ENVIRONMENTAL MANAGEMENT FOR HOTELS

International Tourism Partnership

THE **INDUSTRY GUIDE** TO **SUSTAINABLE** OPERATION

3 WATER

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This manual was published in 2014 when Sustainable Hospitality Alliance was known as International Tourism Partnership (ITP), part of Business in the Community (BITC).

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3 WATER

Water is one of the basic components of all life on earth and is essential in order to sustain it. However, the amount of fresh water on earth is limited and its quality is under constant threat, particularly in heavily populated and industrialised areas. Clean water is therefore one of our most precious resources.

This section examines the fundamental issues concerning our use of water. It provides guidance on how to use less water, how to keep it free from contamination during use and how to ensure responsible treatment of your wastewater.

3.1 THE ISSUES

There are several reasons why we should be more thoughtful about water and how we use it:

- Not everyone is fortunate enough to have adequate clean water, and climate change is beginning to have a profound impact on water distribution in many regions.
- Water stocks are vulnerable to various forms of contamination which can pose a threat to human and other life on earth.
- The hotel and tourism industry could not function without clean water for food preparation, cleaning and hygiene, guest comfort and recreation.

3.1.1 Availability of and access to water

Water distribution over the world is uneven, and historically it has been badly managed whether or not it is scarce. There are not infinite supplies of water to meet the demands of everyone on the planet and already one person in five has no access to safe drinking water, so it is not a resource we can take for granted.

Most water (97 per cent) is in the oceans, which cover 71 per cent of the earth's surface. Two per cent is fresh water, two-thirds of which is tied up as ice in glaciers and at the poles. This leaves approximately one per cent as fresh water on the ground, in rivers, lakes, the atmosphere, and in groundwater. However, with demand rising rapidly due to global population growth, and as water use per capita increases, that one per cent is under threat. Climate change is adding to the problem because our weather patterns have become less predictable and more pronounced. Whilst a number of areas are experiencing periods of prolonged drought, the rain that falls in some other areas is more violent. This leads to flooding and contamination of water supplies without sufficiently replenishing groundwater stocks.

In order to stimulate action to meet the impending crisis, the **UN General Assembly** proclaimed the period from 2005 to 2015 as the International Decade for Action, 'Water for Life', commencing on **World Water Day**, 22 March 2005.

Access to safe water and sanitation is one of the **Millennium Development Goals (MDGs)** which, in setting us on a course to eradicate poverty, inequality, hunger and illness, have set a target to reduce by half the proportion of people in the world without sustainable access to safe drinking water and basic sanitation. This challenge is a hard one to meet, given the rapid pace of urbanisation. It requires a major effort just to keep up the current coverage levels let alone satisfy the huge backlog of rural people who do not have even basic sanitation or access to safe drinking water.

The issues of availability and quality are closely linked, and reducing consumption is an important step in ensuring an adequate supply of good quality water.

3.1.2 Threats to water quality

Because of our extensive use of water in the rapid development of agriculture, industry, energy generation and urbanisation over the past 60 years, water has been contaminated with solid, liquid and gaseous matter of all kinds. We have created innumerable artificial substances that did not exist before in nature, and produced massive quantities of other substances – which although they occur naturally, are present in smaller amounts or as different compounds. The short-term impacts of these chemical imbalances were not immediately visible or felt, and the often complex long-term effects were not known, because no historical data or experience was available.

The contamination of water has occurred to such an extent that the 'self-cleaning' forces in nature, which have worked well over thousands of years, are no longer sufficient and both the quality and quantity of water have been seriously affected in many areas, particularly in countries such as China and Russia. We have lived in the belief that whatever went down the drain was gone forever, sufficiently diluted and taken care of by nature.

Many substances come back in multiple concentrations (known as bio-accumulation) of up to a million times through the food chain. For example, PCBs (polychlorinated biphenyls, see **SECTION 8.8**) may have a concentration of 0.0001 ppm in the ocean. They are soluble in water, but not biodegradable, and can therefore be taken-up by living organisms. The fat tissues of living species absorb PCBs and gradually build up larger concentrations, because no degradation of the compounds takes place. With the law of 'eat and be eaten' the smallest organisms end up in large fish. Each time a larger species consumes a smaller one, an increase in the PCB concentrations in the tissues of the larger will result and ultimately we might consume a fish with up to 10 ppm of PCBs. The disposal of hazardous chemicals into the drains will therefore come back to haunt us.

Water contaminated with raw sewage is one of the world's major causes of disease, particularly in developing countries, where parasites and other water-borne diseases are spread by people drinking contaminated water. The introduction of sewage into aquatic systems may lead to nutrient enrichment, causing eutrophication – where excessive growth of aquatic organisms depletes the oxygen in the water, causing it to become anaerobic and lifeless. Sewage will contaminate fresh water and oceans, causing serious problems to many living species.

In more industrialised countries untreated sewage can be more complex in its composition, due to the quantities of chemical substances discharged to the sewer. Even state-of-the-art treatment cannot remove all the hazardous substances contained within effluent discharged to aquatic environments.

Many chemicals have a synergistic effect when discharged with other chemicals. These effects may be beneficial or adverse. For example, if selenium is discharged with mercury, then the toxicity of the mercury to aquatic life is decreased. But if copper and zinc are discharged together, then the toxicity of the two combined is much greater than the sum of the two compounds when separate.

More detailed information on threats to water quality can be found in **APPENDIX 2**.

3.1.3 Water and the hotel and tourism industry

Water is essential to the hotel and tourism industry – for food preparation, cleaning and hygiene, guest comfort and recreation. Hotels also depend upon the survival of their supply industries such as agriculture and the food and drink industries – none of which could function without sufficient water.

Water accounts for around 10 per cent of utility bills in many hotels **(SEE SECTION 2 FIGURE 2.1)**. Even in areas where water is scarce, it makes commercial sense to use it wisely. Most hotels pay for the water they consume twice – for its initial purchase and then to dispose of it as wastewater. Saving water reduces the amount of wastewater that needs to be treated, thereby lessening the risk of water pollution. In rural or remote areas, it also ensures that local residents are not deprived of their essential supply. Depending on how water-efficient they are to start with, hotels can reduce the amount of water consumed per guest per night by up to 50 per cent compared with establishments with poor performance in water consumption.

The United Nations World Tourism Organization (UNWTO) and other bodies are concerned about the future of destinations where water patterns are altering as a consequence of climate change. Reduced precipitation and increased evaporation in some regions is creating water shortages and competition over water. There are other threats to the industry such as desertification and the increasing incidence of wildfires. Not only do they pose a risk to existing tourism infrastructure but they could affect future demand flows and seasonality. Similarly the increasing frequency of heavy precipitation in some regions is likely to lead to more floods and potential damage to historic architectural and cultural assets as well as to tourism infrastructure. Travellers and tourists will either concentrate visits into shorter time periods or they will go elsewhere. The people in these destinations whose livelihoods depend on tourism will suffer economically.

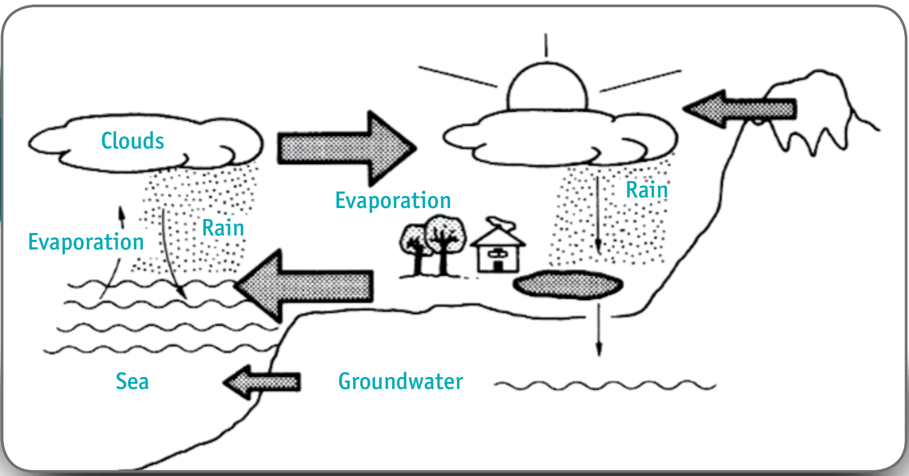
In addition to helping to address the causes of climate change **(SEE SECTION 2)** hotels, together with other tourism operators, have a duty not to use more water than absolutely necessary and to ensure that the water they provide to their guests, customers and staff for drinking, washing and bathing is safe. They must also ensure they do not contaminate or compromise the supply of available water to the rest of the community.

3.2 WATER CONSUMPTION

3.2.1 Where does our water come from?

Water is evaporated in pure form into the atmosphere, where it picks up dust and gases, causing it to precipitate as rain. Water is one of the best solvents for ionic chemical compounds, but not for non-ionic ones. It can absorb and release heat (energy) in massive quantities. Unlike any other substance, water constantly recirculates between the atmosphere and the earth. Through the action of sun and wind, it evaporates from the surfaces of the oceans and continents. Condensation occurs as water vapour rises, forming clouds or fog, the water returning to earth as rain, snow or hail. Precipitation goes into rivers, lakes, the sea and on the ground. There it partially remains or continues its journey sub-surface into the groundwater. Groundwater may go to rivers or oceans, reappear as springs, be pumped, or stay in the ground for centuries. **SEE FIGURE 3.1**

FIGURE 3.1
The water circulation cycle



a NATURAL GROUNDWATER

Natural groundwater fills the spaces between soil particles or rocks below the water table, and is an essential link in the hydrological cycle. Rainfall becomes surface water when it reaches the ground, and where the ground it falls on is permeable, it begins to seep down towards an underground water level known as the water table. The depth of this water table and the time the water takes to reach it both vary greatly with the climate and geology of the area. Groundwater is lost from the ground either naturally, emerging as springs, or artificially, through pumping for human consumption and for irrigation purposes. There must be a balance between supply and loss. If loss exceeds supply, the water table drops.

b SPRINGS

Natural springs or fountains have their origin in groundwater and can be a good source of supply. However, they are generally remote from where they are required.

c LAKES (NATURAL AND ARTIFICIAL)

Owing to the shortage of groundwater in some locations, lakes have become a source of supply, depending on quality, either direct or through infiltration to replenish groundwater. However, quality is often poor.

d RIVERS

Rivers are rarely in a condition that permits use without further treatment, being the waste streams of industry, agriculture and urbanisation. To replenish insufficient groundwater reservoirs, river water may be infiltrated (directly or after pre-treatment) into groundwater.

e OCEANS

It is possible to desalinate water from the oceans. However this is an expensive and energy-intensive process which must be carried out under strict operating procedures to minimise environmental impacts. It is a method that is generally only used where extreme shortages exist.

The supply of pure and plentiful water has, in many places, been jeopardised by pollution. 'Enrichment' of water, with chemicals and waste, has become a universal problem. Polluted water is the world's major cause of disease. Untreated sewage is released into the sea and other water supplies, even in some developed countries. Industrial, agricultural and domestic chemicals and other toxic waste materials further add to the degradation of the primary and essential supply. Everyone needs to take responsibility for protecting and improving our water supplies. A review of the threats to water quality from various pollutants can be found in **APPENDIX 2**.

3.2.2 Water conservation – setting objectives

In striving to become more water-efficient, your objectives should be to:

a SATISFY GUESTS' NEEDS WHILE AVOIDING WASTE

Although your guests are likely to be much more 'water aware' than even ten years ago, they expect to be able to turn on the shower and for there to be a sufficient supply and pressure of water. You need to ensure adequate supplies by saving water in other areas, fitting appropriate water saving equipment and educating your guests about how they can help you in your efforts to conserve water.

b IMPROVE EFFICIENCY

It is always possible to find ways to improve on your water consumption rates. Regular efficiency measurements should become a standard procedure for major water-consuming equipment and areas such as kitchens, bathrooms and the swimming pool or spa area. You should have effective procedures for identifying leaks and dealing with them swiftly.

c OPERATE PROFIT (COST) CENTRES

Those who use the water must be held accountable for it. You will need to install sub-meters and allocate charges to each department for their water consumption. It is also important to ensure that any independent operators on the hotel's premises are re-charged for the water they use.

d USE PERFORMANCE CRITERIA

You will need to develop and use performance criteria for each department, set targets and continuously monitor results.

e INVEST IN NEW TECHNOLOGY

Constantly review available technology and assess whether it can help create efficiencies within your own hotel operation.

f SET HIGH STANDARDS FOR NEW PROJECTS

When planning refurbishment, extensions or new buildings it is important that, from the outset, you incorporate water efficiency measures in the form of low-flow showers and toilets that save water, for example.

g PROVIDE ADEQUATE TRAINING

Make sure that your staff are properly trained in all aspects of water conservation and that they put their training into practice.

3.2.3 Your action plan

In order to set (and achieve) relevant and realistic targets you will need to invest time and resources in careful planning, organisation, training and follow-up. The basic steps are to:

a. Carry out a **water audit** in the hotel, which will show you where the major water costs are and where savings can be made. **FIGURE 3.2** gives an indication of the key areas of water consumption in typical hotels.

b. **Compare** your total and departmental **consumption** figures with hotel **industry benchmarks** to determine the potential for savings so that you can prepare a summary of opportunities.

c. Keep records of your monthly **occupancy** figures (i.e. the total number of guest nights). To calculate the water used per guest per night, divide the total water consumed in guest rooms by the number of guests for that month. If your utility bill is in cubic metres rather than litres, multiply the number of litres by 0.001.

d. Using the water audit results, **establish realistic goals** for each department and the entire hotel.

e. **Communicate** the management's commitment to all employees and explain your objectives and goals clearly to them. Show them the current consumption data, the costs and trends.

f. Make sure that the **entire workforce** participates. Encourage them to put forward their **ideas** and **proposals** on how to reduce water consumption.

g. Implement immediate water savings through **changes in routine** (such as not washing items under running water).

h. **Check regularly for leaks** from cisterns, taps and pipes and that plugs in basins fit properly.

i. Implement a programme whereby guests can opt not to have **towels and linens** changed every day.

j. Install sensors, low-flow and other **water-saving fittings** in kitchens, guest bathrooms and public washrooms. Take advantage of any **financial incentives** being offered by your national or local government to install water-efficient technologies.

k. Use opportunities to **divert and capture rainwater** (rainwater harvesting) for reuse in the hotel grounds.

l. Establish a **monitoring and targeting system**. Monitor results continuously, report on progress and take corrective action as necessary.

m. **Provide training.** Staff must understand how to make prudent use of water and how to maintain equipment for optimum energy-efficiency.

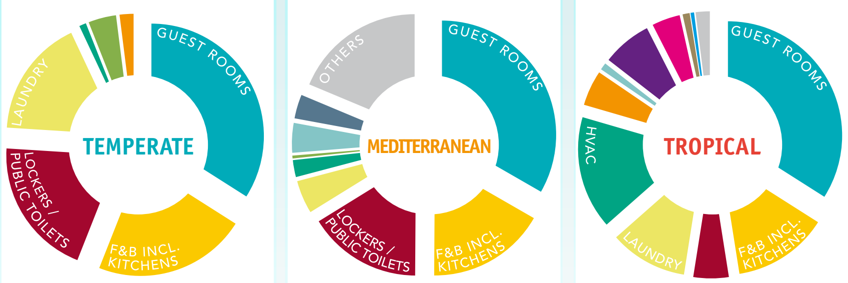
n Develop **standard operating procedures**, and continue to stimulate motivation by giving **feedback**. Reward success.

o **Join forces with other hotels** and provide mentoring to help them reduce their water consumption.

