian manufacturer Caroma Industries pioneered the development of the *dual flush* toilet technology first by reducing the flush volumes to 9 L and then in 1993 launched the current industry standard

6/3 L/flush (0.8/1.6 US gpf) which saves water by offering a separate low flow setting for liquid wastes at 3 L/flush. The average flush volume is 3.8 L (1 US gpf). According to the manufacturer the potential water reduction from the traditional 11 L/flush to a 6/3 type is 67%. They have now followed up these developments with a 4.5/3 L/flush model (1.2/0.8 US gpf) which has the potential to reduce average flush volumes even further.

In the United States since the passing of the 1992 Energy Act for new toilets the minimum performance standard is 6 L/flush (1.6 US gpf) and are known as Ultra Low Flush (ULFT) toilets. However, the current industry push is to move to High Efficiency toilets (HET). To be sold as a HET, the toilet flush volume needs to be a maximum of 4.8 L (1.28 US gpf). Manufacturers and water utilities are also promoting a single full flush pressure–assisted toilets which has a flush volume of 3.8 L (1 US gpf). One reason for the preference for the single flush toilet over the dual flush model seems to be perceived user behaviour (which button to press). However, the pressure-assisted models are known to be noisier than the dual-flush variant.

In any event when retrofitting toilets using less than the standard, buyers need to satisfy themselves that the flow velocities with these ultra-efficient models are adequate to transport the wastes to the public sewer especially in instances with long drain lines and no additional fixtures nearby [10].

Items which will need to be maintained are the cistern rubber seals which need replacement every 2 years and a periodic inspection to replace valves and ballcocks in toilets. In flush-valve toilets inspect the diaphragms for correct operation.

Taps. Installing aerators or flow restrictors is a low cost but highly effective option. Aerators introduce air into the water stream to produce a larger and whiter stream. When installing flow restrictors be mindful that the hot water and cold water hydraulics are balanced. A disadvantage of flow restrictors are that since they have a fixed orifice, they produce higher flows at higher pressure (excess flow) and lower flows at lower pressure. One design that overcomes this limitation is the *pressure-compensating aerator* such as the Neoperl aerator featured in Figure 10.4. Pressure-compensating flow regulators maintain a constant flow regardless of variations in line pressure due to the specially engineered O-ring within the flow regulator that compresses or expands depending on the pressure. When the pressure increases the O-ring compresses against the seating area and relaxes when the pressure reduces as shown.

Leakage from taps can waste significant amounts of water. The following example shows the annual loss in a hotel with 150 rooms.

Leakage per minute (2 drips)	18 ml
Annual water loss	9.5 m^3 (2 500 US gal.)
Percentage of rooms with leaking taps	25%
Total annual water loss from rooms	356 m^3 (94 000 US gal.)
Cost (from Table 10.2)	A$850.00

Figure 10.4 Pressure-compensating aerators

Courtesy of Neoperl GMBH.

Assumptions

Water and wastewater charges	A$2.40/m^3
Occupancy	75%
Shower frequency	2/day
Duration of shower	5 minute/shower
Hot water costs included	
Labour rates	A$60/hr

10.3.3.2 Public Amenities

Public wash basins, toilets and urinals can account for 15–40% of water usage in a hotel. Options to increase water-use efficiency are detailed below.

Taps. Install self-closing taps. The spring-loaded knob automatically shuts off the water when the user releases the knob. Ultrasonic-sensor taps allow water to flow for 10–15 seconds after operation. These are activated when the user's hands are placed beneath the tap; they shut off the water flow when the user's hands are removed from underneath the tap. Figure 10.5 shows a photo of an infrared tap. There is a debate whether these are superior to manually operated taps.

Urinals. Of all the urinal types, the cyclic flushing units are the greatest water guzzlers. Single stall, manual flush cisterns are the most efficient. However, there is the risk of germs spreading from touching flush handles. If sensor-operated on-demand controls are preferred, then individual sensor flush units are a better option than a common sensor for a battery of urinals.

The Australian standard as defined by AS/NZS 6400:2005 is 1.0–2.5 L/stall (L/600 mm width of continuous wall). The US regulations for new urinals

Figure 10.5 Photo of an infrared tap

Courtesy of Zip Industries Pty Ltd.

require that the maximum water flow rate to be no more than 1 US gpf (3.785 L). The UK regulations are 7.5 L/hr.

Zip industries have recently launched the Zip Pearl Solo controller designed to service a single urinal. The system is easy to install. It is powered by a 6 volt lithium battery pack with a typical life of 3 years. An optional 240 volt mains power pack is available if required.

Operation is simple. Once a user has been standing within the range of the sensor for 5 seconds a passive infrared detector activates the flushing cycle. The fill-time for the cistern can be customized and the fast fill design helps eliminate scale problems associated with slow or drip-fed systems. An automatic janitorial flush every 12 hrs is also programmed into the unit.

A LED detector flashes to indicate that battery voltage is low or that the battery must be changed. In the event of battery power loss, the system automatically closes the latching valve to prevent water wastage. This feature is important, since with many sensor-operated systems one of the major causes of water leakage is sensor malfunction as a result of dead batteries. Figure 10.6 shows a photo of a Zip Pearl Solo sensor.

Caroma Industries, the developer of the 6/3 dual flush toilet, has recently launched Cube 0.8 L Smartflush®. It is ideal for institutions concerned about water conservation and yet achieve acceptable performance. The urinal has received the maximum Australian WELS 6 star rating. It uses only 0.8 L/flush without sacrificing performance. This is achieved by the urinal sensing the user and determines the flush mode accordingly. As a result it eliminates

Figure 10.6 Zip Pearl Solo sensor

Courtesy of Zip Industries Pty Ltd.

unnecessary flushing. During peak periods it changes the mode to match the usage.

