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STAKEHOLDER ACCORD ON WATER CONSERVATION

Guideline for Baseline Water Use Determination and Target Setting in the Commercial Sector SAWC G2

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DOCUMENT INDEX

This is the second document in the following series of guidelines for the determination of Baseline Water Use and the Setting of Water Use Targets for various economic sectors:

SAWC G1	Irrigated Agriculture Sector
SAWC G2	**Commercial Sector**
SAWC G3	Manufacturing Sector
SAWC G4	Mining Sector

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APPROVAL

This document has been approved by the Counter Part Group for use in support of the Stakeholder Accord on Water Conservation.

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GLOSSARY

Baseline water use	Water consumption status before implementation of a water conservation programme. Baseline measurements are used as a reference point to determine a site's water savings as it completes its water conservation plan.
Cooling towers	Structures used to cool water through an evaporative process in which the water is contacted with air in counter-current flow.
Consumptive water use	Water use that removes water from the immediate environment and does not make it available to other users in the form of a liquid discharge. Consumptive use is generally a term applied to uses resulting in evaporation, evapotranspiration or incorporation into products.
Drift	Loss of water droplets through the top of a cooling tower as a result of the air draft. Can be reduced by installing drift eliminators.
Grey water	Water recycled from showers, sinks and wash basins.
Internal recycling	Water that is recycled on site. Internally recycled water should not be added to site water use, as it was already recorded as a water use when it was used for the first time.
Mulching	The practice of covering soil (using natural or synthetic materials) in order to reduce moisture loss, prevent weed growth and prevent soil erosion.
Root zone	The area and volume of soil occupied by the roots of a plant. In this document, water that passes through the root zone is considered to be unavailable to the plant. This may not strictly be the case, since it depends on soil type and the specific plant involved, as well as other issues such as the presence or absence of a high water table.
Solar passive design	An approach used in building design and orientation that maintains thermal comfort levels while minimising active heating and cooling.
Stormwater	Rain water diverted into drainage systems for transport to surface water resources.
Stomata	The pores found in the leaves and stems of plants through which gases are exchanged.

GLOSSARY

Water conservation	The process whereby the amount of water used for an activity is reduced without impacting on the outcomes of the activity.
Water efficiency	Also called "water use efficiency". The accomplishment of a function, task, process, or result with the minimal amount of water feasible. Water efficiency aims to reduce the wastage of water and not restrict the use thereof. Commonly quantitatively expressed in terms of water intensity (see below).
Water intensity	Water use per unit of economic activity. In the case of the commercial sector, this is expressed as the amount of water used per unit area of commercial space over a defined period. The lower the water intensity of a site, the more efficient it is.
Work practices	The "way things are done" in the work environment. It is often possible to achieve improved levels of water use efficiency in an environment without (or with minimal) capital investment, by changing work practices.

ABBREVIATIONS

KL	Kilolitres (1 KL = 1000 L)
KPI	Key performance indicator
L	Litres
m	Metres
m^2	Square metres
m^3	Cubic metres
mm	Millimetres
min	Minutes
TDS	Total dissolved solids
YOY	Year on year

1 INTRODUCTION

1.1 Overview

This is one of a series of guidelines outlining the steps to follow at site-level for the:

i. Determination of baseline water use levels and;
ii. Setting of water use targets, within the context of a water conservation programme.

In particular, this guideline supports the objectives of the Stakeholder Accord on Water Conservation, and the chosen water use performance indicators are aligned to those required for reporting as agreed by Accord stakeholders.

This guideline applies to the COMMERCIAL SECTOR, which comprises buildings and the various amenities located on a commercial site, including those outside of buildings but located within the site boundary. Please note that while this guideline does make reference to specific water use practices employed in the commercial sector, it is not intended to be a best-practice guideline on water conservation for this sector. The examples used are purely employed to illustrate principles relevant to the purposes of baseline determination and target setting.

1.2 Guideline objectives

The objectives of this guideline are to ensure that participants in the Stakeholder Accord on Water Conservation within the commercial sector receive guidance on:

- How to categorise the key water-using processes for their individual sites;
- What the water use and water intensity measures appropriate to the commercial sector are in terms of the requirements of the Stakeholder Accord on Water Conservation;
- How to determine baseline water use and establish routine water use monitoring systems;
- How to identify opportunities for water conservation and;
- How to translate identified opportunities into short and long-term water use and water intensity targets.

1.3 When to use this guideline

This guideline has been developed with specific reference to the Stakeholder Accord on Water Conservation. It is however also of use in the following general circumstances:

- When developing a water conservation management plan to identify what can be done to improve water efficiency;
- As input to planning and budgeting processes.