3.2.4 Assessing and benchmarking performance

a FIGURE 3.2 shows examples of the key areas of water consumption at hotels in three climate zones.

Area	Temperate m³	Temperate %	Mediterranean m³	Mediterranean %	Tropical m³	Tropical %
Guest Rooms	18,088	34	17,075	33.3	121,312	34
F&B incl. Kitchens	11,704	22	8,614	16.8	48,168	13.5
Lockers/public toilets	10,640	20	8,255	16.1	17,840	5
Laundry	9,044	17	2,410	4.7	39,248	11
HVAC	532	1	1,231	2.4	57,088	16
Steam generation	2,128	4	205	0.4		
Pool	1,064	2			17,840	5
Gardens			2,154	4.2	3,568	1
Snack Bar			1,743	3.4		
Water supply treatment					24,976	7
Public areas					14,272	4
Boilers					3,568	1
Cold rooms					1,784	0.5
Others/not metered			9,589	18.7	7,136	2



DATA FROM: Fully sub-metered 300-room hotel in Germany with total annual water consumption of 53,200m³ (620 litres per guest)

DATA FROM: Fully sub-metered 270-room hotel in Lisbon, Portugal with total annual water consumption of 51,276m³ (819 litres per guest)

DATA FROM: Luxury fully-serviced hotel in Jakarta, Indonesia with 800 rooms, 100 apartments, 25-acre gardens, sports centre and olympic-sized pool. Total annual water consumption 356,800m³ (820 litres per guest)

FIGURE 3.2
Annual water consumption in hotels

b **FIGURE 3.3** shows water benchmarks for luxury fully-serviced hotels.

FIGURE 3.3
Water benchmarks for luxury fully-serviced hotels[1]

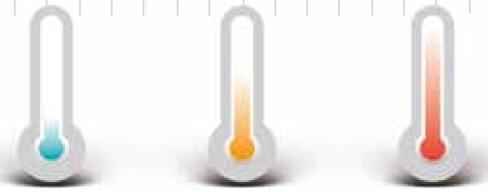
Hotel profile	Climate zone	Water consumption (m^3 per overnight guest)		
		EXCELLENT	SATISFACTORY	HIGH
Luxury serviced hotels	Temperate	< 0.3	< 0.45	< 0.7
	Mediterranean	< 0.4	< 0.6	< 0.8
	Tropical	< 0.8	< 1.0	< 1.4

NOTE: 1 CUBIC METRE = 1000 LITRES. FOR MORE CONVERSION TABLES SEE **SECTION 12.2**

Benchmark results fall into **three categories**:

EXCELLENT	SATISFACTORY	HIGH
The best that typical hotels could expect to achieve.	The gap between the best that most hotels could expect to achieve and average performance.	The gap between the satisfactory level of performance and high consumption. Consumption greater than this is excessive and illustrates poor resource management practices.

...and are separated into **three climate zones**:



TEMPERATE	MEDITERRANEAN	TROPICAL
Assumes full heating, ventilation and air-conditioning (HVAC) using centrally-controlled electrical chillers.	As per temperate.	Year-round air-conditioning and no heating.

It is important that hotels enter the correct climate zone for their location to achieve the most realistic set of benchmarks. Hotels in the sub-tropics and in cold temperate or glacial environments should select the climate zone that is the nearest match (i.e. sub-tropical hotels should select the tropical climate zone and hotels in cold temperate environments should select temperate environments).

Please refer to **3.2.4 c** for the appropriate correction or 'modifier' values if your hotel differs from the profile in **FIGURE 3.4** (for example if it uses absorber chillers, does not have a swimming pool and health club or a laundry, washes more or less laundry, produces more or less covers or operates at a different occupancy level).

[1] Data in **FIGURES 3.3 AND 3.5** sourced from the International Tourism Partnership's environmental benchmarking tool, February 2008.

The luxury hotel

FIGURE 3.4

THE **LUXURY HOTEL** PROFILE ASSUMES A **FOUR OR FIVE STAR FULLY-SERVICED**[2] HOTEL WITH THE FOLLOWING:

- 150 to 1000 rooms.
- An average of 55–100m^2 per room (including public space and back-of-house) with approximately 60 per cent of the total hotel area dedicated to guest bedrooms.
- Year-round opening, operating at 70 per cent occupancy.
- 1.2 guests per room.
- Covers: 2.5 per guest
- Air-conditioning and heating (see climate zones, left).
- A laundry producing 6kg/laundry per occupied room (OCRM) per day.
- A health suite and pool of up to 150m^2 surface area.
- Gardens of up to 1,000m^2.
- 1 employee per room.

C CORRECTION FACTORS:

Depending on the facilities at your hotel you may need to modify the benchmarks in **FIGURE 3.3** so that they are applicable to your specific property, wherever it deviates from the typical profile, using the table below to account for a laundry producing more or less than 6kg/OCRM per day, indoor pool of more or less than 150m^2 surface area, gardens more or less than 1,000m^2, occupancy levels of more or less than 70 per cent etc.

See over for a worked example.

Area	TEMPERATE	MEDITERRANEAN	TROPICAL	
Overnight guests	0.2	0.2	0.3	m^3/guest
Laundry	0.025	0.025	0.025	m^3/kg
Covers	0.035	0.035	0.035	m^3/cover
Pool	0.05	0.05	0.05	m^3/guest
Size versus 150m^2	$\left\{\frac{\text{actual} - 150}{\text{actual}} \times \frac{m^3}{\text{guests}}\right\}$			m^3/guest
Employees	0.05	0.05	0.05	m^3/employee
No cooling tower	-0.150	-0.200	-0.300	m^3/m^2/year
Gardens	$\left\{\frac{\text{actual} - 1000}{\text{actual}} \times \frac{m^3}{\text{guests}}\right\}$			m^3/guest

FIGURE 3.5
Benchmarking modifiers for water

[2] i.e. with premium services and facilities, regarded as a leading hotel in its region.

EXAMPLE 1:
ADJUSTING BENCHMARKS ACCORDING TO OCCUPANCY

ACTUAL OCCUPANCY

The annual number of guests in a 300-room luxury hotel in a temperate climate is: 105,450 (A)

BENCHMARK

0.3 m³/guest (B)
FROM FIGURE 3.3

EXPECTED OCCUPANCY

Included in the benchmark is an occupancy rate of 70 per cent, with a double occupancy rate (rooms with two guests) of 20 per cent: 300 × 365 × 0.70 × 1.2 — 91,980 (C)

CORRECTION FACTOR

This hotel has more guests than in the typical hotel for which the benchmarks apply: A − C — 13,470 (D)

The modifier value for the number of guests is: 0.2 m³/guest (E)
FROM FIGURE 3.5

REVISED BENCHMARKS

The revised benchmarks for this specific property are calculated as follows:

$$B + \left(\frac{D \times E}{C}\right) = B + \left(\frac{13{,}470 \text{ guests} \times 0.2 \text{ m}^3/\text{guest}}{91{,}980 \text{ guests}}\right) = B + 0.029 \text{ m}^3/\text{guest}$$

BENCHMARKS SHOULD THEREFORE BE RAISED BY 0.029 m³/guest

THE NEW BENCHMARKS APPLICABLE TO THIS HOTEL ARE THUS:

Property	Water consumption (m³ per overnight guest)		
	EXCELLENT	SATISFACTORY	HIGH
Typical	< 0.3	< 0.45	< 0.7
THIS PROPERTY	< 0.329	< 0.479	< 0.729

3.3 GUIDELINES FOR AREAS OF MAJOR USE

3.3.1 Guest bathrooms and cloakrooms

a STAFF TRAINING

- Ensure that staff are **trained to look for leaks**, that they report them quickly and ensure that problems are responded to swiftly.
- **Fit the plug** and **use a bucket** to clean baths and basins rather than letting the taps run.
- Clean the toilet **after cleaning the bath and basin**, so that the water can be reused for a final swill down.
- If using concentrated cleaning detergent, ensure that it is **diluted according to the supplier's instructions**. Too little or too much water will decrease cleaning efficiency. Automatic dosing equipment can help ensure the correct formulation.
- **Involve staff** in your water saving programme and seek their suggestions as to how water can be conserved.

b MEASUREMENT

- **Install sub-meters** to measure specific users of water such as guest bathrooms.
- **Measure your consumption on a monthly basis** and keep records so you can track seasonal changes (if relevant) and improvement over time.
- **Set realistic targets** for reducing use based on past figures.

c MAINTENANCE

- **Conduct regular inspections** of faucets, showers, toilet mechanisms, overflows from water storage and pipe joints to detect any leaks as early as possible and repair them immediately. Check also around the grouting by taps and shower fittings for signs of any below-surface leaks.
- **A leaking toilet** can waste up to 750 litres of water per day. If you cannot hear it losing water, add food colouring to the cistern to detect leaks. Coloured water will appear in the bowl if the toilet is leaking.
- Check that **plugs are fitted** to basins and that they produce an **effective seal**.
- Ensure that the **pipe insulation is in good order** and that **water is circulating properly** through the system. This reduces the time the water needs to run to reach the required temperature. It will also reduce the risk of *Legionella* contamination. SEE 3.4.7

d GUEST EDUCATION

- **Communicate** to guests the importance of fresh water resources within the area and provide opportunities to allow guests to use water wisely.
- Encourage guests to **shower** instead of bath.
- Suggest they **do not leave the tap running** when brushing their teeth. It can save up to nine litres each time they do so!
- Suggest they **half-fill the sink** where appropriate.
- Invite them to **reuse their towels and linens** by opting not to have them changed every day.

e WATER-SAVING TECHNOLOGIES

SEE FIGURE 3.6, OVERLEAF

FIGURE 3.6

WATER: GUIDELINES FOR AREAS OF MAJOR USE

WATER-SAVING TECHNOLOGIES

Infrastructure

- Water flow rate is related to water pressure. This means that you can **reduce the water flow** from a fitting operating on a fixed setting if the water pressure is reduced. For example, a **pressure reducing valve** can reduce pressure from 100 pounds per square inch (psi) to 50 psi which reduces water flow by around one third. Lower water pressure also **lessens the risk** of leaking pipes, water heaters and taps.

- Water that has been used in sinks and baths (not toilets) can be **reused** for landscaping through a **grey water recycling system**. The wastewater is treated on site and stored. Some grey water systems pump the grey water back into the building and reuse it in the toilet systems. Grey water recycling requires a second piping system with a pump, settlement tanks, a dosing system for disinfection and filters and it is easier and more cost effective to design these in at the building or major refurbishment stage.

Baths and basins

- Select the **size of baths and basins** carefully as size has a dramatic effect on water consumption. Even using one litre less per bath per guest per year will yield huge savings.

- Consider installing **programmable controls** in guest rooms to dictate the temperature and maximum fill level of the bath. This enables the guest to press a button to fill the bath, and reduces the risk of it overflowing.

Taps (faucets) and shower heads

- **Adjustable flow restrictors** on taps enable them to deliver a lower instantaneous flow rate than screw-operated taps and can reduce water use by over 50 per cent.
- **Faucet aerators** are small valves that break the flow of water into fine droplets and entrain air while maintaining wetting effectiveness. They are inexpensive and can reduce the water use at each faucet by as much as 60 per cent whilst maintaining a strong flow. Typically, they use 7.5 litres of water a minute compared with conventional faucets, which use 11–19 litres.

- **Self-closing percussion** or **push taps** which close automatically after up to 30 seconds are particularly suitable for cloakroom facilities in public areas. These can be activated by **passive infra-red (PIR) sensors** to further reduce consumption. Some types can be supplied in kit form to fit onto existing standard tap bodies without disturbing the pipe-work.
- **Low-flow shower heads** cost very little and use around 9.45 litres a minute compared with conventional heads (which typically use nearly twice that). If properly designed they should feel as effective as higher water volume models.
- Some shower head models incorporate a **vacuum flow valve** which aerates and compacts the water so it leaves the showerhead in a powerful stream but consumption is only around five litres per minute. Test that they work throughout the hotel (especially the top floor), as they require a set water pressure to operate effectively.

Urinals

A urinal flushing every 15 minutes can use as much as 150,000 litres of water a year. Techniques for reducing water use in urinals include:

- **Passive infra red (PIR)** devices which initiate a flush when they detect activity or which flush at shorter intervals during busy times.
- **Timers** that flush more frequently at peak times: the mechanism should be set to flush for no more than 10 seconds at a time.
- **Waterless urinals.** These are generally retrofit units although new urinal bowls are available. Water is only necessary for cleaning. Some models incorporate a special sealed sprung trap through which the liquid waste travels into the drain line. The springs should be checked regularly to ensure they are working properly and are free of debris as the seal ensures against odours. Other models use the principle of floating oil in a trap on top of the water and urine to act as the seal. As the level rises, the water and urine drain away underneath. The level of oil needs to be checked and kept topped up for the system to operate effectively. Another system uses a chemically impregnated pad in a modified S-bend trap. These units can be retrofitted to existing men's toilets. The pads must be changed weekly to maintain hygiene standards.

- **A sleeve-based system** that uses a disposable sleeve designed to remove the odours associated with bacteria and uric acid at source. Unlike the waterless urinal, limited flushing is required in order to allow enzymes lining the sleeve to filter down into the urinal bowl and feed on the uric salts. Flushing removes the debris and sludge from the waste pipes but is limited to 4–6 flushes a day, rather than 4–6 times an hour with conventional urinals. This can lead to water savings of over 90 per cent compared with conventional urinals and the payback period can be as little as nine to twelve months. There is no need to use chemicals and these systems claim to dramatically reduce blockages.

Toilets

- **Low-flush toilets** use six litres of water or less per flush compared with older, conventional toilets which can use 10–20 litres. Flushing less water away will reduce wastewater treatment costs too.
- Toilets with a **dual flush option** can save water by enabling guests to select a full or half-flush.

- **Cistern volume-adjusting devices** can take various forms such as bricks (see image below), plastic containers or bags filled with water ('hippos') or pebbles. These are placed in the cistern to reduce the amount of water used per flush. It is important however to ensure that they do not impede the flushing mechanism or the flow of water. Toilet dams, which hold back a reservoir of water when the toilet is flushed, are another form of displacement device and can typically save 3.8–7.5 litres per flush. Other devices redirect the refill water into the tank, thereby filling it quicker and decreasing the amount of water wasted per flush. To maintain hygiene, you need to be aware of the minimum flushing volume of the toilet.

- **Composting toilets** reduce pollution and eliminate water and sewerage costs. They are most suitable for operation in remote areas and ecologically sensitive environments where there is no or poor water infrastructure.

