Best Environmental Management Practice in THE TOURISM SECTOR

5.6 Optimised pool management

This best practice is an extract from the report Best Environmental Management Practice in the Tourism Sector.

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5.6 Optimised pool management

Description
Swimming pools give rise to a number of environmental impacts, especially where poorly managed, through demand for water, energy and disinfectant chemicals. An indoor heated 25 m pool (300 m²) can lose 21 000 litres of water per week in evaporation (water temperature of 28 °C, air temp of 29 °C and relative humidity of 60 %) (Business Link, 2011). This would equate to 30 litres per guest-night for a hotel with 100 guests. Although this example is for a relatively large pool, it excludes water consumption for backwashing, that can be of a similar magnitude, or greater (Figure 5.32). Ecotrans (2006) suggest that swimming pools increase water consumption by an average of 60 litres per guest-night across hotels and camping sites. Meanwhile, sub-meter data from a German hotel indicate water consumption of 52 litres per guest-night for the pool area, including showers (Hotel Colosseo, 2011).

Figure 5.32 displays the breakdown of water consumption in a typical community swimming pool. The main processes are backwashing, showers, and evaporative losses and leaks. Water use for amenities (e.g. onsite cafes) may not apply to accommodation pool areas.

Sanitisation of swimming pools is usually performed using chlorine, via dosing with compounds such as calcium or sodium hypochlorite. Chlorine compounds react with organic matter to form chloramines, disinfection byproducts that irritate eyes, and, when added in high doses, can form carcinogenic trihalomethanes. A fraction of the chlorine compounds volatilise to the atmosphere, and filter backwash water containing chlorine is toxic to freshwater ecosystems, and must be released to a sewer unless specially treated and/or recycled. Some alternatives to the addition of hypochlorite such as the addition of copper salts are also associated with ecotoxicity problems.

Finally, operation of swimming pools requires energy, to power filter and backwashing pumps, lights, and in some cases water heating and indoor heating and ventilation. ÅF-Energikonsult AB (2001) estimated that hotel swimming pool systems can consume 45 000 kWh to 75 000 kWh per season. Specifically for pool heating, Ochsner (2008) estimate typical energy demand of 50 – 150 W/m² for indoor pools, 50 – 200 W/m² for a pool in a sheltered location, 100 – 300 W/m² for a pool in a partially protected location, and 200 – 500 W/m² for a pool in an unprotected location. Carbon Trust (2005) estimate that a typical public leisure centre containing a 25 m pool consumes over 1 500 kWh/m²yr, of which 65% is for pool heating and ventilation. Ventilation of indoor pools often leads to high heat loss via the exhaust of moist, warm air to the atmosphere: swimming pool areas may experience air change rates of 4 – 10 changes per hour (Carbon Trust, 2005). In addition, water heating for showers can consume
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considerable amounts of energy (sections 5.1 and 5.2). Carbon Trust (2009) estimate that building services account for 35 – 50 % of the operating cost of a modern indoor swimming pool.

Best practice measures

Table 5.29 summarises the main best practice measures to reduce water, energy and chemical consumption in swimming pool areas. In the first instance, the decision to build a pool and the selected design are critical, though these decisions are likely to be guided by marketing considerations. It may not be necessary to have a pool onsite – there may be options to organise a pool share or guest-use scheme with neighbouring establishment(s) or local leisure facility providers. In terms of pool design, outdoor, unheated and natural pools are the options with the lowest environmental impact. Where applicable, particularly for outdoor pools with a relatively short season, installation of a natural pool is best practice (see section 9.6). If the pool is integrated into the building design, the necessary infrastructure can be put in place to recycle pool overflow and filter backwash water for toilet flushing. A good building envelope (section 7.2) will reduce heating costs – high quality double- or triple-glazed windows with blinds where necessary to reflect direct sunlight, with a good quality seal and carefully located entrance areas to minimise drafts.

The most efficient pool disinfection and heating systems should be specified during the design phase, but may also be retrofitted. Outdoor pools can converted to natural pools relatively easily (section 9.6). Drainage barriers can be installed around the pool to collect and recirculate overflow and splash water. Ozone generators or ultra-violet (UV) systems may be installed to reduce chlorine requirements. Simple solar heating tubes or a heat-pump system may be installed to heat (or pre-heat) pool water, and a heat recovery system with controlled ventilation installed to recover heat from exhaust ventilation air. Motion sensors can be installed to switch off features such as fountains when no users are present.