1.4 Principles adhered to in this guideline

This guideline is based on the principles governing the Stakeholder Accord on Water Conservation and assumes that baseline and target setting would be undertaken at site level on a voluntary basis. This guide is not mandatory but is rather a tool aimed at supporting water users in the commercial sector in their water conservation efforts. It is assumed that the guideline is implemented within the regulatory framework governing water use, taking cognisance of all environmental impacts related to the implementation of water conservation projects.

1.5 Structure of this guideline

This guideline is based on the concepts of water auditing. The approach followed in this guideline is comprised of the following steps:

- Determination of the absolute water use and water intensity baselines for the site;
- Identification of viable water conservation initiatives;
- Quantification of water savings expected from implementation of these water conservation initiatives, and the timelines for implementation;
- Determination of expected absolute water use targets for future years by subtracting savings from the baseline;
- Determination of water intensity targets for future years based on the absolute water use targets determined and the floor area of the commercial entity;
- Repetition of this process annually for a rolling five-year period.

The guideline briefly discusses the nature of water use in the commercial sector and then defines a generic water balance for the commercial site. Thereafter the guideline describes key performance indicators (KPI’s) relevant to the sector, to be used as a basis for determining absolute water use and water intensity baselines. Once the process to be used for determination of these baselines has been described, a methodology to identify and quantify water conservation initiatives is outlined. Target setting for a rolling five year period is then described.

2 WATER USE IN THE COMMERCIAL SECTOR

2.1 Overview

For the purposes of this document, the commercial water-use sector is defined as comprising private enterprises in which the primary assets employed in the conducting of business are buildings and their surrounds (i.e. parking areas, gardens and outdoor amenities), typically delineated by a physical boundary.

The type of water used, the quantity of water used and the patterns of water use (volume and seasonality) in the commercial sector can vary markedly between users based on the nature of their operations. Hence a commercial office park will have very different water use characteristics to a commercial shopping mall or a hotel. The idea of this guide is to enable commercial users, regardless of their unique circumstances, to be able to baseline their water use and set meaningful targets.

The four main types of water used in the commercial environment are:

i. Potable water, which is water that is fit for human consumption;
ii. Grey water, which is the water discharged from bathroom fixtures (washbasins, showers and baths);
iii. Black water, which is the water discharged from toilets and urinals and;
iv. Stormwater / rain water, which is collected on site and discharged to a stormwater system which returns this water to rivers or surface impoundments, or is collected for reuse, which is called “harvesting”.

Careful assessment of health risks is required when considering the recycling of water in the commercial environment.

2.2 Typical Water Uses in the Commercial Sector

2.2.1 Water used for staff and customer amenities

This refers to water used for drinking and ablutions i.e. by sanitary fixtures such as toilets, urinals, showers, baths and sinks. Generally potable water is used, though recycled water can be used for applications such as toilet flushing provided it meets required quality requirements in terms of odour, visual appearance, suspended solids and microbial stability. Standards in this regard are not currently in place in South Africa, and hence these requirements should be determined by individual users.

2.2.2 Water used for indoor cleaning

This refers to water used for cleaning the insides of buildings, floors and the like. This water use is typically included with that for staff amenities except in cases where this water is separately metered. Generally this water is obtained from staff ablution facilities.

2.2.3 Water used for garden maintenance

This refers to the water used to irrigate gardens within the site boundary and for related uses such as water features. Potable water is often used, but it is possible to use raw water, recycled water or harvested rainwater for this purpose.

2.2.4 Water used for site cleaning and general use outside buildings

This refers to the water used to clean roads on the site and perform activities such as the washing of vehicles.

2.2.5 Water used for site utilities

This refers to water used for cooling towers, steam generation and hot water production. The precise configuration of the utilities area in commercial buildings can vary significantly between different buildings. Cooling towers can use up to 30% of the water used by a commercial building, and up to 60% in commercial shopping centres. Since the level of evaporation from cooling towers is a function of heat load, modifications to cooling towers to reduce evaporation are not possible. It is however possible to modify other aspects of buildings to reduce the heat load that has to be rejected by cooling towers. An example would be management of the indoor environment and solar passive design of buildings. There are however trade-offs that would have to be made between maintaining a cool environment during hot weather and maintaining a warm environment during cold weather. While incorporation of glazing and shading elements into existing structures is possible, it has to be said that retrofitting of solar passive design features can be difficult, since building orientation is an important element of maintaining thermal balance.

2.2.6 Water used for swimming pools

This use has relevance for commercial undertakings such as health clubs and hotels, and potable water is generally used. Significant uses are the water evaporated from the swimming pool and the water used to backwash the pool filter. Technologies are available locally for treatment and reuse of backwash water through the use of flocculants and settling tanks.