The water savings compared to existing stalls are as follows:

- water savings of 60% compared to standard 2 L single stall urinals
- water savings of 80% compared to a 2 stall urinal using more than 4 L/flush
- water savings of almost 90% compared to urinals using 7.5 L/flush.

These savings are seen from the chart in Figure 10.7.

Waterless urinals. Waterless urinals have known to be in existence in Europe since 1885. Despite this only during the 1990s waterless urinals have come to the attention of water-conservation enthusiasts and cost-conscious users. To cite the water-saving potential of these units assume that a conventional unit flushes at the rate of 7.5 L/bowl/hr (UK regulations) then the water loss is 65 m^3/yr (17 350 US gal./yr). The annual cost of water and wastewater discharge at \$ 2.40/m^3 equates to \$157.

The benefits of waterless urinals are

- reduces water usage significantly.
- in cold climates require no freeze protection.
- eliminates overflows from urinal bowls when blocked.
- reduces costs from usage and water leaks.
- reduces the need to upgrade booster pumps in high rise buildings.
- essentially maintenance free apart from the regular cleaning.

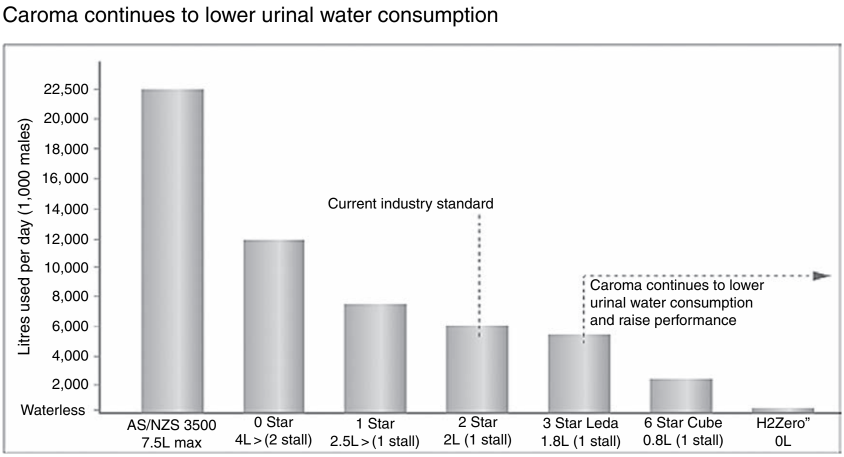


Figure 10.7 Water saving with Cube 0.8L Smartflush®.

Courtesy of Caroma Industries Ltd.

- eliminates pipe blockage in hard water areas due to calcium reacting with urine scale.
- no flush controllers to maintain and batteries to replace in sensor units.
- reduced wastewater treatment plant loads.
- enhances the green image of the organization.

There are a number of waterless urinal technologies in the market. Some include

i) vegetable- or alcohol-based odour barrier in a *disposable cartridge* or *fixed trap*
ii) microbial blocks – bacteria or enzyme seeded
iii) mechanical working traps.

Waterless urinals make use of the fact that urine is a liquid and therefore no additional water is required to flush it down the drain.

The most common is the cartridge type. These units are made of acrylic, fiberglass or ceramic. The cartridge is inserted in the urinal and connected to the drain pipe. When urine flows into the cartridge, it passes through a liquid sealant that is less dense than the urine but is more viscous. Therefore the sealant floats above the urine forming an odour barrier between the urine and the air, preventing the odours from escaping into the air. The urine then flows into a central chamber and into the sewage line. Sealants are vegetable oils or alcohols, both types have a density less than water. This type of waterless urinal is marketed by suppliers such as Uridan and Ernst. A typical bank of waterless urinal units and a waterless trap is shown in Figures 10.8 and 10.9. A problem with these units is that if excess water is poured it runs

Figure 10.8 A bank of Uridan (fixed cartridge type) waterless urinals

Courtesy of Watersave Australia Pty Ltd.

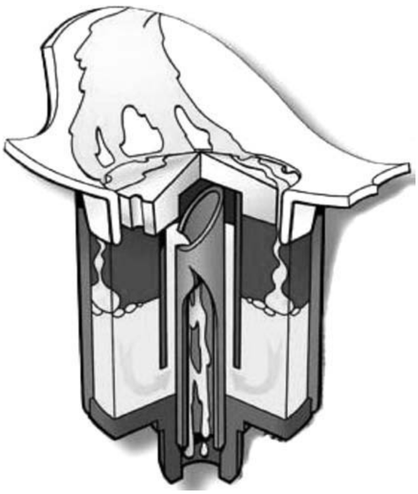


Figure 10.9 Waterless trap

Courtesy of Watersave Pty Ltd.

the risk of losing the oil sealant. This has the potential to cause odours since the sewer gases are no longer prevented from contaminating the building environment.

Disposable cartridges type – Manufacturers recommend that the disposable cartridges be replaced after approximately 6000–7000 uses. In practice these are replaced more often (as low as 2000 uses) which impacts on costs. Used cartridges are a health and safety hazard and therefore they need to be disposed correctly.

In the fixed trap system, only the liquid sealant needs to be topped up after approximately 5000–7000 uses by pouring a measured amount of liquid to the cartridge.

The cartridge has the added benefit of also preventing foreign objects such as cigarette butts being put down the drain.