3.3.2 Laundries

To promote water-efficiency in the laundry operation you should:

a. Ensure **machines are fully-loaded** before use.

b. Wash **small quantities** in a small 5 kg machine.

c. Make sure that all water inlet valves are **closing properly**.

d. Check for **leaking dump valves**.

e. **Minimise the rinse operation** without reducing quality standards. It may be that you can reduce the cycle time by around 10 per cent. However refer also to the manufacturer's recommended setting.

f. Consider using **'intermediate extraction'** between rinse operations.

g. Consider the **re-use of water from previous rinse cycles** for washing by installing temporary holding tanks. Water consumption can be cut by 40 per cent and detergent and heating energy will also be saved.

h. Check that the **level controls** on water re-use tanks are working properly.

i. For hotels with over 500 rooms you could consider installing a **continuous batch washer (CBW)**. Because of the counterflow system, a CBW uses all the rinse water for pre-washing and main suds operation. Compared with a conventional type washer-extractor, a CBW uses 50 per cent less water.

j. Ensure that the **water flow rates** on tunnel washers and continuous batch washers (CBWs) are adjusted to the **manufacturer's recommended setting**.

3.3.3 Towels and linens

a. REASONS TO REDUCE TOWEL AND LINEN USE:

- A towel and linen programme will enable you to make **significant water savings**. For example, through its 'Conserving for Tomorrow' towels and linen programme, participating InterContinental Hotels properties saved more than 52.6 million gallons of water and over 350,000 gallons of detergent in 2004.
- Not only will it dramatically reduce your consumption of water but also the **CO_2 emissions** from energy consumption, detergent and the need for associated wastewater treatment.
- The environmental benefits of reducing resource and detergent use will also **reduce your costs**. The savings can be used for further investment in your environmental programme, staff incentives or donated to charitable organisations.
- Thousands of hotels around the world already offer their guests the option to **reuse their towels and/or bed linen**. Business travellers and conference delegates typically do not spend much time in their rooms and are likely to be familiar with such conservation initiatives through regular travel.
- Less frequent washing means **less wear on fabrics** which prolongs their life. You may also be able to **reduce the stock** of towels and linens when replacement is due.
- Housekeeping staff will have **more time** to spend on tasks other than changing bed-linen and towels.

Not only do towel and linen programmes dramatically reduce water consumption, but also energy and detergent use and the need for associated wastewater treatment

b ISSUES TO CONSIDER:

- In certain **city and airport hotels** where the majority of guests stay for one night only, the savings of a towel and linen programme may not be sufficient to justify the cost of the information cards and providing additional staff training.
- **Luxury hotels** have often been the least likely to ask their guests to become involved, principally because managers are concerned that having to reuse towels is not compatible with a 'luxury' experience and could be viewed merely as a cost-saving measure by the hotel. However, attitudes are changing: guests are sophisticated in their understanding and awareness of environmental and social responsibility issues and increasingly expect to see evidence of the hotel operating in a responsible manner. This is especially true if the destination is in a remote, unspoilt location and close to wildlife and nature activities.

c THE KEY TO SUCCESS:

The key to a successful towel and linen programme is in managing it effectively. This means:

- **being clear about the reasons for doing it** (see above) and incorporating them into your environmental policy and management programme
- **deciding how it will work in practice.** Do you take the lead or do you let the guest decide?
- **communicating** the programme **properly to staff**
- **carrying out effective training**
- **communicating sensitively to guests**
- ensuring that you also **save resources** and **cut waste** through **efficient laundry equipment and practices**
- **monitoring results.**

FIGURE 3.7
Options for changing towels and linens

Frequency of change	Action required by guest	Issues to consider
Daily	No action if guest wants clean towels and linen each day. Environmentally-minded guests need to hang towels neatly back on rack or leave card on bed requesting not to change linen	Environmental savings will depend on how 'green' the guests are. This option is often a good starting point for hotels that are concerned about how guests will react, since the default option is to have them changed each day
Every second or third day unless more frequent change requested	No action if guest is happy with change on alternate or every third day. Guest must specifically request less environmental option – i.e. place tent card on bed requesting linen change or place towels in the bath	Defines the establishment as being concerned about the environment, but happy to oblige guests who wish a more frequent change. Clear instructions need to be given so the guest understands how the system works
Every second or third day with a discount on the bill	As above but guest will also need to indicate on check-in/out or on a form in the guest room that they wish to receive a discount for reusing towels	Appeals to the financial and environmental interests of both the hotel and guest. Some hotels prefer to be 'up-front' about the fact that these programmes save money, so why not pass on the savings? Eco-hotels and resorts that pass on the savings to environmental or wildlife charities find this popular with their guests
Only at guest's request	No action until guest wishes to request change by placing tent card on bed or towels in the bath	Best suited to 'eco' establishments, particularly in areas where water is scarce or washing is difficult and where the clientele are likely to be highly environmentally conscious

d WHICH TYPE OF PROGRAMME?

- There are **various ways** you can run the programme, and it is important to decide which one best fits with your environmental policy and how you wish to promote the programme to your guests. **FIGURE 3.7** shows different approaches that can be followed.
- First, make sure that there is a **towel rail** in the bathroom on which the guest can hang their towels for reuse. It may sound obvious, but in some hotel bathrooms, towels are displayed folded up in alcoves or on shelves and the designer has given no thought to where they might be hung up once they have been used. In cooler climates, an energy-efficient, heated towel rail will encourage guests to hang their towels back up for reuse.
- You can design and produce your own **in-room materials** or purchase **pre-printed cards** through hotel associations or direct from the companies that produce them. Ensure that you have sufficient stock in hand. **The Green Hotels Association** recommends that properties have at least two towel hangers for each guest room so that there is a spare at all times. When ordering cards for bed linen, base the numbers on how many beds there are in the hotel rather than the number of rooms and order at least two sheet cards per bed. Hoteliers have found that some guests like to take the cards away with them.

e STAFF AWARENESS AND TRAINING

- Ensure that all members of **staff are aware** of the programme, the reasons for it, and what is required of those who will be responsible for making it work.
- As a first step, **raise the issue** at your weekly management meeting and solicit feedback from department heads. Decide upon the process by which guest feedback (positive and negative) will be handled. Once you have formulated the strategy, ensure it is communicated to all staff.
- **Proper training** is vital. If a towel card is included in the guest bathroom suggesting that the guest hangs up their towels so that they can use them again, housekeeping staff must follow the correct procedure. They may straighten or refold the used towels neatly for the guest, but not move, remove or replace them. If guests indicate their desire to reuse their towels but the housekeeping staff change them anyway, it undermines the programme and leaves visitors with a very negative impression about the hotel's management. Only change towels left in the tub, on the floor or in the shower tray, not those hung back up on the rail. In addition to using pre-printed cards and door hangers, it is worth sourcing training videos and information packs to help ensure the success of the programme.
- All **sheets must be changed between guest stays**. However guests staying for more than one night often feel it unnecessary to have their sheets changed every day. In this case a card placed on the bed by housekeeping staff can ask the guest to indicate their willingness to participate in the linens programme. It is vital that staff understand that if the guest replaces the card on their pillow in the morning they do not want the sheets on their bed changed that day. In this case staff should simply remake the bed.
- The programme should become a **feature of induction training, regular environmental bulletins** and **reminders** on notice boards.
- All hotel associates (especially front-of-house staff) should be aware of the hotel's **environmental policy** and be able to give examples of initiatives within the hotel if they are asked for them by guests. In many hotels, members of the 'green' team wear special badges so that they can be clearly identified by guests and visitors.

f COMMUNICATION WITH GUESTS

- Time and thought given to composing the words on the **in-room information** will be well spent. Ensure that it is **attractively presented** and explain what other environmental actions you are taking in the hotel, particularly back-of-house, so they do not see the reuse of towels and linens as your only environmental effort.
- Consider carefully how your words come across – you want to **inspire guests** to help you conserve resources and reduce waste and not give the impression you are simply trying to cut costs.
- Make sure that your instructions about the programme are **clear and simple**. It will irritate your guests if they are confused as to what is expected of them. Few guests change their sheets daily at home, and most will be receptive to being given a choice. Explain how the system works in the guest room information, and, if guests need to put a card on the bed, ensure the instructions are also clearly expressed on the card. For example the pre-printed card could say: 'We are happy to provide you with freshly laundered sheets every day, but if you would prefer to help us minimise our environmental impacts, please leave this card on your pillow and your sheets will not be changed today. If you would like more information about how we are trying to reduce our impact on the environment, please see your guest information pack or ask any member of staff'.
- If you leave a **guest questionnaire** in the room, include a section on your towel and linen policy and **solicit feedback**.

g EQUIPMENT AND PRACTICES FOR WATER AND OTHER ENVIRONMENTAL SAVINGS

If your guests are helping you to be environmentally responsible by reusing their towels and linens, you should avoid wasting energy, water and detergent in the laundering process. **If your laundry is outsourced**, talk to your supplier about your towel and linen programme and ask if they are doing all they can to be environmentally responsible. You should also be able to renegotiate the contract based on reduced loads.

For in-house laundries, here are several ways in which to ensure the whole operation is as environmentally efficient as possible:

- Ensure that washing machines and dryers are **properly maintained** and working at **optimum performance**. Check temperature controls and thermostats regularly to ensure they are functioning properly.
- When purchasing new equipment, check the **water and energy consumption ratings** as these will have the most significant environmental impact over its life. Although some equipment may cost more to purchase, it may pay for itself many times over in lower operating costs.
- **Water recycling and heat recovery systems** re-use the comparatively clean discharged effluent from the last rinse of a washing cycle in the first wash process of the next. By re-using the water (and the heat it contains) both energy and water consumption can be reduced. The payback period of such systems is typically under two years.
- **Moisture sensors** in the form of end-point detectors or ‘energy eyes’ can be fitted to most tumble driers. They stop the drying cycle automatically rather than at a pre-set time and prevent over-drying. The payback period for such systems can be as little as six months.
- Train staff to ensure that laundry machines are **fully loaded** each time they are used and set to the lowest washing temperature necessary for effective cleaning. Wash small loads in small capacity machines and iron by hand.
- **Close tumble dryer doors** after unloading to retain heat and make regular checks of seals and gaskets to see that they are closing properly and not letting heat escape.
- Your **choice of detergent** is very important. Consult your suppliers and select the option that is best all-round for the environment. Some detergent products contain enzymes which reduce alkalinity and enable lower washing temperatures. Some suppliers provide automatic measuring systems which dispense only the exact amount required. You should also consider the amount and type of packaging used.
- Investigate **chemical-free alternatives** to detergent, such as ionised oxygen laundry systems. These release ionised oxygen to increase the pH level of the water. The water molecules are activated and penetrate deep into the fabric fibres, lifting out dirt. Not only is the process gentle on fabrics but it is suitable for people with allergies, eczema and chemical sensitivities.
- Fit **water-softening equipment** to reduce the amount of detergent you need to use.
- **Ozone laundry systems** inject ozone into the water which works in conjunction with the laundry chemicals to provide a more efficient wash, reducing energy use through shorter cycles and requiring less detergent.
- **Microprocessor controllers** enable the exact dosage of detergent to be dispensed at the correct temperature for wash results and can regulate wash times and temperatures.
- Collect and deliver items of laundry to guests in **woven or cane baskets** or **reusable cotton bags** rather than plastic ones. Recycle bed linen at the end of its life by making it into laundry bags. If your laundry is handled off-site, ensure that they use a suitable alternative to plastic wrapping.

h BENCHMARKING AND MONITORING RESULTS

- Fit **energy and water sub-meters** so that you can measure your usage for the laundry separately from other areas.
- **Monitor your resource use** on a monthly basis and maintain records so that you can compare your environmental performance and financial savings against the same period each year and on an annual basis.
- **Establish benchmarks** for comparing resource consumption year-on-year. Energy use is typically expressed as kWh/kg of laundry and water use as m^3/kg. You will need to:
  - take readings from all relevant sub-meters and convert them into kWh and m^3
  - calculate or measure the weight of your laundry in kg
  - calculate (on a monthly or annual basis) the energy and water consumed per kg washed (by dividing the consumption figures by the kg of linen washed).

Benchmarks for good water performance in the laundry would be:[3]

EXCELLENT	
12 – 15 litres/kg	for machines **with** recovery systems (water reused from specific cycles)
25 litres/kg	for machines **without** recovery systems.

3.3.4 Swimming pools

In addition to examining water consumption issues relating to swimming pools, this section also addresses water treatment methods and energy use which are fundamental to environmentally responsible pool management.

The key environmental issues concerning the operation of swimming pools are:

- the effect of the **building design** on the environment
- **water consumption**
- the **energy** used to heat the water and, in the case of indoor facilities, the building itself
- **water treatment**, i.e. the method used for sanitising and balancing the water to ensure the health and safety of users
- **air quality** associated with adequate ventilation and air extraction and methods of water treatment.

a WATER

In a large hotel, a swimming pool can increase fresh water consumption by as much as 10 per cent,[4] so before installing one, consider carefully whether a pool is a necessity for your guests. This is particularly the case if your establishment is located where water is not readily available, especially if there is a risk of causing shortages for others in the community. Even where water is plentiful, there is no excuse for wasting it. If a pool is properly managed, you should not have to empty and refill it, merely to top it up throughout its lifetime to compensate for evaporation and backwashing.

- Design the system so that you can **capture and reuse** backwash water to irrigate the grounds.
- When cleaning the area around the pool, **instead of hosing down** the pool surround, use a brush and pan to collect organic debris such as leaves, grass and dust. Hoses should be fitted with automatic **cut-off triggers**.
- Fit **water-saving** shower-heads, dual-flush or water-efficient toilet cisterns and push-button taps in all changing facilities.
- Check the **water meter** last thing at night and first thing in the morning to detect leaks.

[3] See SECTION 2 APPENDIX 4
[4] **Source:** Institute of Hospitality, formerly the Hotel and Catering International Management Association (HCIMA)

- In coastal areas, a **reverse osmosis (RO)** plant is an option for converting sea water for use in pools to conserve fresh water. However, acids and caustic substances are required to keep these systems clean, creating a waste stream that must be neutralised before being discharged. Care should also be taken with siting. Most good RO systems incorporate waste neutralisation, making the process simple and efficient.
- Using RO-produced water as a top-up reduces the level of total dissolved solids (TDS) in the water and in turn reduces the amount of water that has to be dumped to drain to maintain water quality. It can also reduce heating costs.

b ENERGY

When designing and siting an indoor pool, use every opportunity to save energy through, for example, using high quality **insulation and glazing** systems to minimise heat loss and increase daylight and ensuring that entrances and ventilation points are sheltered from prevailing winds. Whether it is an indoor or an outdoor pool, your **choice of heating system** will have a major effect on both environmental impact and operating cost.