2.2.7 Water used for appliances

Appliances such as dishwashers, washing machines and steam irons can use significant quantities of water. Wherever possible, the design-rated water use of appliances should be investigated in order to ascertain water use due to individual appliances.

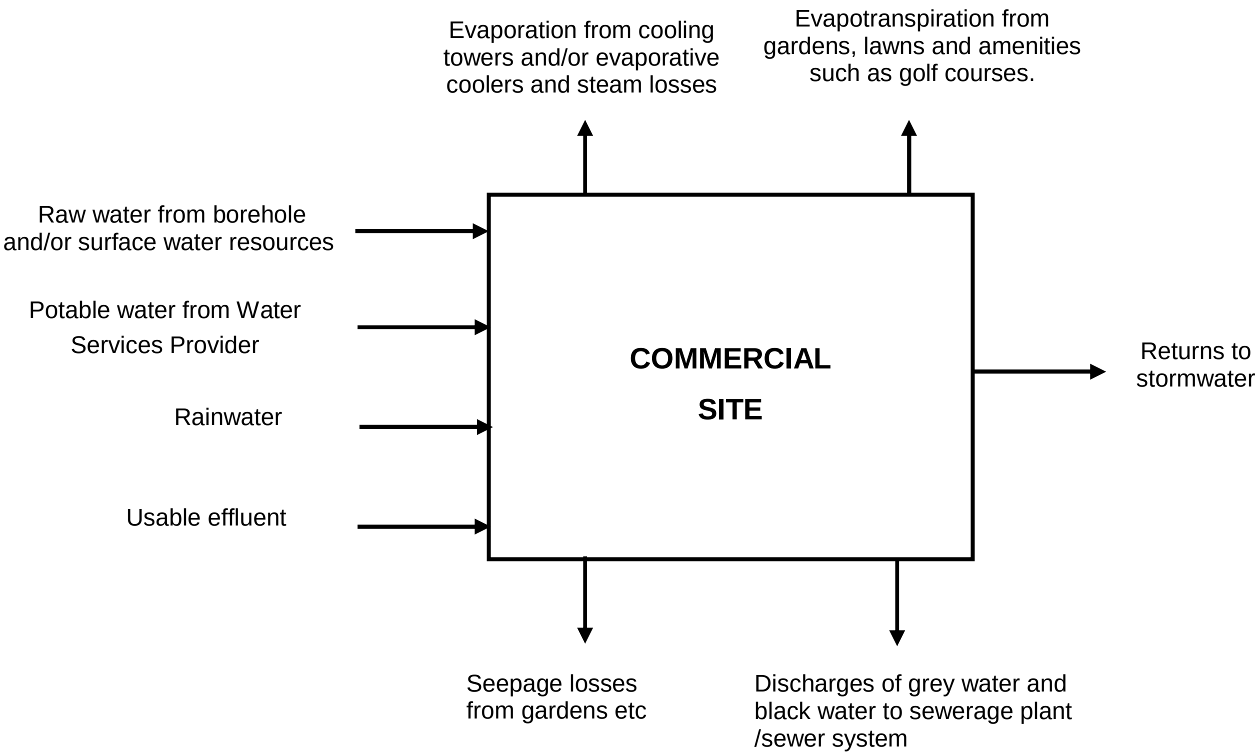
2.2.8 Water used for specialist applications

Certain commercial undertakings may use water for unique applications, an example being the use of water in theme parks and amusement operations. In these instances each use has to be examined from an individual perspective. Examples of such uses would be the operation of water slides, man-made watercourses, wave pools and other such water-intensive commercial activities.

3 DEFINITION OF THE SITE

In order to define the key performance indicators (KPI's) to be used for baseline water use performance determination and the setting of water use targets, it is necessary to define the water management system at a typical commercial site. Figure 1 below outlines the key components of this system.

Figure 1: Water Management System on a Commercial Site



The following are general notes applicable to Figure 1:

i. "Potable water" is the treated drinking-quality water supplied by water services providers and is the primary water source used by the commercial sector in South Africa;
ii. "Rainwater" may be directed to on-site stormwater drains and/or harvested for use on site;
iii. "Raw water" refers to untreated water from surface water resources such as rivers or impoundments or water sourced from boreholes. Such water, should it be used without treatment, would typically be employed in the irrigation of gardens or grounds;
iv. "Usable effluent" refers to discharges from users outside the site boundary, either treated or untreated, which are of a quality that permits their use on site;
v. "Evaporation from cooling towers and/or evaporative coolers" would only apply to buildings which use these devices as part of their air-conditioning/ cooling systems or commercial sites that employ cooling towers for other purposes;

vi. "Evapotranspiration from gardens and lawns" refers to evaporation of applied water as well as rainwater from land and plant surfaces, as well as the loss of this water through the stomata of plants;

vii. "Seepage losses from gardens" would entail water that seeps beyond the root zone of plants. The fate of this water depends on individual geohydrological considerations for each site. It may well find its way into surface or groundwater resources and be made available to other users, though it must be said that the quantities of seepage typically associated with commercial undertakings is small relative to that for a sector such as irrigated agriculture;

viii. "Discharges of grey water and black water to sewer" would entail discharges of any grey water and black water that is not reused on site.