Caroma Industries have released a new type of trap called the H2Zero™ Cube. It operates utilising unique patented cartridge technology that does not use an oil-based seal as used in traditional waterless urinals. Housed within the cartridge the Bio Fresh deodorising block is activated during use, while the Bio Seal™ allows urine to pass through the seal freely. The Bio Seal™ acts as a one-way air-tight valve to seal the cartridge from the drainage system and against back-pressure situations. The manufacturer claims that this operation guarantees consistently superior performance and hygiene compared to other waterless urinals. Figure 10.10 shows this unit.

Bacterial blocks. The bacterial blocks are made from naturally occurring bacteria in a urine-soluble block. These blocks are placed in conventional urinals (the water supply is shut off) and upon contact with urine dissolves releasing the bacteria. The manufacturers claim that the bacteria decompose the urine to a non-odorous non-scaling form. It also releases a citrus smell. Maintenance is confined to spraying the urinal with a bacterial booster to increase the breakdown rate of bacteria as well as pouring a little water down the urinal on a daily basis to minimise uric acid formation. Their biggest advantage over the cartridge type is that they do not require retrofitting of the existing urinal.

Figure 10.10 H2Zero™ Cube

Courtesy of Caroma Industries Ltd.

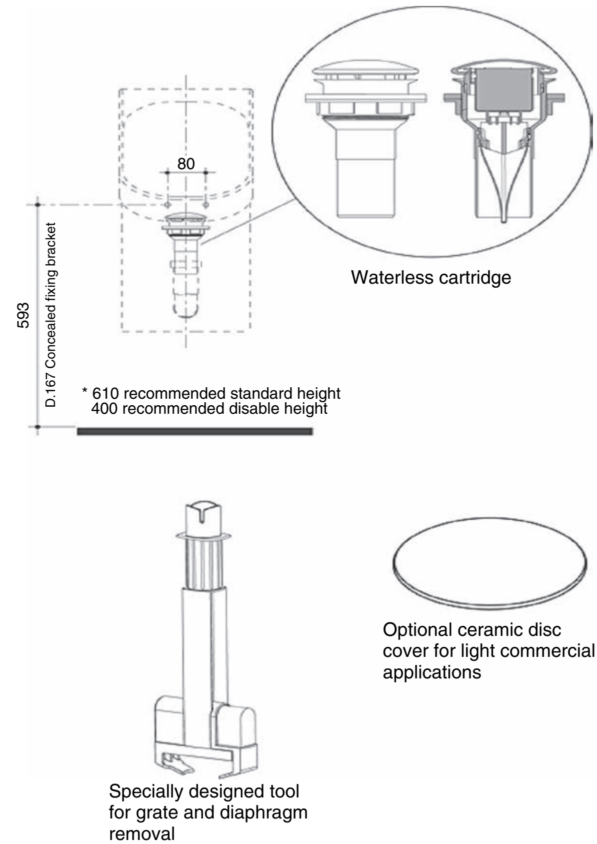


Figure 10.10 (Continued)

Ongoing costs are for the purchase of bacterial blocks (which can last up to 2 weeks) and bacterial booster. In some cases the costs have been greater than the water savings.

Mechanical working traps – trap with duck bill. Suppliers such as Sphinx offer a waterless urinal known as duck bill where a hose made from special waterproof material serves as a trap. Its opening is round at the top and pressed together. It lets the urine through and immediately closes shut afterwards. This type of trap come without the floating sealing liquid nor need power to activate the device. Since there are no moving parts it minimises the potential for maloperation or trap failure.

User acceptance. The acceptance of these technologies has been mixed. Early concerns of urine smell are no longer an issue with these units if regular cleaning in accordance with the manufacturers' recommendations is carried out, that is by spraying the bowl with a disinfectant daily and wiping it down with a soft cloth. In hard-water areas, to prevent scale build up it is suggested cleaning with two liters of warm water mixed with detergent every week. There is some concern that without a permanent water seal in the urinal sewer gases could potentially pose threats to public health from toxic gases including hydrogen sulphide, methane and airborne pathogens. Consequently the International Association of Plumbing and Mechanical Officials (APMO) Standards Council have held off approving Waterless Urinals.

Researchers have also cast doubts on whether 2 L per week in the absence of any other fixtures being connected to the sewer line is sufficient to prevent struvite formation in them.

The following factors need to be considered for successful installation of waterless urinals:

- Ensure correct drain pipe material and slope – Drain lines must slope at least 2 cm/m (1/4 in./ft). The drain lines require adequate venting for trouble-free operation. For these reasons, older urinals built for water flushing may not be always suitable for retrofitting with waterless urinals.
- Ensure that other water fixtures are present to minimise sedimentation – Professor Mete Demiriz of Gelenkirchen University, Germany investigated a number of liquid seal and cartridge-type urinals over a 2-year period and concluded that there is sedimentation in the drain lines which cannot be removed by simply adding high water volumes through the urinal [11].
- Replace copper piping – If the drain lines are of copper these need to be replaced with non-metallic sanitary plumbing to prevent the breakdown products of urine (ammonia) corroding copper piping in accordance with plumbing standards such as the Australian AS/NZS 3500.
- Eliminate drain pipe obstructions – If retrofitting to existing systems, best to clean the sewage line with a power cutter before installation.
- Maintain a urinal maintenance log – Maintain a log book to record dates of cartridge purchases and their replacement.

Costs and savings. Initial installation and annual operating costs can vary by vendor. The cost savings achievable from these units are dependent on

- The type of waterless urinal installed. For example, the microbial blocks have minimal installation costs but the ongoing costs can be more than for the fixed cartridge type. Whereas, with the cartridge type, retrofitting will incur additional costs.
- The flush volume of the urinals that are replaced.
- The number of users per day.
- The pricing structure for water and sewer usage.
- The maintenance costs (dependent on the cost of cleaning and cartridge seal replacement).