Finally but importantly, many optimisation measures can be taken for all existing pools by applying good management techniques and minor retrofitting. Installation of a water sub-meter to record inflow to the pool is an important measure to enable performance tracking and the identification of problems. Hazell et al. (2006) found that the majority of public swimming pool managers surveyed could not provide annual water consumption data. Monitoring and benchmarking of water, energy and chemical consumption is therefore a key best practice measure for pool/accommodation managers.

Use of pool covers, careful regulation of temperature and chemical dosing, maintaining water at the correct level below the pool sides and careful control of filter backwashing can all significantly reduce water and energy consumption. Backwash water can be filtered and used for irrigation. Careful (automated) control of HVAC systems for indoor pools can reduce heating energy consumption, and careful control of water circulation through filters (manually, based on usage rate, or automatically, based on water quality monitoring) can reduce energy, especially if combined with variable speed pumps. Regular sweeping of the pool area and requiring users to pass through a foot bath can reduce disinfection and backwashing requirements arising from contamination.
### Table 5.29: Best practice measures to reduce water, energy and chemical consumption in swimming pool areas

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Best practice measures</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management</strong></td>
<td>Monitor energy, water and chemicals consumption (see sections 5.1 and 7.1)</td>
<td>All pools</td>
</tr>
<tr>
<td>Disinfection</td>
<td>Natural pools (see section 9.6)</td>
<td>Lower usage pools</td>
</tr>
<tr>
<td></td>
<td>Require users to pass through foot bath</td>
<td>All pools</td>
</tr>
<tr>
<td></td>
<td>Sweep debris from surrounding area</td>
<td>All pools</td>
</tr>
<tr>
<td></td>
<td>Optimised chlorine dosing</td>
<td>All chlorine pools</td>
</tr>
<tr>
<td></td>
<td>Electrolysis, ozonation or UV</td>
<td></td>
</tr>
<tr>
<td><strong>Water efficiency</strong></td>
<td>Monitor water consumption</td>
<td>All pools</td>
</tr>
<tr>
<td></td>
<td>Optimised backwashing frequency and timing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Backwash water recycling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Backwash water reuse</td>
<td>Where water scarce</td>
</tr>
<tr>
<td></td>
<td>Timer-controlled low-flow showers (section 5.2)</td>
<td>Shower areas</td>
</tr>
<tr>
<td><strong>Energy efficiency</strong></td>
<td>Ensure good building envelope (section 7.2)</td>
<td>Indoor pools</td>
</tr>
<tr>
<td></td>
<td>Position in sunny and sheltered area</td>
<td>Outdoor pools</td>
</tr>
<tr>
<td></td>
<td>Avoid excessive water temperature</td>
<td>Heated pools</td>
</tr>
<tr>
<td></td>
<td>Correct use of pool cover</td>
<td>All pools</td>
</tr>
<tr>
<td></td>
<td>Demand-control of water circulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solar or heat-pump water heating</td>
<td>Heated pools</td>
</tr>
<tr>
<td></td>
<td>Controlled ventilation with heat recovery</td>
<td>Indoor pools</td>
</tr>
</tbody>
</table>

**Achieved environmental benefit**

**Water**

Figure 5.33 displays potential water savings from different processes for a 25 m swimming pool (a large accommodation pool).

Smith et al. (2009) claim that pool covers can reduce outdoor pool evaporative losses by 200 litres per day in warm climates. This figure may be close to 1 000 litres per day for heated indoor pools. Covers also reduce energy consumed for pool heating and ventilation by 10 – 30% (Carbon Trust, 2005).

Optimisation of backwashing frequency based on filter pressure rather than fixed intervals can reduce water consumption for backwashing by over 50%. For example, backwashing a sand filter once every three days for five minutes, instead of once every day for five minutes, could reduce water consumption by 1 500 litres per day, or 550 m$^3$ per year.

Reverse osmosis can enable the reuse of up to 65% of backwash water, potentially saving around 500 m$^3$ per year (Hazell et al., 2006).