- **Condensing boilers** are particularly suitable for indoor pools and providing underfloor heating. For larger pools, a **combined heat and power (CHP)** plant could be used to supply heat. SEE SECTION 2 APPENDIX 7
- **Solar thermal panels** (in the form of unglazed collectors) are simple and inexpensive and are suitable for heating outdoor pools. Once the system is installed there is little maintenance and the heating is free. They do however require a large area of panelling to achieve a significant rise in temperature. Typically, this should be equivalent to at least half the area of the pool.
- **Heat pumps** offer water heating and air cooling from one plant. They are mechanical refrigeration devices that upgrade low temperature heat to a useable temperature. For swimming pools, the heat source is usually the ambient air. The smaller the uplift in temperature required, the better the efficiency of the heat pump. Running costs vary according to the pool insulation and weather conditions but heat pumps typically deliver 2–3 kW of heat output for each kW of electricity input. When purchasing the pump it is important to check that it uses refrigerants which are less harmful to the ozone layer.
- **Recover heat** wherever possible. Careful siting of the plant room will minimise routing and ducting of services and increase heat recovery potential.
- A **computer-controlled** boiler management system will ensure optimum performance of the boiler, reducing your costs and CO_2 emissions. This system should be linked to the ventilation system so that it operates automatically and only when required.
- Equate the running hours of the **circulation pump** with the use of the pool. This can be done automatically with the use of variable speed pumps in conjunction with automatic water quality testing equipment.
- Use **energy-efficient** lighting with timer and motion detector devices and label light switches so that only the lights that are required are switched on.
- Most of the heat lost from a pool is from the water's surface through direct conduction and convection to the air and through evaporation. The use of a **pool cover** when the pool is not in use will help retain heat and save energy. It can be made to fit the pool and can be mechanically operated. Even indoors, a cover helps to reduce both the ventilation requirement and damage created by condensation.
- Automatic door closers and draught excluders will **cut heat loss** and improve user comfort. They may also help you to reduce temperature settings.
- Regular **inspection and preventative maintenance** will help keep equipment running efficiently and identify areas where performance can be improved.
- Minimise the environmental impact of your energy use by **purchasing green electricity** generated from renewable sources such as wind power.

c WATER TREATMENT

Pool water must be sanitised to prevent the growth of micro-organisms that can cause stomach upsets and infections particularly in the ear, nose and throat. Correctly treated water will provide a healthy and visually appealing environment for users and prolong the life of the pool and equipment.

Bacterial control is achieved by adding a **sanitiser** (usually chlorine-based), a **flocculant** (to help mass together particulates and bacteria in the water) and **filtration** to remove the products of flocculation. The sanitiser must leave a **'residual'** in sufficient concentration to continue to protect against and destroy any bacteria entering the water. It is also important to balance:

- the **pH** – or acidity of the water, with 7 being neutral. Less than 7 is acid and any higher is alkaline. A level of around 7.2–7.6 is recommended for most pools. Incorrect levels can cause itchy skin and red eyes in swimmers and can impede the action of the sanitiser.
- **total alkalinity (TA)**, which is a measure mainly of bicarbonates and carbonates. This should range between 80–200 ppm depending on your pool. If the TA is too low it can render the pH unstable so that small additions of chemicals result in major shifts in pH.
- **calcium hardness** – i.e. the amount of dissolved calcium in the pool. The recommended minimum is 80 ppm. Lower levels of calcium hardness mean the water can be corrosive to the pool and equipment.

SEE FIGURE 3.8 OVERLEAF

d ISSUES TO CONSIDER

- In addition to environmental issues, there are many **safety** hazards associated with pools, such as slipping on wet pool surrounds, falling into full or empty pools, drowsiness from a warm humid atmosphere, chemical burns, sharp tiles and edges etc. Effective measures should be taken to ensure the safety of pool users and to prevent unauthorised access when the pool is not in use.
- All **staff** in charge of pool maintenance and operation should be well-trained and competent, working to established, approved procedures under the direction of knowledgeable and responsible management.
- Keep **full records** of operation and maintenance. This should include all the equipment manufacturer's manuals, dates of your water treatment programme and inspection, MSDS documentation for all treatment chemicals, equipment repair and system water volume records as well as the contact numbers for the individuals responsible for maintenance and shut-down of the equipment.
- The pool should have a **bathing load** appropriate to its size, use, circulation rate and turnover and this should not be exceeded.
- Disinfection and dosing are best controlled continuously by **automatic monitors**. Strict control of bathing load and monitoring every two hours should ensure that combined chlorine levels are minimised. These levels should be ideally zero, or at least under 1 mg/litre and certainly less than half the free chlorine figure.
- **Never mix chemicals**, even different types of chlorine, as fire or explosion may result. Only add chemicals to the water, **never add water to chemicals**.
- When correcting the TA or pH levels, add **small quantities** of acid or alkaline and then wait an hour before testing.
- For indoor pools, ensure that the pool hall is **properly ventilated**. The space temperature should be between 24 and 30°C and relative humidity kept to 60 per cent. Ventilation should be variable according to occupancy with a potential for 100 per cent outside fresh air. This can be controlled by a carbon monoxide (CO) detector.
- Minimise the pollution introduced by bathers by encouraging them to **shower before they swim**, especially if they have been using sun lotion or oil.
- Posters in changing rooms can be helpful to discourage people with **babies** from using pools that are too big to be drained if there is a fouling accident. All **young children** should use the toilet first, shower, and wear a waterproof costume, not nappies. Nappy changing areas should be conveniently sited in changing areas with special disposal bins. These areas should be cleaned regularly and equipped with nearby sinks for washing hands.
- For information on avoiding **Legionnaires' disease** see **3.4.7**.

FIGURE 3.8 SWIMMING POOL WATER TREATMENT METHODS

Chorine

Sodium and calcium hypochlorites are the traditional treatment for pool and spa water as they are fast and effective sanitisers. Available in granular, liquid or tablet form, hypochlorite is stable enough in solution to allow a residual throughout the pool water for continued protection. Around 90 per cent or more of the free chlorine residual is used to oxidise (destroy) organic matter introduced into the pool by bathers. If it was only necessary to kill bacteria, much lower levels could be used.

- The critical issue with chlorine is to ensure that **dosing levels** are correct. Sometimes people complain about a smell of chlorine, believing the pool must contain too much. However, it is more likely that there is insufficient chlorine to destroy the **chloramines** which are the by-products of chlorination that irritate eyes and skin and cause an unpleasant smell. Levels of free chlorine should be maintained as low as is compatible with good results from microbiological testing (which should be carried out on a monthly basis as a minimum). In a well-designed and run pool, concentrations of 0.5–1 mg/litre (for chlorine gas and hypochlorites) should be sufficient. It is important to keep combined chlorine levels at less than half this level. This may involve keeping pH values down to about 7.2 to ensure the chlorine's efficacy and using extra ozone or ultraviolet plant room treatment to enhance the water quality. Because chlorine is used up more quickly in hot water, a heated pool will require more chlorine.

- There are many **health and safety** concerns surrounding the use of chlorine, some controversial and not all proven. Even though it is used in minute quantities to disinfect drinking water, chlorine is used to kill living organisms so it must be treated with respect when it comes to humans. Studies have shown that chloramines can aggravate asthma, particularly in children who use chlorinated pools frequently. Chlorinated water can contain chemical compounds called trihalomethanes which are carcinogens (cancer producing). They are caused by the combination of chlorine with organic compounds in water and can be stored in the body.

Chlorinated isocyanurates

These are organic compounds that decompose in water to produce cyanuric acid and chlorine. The most common forms are **sodium dichloroisocyanurate dihydrate** and **trichloroisocyanuric acid**, both of which are solids. They provide a reserve of free residual chlorine, but the more cyanuric acid there is, the more free chlorine is locked up as chloroisocyanurate, so automatic dosing is recommended and levels should be monitored regularly. Usually available in tablet or granular form, they are most suited to lightly-loaded pools, particularly in hard water areas.

Salt chlorination

Also known as 'in-situ' **chlorine generation** or **electrochlorination**, this process uses electrolysis to generate sodium hypochlorite from a bank of salt (sodium chloride) in the pool water via an electolytic cell. As it is depleted, the free available chlorine (FAC) reverts back to salt to be reused. The units containing the electrical cells are available in different sizes depending on the pool size and it is important to ensure that the device will generate sufficient chlorine to cope with peak loads. On occasions it may still be necessary to add additional chlorine to ensure satisfactory residual levels.

Ionisation

Ionisation was first invented by NASA to keep drinking water clean for astronauts. Ionisers comprise an electronic control unit and an assembly of copper and/or silver electrodes which introduce soluble copper and silver ions to the pool when an electric current is passed through the unit. Silver is used to control bacteria, whilst copper is an effective algaecide. Ionisation polarises the water so that particles of organic matter attract one another, becoming heavy and falling to the bottom of the pool where they are sucked away by the filter. For this reason ionised pools are often said to look cleaner than chemically treated pools. The units should be cleaned and the electrical charge monitored every day.

Because ionisation does not oxidise unwanted organic matter, some chlorine is still required, although the amount can be greatly reduced and some pool operators dispense with it completely. Salt may need to be added occasionally to help slough off the copper and silver molecules – ionisers are not suitable for use in hard water areas without first using a water softener. If the copper levels are allowed to rise above 25 ppm for an extended period the copper can discolour pool surfaces. Ionisers are available in several forms including a disc that floats on the surface of the pool.

Ozone generation

Ozone generators create ozone (O_3) by passing air through an electrically-charged chamber. Ozone, an extremely powerful oxidising agent, is unstable and must be generated at the point of use within the pool water treatment plant. Normally it is introduced after the main sand filter, where it disinfects and cleans the water and is then removed from the water by a carbon filter. Because there is no residual, the process is usually used with chlorine-based disinfectants, although it does enable the amount to be reduced significantly. Because ozone breaks down most organic contaminants, not just bacteria and pathogens, it actually improves the quality of the pool water, making bathing a more pleasant experience. However, ozone can present a health hazard if allowed to accumulate in enclosed areas. Ozone generation systems can be quite expensive to install and require strict adherence to the operating procedures.

Bromine-based disinfectants

Bromine is not as widely used for pool treatment as chlorine as it is not generally regarded as being as effective, but it is more commonly used as a biocide in spa baths. There are three basic systems:

- **Elemental liquid bromine** – which disinfects and oxidises in a similar way to chlorine but is more hazardous to use.
- **Bromochlorodimethylhydantoin (BCDMH)** – an organic compound that disinfects with a free bromine residual. As with chlorinated iso-cyanurates, the correct relationship must be kept between the disinfectant residual and the organic component for correct micro-biological treatment.
- **Sodium bromide plus hypochlorite** – a system that involves converting bromide to free bromine residual. Sodium bicarbonate solution is also added as a buffer. Bromide levels must be checked and maintained to avoid the build-up of by-products.

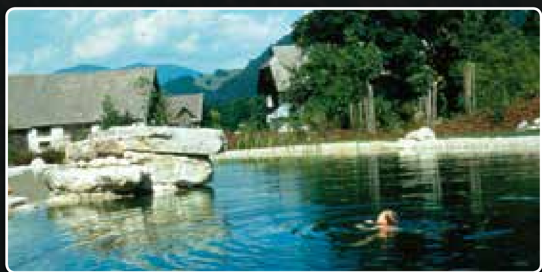
Ultra violet (uv) disinfection

As with ozone, **ultra-violet (UV) light** is used to purify the water as it passes through the plant room. Bacteria are killed when subjected to certain wave-lengths of UV light. Having UV irradiate water as it passes through a treatment chamber in the return line may kill any bacteria that pass through the chamber but it leaves no residual treatment. The process is therefore usually used with chlorine-based disinfectants, although it does enable the amount to be reduced significantly. UV is easy to install and maintain and is suitable for use in most pools.

Natural swimming pools or 'swimming ponds'

Depending on the climate, some open-air swimming pools have a short season and can look unsightly for the rest of the year. A **'natural' swimming pool** or **swimming pond**, however, looks good all the time as it is, in effect, a lake or pond built for swimming in.

Pioneers in Austria first experimented with natural swimming pools around 25 years ago. Beginning with trial and error and then using applied science, the natural swimming pool has evolved to be the first choice for many hotels, municipalities and private owners there. They are increasingly popular especially in Italy, Switzerland, Germany and even the UK.



Designed to look like a natural water body, these pools incorporate a wall below the surface dividing the body of water into two zones – one for swimming and the other for water cleaning. The bottom of the pool is sealed with a heavy-duty rubber liner. The **'regeneration'** zone includes marsh plants in a substrate of washed gravel, lime (to maintain pH), loamy sand and nutrient bond. The pool water is pumped through the substrate, which acts as a natural filter for small particles. Most of the water cleaning takes place in the micro-organisms and microbes, which break down pollutants into basic elements. The plants use nutrients from the water as food, which helps prevent algae. The cost to build is roughly comparable with a conventional pool but they can save on operation costs as no chemicals are involved at all.

The proportion of the regeneration zone of the total system alters with the size of the pool. In percentage terms, smaller pools require larger regeneration areas. Technologically-supported pool facilities are more suitable for coping with short-term peak loads such as in hotels and public facilities.

e See below for some commonly encountered terminology used in swimming pool and spa water treatment.

B

BUFFER
Sodium bicarbonate, the addition of which raises alkalinity in water.

C

CHLORAMINES
Also called **combined chlorine** – the chlorinated disinfection by-products (DBPs) that irritate eyes and skin and cause an unpleasant smell.

CRYPTOSPORIDIUM
An organism known to cause gastro-intestinal illness if present in drinking water and swimming pools. Usually spread through poor hygiene or diarrhoea. The cysts are not killed by chlorine and must be filtered out.

D

DISINFECTION
99 per cent destruction of all disease-causing bacteria (pathogens) on the object being disinfected.

F

FREE AVAILABLE CHLORINE (FAC)
Hypochlorous acid and hypochlorite available for disinfection.

O

OXIDATION
The combination of an element with oxygen resulting in destruction of the substance being 'oxidised'. Occurs when chlorine oxidises organic matter introduced by bathers into pool water. Oxidising does not necessarily equate to sanitation nor does sanitation necessarily mean oxidation. For example, potassium monopersulfate, a non-chlorine oxidiser commonly used in the pool industry, is an ineffective sanitiser whereas polyhexamethylene biguanide (PHMB) is a sanitiser but not an oxidiser.

P

PPM
Parts per million, the same as **milligrams per litre**.

R

RESIDUAL
The free and combined chlorine or total bromine left after dosing to provide continuous bacterial control.

S

SANITATION
The destruction of microorganisms to levels (usually by 99 per cent or more) deemed safe by public health standards. This is the correct term to be used for pool and spa water treatment. Achieved by using a 'sanitiser'.

STABILISED CHLORINE
Chlorine which has been combined with isocyanuric acid to protect it from UV rays which dramatically reduce its efficacy. The acid can also be added separately but levels must not get too high as this can then impede the chlorine's effectiveness.

STERILISATION
100 per cent destruction of all bacteria on the object being sterilised. This is not possible in a pool or spa as there is simply too much activity – bathers entering and leaving, changes in air volume, large spaces, etc.

T

TOTAL CHLORINE
Combined plus free chlorine.

3.3.5 Spas

In addition to examining the water-related issues created by spas, this section highlights the issues of energy use, air quality, hygiene and product sourcing – which are also fundamental to environmentally responsible spa management.

THE ORIGIN OF SPAS

The word 'spa' is often used to describe a spa pool, hot tub[5] or jacuzzi®.[6] In its broader sense however, a spa is a facility offering a much broader physical and sensory experience. The modern spa descends from the ancient practice of bathing in hot springs and mineral waters dating back as far as the Babylonians and Greeks.