In general, it is accepted that the cartridge type will provide a payback within 3 years when retrofitted into an existing urinal.

10.3.3.3 Kitchens

In many instances, the water-saving potential in kitchens are ignored. Kitchens account for 7–20% of water usage in a hotel. Savings in water usage also realises energy savings.

Within the hospitality sector, restaurants have the highest energy intensity. US data suggests that restaurants on average use 2.84 GJ/m^2 (250 MBtu/ft^2), roughly 2.5 times more energy per square area than commercial buildings [12]. Food preparation, refrigeration and sanitation represent nearly 60% of the energy consumed in a typical food service facility. The total energy savings potential in a commercial kitchen can vary from 10 to 30%, depending upon the technologies installed.

Benchmarking water usage using industry standards is a first step towards understanding water-saving potential in a commercial kitchen.

The industry standard is *liters per food cover*. A '*food cover*' is defined as any transaction or sale, whether a cup of coffee or a multiple course meal. Sydney Water recommended L/food cover for hotel situations are [7] given in Table 10.3.

These figures will need to be multiplied by a factor to account for the different types of restaurants such as Chinese and stand-alone A-la carte restaurants. Inefficient uses of water in kitchen operations arise mainly from two areas: equipment **design and behavioral patterns**. The water-saving opportunities in kitchens are

- sinks
- dishwashers
- Asian wok cookers
- ice makers
- garbage disposal units
- leakage.

Sinks. Below are some easy and practical ideas to save water and energy to maximise your profits.

- Turn off taps when not in use.
- Minimise leakage by replacing worn washers.

Table 10.3 Water efficiency per food cover

Rating	Water Usage (L/food cover)
Good	<35
Fair	35–45
Poor	>45

- Water usage in sinks and basins can be halved by installing aerators or flow control regulators. A tap using 25 Lpm (6.6 US gpm) as against a tap rated at half the amount can waste 40 m^3/yr (10.5 thousand US gal./yr).
- Install infrared motion-activated sensors or pedal-operated taps.
- Do not thaw frozen foods or wash rice under running water. If thawing is done under running water, assuming a minimum of 1 hr/day at a flow rate of 18 Lpm up to 591 m^3 (156 000 US gal.) per year could be wasted. At $2.40/$m^3$ this could amount to $1419/yr. Use a stand-alone thawing unit or the bottom shelf of refrigerator.
- When washing pots fill sinks for washing pots instead of running water.
- Educate your staff on saving water and energy.

Low-flow pre-rinse spray valves. Pre-rinse spray valves (PRSV) are used to pre-rinse dishes and pans before loading to a dishwasher. In western style commercial kitchens these units can account for a significant amount of water usage. PRSVs consist of a spray nozzle, a squeeze lever that controls the water flow, and a dish guard bumper. Models may include a spray handle clip, allowing the user to lock the lever in the full spray position for continual use. In conventional PRSVs, water flows at low velocity in a circular pattern from multiple holes similar to conventional showerheads. These can use 10–20 Lpm (2.64–5.2 US gpm) of water with an average flow rate of 13.7 Lpm (3.6 US gpm) [13].

In North America [13–16] due to the efforts of Food Service Technology Center (FSTC), and the California Urban Water Conservation Council, low flow pre-rinse spray valves have become a viable water conservation measure in commercial kitchens. Unlike the conventional PRSVs, low-flow PRSVs produce a fan like spray using just 6–8.3 Lpm (1.6-2.6 US gpm) with an average flow of 5.6 Lpm (1.4 US gpm)[13]. Figure 10.11 shows photos the difference in flows between the water efficient model from those of the conventional models.

A '*cleanability test*' has been developed to qualify as a low flow model. The American Society of Testing and Materials *ASTM F2324–03* requires that the spray valves be able to clean plates in 21–30 seconds per plate at a pressure of 406 kPa (60 psi). In Australia, low flow PRSVs have been added to the mandatory WELS scheme. In addition to saving water, these units also reduce gas or electricity. The quantum of water savings correlates with hours of usage. Very small establishments could use for less than an hour to large users using greater that 4 hours per day. As Table 10.4 shows the water and energy savings achievable when the units are used for 2 hours per day is A$5020 with a payback of 15 days.

It is worth remembering that high water pressures in excess of 551 kPa (80 psi) could potentially cause splashing and low water pressures less than 276 kPa (40 psi) will result in poor cleanability and dissatisfaction with the unit. Therefore check the line pressure before installing a low flow variant.

Figure 10.11 A photo of a low flow pre-rinse spray value in action

Courtesy of Niagara Conservation Inc.

Table 10.4 Water and Energy Savings from low flow pre-rinse spray valves

Performance	Base model	Best available
Nominal flow rate at a pressure of 406 kPa (60 psi)	13.7 Lpm (3.6 US gpm)	6 Lpm (1.6 US gpm)
Annual water use (usage is 2 hrs per day for 313 days of the year).	514 m^3 (135,950 US gal.)	227 m^3 (60,096 US gal.)
Annual water and sewer costs at \$2.40/m^3	A\$2,364	A\$1,282
Annual energy use.	94 GJ	42 GJ
Increase in water temperature 31° C.		
Heater efficiency at 70%		
Annual gas cost at A6/GJ	A\$564	A\$249
Water and energy costs based on a 5-year life of equipment.	A\$8,996	A\$3,977
Water and Energy cost savings over the 5 years.	–	A\$5,020
Installed cost	A\$214	A\$214

Asian wok stoves. Asian wok stoves are typically the heart of any Chinese restaurant's kitchen. Studies conducted by Sydney Water's Every Drop Counts Business Program have shown that these stoves waste as much as 5000 L/day (1,321 US gal./day) [17]. By installing a *waterless wok stove* the initial capital can by recouped in 1 year. This is explained below.