Installing low-flow and timed showers could result in a similar magnitude of savings, in the region of 500 m$^3$ per year.
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Chemicals
Proper control of pool filtration and disinfection can significantly reduce chlorine (e.g. sodium hypochlorite) inputs. UV-disinfection of pool water can reduce chlorine inputs by up to 30%, and may also reduce the need for top-up water to dilute chlorine by-products (Leisure-design, 2012). Reduced chemical use leads to upstream environmental benefits in terms of reduced resource consumption and air emissions, and downstream environmental benefits in terms of reduced ecotoxicity impacts in receiving waters.

Energy
Installation of a real-time (continuous, automated) energy monitoring system alongside provision of staff training and awareness raising on energy issues by Knowsley Metropolitan Borough Council in the UK led to electricity savings of 24% and gas savings of 30% in leisure centre sites (Carbon Trust, 2005).

HVAC heat recovery and heat-pump heating and dehumidification can reduce HVAC energy consumption by 50–80% compared with simple open extraction systems.

Variable speed drive pumps may reduce pump electricity demand by up to 80% (Leisure-design, 2012).

Balantia (2012) refer to a potential energy saving of 146 kWh per m² pool surface per year from installation of a pool cover on a small indoor pool in a luxury Spanish hotel.

Carbon Trust (2005) indicate that good practice can reduce energy consumption by 848 kWh/m²·yr for a typical public leisure facility containing a 25 m swimming pool, primarily through a reduction in heating fuel consumption (Table 5.35). Best practice, including use of heat-pump heating, could potentially reduce the residual 725 kWh/m²·yr by a further 50%.

Figure 5.33: Estimated potential annual water savings across different processes for a 25 m pool
Appropriate environmental indicator

Water consumption
Water consumption for swimming pools in tourism establishments is poorly documented. The ideal indicator for water use efficiency is water consumption per user, although this indicator is not regularly reported, perhaps in part because the number of users are not necessarily recorded in accommodation premises (though estimates based on surveys may be made). An alternative indicator is water consumption per m² of pool area, also not frequently reported.

As referred to in the description, above, there are some data relating to water consumption for hotel swimming pools averaged per guest-night. This is a relevant indicator based on data that should be readily available (if sub-metering of pool area water consumption is in place). It is important to define what is included in this measure – specifically, whether it represents just pool water consumption, or also water consumption for the entire pool and spa area (i.e. including showers and toilets, etc.).

Energy consumption
As with water consumption, energy consumption for swimming pool areas is not well reported. Ideal indicators are kWh/m² yr or kWh/user. However, it is sufficient to report on the simple indicator kWh per guest-night, enabling easy comparison with total energy consumption indicators (section 7.1).

Chemical consumption
The type and quantity of chemicals consumed per m², per user or per guest-night is the relevant indicator here. For example, grams sodium hypochlorite per guest-night.

Benchmark of excellence
Owing to the lack of data on water, energy and chemical consumption in swimming pools, it is not possible to propose a performance benchmarks for swimming pools. Instead, the following management benchmark is proposed:
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BM: implementation of an efficiency plan for swimming pool and spa areas that includes:
(i) benchmarking specific water, energy and chemical consumption in swimming pool and spa areas, expressed per m² pool surface area and per guest-night; (ii) minimisation of chlorine consumption through optimised dosing and use of supplementary disinfection methods such as ozonation and UV treatment.

Cross-media effects
The main cross-media effects associated with measures in this section are:

- energy requirements for UV treatment to reduce chlorine requirements (small compared with avoided upstream chlorine production and potential downstream ecotoxicity effects);
- energy requirements for reverse osmosis to reduce water consumption (this is also expensive, and therefore only justified in areas of intense water scarcity);
- water consumption by bathers taking showers before entering the pool, to reduce chlorine requirements (as with previous effect, depends on water scarcity of the area).

Operational data
Monitoring and benchmarking
In the first instance, all water, energy and chemicals used for operation of the pool area should be monitored and used to benchmark performance over time (monthly and annual basis). Sub-metering should be in place to enable monitoring of water consumption for:

- the swimming pool
- changing (shower and toilet) areas.