ix. "Returns to the stormwater system" comprise that portion of rainwater that is not harvested for reuse.

Figure 1 represents the generic overall water balance for a commercial site. It should be clear that by reducing the amount of water leaving the site boundary through evaporation, evapotranspiration and discharges, the amount of water that has to be transported across the site boundary for use on site is reduced. Rainwater harvesting and grey water recycling are examples in this regard. The other key way to reduce water use on site is to reduce the amount of water used by water-demanding processes at point-of-use. An example here would be the use of waterless urinals.

4 KEY PERFORMANCE INDICATORS

4.1 Why Key Performance Indicators are Necessary

KPI's can be established at a number of levels, for example to measure the performance of an entire site or to measure the performance of an individual process within a site. Within a commercial site, it is therefore possible to develop KPI's that could be used to measure the water requirements and water use efficiency of a swimming pool, for example.

The use of quantitative measures of water use performance allows individual sites to track performance over time as well as to benchmark performance against that of other sites. This document considers only site-level performance. More detailed KPI's would have to be developed by users at each site based on the nature of individual water-demanding processes on that site. These lower-level KPI's would permit improved management of water use at the site level.

4.2 Site-level Key Performance Indicators

The two key measures regarding water use at site-level in the commercial sector are the following:

i. The absolute volume of water used over a defined time period, which is an indicator of the demand that a site places on freshwater resources and;
ii. Water intensity, which is an indicator of the sustainability of the site's water use.

Each of these measures is now discussed in more detail.

4.2.1 Absolute Water Use

Absolute water use is simply the total volume of water used by a site over a defined time period. The units of absolute water use in the commercial environment are m^3/annum (which is equivalent to kL/annum). For any particular commercial installation, the calculation of absolute water use, using Figure 1 as a basis would be:

Equation 1: Absolute Water Use

Absolute Water Use = potable water use / annum + raw water use / annum + harvested rainwater / annum + usable effluent / annum

Example1:

A commercial office park comprising 4 large buildings uses 750,000 m^3/annum of potable water and 10,000 m^3/annum of harvested rainwater. What is the absolute water use of the site?

No raw water or usable effluent is used by the site, hence the absolute water use is:

Absolute water use = 750,000 m^3/annum + 10,000 m^3/annum = 760,000 m^3/annum

4.2.2 Water Intensity

An efficient water user uses the minimal amount of water feasible to achieve a given outcome or result. The measurement of water use efficiency therefore requires an indication of absolute water use as well as a measure of the level of economic activity associated with that level of water use.

For commercial buildings, the measure of water use efficiency generally used is that of "water intensity", which relates water use over a defined time period to the square meters of building space served. Note that this is not the area of the entire site, but the floor area of the buildings on the site. In multi-storey buildings, the area of each floor must be accounted for.

<u>Equation 2: Water Use Intensity</u>

Water Use Intensity = Absolute Water Use / Building Floor Area

<u>Example 2:</u>

The buildings in example 1 each have a floor area of 100, 000 m^2. What is the water intensity of the site?

Total building floor area = 4 x 100, 000 m^2 = 400, 000 m^2.

Water intensity = 760,000 m^3/annum / 400, 000 m^2

= <u>1.9 m^3/m^2/annum</u> (= 1.9 kL/m^2/annum)

Water intensity alone does not provide complete information on how efficient the site is, since an absolute measure of efficiency would require comparison to a benchmark value, which is discussed in more detail later in this guideline. Water intensity does however provide a measurement that can be used to monitor trends in water use efficiency at a site, since the lower a site's water intensity, the more efficient the site may be considered to be. Figure 2 below outlines how trends of water intensity may be interpreted at an individual site and also compared to trends at other sites.

Figure 2 compares three sites, Sites A, B and C over a period of 4 years. Site C is seen to use water more efficiently than sites A and B, but has not experienced any changes in performance over the four year period. Site B is seen to have made significant improvements in water intensity over the period, while site A exhibits an alarming increase in water intensity, indicating a decline in water use efficiency.