Conventional wok stoves use water for two main purposes:

1. As cooling water to cool the cook top of wok stoves to prevent the metal from overheating and warping. Therefore water flows at three to four liters per minute, which adds up to 2500–3500 L/day going to drain.

2. Rinsing of the wok between dish preparations requires another 2000–3000 L per day. These swivel taps are not shut off when not in use.

Recognising these two problems, Sydney Water pioneered the development of a *waterless wok* stove that is air cooled with special swivel tap that shuts off when pushed to a side. The resultant cost benefits are

- Water savings of 5000 L/day/stove. Annual water savings of 1800 m^3/yr.
- Monetary savings of $4500/yr based on water and sewer usage costs of $2.40/$m^3$ and 360 days of operation per year.
- Kitchen grease traps are also not overloaded since less water goes to the drain. However, since the grease traps are working more efficiently the grease trap will need to be emptied more frequently.

Top photo of Figure 10.12 shows the constant water flow required to cool a conventional wok and the spout also wasting water. The schematic shows the air flow pattern in these units. Figure 10.13 shows the absence of water on the hot metal plate in a waterless wok, the spout doesn't waste water and the schematic shows how the air flow keeps the units cool. The graph in Figure 10.14 shows the reduction in costs per food cover for the two types of woks.

Dish washers. Commercial kitchens have multiple dishwashers. These dishwashers can be operating from 1 hr to 16 hrs a day. In such instances, they can waste a lot of water if not maintained correctly.

Essentially there are four types of dish-washing machines in commercial kitchens. These are classified as "undercounter, door, conveyor and flight". Irrespective of the type they all have wash, rinse and sanitising cycles. The water usage and capacities of these four types are given in Table 10.5

The following are the water- and energy-saving techniques for dishwashers.

- Train staff employees on the importance of operating the dishwasher at full load.
- Ensure that water jets are not missing. The water jets need to be replaced periodically. The water flow quadruples with a doubling of the diameter of the nozzle.
- Use low-flow pre-rinse sprays to remove food scraps before loading a dishwasher.
- Use a water-efficient machine if possible.
- Recycle final rinse water if equipped to do so.
- Stick to the manufacturer's recommended flow rates.
- Install electric *eye sensors* to run the machine only when dishes are present. The sensor feature helps maintain the temperature in the tanks and extends machine life by reducing the pump operating time.

Conventional Wok Stove

Water-cooled wok stove

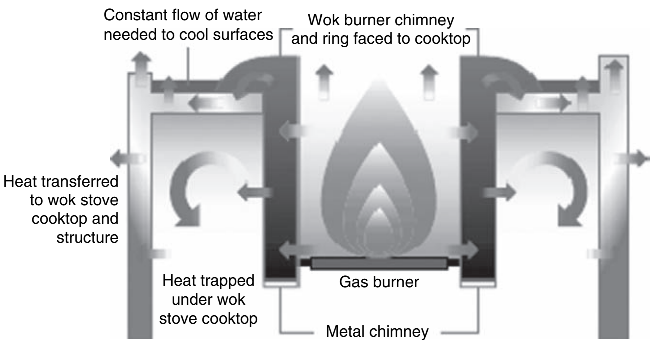


Figure 10.12 Conventional wok stove and air-flow pattern

Courtesy of Sydney Water.

- Reuse the rinse water from the dishwasher as flush water in garbage disposal units.
- Use water from the steam table, instead of fresh water, to wash down the cook's area.
- Investigate if the local water or energy utility gives rebates for replacing older (water and energy) inefficient models.

Here are some points to remember about chemical sanitisers. Using low temperature or chemical sanitizer machines is one way to save on hot water costs and reduce some ventilation requirements. Chemical sanitising machines use a sanitising chemical in the final rinse rather than hot water to do the job. While chemical sanitisers reduce energy costs, this needs to be weighed up with increased chemical costs and 'cleanability'. High-temperature machines are better able to break down animal fats and grease as well as lipstick on glassware and dishes. If the active ingredient in the

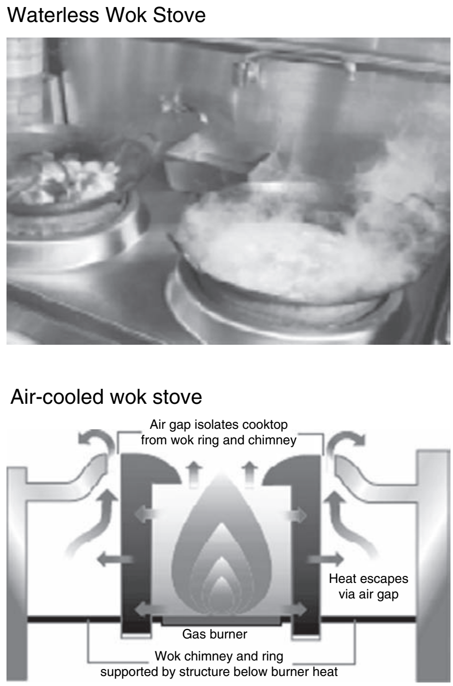


Figure 10.13 *Waterless wok* stove and air-flow pattern

Courtesy of Sydney Water.