Following initial data collation and normalisation relative to pool area and number of users (e.g. L/m².yr or L per user water consumption), a consultation with swimming pool specialists may be used to inform on the level of efficiency represented by these data, and scope for improvement.

Frequent assessment (ideally daily checks) of consumption data can provide a useful indication of systems problems and maintenance requirements. For this purpose, the installation of automated recording systems is useful (see sections 5.1 and 7.1).

Shower and toilets in changing areas can be a major source of water consumption. Operational data on installing low-flow fittings (showers and taps), shower timers (percussion valves or sensors) and efficient dual-flush toilets in changing areas can be found in section 5.2.

Filtering and backwash optimisation
Filter circulation pumps are often over-sized owing to limited available size options, leading to excessive filter pressure with associated energy wastage and less effective filtration. Variable speed drives (inverters) may be fitted to pumps to enable precise control of pump speed according to demand.

Backwashing sand filters is a water-intensive process, requiring in the region of 225 to 450 litres per minute for a standard pool. Many hotel pool filters are backwashed as a matter of routine once or twice a day, compared with typical requirements of once every two or three days. Backwashing should be based on filter pressure rather a fixed schedule – for example, when the filter pressure required is over 0.5 bar more than the pressure required for a clean filter.
The backwash process should not take more than three to five minutes, and the subsequent pipe rinsing process just 15 to 30 seconds (Travel Foundation, 2011). It is important that all pool maintenance procedures, including backwashing, are clearly displayed in the pool room, and staff properly trained.

It has been claimed that recycled glass may be a more efficient filtration medium than sand, and that installing pre-filters can reduce the need for backwashing by up to 50% (Leisure-design, 2012). This latter reference refers to the design of a 'Passive Pool'.

**Backwash water recycling**

Filter backwash water may be recycled back into the pool following appropriate treatment to achieve required water quality standards – usually locally applicable drinking water quality standards as pool water may be swallowed (NSW Gov, 2012). Controls should be put in place to protect against system failures and ensure health protection.

Reverse osmosis is considered to be the best available technology for the treatment of backwash water for recycling, and has been shown to remove over 99.5% of dissolved salts, up to 97% of most dissolved organics and 99.99% of micro-organisms (NSW Gov, 2012). It is important to consult with a qualified expert on the design of a backwash water recycling plant as such plants work most effectively when combined with other treatments. For example, pre-treatment using ultra-filtration and granular activated carbon may be necessary to prolong the life of the reverse osmosis membrane.

**Disinfection**

Disinfection of pool water involves destruction of 99% of exposed pathogens using a disinfection agent such as hypochlorite, and removal of particulate matter using a flocculating agents and filtration (ITP, 2008). The residual disinfection agent (e.g. free chlorine from hypochlorite) must be present in a sufficient concentration to kill new bacteria. Over 90% of free chlorine is consumed through organic matter oxidation, emphasising the importance of measures to minimise organic matter loading (cleaning pool area, installing a foot cleaning bath for users).

Careful management of dosing and pool pH (Table 5.30) is critical to minimise hypochlorite consumption, irritation problems, and water consumption through dilution compensation for overdosing. Automatic dosing is the best solution, based on monitoring of residual chlorine concentrations at least every two hours. Target chlorine concentrations should be adjusted according to microbiological parameters, tested at least every month (ITP, 2008). It is important to note that chlorine requirements increase with water temperature.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Acceptable range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.2 – 7.6</td>
</tr>
<tr>
<td>Total alkalinity</td>
<td>80 – 200 ppm</td>
</tr>
<tr>
<td>Total chlorine (gas plus hypochlorites)</td>
<td>0.5 – 1.0 ppm</td>
</tr>
<tr>
<td>Combined chlorine (chloramines)</td>
<td>&lt;half total chlorine</td>
</tr>
</tbody>
</table>

*Source: ITP (2008).*

It is relatively straightforward to install a UV filter through which filtered water can be passed to kill bacteria, thus reducing the residual chlorine requirements. Ozone generators can also be added (ozone produced by passing an electric current through air), to bubble ozone through water after filtration, also reducing residual chlorine requirements and improving water quality by oxidising organic compounds. Water must then be passed through a carbon filter to remove any remaining ozone.
However, ozone generation and use requires careful regulation, as ozone leaks can be extremely hazardous to health. Additionally, ozone is highly reactive and unstable, making it difficult to control ozone concentrations in the ozone chamber and thus to regulate disinfection.