Figure 2: Examples of Water Intensity Trends at Commercial Sites

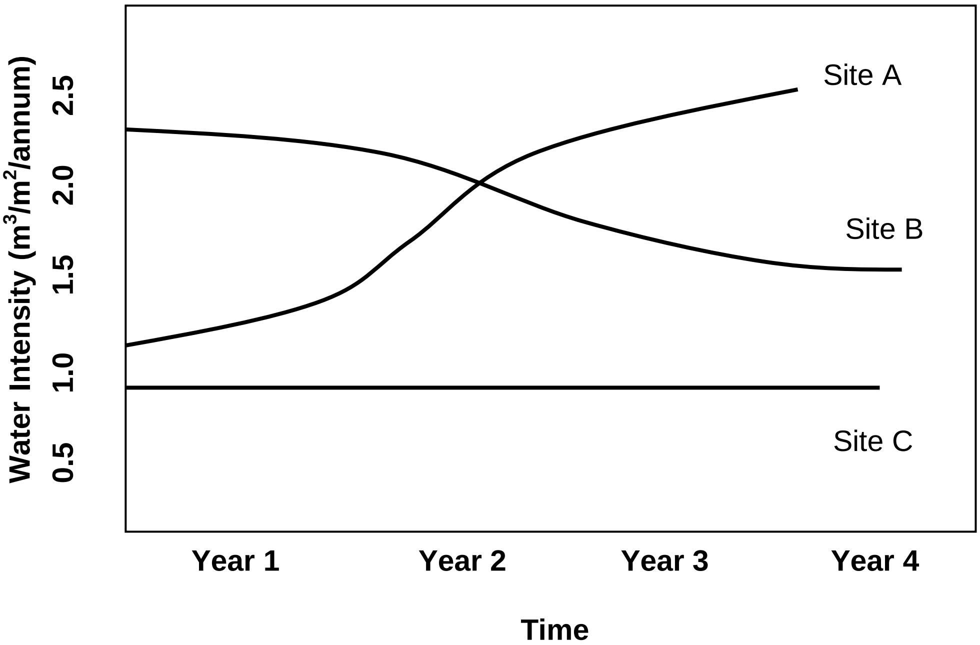


Table 1 below contains the raw data for site B measured for each of the four years in question. The table also contains the year on year percentage change in water intensity.

For any year, $Year_n$ followed by a year, $Year_{n+1}$, the percentage change year on year is:

<u>Equation 3: % Change in Water Intensity Year on Year</u>
% Change YOY = (Water intensity in $Year_{n+1}$ -Water intensity in $Year_n$) x 100 / Water intensity in $Year_n$

For any year, $Year_n$ the change in water intensity relative to the base year, $Year_b$ is:

<u>Equation 4: % Change in Water Intensity Relative to Base Year</u>
% Change Relative to Base Year = (Water intensity in $Year_n$ -Water intensity in $Year_b$) x 100 / Water intensity in $Year_b$

Hence, for example, the %change in water intensity from the base year to year 4 would be:

% Change = (Water intensity in Year 4 – Water intensity in Year 1) x 100 / Water intensity in Year 1.

Table 1: Water Use Efficiency Example

SITE B	***YEAR 1***	***YEAR 2***	***YEAR 3***	***YEAR 4***
Water Intensity m^3/m^2/annum	2.5	2.0	1.75	1.5
% Change YOY	N/A	-20%	-12.5%	-14.2%
Change Relative to Base Year m^3/m^2/annum	N/A	-0.5	-0.75	-1.0

At Site B the trend is an improvement in water intensity, decreasing from 2.5 m^3/m^2/annum to 1.5 m^3/m^2/annum. This results in a decrease of 40% over the four year period relative to the base year, reflected by a decrease in water intensity of 1 m^3/m^2/annum.

5 DETERMINATION OF BASELINE WATER USE

5.1 The Need for Baseline Water Use Determination

Determination of the baseline is the process of establishing the status of absolute water use and water intensity for a commercial site at a defined point in time. This should preferably be done before the implementation of a water conservation programme. When this baseline has been established, it serves as a benchmark against which water use performance improvements may be judged.

5.2 Pre-requisites for Baseline Water Use Determination

In order to determine the baseline water use for a commercial site, the following are the minimum pre-requisites necessary.

5.2.1 Measurement of Site Water Use

Determination of baseline water use requires that the volume of all water that enters the site from outside the site boundary be measured. This implies that metering systems be in place to measure the volumes of potable water, usable effluent (from external sources), harvested rainwater and raw water on a routine basis.