The origin of the word 'spa' may be the Belgian town, Spa, or the city of Bath in England, both known since Roman times and synonymous with a place to be restored and pampered. Alternatively it could be an acronym for the Latin phrase '*sanitas per aqua*' meaning 'health through water'.[7] In the 19th century, Europe's great spas were destinations for the wealthy who went there to 'take the waters'. Water treatments are still at the heart of the spa experience in many locations.

Spas range from the 'day spa' offering therapeutic massages, facials, and body treatments such as scrubs, wraps, depilation and exfoliation to the 'destination spa' where guests immerse themselves in a total spa experience. A destination spa may offer detoxification, exercise, medical evaluations, stress management, nutrition education, healthy food, a personally-tailored treatment plan and even spiritual renewal.

Spas and 'wellness centres' are an increasingly popular antidote to the stresses of life. Operators include sports complexes, health clubs, hotels and cruise ships, and even airports (which offer 'spa services' such as massage, pedicures and facials).

HOW DO SPAS IMPACT ON THE ENVIRONMENT?

There are a number of environmental, safety and health issues involved with spa operation. These include:

- the effect of the **building design** on the environment
- **water quality** and the need to maintain a safe and healthy environment
- **water consumption** and **waste water disposal**
- the **energy** used to heat and cool water, treatment rooms and other areas of the building
- **air quality** associated with adequate ventilation and air extraction and methods of water treatment
- the content of **spa products** and issues surrounding their **disposal**.

a SPA DESIGN

- The first thing to work out is **how many people** will be using the spa and to design the facilities accordingly. The plant room for the spa pool will generally take up more space than the pool itself and this should be taken into account at the outset.
- Spa pools must have a **design bather load** appropriate to their size, use, circulation rate and turnover and this must not be exceeded.
- Ensure that the external building for the spa facility is **sensitively designed** and in keeping with the surrounding local environment. Consider building in the local traditional style.
- Use **natural systems** as far as possible in order to minimise energy used for heating and cooling. In hot climates, make use of **natural ventilation** techniques to create a through flow of air and reduce dependence on air-conditioning systems. In cool climates, use **high quality insulation** and **glazing systems** to minimise heat loss and increase daylight, and ensure that entrances and ventilation points are sheltered from prevailing winds.

[5] Hot tubs are designed for domestic use and their operation is not included in this publication.
[6] Jacuzzi is a brand name often mistakenly used as a generic term for a spa pool.
[7] **Source:** A Little Spa History, see **http://spas.about.com/cs/spahistory/a/spahistory.htm**

- **Recover heat** wherever possible. Careful siting of the plant and treatment rooms will minimise routing and ducting of services and increase heat recovery potential. Consider using extract air to reheat fresh air.
- Use **locally available, sustainably sourced materials** wherever possible and also where possible employ workers from the **local community**.
- If you are using **wood** for spa bath surrounds, ensure it is from **sustainably sourced** timber. Alternatively, investigate the use of **recycled materials**.

Apex Hotels' 'Yu Spa' includes an environmentally friendly ozone swimming pool

b WATER TREATMENT AND QUALITY

- It is important that the **source and composition** of the water used in the spa is known and can be monitored. Spa water is either naturally enhanced with minerals or they are added.
- **Legionnaires' disease** can be contracted through inhalation of droplets of contaminated water transmitted in the form of spray, particularly in showering facilities and spa pools (SEE 3.4.7). Rigorous attention to cleaning and maintenance of equipment is essential to avoid an outbreak. Showers and spa pool systems should be **regularly cleaned** and **flushed through** with a 50mg/litre chlorine solution for one hour or a 20mg/litre solution for 2.5 hours. **Supply water** for showers should be stored above 60°C, piped at 50°C and mixed at 40°C to kill *Legionella* bacteria.
- The relatively small volume of water in relation to the number of bathers means that spas can easily harbour harmful bacteria. Ensure that spa pool users **use the toilet** and **take a shower** (unclothed) before entering the water. Creams, oils and fragrances all place an additional burden on the water treatment system.
- Spa pool water must be **treated** to prevent the growth of micro-organisms that can cause stomach upsets, skin and other bacterial infections. Correctly treated water will provide a healthy and visually appealing environment for users and prolong the life of the bath and equipment.
- Bacterial control is achieved by adding a **sanitiser** (usually chlorine-based) and **filtration**. The sanitiser must leave a 'residual' in sufficient concentration to continue to protect against and destroy any harmful bacteria entering the water. The most common way of treating spa pools is by **ozonation** combined with **chlorine** or **bromine**-based disinfectants. There should be a residual concentration of 2–4mg/litre[8] if using inorganic chlorine, 3–5mg/litre for organic chlorine and 4–6mg/litre for bromine.

[8] Milligrams per litre (mg/litre) is the same value as parts per million (ppm).

- Public spa pools must be equipped with a suitable filter and operated according to the **manufacturer's instructions**. Running of the water circulation, filtration and treatment system should equate to the use of the pool. This can be done automatically with the use of variable speed pumps in conjunction with automatic water quality testing equipment.
- Disinfection and dosing are best controlled continuously by **automatic controllers**. However this does not obviate the need for manual testing.
- **Testing for pH and disinfectant values** should be carried out **three times a day**, recorded and the records retained for a period of at least five years.
- **Replace all the water** in the spa pool once the number of bathers through the pool equals half of the volume in gallons. For example a 500-gallon spa pool should be drained, cleaned and the water replaced after every 250 bather entries.
- If the water supplying the spa pool has been produced through a **reverse osmosis (RO) plant** (which may be the case in coastal areas) it **may affect the water testing** results. Consult your testing equipment manufacturer if your water is supplied through an RO system.

c WATER CONSUMPTION AND DISPOSAL

- Operating a spa involves considerable **consumption of water** per user. In locations where water is not plentiful, proper consideration needs to be given as to how this might impact upon the **availability** of water for other members of the community.
- To **detect leaks**, check the **water meter** last thing at night and first thing in the morning and carry out visual checks on all plumbing.
- Fit **water-saving** shower-heads, dual-flush toilet cisterns and push button taps in all toilet and showering facilities.
- Opportunities for **capturing and reusing** spa pool water are limited due to the concentration of chlorine or bromine. **Expert advice** should be sought if you plan to redirect backwash water to irrigate the grounds or install a grey water recycling system for flushing toilets.

d ENERGY USE

- Check energy ratings and only purchase **energy-efficient** equipment. Typically, spa pools operating for ten hours a day consume around 50kWh per day.[9]
- Use **energy-efficient** lighting with timer and motion detector devices and label light switches so that only the lights that are required are switched on.
- The **choice of heating and/or cooling system** will have a major effect on both environmental impact and operating cost. **Condensing boilers** are suitable where underfloor heating is required.
- If possible heat the spa pool at **'off-peak'** times to reduce peak loads and save money. If using electricity for heating, purchase **'green' electricity** generated from renewable sources such as wind power.
- Investigate the possibilities for using naturally-occurring **geothermal energy** to help with heating the spa area.
- Set the **thermostat** to a lower temperature during warmer months (where there are seasonal differences).
- For cooler climates **automatic door closers** and draught excluders will cut heat loss and improve user comfort. They may also help you to reduce temperature settings.
- Using a **cover** when the spa pool is not in use will help retain heat, save energy and reduce both the ventilation requirement and any likely condensation damage.
- Regular **inspection and preventative maintenance** will help keep equipment running efficiently and identify areas where performance can be improved.

[9] Based on 35kWh for electric heater, 11kWh for filter pump and 7.5kWh for the pump for the jets.

e AIR QUALITY

- Disinfection puts pollutants into the air and the levels increase with higher temperatures. The building must therefore be **properly ventilated**. Space temperature should be around 30°C and relative humidity kept to 60 per cent (plus or minus five per cent). Ventilation should be variable according to occupancy with a potential for 100 per cent outside fresh air supplied at 10 litres per second per person ($36m^3$/hour).

f SPA PRODUCTS AND MATERIALS

- Think carefully when sourcing products for use in the spa. Ensure that they are made of **natural, plant-based ingredients**, are biodegradeable and non-toxic.
- Can the products be sourced from **local suppliers** using **local ingredients**? Your choice may provide an opportunity to generate **complementary economies** in the local community with, for example, herbal medicines.
- Can you buy products in **bulk containers** to reduce the total amount of packaging? Are the containers **refillable**?
- Are the products packaged in **recycled, recyclable or reusable packaging**?
- Ensure that wraps are **disposable** or **fully sanitised** after each use. Use **biodegradable plastic** for wraps and hand and foot treatments where these are available.
- Ensure that staff follow **strict hygiene procedures**. Products can easily be contaminated through 'double dipping' implements into product containers. Products should either be emptied into individual containers for use on the client and any remaining product disposed of, or a clean spatula or implement should be used each time each product is removed from its container.
- Care needs to be taken over the **disposal** of spa products such as massage oils and preparations once they have been used. Oils and other products will find their way into the waste water stream when spa users take a shower for example, so it is vitally important that these are not discharged without proper treatment to neutralise them and remove oily waste.
- Never pour **waste massage oils** into the drains. Ensure they are collected for recycling or proper disposal by a specialist contractor.

g GENERAL CONSIDERATIONS

- Be aware of your **legal requirement** to operate spa pools and facilities safely and without danger to human health.
- All **staff** should be well-trained and competent, working to established, approved procedures under the direction of knowledgeable and responsible management. Ensure everyone clearly understands their responsibilities.
- Effective measures should be taken to ensure the **safety** of spa users, particularly those who may have physical disabilities, and to prevent unauthorised access when the facilities are not in use. Entry to the spa pool itself should be clear to users and if necessary a handrail should be installed.
- Keep **full records** of operation and maintenance. This should include all the equipment manufacturer's manuals, dates of your water treatment programme and inspection, MSDS documentation for all treatment chemicals, equipment repair and system water volume records as well as the contact numbers for the individuals responsible for maintenance and shut-down of equipment.
- Initiate a **'green team'** of individuals from different departments to ensure that the environmental issues of all aspects of the operation can be managed.
- Ensure that **drains** in wet rooms and showers are kept scrupulously clean and free from hair and other debris.
- Hand and foot bowls should be cleaned thoroughly between uses and all instruments properly **sanitised**.
- Towels should be laundered at 60°C in order to protect users against the possible transfer of **skin infections**.

- Consider the impacts associated with the laundering of clean towels and robes (in terms of **energy, water and detergent use**), whether this is carried out on or off-site. If possible encourage residential spa users to keep their robes for two to three days before laundering. For more information on towel and linen programmes **SEE 3.3.3**.

3.3.6 Gardens

Even in locations where water is plentiful, it makes financial sense to use water resources sensibly in your grounds and gardens.

a. Use **rainwater harvesting** techniques to divert and capture rainwater from roofs and gutters. Water can be diverted into underground storage tanks or into water butts. Plants actually prefer rainwater to treated water from a tap.

b. If possible, use **grey water** from baths and sinks for irrigation. Consider installing a treatment system that will enable you to use treated black water from toilets in the gardens. The treatment plant needs to be carefully positioned in relation to prevailing winds and screened from view. Management of these systems must be well controlled to avoid offensive smells and a back-up source of water must be available should there be a breakdown.

c. A well-designed and controlled **irrigation system** will deliver water when and where it is needed on a regular basis and will help plants to thrive.

d. **Do not use hoses** for watering plants and avoid the use of sprinklers on lawns if possible.

e. **Avoid using high pressure jets** to clean paving. Brushing first then rinsing with a hose on a low setting or using a watering can is often sufficient.

f. Before planting a new bed, **condition clay soils** with powdered or liquid gypsum to improve water penetration.

g. Using your own organic **compost** will add nutrients and help retain moisture in the soil by improving the structure. There are also special **polymers** which can be added to the soil mix to help retain moisture.

h. Match the **choice of plant material** to the local climate by, for example, using arid and semi-arid plants in a desert environment. Avoid laying lawns where water is scarce, and select the grass carefully – some are much better suited to hotter and drier climates. Choose ground cover or 'prostrate' plants as an alternative to laying turf.

i. **Plastic, glazed or painted pots** retain water better than clay pots as they are less porous.

j. Line **planters** with an impermeable or semi-permeable layer to cut down moisture loss.

k. **Remove weeds** regularly from garden beds as they compete with the other plants for water.

l. If a **water feature** is essential, give thought to the design and how quickly the water will evaporate – a low level 'trickle' feature will use less water than a large fountain.

SEE ALSO SECTION 9.8

Match your choice of plant material to the local climate as **indigenous plants** will thrive best

3.4 WATER QUALITY

The aim in managing your supply of drinking water and the water that is used and stored in equipment is to ensure that no environmental contamination takes place. This will reduce the likelihood of hazards to human health and prolong the life of equipment and plumbing systems by minimising corrosion, scaling and deposits.

3.4.1 Standards and compliance

The first thing is to identify the standards that are applicable to your hotel and to assess the extent to which these are being met at present. Water quality standards are set by organisations as such as the **World Health Organization (WHO)**, the **European Commission (EC)**, national and local statutory regulators, the hotel industry and your own hotel group. A list giving examples of legislation governing drinking, bathing and discharge water standards can be found in **APPENDIX 1**.

Regulations, codes and industry standards vary greatly and will have to be considered for each hotel on an individual basis. Where local standards are inferior to WHO, EC or industry standards, you should aim to attain the more stringent standards.

FIGURE 3.9 shows guidelines for permissible concentrations in potable water quality, compiled from data published by WHO,[10] and the EC.[11] More detailed information should be sought from the full documents (see footnotes below).

3.4.2 Taking remedial action

Once the standards and your compliance with them have been established, remedial action on water quality may be required. This is either an external measure, where officials at your local waterworks need to be informed of the failure in standards, or an internal matter, where local supply cannot meet your requirements. The latter may be the case where local legislation requires a lower grade of supply than your standard, or where contamination is occurring in the distribution system. A domestic treatment plant will also be required if the hotel has its own wells.

Begin by checking the proper functioning of existing water plant. Additional water treatment can be introduced to combat specific quality failures. **FIGURE 3.10** overleaf identifies some of these quality defects and techniques in their treatment.

In order to prevent corrosion, biological fouling, foaming, sealing and deposit formation, further treatment is required for non-domestic water systems such as steam boilers, hot water boilers, cooling systems (open and closed), heating systems, chilled systems, humidifiers, swimming pools/whirlpools, fountains, fire-fighting equipment, non-potable water used for irrigation and effluent treatment (general, laundry and kitchen).

Details for the required treatment, method of dosage, maintenance procedures, handling and storage of chemicals, sampling, analyses and tests may need to be discussed with a water-treatment consultant.