**Pool heating and circulation**

Pool heating requirements can be minimised by:

- ensuring that water temperature does not exceed recommended values (Table 5.31)
- minimising air-flow over the pool surface
- using a pool cover when the pool is not in use
- minimising water losses through back-washing and dilution to control pool chemistry.

### Table 5.31: Recommended pool water temperatures for different pool types

<table>
<thead>
<tr>
<th>Pool type</th>
<th>Recommended water temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional pool</td>
<td>28 °C</td>
</tr>
<tr>
<td>Leisure pool</td>
<td>29 °C</td>
</tr>
<tr>
<td>Hydrotherapy pool</td>
<td>32 – 40 °C</td>
</tr>
<tr>
<td>Spa pool</td>
<td>40 °C</td>
</tr>
</tbody>
</table>

*Source: Carbon Trust (2008).*

Ideally, pool water heating may be achieved in combination with ventilation air dehumidification (see below). Air-water or water-water heat pumps are well suited to the low temperature heating requirements for pool water (section 7.4). Alternative sources of water heating particularly well suited to swimming pools include unglazed and glazed solar thermal collectors and heat pumps. The former are simple black pipes that absorb solar radiation to heat water flowing through them and are relatively cheap to install (ITP, 2008). Typically, an area equivalent to at least half the pool area is required.

**HVAC**

For indoor pools, operational data on improving the building envelope to minimise heat loss can be found in section 7.2. Specifically for swimming pools, it is important that the walls and base of the pool structure are well insulated where these are built down into the ground. Also, care should be taken to exclude drafts, by installing draught exclusion insulation, self-closing doors and foyer areas.

Best practice in HVAC system configuration, as described in section 7.3, applies here. HVAC within pool areas may be integrated into the accommodation building HVAC system, possibly via an automated building management system (section 7.1). The main objective of a pool-hall ventilation system is to distribute air in order to:

- provide comfortable temperatures for occupants
- avoid uncomfortable draughts
- remove smells produced by water treatment
– minimise evaporation and condensation.
To achieve this, pool ventilation systems may be zoned into three main areas, with specific requirements and recommendations (Table 5.32).

Table 5.32: Requirements and guidance for ventilation in three main zones of pool centres

<table>
<thead>
<tr>
<th>Zone</th>
<th>Requirements</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Pool surface  | – Remove contaminants (although odours caused by water treatment process are not usually dangerous)  
– Evaporation control (minimise air movement at the pool surface) | – Control the water treatment process to minimise odours  
– Air requirements for bather respiration are met by diffusion and do not require additional ventilation  
– Direct ventilation air onto the building envelope to minimise evaporation from pool surface and to reduce the risk of condensation and mould problems on the building fabric |
| Pool side     | – Comfort of the bather (before entering and after leaving the pool)  
– Comfort of the poolside staff | – Redirect any grilles and jets near the pool side to avoid direct air flow from the ventilation system  
– Staff should be discouraged from opening doors or windows, which creates draughts (instead, localised cooling can be provided by increased air movement such as through simple overhead fans). |
| Other areas   | – Protecting the pool hall structure from condensation  
– Providing comfort to non-swimmers | – Provide separate air flows for the pool and other areas to minimise mixing between areas  
– In a new pool building, the air flow could be directed upwards from a slot at the foot of the walls in ‘laminar flow’  
– For existing pool buildings, inlet grilles and jets can be repositioned so that drier air entering the pool hall can be pointed towards the sides of the building rather than down on to the pool  
– Comfort for spectators can be improved by having a similar arrangement to direct drier incoming air over them.  
– It may be necessary to blow drier air into ceiling voids to ensure that condensation does not occur on hidden parts of the structure |


For stand-alone HVAC control in an indoor hotel swimming pool, Carbon Trust (2009) recommend an air handling unit employing heat recovery and/or a heat pump, controlled by a thermostat and humidistat, to maintain an air temperature of 29 °C and relative humidity of 60%. Note that air temperature should not be more than 1 °C above pool water temperature in order to avoid excessive evaporation. Two main options are available.
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- Plate heat exchangers may recover 75 – 80% of sensible heat from outgoing air, but only recover latent heat (from moisture) when the outdoor air inflow temperature is low enough to cause condensation within the heat exchanger.