The metering systems must be capable of measuring the cumulative volume of water used for the period of interest. Metering intervals for commercial sites should be no longer than one month in terms of routine monitoring. Meters that have a counter that cannot be reset are preferred, since the volume used between measuring periods can then simply be found by subtracting the most current reading from the reading before it. The use of meters that can be reset may result in lost information, since they could be reset in the middle of the month for example. Water use would in this case be under-stated. Water supplied by water services providers would be metered and volumes would appear on water bills.

In the case of rainwater harvesting, it is possible to use a sight-glass fitted to the outside of the rainwater harvesting tank to assess water use. Where this is the case however, careful record-keeping is required to capture the water level in the tank before and after each use and to account for level changes due to harvesting itself. Where harvesting systems are automated e.g. if they are linked to garden irrigation systems, an in-line meter with a cumulative counter is recommended. The units of measurement of the meter must be properly accounted for e.g. the meter may read in litres while the water balance for the site may be represented in cubic meters, requiring a conversion.

5.2.2 Measurement of Building Area

Building area may be determined from physical measurements or from site plans. It is not just the area of the building footprint that is of interest, but the occupied area of the building. Hence with multi-storey buildings, the area of each floor needs to be taken into account. All areas under roof are to be included in the total area used for baseline determination.

For some commercial undertakings, building area may not be a meaningful basis to use for the calculation of water intensity. An example would be for a site that includes a golf course or an aquatic centre. For such sites, some other meaningful area value must be used, e.g. the area of the golf course could be added to the building area. Once this approach has been taken, it is clearly important to be consistent as to the area basis used.

While it is possible for commercial sectors such as the hospitality sub-sector to include occupancy rates into the calculation of area routinely, this guideline proposes that the fixed building area be used for the sake of consistency and simplicity.

5.3 Determination of Baseline Water Use

It is not uncommon for there to be seasonal impacts on commercial water use. As a minimum therefore, at least a full year's data must be used to determine the baseline water use for a commercial site.
The cumulative water volume for the year must be ascertained using equation one:

Absolute Water Use = potable water use / annum + raw water use / annum + harvested rainwater / annum + treated effluent / annum

This volume of water must then be recorded as the baseline absolute water use for the 12 month period selected for baseline determination.

The baseline Water Intensity must then be determined using equation two:

Water Use Intensity = Absolute Water Use / Building Floor Area

Some discretion is required in selecting the year to be used for baseline determination. It is preferable to select a baseline year in which no extraordinary business activity occurred on the site. If data for such a year is not available, then as far as possible the collected data should be corrected to accommodate anomalies. Hence if a large part of a building was closed for renovations, or if occupancies at a hotel were very different to those typically expected, the area used to calculate water intensity may be corrected. It is not necessary to use a calendar year for baseline water use determination since the use of data from any 12- month period during which operations proceeded as normal would address seasonal fluctuations in water demand. The exception to this rule would be where activity levels vary widely between two different years.

Should water use targets be agreed at some time in the future for the purposes of the Stakeholder Accord on Water Conservation, a baseline year common to all Accord participants may be specified. In this instance, should the chosen year be one in which unusual water use activity may have occurred, it is recommended that either the area or the water volume used be corrected to reflect a more average situation. These corrections must be rigorously related to the specific issues driving unusual water use performance.

6 IDENTIFICATION AND QUANTIFICATION OF WATER CONSERVATION OPPORTUNITIES

6.1 Overview

This guideline describes the technical approach to be used in setting water use targets. This technical approach should be complemented by certain strategic considerations e.g. business priorities or problems with water scarcity in specific locations. The detail of these considerations is considered outside the scope of this guideline, since they are unique to each organisation. They are however an important input to decisions regarding the viability of each water conservation initiative that is identified, which will ultimately determine whether individual initiatives are implemented or not. The assessment of viability is a matter that is left to the discretion of individual organisations as far as this guideline is concerned.

6.2 Quantification of Water Use in Priority Areas

6.2.1 Determination of a detailed water use breakdown

In order to determine water use targets, it is necessary to first identify each of the water-saving opportunities on the site, and to quantify the amount of water that could be saved. The first step in doing this is to determine how much water is used in various areas of the site. This allows users to identify which areas require the most focus in terms of water conservation. Specific projects can then be pursued within these areas of focus.

The example of an office park will be used to illustrate this concept. The site should first be divided into major water-use areas. For an office park these would be:

- Staff amenities, such as toilets and washrooms;
- Cooling towers, where these are installed;
- Irrigation of gardens and lawns, including water features;
- Cleaning / carwash and;
- Staff canteen/kitchen.

The other major water use which should not be ignored would be water losses. Where water losses cannot be determined as a separate water use, they would, by default, be included as a component of the other water use groups on the site, since they would be reflected in the water volume used.