[10] **Source:** World Health Organization Guidelines for Drinking Water Quality **www.who.int/water_sanitation_health/dwq/gdwq0506.pdf**

[11] **Source:** Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption **http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:EN:PDF**

<table>
<tr><th>Parameter</th><th>WHO standards (mg/l)</th><th>EC parametric value (mg/l)</th></tr>
<tr><td>Aluminium</td><td></td><td>0.2</td></tr>
<tr><td>Ammonium</td><td></td><td>0.0005</td></tr>
<tr><td>Aromatic hydrocarbon (fuel)</td><td>0.001</td><td>0.0001</td></tr>
<tr><td>Arsenic</td><td colspan="2">0.01</td></tr>
<tr><td>Cadmium</td><td>0.003</td><td>0.005</td></tr>
<tr><td>Chlorides</td><td colspan="2">250</td></tr>
<tr><td>Chromium</td><td colspan="2">0.05</td></tr>
<tr><td>Conductivity ($\mu S.cm^{-1}$ at 20°C)</td><td></td><td>2500</td></tr>
<tr><td>Copper</td><td colspan="2">2</td></tr>
<tr><td>Cyanides</td><td>0.07</td><td>0.05</td></tr>
<tr><td>Hardness (as $CaCO_3$)</td><td>100–300</td><td></td></tr>
<tr><td>Iron</td><td>0.3</td><td>0.2</td></tr>
<tr><td>Lead</td><td colspan="2">0.01</td></tr>
<tr><td>Magnesium</td><td></td><td></td></tr>
<tr><td>Manganese</td><td>0.4</td><td>0.05</td></tr>
<tr><td>Mercury</td><td>0.006</td><td>0.001</td></tr>
<tr><td>Nickel</td><td>0.07</td><td>0.002</td></tr>
<tr><td>Nitrate</td><td colspan="2">50</td></tr>
<tr><td>Nitrite</td><td>3</td><td>0.0005</td></tr>
<tr><td>Organic chlorine</td><td></td><td></td></tr>
<tr><td>Pesticides</td><td></td><td>0.0001</td></tr>
<tr><td>pH</td><td>6.5–9.2</td><td>6.5–9.5</td></tr>
<tr><td>Phenols</td><td>0.001</td><td></td></tr>
<tr><td>Potassium</td><td></td><td></td></tr>
<tr><td>Silver</td><td></td><td></td></tr>
<tr><td>Sodium</td><td>250</td><td>200</td></tr>
<tr><td>Sulphate</td><td>200</td><td>250</td></tr>
<tr><td>Temperature (°C)</td><td>10–15</td><td></td></tr>
<tr><td>Total dissolved solids (TDS)</td><td>1,000</td><td></td></tr>
<tr><td>Zinc</td><td>5.0</td><td></td></tr>
</table>

NOTE: Where the figures for both organisations are the same they are shown as a single entry. A blank field indicates that no figure for permissible concentration is given, or we have been unable to find one. Figures are shown in milligrams per litre unless otherwise stated.

1 milligram per litre = 1 part per million

SOURCES: WHO standards, EC Parametric values

FIGURE 3.9
Potable water quality: permissible concentrations[12]

[12] Permissible means the **maximum** concentration for hazardous ingredients. Those which are not harmful can be expressed as a range.

FIGURE 3.10

Water quality problems and simple solutions

Problem	Treatment technique
Suspended solids	Filtration via a sand filter
High salt content	Desalination via ionic/reverse osmosis
Iron	Potassium permanganate treatment and filtration
Acidity	Removing eventual carbon dioxide and dosing of alkaline liquids (caustic soda) to increase pH
Corrosivity and scale	Adding chemicals (phosphates/silicates)
Hardness	Check the Langelier Saturation Index, and the Ryznar Stability Index to determine required degree of softening and blending for each system
High temperature	Cooling
Bacteriological contamination	Chlorination and flocculation (alum sulphate)
Odour or taste	Filtration via an activated carbon filter

3.4.3 Reducing harmful substances

You should identify any materials, chemicals and substances which are used in the hotel that may have a harmful effect on the environment. This can be done internally department-by-department, and externally by a contractor. Particular substances to look out for are cleaning agents; pest and rodent control chemicals; paints, varnishes and lacquers; solvents; maintenance chemicals – especially for water treatment; oils, greases; preservation chemicals; substances in fire-extinguishing equipment; fertilisers and washing powders.

In all cases the chemical content should be identified, and you should decide which ones can be discontinued or replaced with less harmful alternatives. Where either path is impossible, establish procedures for the handling, storage, use and disposal of those materials considered to be harmful. SEE ALSO SECTION 8

The relatively small effort of paying attention to the conservation of the quality of water benefits human health and the environment as a whole.

3.4.4 Prohibited chemicals

Certain chemicals are now prohibited in many countries and you should not use them. A list is given in **FIGURE 3.11**, although it is not exhaustive.

3.4.5 Potential hazards from physical plant

It is important to conduct an inspection of equipment and plant containing water at the property to assess any potential risks it could present to health.

a COLD WATER STORAGE TANKS

- Check that there is **no stagnant water** and that sufficient turnover is taking place. Supply and suction must be opposite at either end.
- Is any tank **isolated and not in use**? Tanks should be kept **continuously in operation** or decommissioned.
- Are there any openings that might permit **contamination**, either from airborne particles, birds, accidental damage or sabotage? Tanks should be kept locked tight.
- **Regular inspection** and **maintenance** should be carried out to detect and remove deposits on the tank floor and walls.

b HOT WATER STORAGE TANKS

- Check for **stagnant water**.
- Is any hot water tank isolated and not in use for technical or energy-saving reasons? Tanks need to be **kept in operation**.
- Can **bacteria** such as *Legionella pneumophila* develop due to favourable breeding conditions? SEE 3.4.7

PROHIBITED CHEMICALS

a WATER TREATMENT

- chromates (cooling towers)
- hydrazines (boilers)
- amines (boilers) when steam comes into contact with food

b PESTICIDES AND INSECTICIDES

SEE ALSO SECTION 8.6

Below is a list of the twelve pesticides that are not permitted to be used under the **Stockholm Convention on Persistent Organic Pollutants (POPs)**.[13] More information on these is given in SECTION 8 APPENDIX 3:

- Aldrin
- Chlordane
- DDT
- Dieldrin
- Dioxins
- Endrin
- Furans
- Heptachlor
- Hexachlorobenzene (HCB)
- PCBs
- Toxaphene

Other pesticides and substances that are prohibited or their use is restricted in many countries include:

- Anticoagulant concentrate
- Arsenic
- Captafol
- Carbaryl
- Cyanit
- Dinosep
- Sodium fluoro acetate
- Lindane
- Mercury
- Methyl bromide
- Phosphorus
- Polychlorinated Biphenyls (PCBs)
- Thallium sulphate
- Zinc phosphate concentrate

c CLEANING CHEMICALS

SEE SECTION 8.4

FIGURE 3.11
Prohibited chemicals

[13] See www.pops.int

c WATER SYSTEMS

- Are there any **cross-connections** with other non-domestic systems? If so, remove them.
- Is any **back-siphoning** possible from domestic or feed connections to other systems? Check:
  - the cooling tower
  - humidifiers
  - feedwater tanks
  - fountains
  - bidets.
- **Modify** the installation accordingly. Install a vacuum-breaker.
- Are there any **dead-legs** where stagnant water can be harboured? Isolate or integrate them into the system flow.
- Are any materials present that are **hazardous to health** such as lead or asbestos? These may need to be removed. SEE SECTION 8.7
- Are **grease traps** installed in all waste pipes from kitchens? Where they are missing, install them.
- Can the **non-potable** water supply (used for irrigation) be accessed by guests or employees? Make sure it is secured through a lock, padlock or other means.
- Are you making unnecessary or excessive use of **water softeners**?

d OTHER PLANT

- Check for **leaks or spills** from fuel oil storage tanks.
- Are there any **PCBs** in transformers or capacitors? SEE SECTION 8.8
- **Trihalo-methane** (chloroform, etc.) in pool water can be removed by adding flocculants such as sodium chlorite ($NaClO_2$) before filtration.

3.4.6 Assessing operating procedures

You also need to check that your operating procedures are such that they do not pose a hazard through water contamination. Check internally department-by-department. In particular, look at:

- **a** **disposal practices**
- **b** operation, maintenance and regular cleaning of **grease traps**
- **c** handling, storage and use of **chemicals**
- **d** **winter use of salt** to thaw ice and snow.

Any harmful operating procedures should be eliminated or reduced and replaced with alternative methods.

3.4.7 Precautions against *Legionella pneumophila*

Legionella pneumophila is a bacterium that is widespread in natural sources of water and also exists in building water services. It colonises hot water recirculating systems, particularly large complex systems such as those found in hotels. It is thought to reach these systems through low-level contamination of the public water supply, through wind-blown droplets reaching open tanks and cooling towers, or through pipework being contaminated during building construction. Sludges – such as iron oxide – in the bottom of calorifiers and elsewhere allow the bacterium to multiply.

Susceptible people who inhale very small droplets of water contaminated by *Legionella* can develop a form of pneumonia, which can be fatal. Several conditions must be met for this to occur: the *Legionella* must be virulent and present in sufficient numbers to cause infection; it must be carried to the host without too much injury during transport; it must reach the deepest part of the lungs; and the host's defence system must he unable to stop the infection.

The bacteria are difficult to eradicate completely, so prevention takes the form of minimising the concentration of the bacteria in the water and preventing the occurrence of very small droplets.

The temperature of stored water is critical. The optimum temperature for the bacterium to multiply is 37°C, but it ceases at 45°C although it will survive at higher temperatures – a matter of hours at 50°C and a matter of minutes above 60°C. It remains dormant below 20°C. A rise in temperature from the level where it is dormant to that where it is favourable causes active multiplication.

The following actions will help prevent an outbreak of *Legionella*:

a SYSTEMS AND TANKS

- Systems should be designed with **short pipe runs** and no 'dead legs'.
- Tanks should be connected in series to **eliminate stagnant water**.
- **Non-metallic tanks** made of fibreglass or rubber tank linings are recommended.
- **Cold water** should circulate at temperatures below 20°C, and cold water services should not be placed near heat sources.
- **Hot water** should be stored above 60°C and circulated above 50°C. Calorifiers and hot water pipes should be lagged to ensure that these temperatures are maintained.
- All **newly installed pipework** for hot or cold water services should be sterilised on commissioning and before being brought into use.
- **Inspect storage tanks** and **calorifiers** annually, remove all sludge, scale and sediment and sterilise before bringing back into use.
- **Shower heads** should be routinely de-scaled and disinfected.

b COOLING TOWERS

- Cooling towers should be **sited** as far away as possible from air-conditioning and ventilation inlets and from opening windows and occupied areas. They should be constructed to facilitate cleaning and maintenance and use materials which do not promote bacterial growth.
- Cooling systems should have an established **water treatment programme** to monitor, log and control scale and corrosion. Complementary biocides should be used alternately for weekly shock treatment. Constantly blow-down to limit the concentration of salts.
- **Checks** for *Legionella* should be conducted at six-monthly intervals.
- All cooling systems should be **stripped down, cleaned and disinfected** at least twice a year in addition to regular water treatment.
- Disinfection is generally by **chlorination** so that a level of at least 20 ppm of free residual chlorine is maintained for a given period in cooling towers and higher levels for storage tanks.
- Particular care is needed when **standby supplies** are brought into service in case these are themselves contaminated.

c WATER TREATMENT

- Water treatment activities should be carried out only by **suitably trained personnel** using the appropriate safety equipment. This includes wearing protective clothing and having first aid facilities available. Care should be taken to avoid damage to catering and other equipment which may be affected by the chlorination process.
- **Effluent** from cleaning and maintenance should be neutralised by a hose and run off to a foul sewer, after having received permission to discharge to sewer from the relevant authorities.

3.5 WASTEWATER TREATMENT

3.5.1 Why is wastewater treatment important?

a. Inadequately treated wastewater poses a serious **threat to human health** and can lead to the spread of diseases such as typhoid and cholera. Raw sewage should never be released anywhere except to a dedicated local sewage treatment system or septic tank.

b. **Environmental legislation** is becoming tighter and more likely to be accompanied by fines and prosecution – 'the polluter pays' principle. Offenders are increasingly likely to be held liable for compensation for damage caused by discharges to groundwater and the aquatic environment.

c. **Regulations and standards** for effluent discharge into water vary around the world. In all countries a Biochemical Oxygen Demand (BOD) level will be specified for the quality of wastewater that you finally discharge to the sewer or aquatic environment. Many countries also specify other criteria, and the amount of water you consume and its relative level of contamination will dictate how easily you meet them. Ask your local authority, water company or appropriate government department for the standards with which you must comply. If local standards are not very stringent, aim to meet those laid down by the World Bank for liquid effluent and treated wastewater for irrigation. SEE FIGURES 3.12 AND 3.13

d. **Health complaints** such as stomach upsets, vomiting or ear and skin infections caught from swimming in polluted water could shut down your operation and threaten the **reputation and viability** of the resort. In some countries, tour operators now check fresh and wastewater management processes as a core part of their contract arrangements.

e. **Pollution of the aquatic or marine environment** can cause outbreaks of algae or 'red tides', and can damage unique and important resort features such as coral reefs.

f. There are serious **shortages of clean fresh water** in many tourist areas. Depletion of water resources leads to desertification and degradation of other natural environments. Reusing treated wastewater reduces the volume of fresh water used and helps to preserve fresh water environments.

g. Up to 50 per cent of water can be recycled and reused through investment in wastewater management systems. This will improve your **security of supply**, particularly in water-stressed areas or during periods of peak demand. It can also produce considerable **cost savings**.

h. Minimising wastewater that has to be treated through public facilities **reduces energy and chemical use** and the need for **public infrastructure**.

3.5.2 Wastewater treatment techniques

For more information on the different wastewater treatments available, SEE FIGURE 3.14 overleaf.

3.5.3 Installing a treatment system – issues to consider

a. Treatment systems that use **natural** rather than chemical processes are suitable where the discharge water is going directly into the environment (such as via a reed bed or pond) However, if guests and clients are likely to come into contact with wastewater, through water-sports for example, chemical treatment of the discharge water will be necessary in order to kill off any harmful pathogens.

Pollutant	Unit	Guideline value
pH	pH	6–9
BOD (Biochemical Oxygen Demand)	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/100ml [15]	400
Temperature increase	°C	≤ 3
Total residual chlorine	mg/l	0.2

SOURCES: INTERNATIONAL FINANCE CORPORATION ENVIRONMENTAL, HEALTH, AND SAFETY (EHS) GUIDELINES APRIL 2007: WASTEWATER AND AMBIENT WATER QUALITY AND WORLD BANK POLLUTION PREVENTION AND ABATEMENT HANDBOOK 1998

FIGURE 3.12
Indicative values for treated sanitary sewage discharges[14]

Pollutant	Unit	Guideline value
Coliforms	Geometric mean no. per 100ml	≤ 200
Intestinal nematodes	Arithmetic mean no. of eggs per litre [17]	≤ 1

SOURCE: WHO GUIDELINES FOR THE MICROBIOLOGICAL QUALITY OF TREATED WASTEWATER USED IN AGRICULTURE, BULLETIN OF THE WORLD HEALTH ORGANIZATION, 2000

FIGURE 3.13
Guidelines for treated wastewater used for irrigation of hotel lawns and gardens[16]

b. There are a variety of **packaged systems** on the market suitable for installation within hotel grounds. They need not be highly **visible** and, if they are operating correctly, will not create **odours** or excessive **noise**. Ideally the system should be able to treat all of the hotel's wastewater and generate effluent of sufficiently high quality for reuse for irrigation.

c. **Grey water systems** enable up to 50 per cent of wastewater to be returned to the hotel after treatment for toilet flushing. Because of the separate pipe-work involved, grey water systems are expensive to install and chemical treatment of the recycled water is necessary for health and safety reasons. They are therefore best designed into the building at the outset, although increasingly hotels are choosing to retrofit them because of the savings to be made. **Payback time** is difficult to calculate, as it will depend on the type of systems installed and the relative cost of the potable water to that of the reuse water. The payback can be anything from two to fifteen years depending on the cost of water at your location.

d. **Accurate design information**, sizing, adequate safety factors, flow control and correct installation are all essential factors if the system is to operate successfully. The energy consumption of the plant itself should also be taken into account when assessing systems.