- An alternative, more expensive, option is to install a heat pump dehumidification, in which a heat pump is used to: (i) cool a condensing surface over which moist air from the pool building is circulated; (ii) heat re-circulating and incoming air; (iii) possibly also heat pool water. Such systems can reduce HVAC energy consumption by up to 50 – 80% compared with open-air extraction systems.

Ventilation rates should be adjusted to account for factors such as the number of bathers, evaporation rate and water quality. Carbon Trust (2008) suggest a guideline figure of 10 litres of ventilation air per second, per square metre of total pool hall area (equating to approximately 4–6 air changes per hour depending on the height of the pool hall). However, best practice is to employ modulating dampers in combination with variable speed fans, humidity and CO sensors, so that pool air can be mixed with fresh air and re-circulated, in order to match the air exchange rate with humidity and air quality requirements. This is dependent on good air quality being maintained in relation to disinfection agents and by-products.

Application of a pool cover overnight not only reduces heat and water loss from the pool water body, but reduces over-night HVAC requirements. It may be possible for HVAC system to be shut down overnight, although to avoid condensation damage it may be preferable to leave the system on standby and activated by humidistat (if relative humidity increases above 70%).

Applicability

Table 5.29, above, refers to the applicability of specific best practice measures within this BEMP section.

Economics

Best practice measures referred to above realise economic benefits in the form of:

- reduced energy demand
- reduced water demand
- reduced chemical demand
- lower maintenance costs for filters, pumps, and the building fabric (less condensation damage).

Record keeping and good management practices do not involve significant capital costs but can realise substantial savings in relation to the above costs (Carbon Trust, 2005). Installing an automated building management system can lead to a further 10% energy cost savings, and can realise relatively short payback for larger leisure centres (Carbon Trust, 2006).

Energy savings

For a 25 m pool situated within a 1000 m² complex, energy savings from good management practices and basic retrofits such as variable speed pumps and heat exchangers (see Figure 5.34) could range from EUR 50 000 to EUR 85 000 per year at energy prices of EUR 0.06 to 0.10 per kWh.

Installing a recirculation system with a heat pump would require an investment of approximately 30% more than for a full fresh air system controlled via a humidistat, but a 20% reduction in energy costs should lead to a payback of approximately two years for a 100 m² pool (Carbon Trust, 2009).

Installing automatic variable speed control of swimming pool pump motors at Hutton Moor Pool saved approximately EUR 8 000 per year (Carbon Trust, 2005) – these savings are likely to be considerably higher at current energy prices. The lifetime savings of high-efficiency variable speed
motors can be many multiples of capital costs. Carbon Trust (2005) note that lifetime operating costs for a EUR 350 motor for a pool circulation pump can exceed EUR 35 000.

**Water savings**
Economic benefits associated with water savings are smaller than benefits arising from energy savings. At a water price of EUR 2.50 per m$^3$, annual water savings of almost 2 000 m$^3$ for a 25 m pool (Figure 5.33) would translate into annual cost savings of almost EUR 5 000.

As referred to in section 5.2, installation of low-flow shower, tap and toilet fittings or retrofit options is associated with short payback periods, often less than one year.

Pool covers have a payback period of 1 – 3 years, dominated by the energy rather than water saving (Carbon Trust, 2005).

Reverse osmosis backwash water recycling requires high capital, operational and maintenance costs, and may only be worthwhile in areas of extreme water shortage.

**Driving force for implementation**
As referred to above, optimised pool management can lead to significant economic savings through reduced energy, water and chemical consumption, and reduced maintenance requirements.

Careful control of pool water quality and chemical dosing, in particular avoiding excessive chlorination, can increase user enjoyment.

**References**

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- Hazell, F., Nimmo L. & Leaversuch, P., Best Practice Profile for Public Swimming Pools – Maximising Reclamation and Reuse, Royal Life Saving Society (WA Branch), 2006 Perth (Western Australia).
- Hotel Colosseo, personal communication November 2011.
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