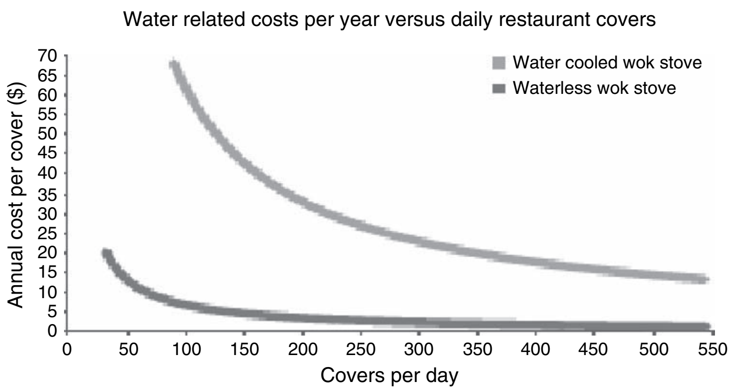


Figure 10.14 Water-related costs per year of a traditional and waterless wok stove

Courtesy of Sydney Water.

sanitiser is bleach (sodium hypochlorite), this may attack certain materials, including silver, aluminium and pewter.

To adapt an old cliché, *take care of your dishwasher and it will take care of you*.

Table 10.5 Dishwasher types and water usage

Type	Description	Typical Fresh Water Usage per rack
Undercounter	40–50 settings per hour. Suitable for bars and snack bars etc. Highest water user.	2.5–10 L (1.1–2.6 US gallons)
Door	90–110 settings per hour. Most widely available. Seen in small-to medium-size restaurants. Some models are equipped with recycling of rinse water.	3.5–9.5 L (0.9–2.5 US gallons)
C – Line Conveyor Rack	>200 settings per hour. Most widely used in hotels. Equipped with separate pre-wash, wash and rinse compartments. A pre-wash helps minimise detergent use by not introducing it until heavy soils are removed from the china. The next higher capacity and better performance is the addition of a rinse tank or an extended wash tank. A rinse tank gives the ability to recirculate water and therefore conserves water. All machines have a fresh water final sanitising rinse.	3.0–6.0 L (0.8–1.6 US gallons)
Flight	High volume washing capability 14 000 dishes per hour. Dishes loaded directly on to belts. Comes equipped with electric eye sensors so that machine only operates when the belts have dishes.	2.5–9.5 L (0.7–2.5 US gallons)

10.3.3.4 Cooling Tower: Air-Conditioning and Refrigeration

The hospitality sector is dependent on air-conditioning and refrigeration for guest comfort and for maintaining food at the right temperatures. They also account for 47% of energy use in a typical hotel. Generally, hotels with extensive air-conditioning use 50% more electricity than those without, and also use more for heating, given the extra ventilation needs [18]. Cooling towers are a necessary component of a large air-conditioning system and was covered at length in Chapters 5 and 6.

Here are some specific tips to reduce the air-conditioning and refrigeration loads in the hospitality sector. Reducing the air-conditioning and refrigeration loads reduces cooling water requirements when they are connected to water-cooled condensers.

- When setting up a function, make certain that the cooling and lighting are off until 1/2 hr before the start of the function.
- Keep refrigeration doors closed. Use strip curtains or plastic swing doors on walk-in refrigerators and freezers. These measures will reduce compressor run time.
- Replace worn door gaskets in refrigerators.

10.3.3.5 Laundry

Some hotels have on-site laundries. Typically they are of the washer extractor type rather than tunnel washers. Water conservation opportunities for laundries are covered in Chapter 15.

10.3.3.6 Ice-Making Machines

Ice-making machines are common in restaurants, hospitals and hotels. They are noted for their high consumption of electricity.

Ice-making machines use water in two ways: for cooling the machine and for freezing water into ice. It is estimated that a water-cooled ice machine producing 363 kg (800 lbs) of ice per day and running at 75% capacity will consume about 3400 L/day (900 US gal./day) just for cooling [19].

There are four categories of ice makers:

1. Cube – clear, regularly shaped ice of a certain weight. The vast majority fall into this category.
2. Flake – ice formed into chips or flakes that contain up to 20% liquid water.
3. Crushed – ice that consists of small, irregular pieces made by crushing larger chunks of ice. Primarily used to cool drinks.
4. Nuggets – ice made by extruding and freezing slushy flake ice into small pieces.

Ice *cube* makers use more water than *flake* ice machines because a large proportion of water used in ice cube makers is used to purify the ice by removing the minerals in water to produce clear ice cubes. Flaky ice is not required to be crystal clear and therefore the minerals that give rise to cloudiness need not be removed.

A typical ice-making machine has the following components:

- a condensing unit used for cooling
- an evaporator surface for ice formation
- an ice harvester
- an ice storage container.

The condensing unit can be air-cooled or water-cooled as described below.

There are three types of ice makers:

1. ice-making head
2. self-contained
3. remote condensing unit.

Water usage can vary from 110 to 2500 L to produce 100 kg of ice.

Types of condenser. Ice makers are available with two types of condensers as discussed below.