The simplest way to ascertain water use by these different areas would be to read the volume of water used from water meters that supply each of these areas. The use of meters to measure water use in individual areas of a site is called sub-metering. The use of sub-metering is a good practice, since it allows ongoing monitoring and optimisation of water use in individual areas. It may not, however, always be possible to read the water use in individual areas from meters, since these meters may not be installed. It is generally not practical to meter every individual use due to the costs involved. In this instance it becomes necessary to calculate and/or estimate the water use of individual areas. Even at sites at which sub-metering is in place, it will still be necessary to examine individual processes and uses if water conservation opportunities associated with each of these uses are to be determined.

6.2.2 Quantification of water use in staff amenity areas

Staff amenity areas use plumbing fixtures and fittings such as taps, showerheads, toilets, mixers and the like. There are three components to water use in these areas:

i. The frequency with which each fitting is used;
ii. The duration of each use;
iii. The flow rate of water over the duration of each use.

These last two issues may be grouped into a single item, which would be the volume of water used each time a fitting is employed.

<u>Example 3:</u>

The showers at a health club are used 100 times a day on average for 3 minutes at a time and at a flow rate of 15 litres per minute. Calculate the average daily water use due to the showers.

Water use = frequency x duration x flow rate

= <u>100 uses/day x 3 min/use x 15 L/min = 4,500 L/day.</u>

In order to assess water use due to amenities, it is therefore necessary to estimate frequency of use, duration of use and flow rate during use (or volume with each use) for all plumbing fittings. The data on flow rate or volume used could be obtained from manufacturer’s specifications. These may not be readily available, and in this instance physical measurements may have to be made. For example, the volume of a washbasin may be determined from physical measurements, and the time taken to fill it could be divided into this volume to ascertain the flow rates of taps. Note that when assessing taps, it is the typical flow rate during use that is of interest, not the maximum flow rate.

Table 2 below outlines what the breakdown of water use in an area of a commercial office building could look like after an assessment of the amenities areas has been conducted.

Table 2: Quantification of Water Used for Amenities

Area	Fitting	Flow Rate (L/min)	Duration Per Use (min)	Volume Per Use	No. of Uses Per Day	Volume Per Day	Volume Per Annum
Kitchen	Tap 1	12	0.5	6	40	240	59,040
	Tap 2	10	0.5	5	50	250	61,500
	Tap 3	9	0.5	4.5	34	153	37,638
	Dishwasher			17	3	51	12,546
Change room	Tap 1	14	1	14	30	420	103,320
	Tap 2	14	1	14	30	420	103,320
	Tap 3	14	1	14	30	420	103,320
	Toilet 1			8	10	80	19,680
	Toilet 2			8	15	120	29,520
	Shower 1	16	5	80	13	1,040	255,840
	Shower 2	16	2	32	10	320	78,720
						3,514	**864,444**

This section of the building is shown to use approximately 864 KL per annum. In order to assess the use by amenities across the site, a similar analysis would have to be conducted for all amenity areas and the volumes approximated for each would have to be added to arrive at the total use by amenities.

6.2.3 Quantification of water use by gardens and lawns

Where metering is not in place, water use can be estimated from the frequency of irrigation, its duration and the flow rate of water delivered to the irrigation system or via a garden hose. The flow rate can be determined by discharging water into a receptacle of known volume and then determining the time required to fill it, with the volume divided by the time being the calculated flow rate. Total annual water use due to irrigation can then be calculated using a similar approach to that used for amenities. Note however that frequencies and durations in this area will display fairly strong seasonality, with reduced irrigation during the rainy season.

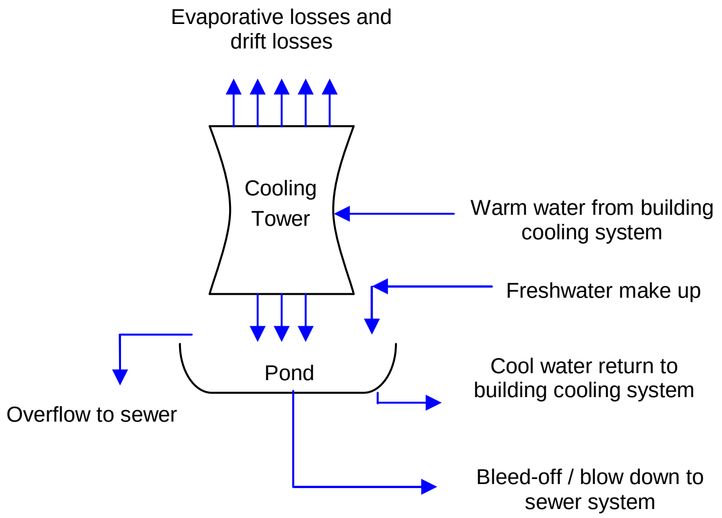
6.2.4 Quantification of water use for cleaning/carwash

This refers to cleaning outside the building (cleaning of the building interior should be factored into the water use ascertained when assessing staff amenities). Determination of water use can be carried out in much the same way as for the assessment of water use by gardens and lawns.