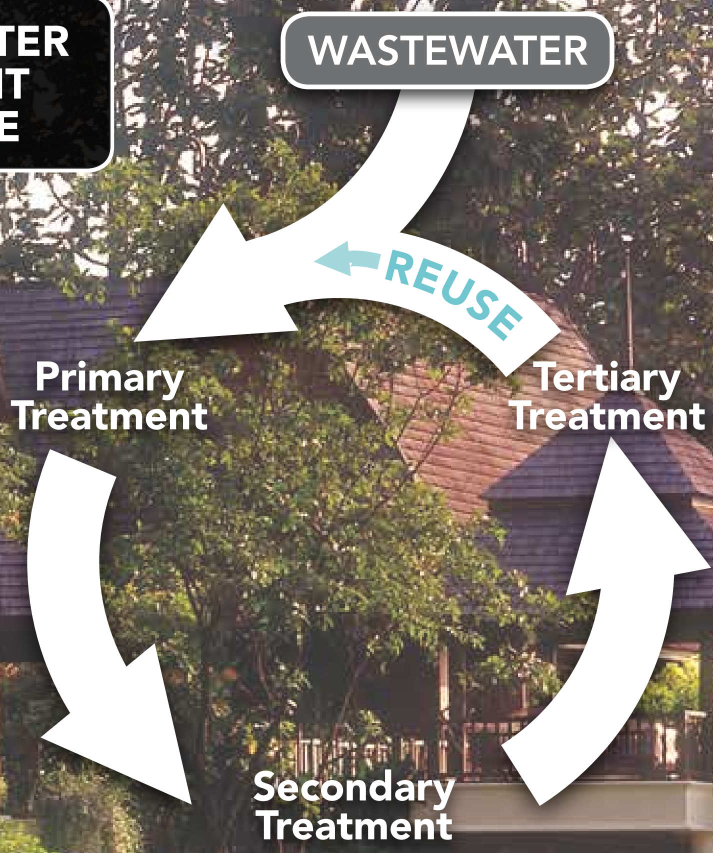
[14] Not applicable to centralised, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation.

[15] Most probable number (MPN).

[16] Note these figures are not applicable for irrigation of fruit and vegetables for human consumption.

[17] During the irrigation period.

FIGURE 3.14 **WASTEWATER TREATMENT AND REUSE**



Preliminary treatment

This initial stage screens out debris such as sticks, rags, large particles and other items that may have found their way into the system, in order to protect the pumping and other equipment in the treatment plant. It uses equipment such as bar screens, grinders and grit chambers. The debris that is collected is usually disposed of in landfill.

Primary treatment

Process by which the sewage is usually first screened for large debris and then allowed to settle in sedimentation tanks so that suspended solids and greases separate from the wastewater. The sludge is removed from the bottom and disposed of in various ways whilst floatable solids, oil and grease are skimmed off the surface. Conventional primary settlement removes 25–40% of the BOD and 40–60% of the total suspended solids. It reduces faecal coliform levels by 45–55%.

Systems available

SEPTIC TANKS

These typically hold solids in a tank while liquids are drained off to feed local vegetation or into soakaways. In sensitive ecosystems, liquids can be collected in holding pools for treatment prior to discharge. They usually require periodic emptying by a registered contractor.

Suitable for smaller hotels and guest houses, septic tanks can be installed for the lowest initial cost. However, they do not provide effluent that can be reused easily and so offer limited payback. They can be bought cheaply in packaged form and require minimal management. Micro-organisms are essential to breaking down the solid waste so careful management of chemical inputs is critical.

COMPOSTING TOILETS

Suitable only for small-scale use, these toilets can be an inexpensive alternative to septic tanks. They impact less on the landscape and have a low management requirement.

Composting toilets reduce the bulk of waste and transform it into a high-nutrient compost which can be used for agricultural purposes.

Ventilation is required (which can be via a small solar-powered fan). These systems work most effectively in warm atmospheres as they require heat to breed the necessary micro-organisms to break down the wastes.

Shown here in the background, the **Four Seasons Chiang Mai** utilises a waste water treatment plant from which water is pumped into the resort's gardens and to its rice fields, where a family of water buffalo grazes. The rice is harvested three times a year and collected in a barn for donation to local charities and temples.

Secondary treatment

Biological treatment process to further reduce the solids through the action of bacteria and other micro-organisms. Oxygen is critical to this process. Three approaches are used: fixed film, suspended film and lagoon systems. Secondary (or biological) treatment gives an 85–95% reduction in BOD and suspended solids, and removes 90–99% of coliform bacteria. Generally, the cleaner the effluent, the greater the amount of sludge produced. However, even effluent from a plant using secondary treatment can be harmful to aquatic life because it can remain high in ammonia, which is toxic to fish and other marine organisms. There is usually a settlement tank after this process.

Systems available

NATURAL WASTEWATER TREATMENT

Natural systems for wastewater treatment are also known as rootzone or wetland systems. They use natural vegetation to break down wastes in a cascade and need to be individually designed to fit the particular ecosystem. In this way they can be designed into the landscape, making them a feature in their own right.

Natural effluent treatment systems are fairly expensive to construct and need a large amount of space. Once installed, they can operate for many decades with low maintenance requirements and no chemical input. In some cases, they also provide a crop (of reeds or other plant species) which can be used for commercial purposes.

Suitable for isolated, rural areas with no access to main drainage, these systems must be carefully designed to avoid excessive run off from nearby areas of hard-standing or fields treated with agri-chemicals which may contaminate the system.

ROTATING BIOLOGICAL CONTACTORS (RBC)

This technology has been available for more than 30 years and provides effective treatment for wastewater. Systems can be installed in close proximity to the hotel and the only evidence of their existence is pipe-work and tank exteriors which are raised by one to five metres. They can be purchased as packaged systems and installed by specialists to suit the operating requirements of a wide range of environments. As with submerged aerated filters, they produce sludge which needs to be removed periodically.

ACTIVATED SLUDGE

This is a widely used, older technology with many variants, including Sequencing Batch Reactors (SBR), Extended Aeration and Deep Shaft (for large city installations). The activated sludge process produces a high quality effluent and is more typically used for larger populations in towns and cities. The sludge produced by these systems must be removed periodically.

SUBMERGED AERATED FILTERS

These systems can be bought as packaged systems and installed by specialists to suit the operating requirements of a wide range of environments. Typically they fit into the basement or a dedicated small treatment area away from the hotel.

These systems may require a chemical input, but are fairly energy efficient to operate. They produce some sludge which needs to be removed periodically. Sewage sludge usually contains bacteria, viruses, household chemicals and nutrients that can be harmful to the environment in large doses. Properly digested and stabilised sludge can be safely disposed of in agricultural areas or government designated disposal sites with the proper consents.

In some countries the sludge is dried and used as fertiliser within the hotel gardens with certain safeguards, but in others it is considered hazardous waste and must be disposed of accordingly.

Tertiary treatment

Focuses on removal of disease-causing organisms from the water and improving the quality of secondary treated effluent. Methods include slow and high-rate sand filtration, microstraining, chemical precipitation, reed beds, lagoons, carbon adsorption, membrane treatment (ultra-filtration/reverse osmosis), UV treatment and chemical disinfection. May be followed by advanced treatment to remove nutrients from wastewater.

Systems available

SAND FILTRATION

Removes much of the residual suspended matter to create effluent that is very low in turbidity and bacteria.

MICRO FILTRATION (MF)

Less common in hotels, these systems pass wastewater through an extremely fine membrane which actively filters bacteria from the effluent. It may be necessary to undertake tertiary treatment of the effluent with chlorine or with strong UV light to kill pathogens.

ULTRA FILTRATION (UF)

A filter system finer than MF which filters bacteria and viruses from the effluent. Generally disinfection chemicals are only used to prevent re-growth in the system.

IONISATION

Ionisation systems replace chemicals in conventional treatment systems with an electrical current that kills off harmful pathogens.

CHLORINATION

Chlorine is a common method for the disinfection of wastewater, although it is not permitted in some countries as chlorination of residual organic material can generate chlorinated-organic compounds that may be carcinogenic or harmful to the environment. Since residual chlorine is toxic to aquatic species, the treated effluent must also be chemically dechlorinated which adds to the complexity and cost of treatment.

ULTRA VIOLET (UV) DISINFECTION

These systems use ultra violet (UV) lamps, similar to those used in sunbeds, to kill the bacteria present in the water. They can be effective on a small scale and are environmentally preferable as they do not require any chemicals for their operation. They do, however, have an energy requirement which can add to a hotel's costs.

Properly maintained, they are as effective as other treatment systems, but may require chemical back-up if treated effluent is discharged close to a water body which is used for recreational use. Effluents need to be carefully assessed for how successfully they can be treated.

Reuse

After tertiary treatment, water can be used for irrigation of the hotel grounds or returned to the grey water recycling plant.

- **e** In **selecting a system** or briefing a consultant or engineer you must ensure that regulatory standards can be met in both **high and low season periods**. This is one of the most difficult aspects to cater for in resorts. Some systems are designed to maintain a consistent flow during peak periods with streams which can be shut down to save running costs during periods of lower occupancy. Most local authorities or water companies have an individual responsible for wastewater discharges to the aquatic environment and it may be useful to discuss any plans for a new treatment system with them.

- **f** Study the claims which suppliers make carefully and look out for internationally-accepted **ISO 9001 and ISO 14001** certifications. Also check with your environmental protection agency that the system will enable you to comply with the appropriate water pollution legislation and regulations, even accounting for seasonal fluctuations.

- **g** All systems require careful management of **inputs into the wastewater cycle** and careful checking of treated effluent. Excessive use of chemicals such as bleach will kill the micro-organisms that break down the effluent. Do not use them unless absolutely essential, and if you do, it is better to use small diluted amounts more regularly rather than shock doses.

- **h** Many treatment plants cannot break down grease properly, so well-designed **grease traps** must be properly installed. All effluent from kitchens should pass through grease traps. It is also worth considering dosing sinks and drains with enzymes to prevent the build-up of fats in waste pipes and drains.

- **i** All wastewater treatment systems require management by **skilled operatives** and **regular inspection and maintenance** is essential. The effectiveness of your system can be affected by a number of factors and care should be taken to prevent kitchen oils and fats, food waste, pesticides, fertilisers, chemicals, diesel oil and paints and cleaning cloths from entering the system.

- **j** **Staff** should be trained and should fully **understand** how to optimise the processes involved and avoid wasting cleaning products. Check whether the company you use provides full and adequate training.

- **k** **Liquid effluents** should be **monitored daily** for pH and chlorine and weekly for all other parameters. This data should be analysed to ensure that it conforms to operating standards and any corrective measures taken. It is particularly important to monitor **effluent from the laundry** and correct the pH (acid/alkalinity) if it is outside the permissible range.

- **l** Some reuse treatment systems using either grey water or treated black water can produce a slightly stale smell in rooms if used for WC flushing. Check with the supplier/manufacturer if they incorporate **odour-reducing** equipment.

- **m** Ensure that your system supplier can provide **technical and engineering support**.

- **n** Ask whether the supplier will remove any **sewage sludge** or whether they can recommend a company which will carry this out.

- **o** Any **temperature increase** in discharged treated wastewater should be no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, this distance should be taken as 100 metres from the point of discharge.

- **p** Treated wastewater contains **dissolved salts** which are difficult to remove. The soil type needs to be taken into account if treated wastewater is to be used for irrigation as salt build-up can lead to problems over time. Salt is less likely to accumulate in fast draining soils.

- **q** **Chlorination** should not be considered as a first option for disinfection as it is difficult to maintain a uniform and predictable level of disinfecting efficiency. Not only will it be expensive to operate, but chlorinated, organic by-products may be toxic, mutagenic or carcinogenic. Its use is not permitted in some countries.

3.5.4 Common terms used in wastewater treatment

A

AERATION TANK
Chamber used to inject air (oxygen) into water.

AMMONIACAL NITROGEN
Highly toxic to the aquatic ecosystem and more difficult to treat than simple BOD. Typically, levels of ammoniacal nitrogen are high from hotel establishments due to food preparation and bars.

B

BLACK WATER
Water that contains animal, human or food waste.

BIOCHEMICAL OXYGEN DEMAND (BOD)
Also known as the organic load. A measure of the oxygen needed by micro-organisms to break down the organic matter in the waste water. These organisms absorb more oxygen from the receiving water body if it has a high bio-chemical content, depleting the amount available for other aquatic life.

C

CHEMICAL OXYGEN DEMAND (COD)
Indicates the oxygen concentration required in order to oxidise all the carbon compounds in the sample.

COLLOIDAL SOLIDS
Very small, finely divided solids (which do not dissolve) that remain dispersed in a liquid for a long time due to their small size and electrical charge.

D

DISCHARGE LICENCES OR CONSENTS
Targets set by the local authority on discharges. Typically, this may be expressed as 20:30 with 20 referring to milligrams per litre of BOD and 30 to milligrams per litre of suspended solids. With ammonia consents becoming more common, there may be a third figure e.g. 20:30:10. This relates to the amount of ammoniacal nitrogen permitted in milligrams per litre. Domestic raw sewage equates to around 300 BOD, 250 suspended solids and 35 ammoniacal nitrogen.

E

ESCHERICHIA COLI (E.COLI)
Present in both human and animal faeces. Its presence in water indicates the likelihood of more dangerous strains of bacteria.

G

GREY WATER
Waste water from kitchens, bathrooms, and laundries.

H

HELMINTH STANDARD
Indicator for all large pathogens (that settle readily) including the protozoa *Amoeba* and *Giardia*.

HOLDING TANK
A tank designed to hold sewage for a certain period so that the discharge rate can be evened out during that time.

P

PATHOGEN
Infectious, biological agent (germ) that causes disease or illness.

R

REVERSE OSMOSIS (RO)
Filtration process by which waste water moves through a membrane against the concentration gradient.

S

SLUDGE
A mixture of solids and water produced during the treatment of sewage.

SUSPENDED SOLIDS (SS)
Particles that can be observed in the water. They coat the surface of plant life and inhibit photosynthesis.

T

TURBIDITY
An indicator of water quality. A cloudy appearance often indicates the presence of colloidal solids which may be harmful to human health. Turbidity can also be indicative of silt or clay particles, discharge of sewage, or of the presence of large numbers of micro-organisms.

W

WASTEWATER
Spent or used water which contains dissolved or suspended matter.

WATER POLLUTION
The presence of sufficient harmful or objectionable material to damage the water quality.