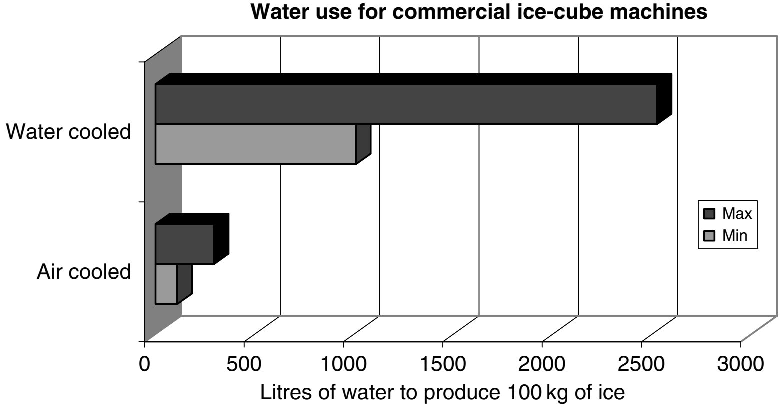
Air-cooled condensers. They are the most energy intensive of the models but use the lowest amount of water. Energy usage varies from 44 to 180 MJ to produce 100 kg (5.4–22.5 kWh/100 lb) of ice. Air-cooled condensers can be found in ice-making head, self-contained units or remote condensing units. If the air-cooled condensers are located inside the building it adds to the air-conditioning load of the building. Remote condensing units are split-system models in which the ice-making mechanism, the condensing unit and the ice storage bins are in separate sections. Remote air-cooled condensers transfer heat generated by the ice-making process outside of the building. Like water-cooled units, they reject heat outside of conditioned spaces and therefore do not increase air-conditioning loads. They also reduce noise levels inside by up to 75%, but there are extra installation costs for running lines to a remote location.

Water-cooled condenser models. They are more energy efficient than air-cooled units, using 37–113 MJ/100 kg (4.7–14.2 kWh/100 lb) of ice. There is no addition to air-conditioning loads, because the heat removed in making the ice is discharged outside the building. However, as shown in Figure 10.15, water usage is nearly 10 times that of air-cooled machines [19, 20].

Self-cleaning models use significantly more water than others. Typically, ice makers are cleaned and sanitised every 2–6 weeks, which requires emptying the bin of ice, adding cleaning solution, switching the controls to a cleaning mode that circulates the cleaning solution through the machine and then producing enough ice to be sure the machine is cleared of the solution. While self-cleaning models automate most of these steps they consume more water.

Water conservation tips for ice machines are as follows:

- Water-cooled ice makers need to be connected to a cooling tower so that the condenser cooling water does not go to the drain. Single-pass cooling needs to be avoided.
- Use the minimum flow rates for condenser cooling as per the manufacturer's guidelines.
- If cooling water cannot be connected to a cooling tower, then consider the possibility of reusing the cooling water in a non-potable application.
- Select ice-flaking machines over ice-cube machines since these require less water. The US Department of Energy's Federal Energy Management Program has produced a fact sheet *How to Buy an Energy Efficient Commercial Ice Cube Machine*. This can be downloaded from www.eren.doe.gov/femp/procurement.



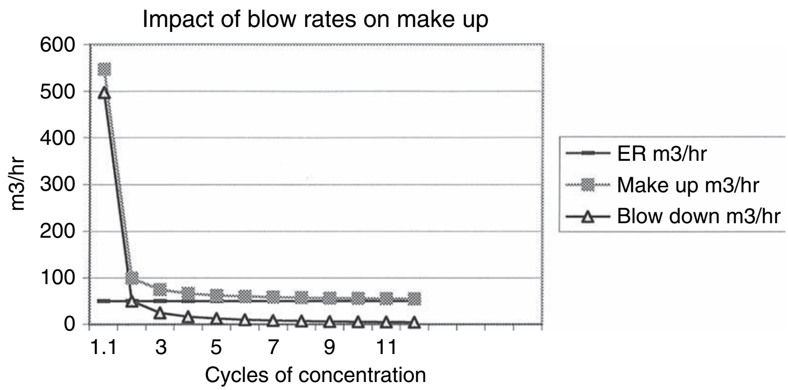


Figure 10.15 Water usage in commercial ice-making machines

Adapted from North Carolina Department of Environmental and Natural Resource *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*.

- Typical useful life of an ice-making machine is 5 years. If replacing older machines do not oversize machines, since this increases purchasing costs as well as energy and water costs and usage. Consider the possibility of air-cooled condensers over water-cooled condensers. However, be aware that air-cooled condensers produce less ice than water-cooled models as well as consume more electricity.
- For ice-cube makers use softened water. Softening the water removes the minerals that leads to cloudiness and therefore less bleed-off is required from the machine.
- Train employees to use ice only when required.

10.3.3.7 Swimming Pools

It is difficult to find a hotel, motel or club without a swimming pool of some sought, in the scheme of things these do not use large amounts of water unless there are leaks. From the vast number of water audits of hotels and clubs carried out by Sydney Water, the percentage of water in use in swimming pools is only around 3%.

Recommended actions will be covered in Chapter 12.

10.3.3.8 Staff Rooms

Retrofit shower heads, taps and basin taps with water-efficient models.

10.3.3.9 Irrigation

Many resort hotels have large gardens, golf courses that consume significant quantities of water.

There are many good publications on water efficiency for landscapes such as *Handbook of Water Use and Conservation* by Amy Vickers. The suggestions given below are not exhaustive. Water utility web sites too have information specific to the location and climate. The reader is directed to refer to these sites for more details.

However some principles are given below:

When discussing water efficient landscapes it is important to recognize the trifecta of:

- Right plants
- Right irrigation
- Right soil

An over reliance of one factor over the other two does not produce the optimum results.

Right plants

1. Plant selection to suit the climate, site layout (includes slope, degree of shading) and existence of other plants. Consider the degree of traffic.
2. Group plants with similar water needs together. Some plants need more water than others. High water demanding plants to be planted at the bottom of slopes.

   Choose plants with adaptations that make them natural water savers. Give preference to indigenous plants. In general, plants with hairy, succulent, wax-coated leaves or with fine, stiff foliage (sclerophyllus) are adapted to growing in dry environments. Water saving grass such as Nioka and Palmetto have deep roots and are therefore drought tolerant. They also don't need mowing as frequently as other lawns.