3.6 MORE INFORMATION

3.6.1 Contacts

1. Association of Pool & Spa Professionals (APSP)
   www.theapsp.org
2. British International Spa Association (BISA)
   www.spaassociation.org.uk
3. BSRIA
   www.bsria.co.uk
4. Building Research Establishment (BRE)
   www.bre.co.uk
5. Envirowise
   www.envirowise.gov.uk
6. European Working Group for Legionella Infections (EWGLI)
   www.ewgli.org
7. Health Protection Agency
   www.hpa.org.uk
8. Health and Safety Executive (HSE)
   www.hse.gov.uk
9. International Spa Association (ISPA)
   www.experienceispa.com
10. Netregs
    www.netregs.gov.uk
11. Pool Water Treatment Advisory Group (PWTAG)
    www.pwtag.org
12. The Chartered Institution of Water and Environmental Management (CIWEM)
    www.ciwem.org
13. The Swimming Pool and Allied Trades Association (SPATA)
    www.spata.co.uk
14. Swimming Pool and Spa Alliance (Australia)
    www.spasa.org.au
15. UK Environment Agency
    www.environment-agency.gov.uk
16. US Environmental Protection Agency (US EPA) Office of Wastewater Management
    www.epa.gov
17. Water Quality Association
    www.wqa.org
18. World Health Organization
    www.who.int
19. Green Hotelier
    www.greenhotelier.org

3.6.2 Resources

1. Drinking water contaminants
   www.epa.gov/safewater/contaminants/index.html#primary
2. European Guidelines for Control and Prevention of Travel Associated Legionnaires' Disease
   osha.europa.eu/data/links/the-european-guidelines-for-control-and-prevention-of-travel-associated-legionnaires-disease
3. L8 The Control of Legionella Bacteria in Water Systems
   www.hse.gov.uk/legionnaires/index.htm
4. Management of Spa Pools: Controlling the Risks of Infection
   www.hse.gov.uk/pubns/spalegion.pdf
5. Ohio State University Fact Sheet - Wastewater Treatment Principles and Regulations
   http://ohioline.osu.edu/aex-fact/0768.html
6. Pool and Spa Advice
   www.poolandspaadvice.co.uk
7. Rainwater and greywater in buildings: project report and case studies
   www.bsria.co.uk/information-membership/bookshop/publication/rainwater-and-greywater-in-buildings-project-report-and-case-studies/
8. Reed Bed Wastewater Treatment The Chartered Institution of Water and Environmental Management (CIWEM)
   www.ciwem.org/policy-and-international/current-topics/water-management/reed-bed-wastewater-treatment.aspx
9. Swimming Pool Water: Treatment and Quality Standards
   www.pwtag.org
10. International Finance Corporation Environmental, Health, and Safety (EHS) Guidelines: Wastewater and Ambient Water Quality
    http://bit.ly/SAke3O
11. Water, Sanitation and Health
    www.who.int/water_sanitation_health/en
12. US EPA Water Sense (and Ho2el Water Challenge)
    www.epa.gov/watersense
13. The Travel Foundation Greener Accommodations Toolkit
    www.thetravelfoundation.org.uk/green_business_tools/category/tools_for_accommodation_providers
14. Tourism Concern, Water Equity in Tourism
    www.tourismconcern.org.uk/wet.html

APPENDIX 1 Water quality laws and standards

The list below gives some of the legislation, regulations and standards governing water quality. It is not comprehensive and you should check with your local environmental agency to ensure that you are aware of all legislation and standards applicable to your operation.

1. **EU legislation on water**
   europa.eu/legislation_summaries/environment/water_protection_management/index_en.htm
2. **US legislation on water**
   water.epa.gov/lawsregs/
3. **WHO Guidelines on Water, Sanitation and Health**
   www.who.int/water_sanitation_health/en/

APPENDIX 2 Threats to water quality

GROUNDWATER – QUALITY AND QUANTITY

Groundwater is the major source of supply for many people. However, in too many locations extensive exploitation has already led to a reduction of the groundwater table. At lower levels more salts go into solution, and, with increasing acidity (caused by acid rain), more metals. With less water available at the surface level, roots of plants no longer get sufficient water, which can eventually cause once fertile land to turn into an arid wilderness. The lack of groundwater in turn forces us to replenish previously good quality water with polluted river or lake water. Agricultural wastes, polluted rain water and accidental spills contribute further to the contamination of groundwater. The result is a higher turnover rate of the aquatic cycle, with more and more contaminants entering the groundwater – a vicious circle.

Forests influence nature's storage capacity and discharge flows by acting as huge filtration plants. Substances are partially removed and chemically modified, and partially absorbed. When forests die or are cut, the aquatic cycle is interrupted. The results are a faster flow of water in rivers, with less water available to feed groundwater, and loss of filtration. Ultimately the depletion of forests contributes to climate change as trees are an important mechanism for absorbing the greenhouse gas CO_2.

FACTORS THAT AFFECT WATER QUALITY

Stresses on water differ substantially in their form and ecological effects. They fall into the following four major categories:

1. BIOLOGICAL

- (a) Easily biodegradable compounds and nutritive substances
- (b) Non-biodegradable organic compounds
- (c) Microbiological substances

2. CHEMICALS (INORGANIC)

- (a) Essential elements and salts
- (b) Non-essential elements and toxic substances

3. WASTE HEAT

4. RADIONUCLIDES

1. BIOLOGICAL

(a) Easily biodegradable compounds and nutritive substances

Compounds that biodegrade easily are mainly organic ones. Bacteria in nature and in sewage treatment plants digest organic matter as food in the presence of oxygen (aerobic digestion). Phosphate and nitrogen-rich (eutrophic) water can lead to an explosive growth of algae, which leads to a loss of the oxygen required for the aerobic digestion of organic matter. The cleaning mechanism of the bacteria cannot work any more, leaving organic matter in suspension.

Anaerobic (without oxygen) bacteria now start absorbing organic matter at a much slower rate, with the formation of ammonia, hydrogen sulphide and methane. The ecological system dies and with it its living species, including fish.

Hotels release considerable amounts of organic waste into the sewerage system. Oils and meat (especially blood) create very high organic loads.

The loading of water with organic waste is measured in terms of its biochemical oxygen demand (BOD).

(b) Non-biodegradable organic compounds

These substances are synthetic organic compounds – chemicals synthesised from carbon and other elements such as hydrogen, nitrogen, or chlorine. They do not occur naturally, but are manufactured to meet hundreds of needs in our daily lives, ranging from moth balls to hair sprays and cleaning agents to pesticides, and they are of increasing concern. Synthetic organic compounds remain in the water and reach other ecological systems, such as rivers, lakes, oceans and the soil, from which they come back through the food chain (via fish, meat, vegetables and fruit) in concentrations that can increase a thousandfold or a millionfold.

These substances include those shown in the following table:

APPENDIX 2
.../continued

CHLORINATED HYDROCARBONS*:
- pesticides: DDT, lindane
- solvents: chloroform, tetrachloroethylene
- polychlorinated hydrocarbons
- PCBs **SEE SECTION 8**

POLYCYCLIC AROMATIC HYDROCARBONS (PAH):
- benzo(a)pyrene

HALOGENIC HYDROCARBONS
(compounds of fluorine, iodine, bromine and chlorine with hydrocarbons)

CFCs

TRIHALOGENATED METHANE (THM) which forms by chlorination:
- chloroform
- bromoform

BROMODICHLORO-METHANE:
- dibromiochloro-methane

TENSIDES
(washing powder)

COMPLEX COMPOUNDS (INCLUDING EDTA, NTA) contained in:
- washing powder

CLEANING AGENTS

MEDICINE

FOOD

COLOURING AGENTS

PLASTIC

PHOTOGRAPHIC MATERIALS

* **CHLORINATED HYDROCARBONS CAUSE ACUTE OR CHRONIC DAMAGE AND TERATOGENIC, MUTAGENIC AND CARCINOGENIC EFFECTS.** THEY DO NOT DECOMPOSE IN WATER, BUT ACCUMULATE IN THE FATTY TISSUES OF ANIMALS AND HUMANS. THEY ALSO REDUCE THE CAPACITY OF WATER-TREATMENT PLANTS (ACTIVATED CARBON), WHICH ARE DESIGNED TO RETAIN OTHER CRITICAL SUBSTANCES. IN COMBINATION WITH CHLORINE (A COMMON METHOD OF WATER TREATMENT), THEY CAN TURN INHERENTLY HARMLESS SUBSTANCES INTO POTENTIAL CARCINOGENS.

c Microbiological substances

Bacteria, which can cause diseases, such as Legionnaire's, or epidemics such as gastro-enteritis or salmonella food poisoning.

2. CHEMICALS (INORGANIC)

a Essential chemicals

Many elements contained in water are desirable and even essential for the mineral metabolism of the body, so long as they do not exceed certain limits. These include:

Chromium (Cr)	Fluorine (F)
Copper (Cu)	Sodium (Na)
Iron (Fe)	Potassium (K)
Manganese (Mn)	Calcium (Ca)
Selenium (Se)	Magnesium (Mg)

However, in larger quantities they may be hazardous to health:

- Chromium and selenium are strong poisons and can cause liver and kidney damage.
- Fluoride (the reduced form of fluorine) is essential to healthy teeth, but larger quantities attack the nervous system and cause osteosclerosis.
- Sodium is important for the body's metabolism. In larger quantities it causes high blood pressure and heart and kidney problems, the latter particularly in children. A maximum content of 20 ppm or mg/litre in drinking water is considered acceptable. Most public supplies are within this range, except, for example, in some countries that use desalinated sea water for their drinking water supplies in which case it can reach 200 ppm.

Softeners, installed in many hotels for the purpose of preventing scale deposits, increase the sodium content considerably. Depending on the hardness of the water, the calcium and magnesium salts that are important for health* become sodium salts. The hardness of most waters is in the range 100–300 ppm. After softening, water is blended to approximately 60–80 ppm hardness. The resultant sodium content has now increased from 20 ppm originally to 80–350 ppm:

1 calcium-ion = 1.15 sodium-ion
1 magnesium-ion = 1.92 sodium-ion

Many mineral waters contain high sodium concentrations of well over 20 ppm.

* **CALCIUM AND MAGNESIUM ARE VERY IMPORTANT ELEMENTS FOR BONES AND TEETH (Ca) AND THE METABOLISM (Mg).** MANY PEOPLE SUFFER FROM INSUFFICIENT QUANTITIES.

APPENDIX 2

.../continued

b Non-essential chemicals

Substances with poor decomposition abilities are salts, heavy metals and also radionuclides. Some of them are dangerous to health:

CHEMICAL		POTENTIAL HARM CAUSED
ELEMENTS	Aluminium (Al)	
	Arsenic (As)	can cause cancer and other serious diseases
	Cadmium (Cd)	liver damage
	Lead (Pb)	damage to haemoglobin, nervous system and brain
	Mercury (Hg)	severe damage to kidney, liver, nervous system
	Nickel (Ni)	lung cancer
	Phosphorus (P)	
	Silver (Ag)	
SALTS	Sulphates	
	Nitrates	Nitrates convert to nitrites* in galvanised piping, food and the body
	Cyanides	Cyanide is a quick acting poison
	Phosphates	
MINERALS	Asbestos	SEE SECTION 8.7

* **NITRITES CAUSE CYANOSIS (DUE TO THE INABILITY OF THE BLOOD TO ABSORB OXYGEN).** NITRITE THEN REACTS FURTHER WITH AMINES WITHIN THE STOMACH TO FORM CARCINOGENIC NITROSAMINES.

3. WASTE HEAT

Water discharged to watercourses (e.g, from factories and other industrial processes) that is of a higher temperature than that of the water into which it is discharged can cause thermal pollution, which can lead to problems such as algal blooms.

4. RADIONUCLIDES

Radionuclides are also known as radioactive isotopes or radioisotopes, and play an important part in the technologies that provide us with food, water and good health. However, they can also constitute real or perceived dangers.

Radionuclides are used in food preservation to stop the sprouting of root crops after harvesting, to kill parasites and pests, and to control the ripening of stored fruit and vegetables. They also perform an important role in agriculture and animal husbandry helping to improve crop yields, disease and weather-resistant varieties, the study of how fertilisers and insecticides work, and the production and health of domestic animals. They are also found in smoke detecting equipment.

If radionuclides are released into the environment, through accident or poor disposal for example, they can potentially cause radioactive contamination which is harmful to human health.

APPENDIX 3 Water treatment

LIMIT VALUES

A limit value defines the maximum concentration level of a substance, below which undesirable effects on the environment and human health are avoided. However, it cannot be defined as an exact borderline between health and risk.

Limit values are not scientifically proven standards like mathematical formulae, but are the result of subjective political, moral, ethical scales and philosophies. It should be kept in mind that all harmful substances are a possible threat to health until the contrary can be proven, which is often difficult.

Limit values are primarily based on experiments with animals, and substances are tested individually. How a substance reacts over many years in humans, especially in conjunction with other substances, is very hard to determine.

It is very important to establish control limits that should not be exceeded. However, the definition of limit values for many harmful substances is questionable, and is often a legalisation of existing inevitable conditions. Because of the difficulty in reliably analysing, testing, and monitoring the enormous number of known substances in water, limit values have not even been defined for many of them. Limit values also need to be continuously reviewed to reflect advances in the latest analytical procedures.

LIMITATIONS OF WATER TREATMENT

The first public waterworks were built 120 years ago, after serious health hazards developed and disastrous epidemics spread with the rapid development of industrial society. In the decades following World War II there was a further drastic increase in the contamination of water in line with the steep growth rates. As contamination grew, so did the requirements for water treatment. The cost of raw water and sewage treatment has risen dramatically and will continue to do so in the future.

Most waterworks are well equipped to handle basic requirements in the supply of good quality water, although they may occasionally have problems with sudden or unexpected contamination and loads.

The most common methods of raw water treatment are:

- filtration, to remove suspended solids, taste and odour
- biological oxidation, to remove organic matter including bacteria
- removal of iron, manganese, acids, odour and taste

Present technology has limitations, and for a number of substances there are limits to what can be controlled and how well. As contamination increases, and with the limitation of treatment plants, alternative sources of supply must occasionally be found. Sometimes wells must be closed owing, for example, to high nitrate or halogenated hydrocarbon concentrations.

The main problems for water treatment plants are:

- over-fertilisation for agricultural purposes with nitrates, phosphates
- pesticides
- waste (rubbish dumps and effluents from untreated and treated sewage)
- accidental spills or discharges (chemicals, fuel oil, PCBs, storage tanks)
- abrasion from tyres (traffic)
- contaminants from rain, surface run-off.

The following substances are difficult and extremely expensive to remove (if at all possible):

- non-biodegradable synthetic organic compounds
- heavy metals
- compounds that are formed through chlorination
- phosphates (washing powders, fertilisers, water treatment)
- ammonium, chlorides (salt), sulphates, nitrates
- NTA, EDTA.

Sewage treatment plants remove primarily suspended and organic matter and, to a degree, they can remove a number of undesirable substances. In addition, plants differ greatly in their number and quality. Requirements for treating effluents have risen sharply in recent decades, as has the cost. In some cases sewer charges per unit already exceed the fresh water costs. The ultimate goal must therefore be the protection of the groundwater.

If the community has sufficient capacity for wastewater treatment, hotels should be connected to the existing sewers. If the community is not or is insufficiently equipped, hotels should install their own wastewater treatment unit. As technology has progressed, smaller and less expensive equipment has become widely available. The aim should always be to eliminate problematic substances at source rather than putting them into the treatment system.