Grey-or silver-foliaged plants are also usually suited to dry conditions. Sydney Water has an online plant selector to help consumers select the right plant combinations for the location.

Right irrigation

Right irrigation can be described as the right amount of water at the right time. Efficient irrigation practices consist of:

1. Right watering practice – water when evaporation is lowest – early morning and evening. About 10 mm (sandy soils) to 30 mm (loamy soils) of water should be applied to wet the soil to a suitable depth.
2. Right equipment – for plants - drip irrigation systems that water the root zone. Low volume pop-up sprinkler heads for lawns. Use the correct pressure and select the right nozzle size and diameter of pipe.
3. Right spacing between sprinklers - In general, the spacing between sprinklers should be about 50 to 60 percent of the wetted diameter. Minimise overspray of concrete and other paved areas.
4. Right scheduling of irrigation - Automatic systems and rain and moisture sensors to increase the efficacy of the irrigation system. A rain sensor attached to a controller catches moisture and prevents the sprinkler system to water in the rain. Timers irrigate according to a preset hours. SCADA control systems can be used for large lawns such as in parks, universities etc. Soil moisture sensors overrides the system when soil moisture is adequate. These are more accurate than rain moisture sensors since they measure the moisture in the root zone. All of these sensors are useful if the system can be monitored and adjusted regularly.

Weather based evapotranspiration controllers (ET) are devices that estimate the watering needs of a particular site based on the formula given in (10.1).

Water requirement = (potential – actual) evapotranspiration.(10.1)

These range from stand alone controllers based on local site sensors to controllers with remote programming ability.

Right soil

It is important to ensure that the soil is suitable for the plants. The chemical and physical attributes such as pH, permeability and water retention capabilities are just as important as the right irrigation equipment. Mulching is a proven method to reduce the natural evaporation of water. Organic mulches add nutrients and humus to the soil as they decompose, improving it and its moisture-holding capacity and reducing the need for watering and maintenance. Mulches range from grass clippings to Lucerne and sugar cane. The last two protect against nitrogen draw off from the soil.

10.4 Staff Awareness Programmes

Staff awareness programmes play a crucial role in a holistic water conservation programme. Behavioural change programmes among employees lead to water savings at minimal cost; however, it is difficult to predict their savings potential beforehand. The Westin Hotel in Seattle, United States, had achieved 6% reduction in water savings amounting to 38 kL/day (10 000 gal./day) through behavioural measures [21]. However, when designing a behavioural change programme, the educational and social backgrounds of the employees may require innovative approaches. For example, in the Australian catering and restaurant industry, 70% of the workforce have no post-school qualifications and 48% of the workforce all work either part-time or casual [22]. If the majority of the employees are from non-English-speaking backgrounds, the information may need to be translated into suitable languages.

A summary of potential behavior measures are listed below:

- *Reduce or discontinue triple sheeting* – No cost. Leads to water, chemical and energy savings.
- *Train kitchen staff* to correctly thaw frozen food, rice rinsing, cleaning of dishes using pre-rinse spray valves, dishwasher loading and equipment cleaning. Minimal costs with immediate paybacks.
- *Train housekeeping staff – to reduce water usage during cleaning of rooms* – It is common practice for cleaning staff to flush the toilet as they walk into a guest room irrespective of the cleanliness of the toilet bowl. After cleaning, the toilet is flushed again: By flushing the toilet only after cleaning (providing the bowl is clean to start with), the Westin Seattle saved on average 11.3 kL/day (3000 US gpd) [21].
- *Provide ice water only on request* – Restaurant staff bring ice water and refill guest glasses with ice water irrespective of whether the guest requested it or not. By stopping this practice, water and energy can be saved.
- *Wash floors, loading docks and rolling carts* – Train staff to use water judiciously. Use a broom where possible.
- Display the current water and energy consumption per room or guest night charts so that they can see the fruits of their labour.
- *Reward employees for doing the right thing* – Through newsletters, bulletin boards, websites and meetings. Publicise their efforts. Give a cash bonus incentive if the department's target water usage is achieved. Send employees on appropriate training courses.

10.5 Guest Awareness Programmes

Towel-linen exchange programmes are a well-accepted guest awareness programme, where a guest staying for more than one night is encouraged to reuse the towel and bed sheets rather than being changed daily. Even with only a 25% participation The Sheraton Rancho Cordova has seen a 5% reduction in water usage [21]. These programmes are more prevalent in hotels where the majority of guests are for business. However, their wider use is hindered by a number of preconceived notions. These include

- fear that the guest will complain
- guests may perceive the hotel as being *cheap*
- previous guest complaints
- corporate policy against towel-linen programmes.
- belief that daily linen service is commensurate with room price.

Rather than being considered *cheap* guests, support such initiatives. A Holiday Inn study showed that 80% of their business and leisure travellers were more inclined to stay at a place where a towel-linen programme was in place. Increasingly travellers are adopting *value based behaviour* to rate hotels. Thus they can align personal values with business values by giving their business to those that are striving to make the planet a better place to live.

Case Study

The Fairmont hotel chain is the largest luxury hotel operator in North America. In recognition of their commitment to the environment the Fairmont Hotels & Resorts (BC Region) was awarded the *2005 Energy & Environment Award* from the Hotel Association of Canada. The press release states,

"This award is given to a lodging property that has developed a culture towards integrating environmental management practices that improve everyday operations and the bottom line, while maintaining quality service and meeting guest expectations".

Among other environmental initiatives they have a policy of informing the guest that: "To reduce the negative impact on our environment through the use of laundry detergent chemicals and energy consumption, it is our practice to change bed linen once every three days or upon request."

Adapted from: *www.waterinthecityvictoria.ca*.

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