6.2.5 Quantification of water use by cooling towers

Figure 3 below outlines the generic water uses associated with cooling towers in commercial installations.

Figure 3: Cooling Tower Water Use



The losses from a cooling system which incorporates one or more cooling towers comprise leaks from the reticulation network, evaporation from the cooling tower itself, cooling tower overflows, drift losses and blow down (also called bleed-off) of concentrated cooling water. The sum of these losses is equal to the total volume of make-up water required to maintain the volume in the cooling system. This is represented by the simple mass-balance relationship:

Equation 5: Cooling Tower Make-Up Volume

Make-up Water Volume = Evaporation losses + Bleed-off volume + Leaks + Overflows + Drift Losses

If the freshwater make-up and blow down volume are metered, the difference between the two would be equal to the sum of the evaporation losses, overflow losses, drift losses and the volume lost due to leaks. The volume used by a cooling tower and its associated reticulation network is simply the volume supplied as freshwater make-up. As a general rule, this volume should always be metered, since it would represent a significant part of the water use in a commercial building fitted with cooling towers. Should it not be metered, it can be calculated provided that the water pressure is known along with details of the pipe-work and fittings. Where a float valve is used, metering remains the best option since it will be impossible to determine the frequency of opening of the valve and calculation of the make-up volume would then be subject to significant error.

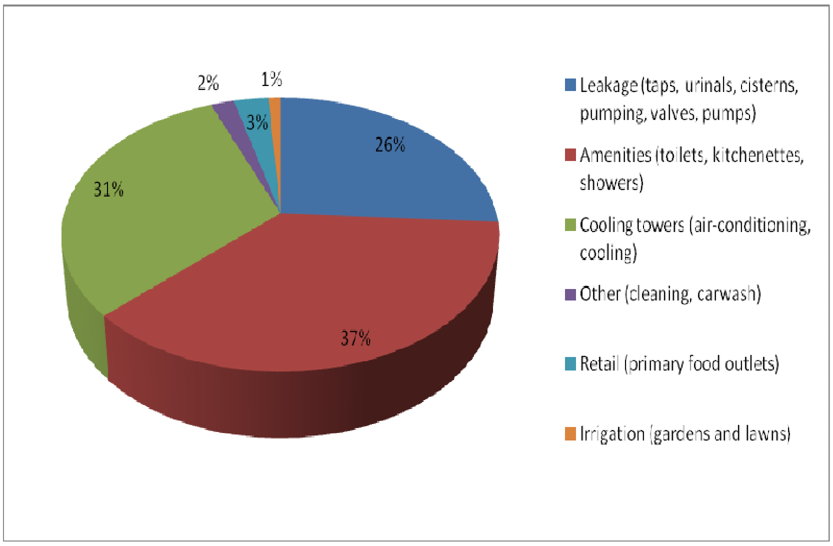
6.2.6 Quantification of water use by canteen or staff kitchen

Note that this is different to the water use due to kitchenettes, which are smaller facilities generally used to prepare hot beverages and to microwave food. Staff canteens/kitchens tend to be larger and designed to serve large groups of people. They may have numerous specialised appliances, some of which may consume significant quantities of water e.g. dishwashers. The approach used is similar to that used to assess water use by staff amenities.

6.2.7 Compilation of a site water use overview

The aim of gathering the information on individual water use areas is to be able to construct a breakdown of water use on the site, which would assist in pointing out where the biggest opportunities are. Figure 4 below outlines an example of such a breakdown, based on audits carried out on office buildings in Australia.

Figure 4: Typical Breakdown of Water Use in Buildings



Source: Quinn R et al (2006)

For a commercial site with characteristics as in Figure 4, assuming that this water use profile was established prior to implementation of any water conservation projects, primary water saving opportunities would be:

i. Improvement of maintenance practices to reduce leaks. Given that a quarter of the water used comprises losses due to leaks, repairs are most likely a cost-effective means of reducing water use, and one that could be implemented relatively quickly;
ii. Investment in water-efficient plumbing, fittings and fixtures, as well as the introduction of water-efficient appliances;
iii. Reduction in the heat load being rejected at the cooling towers. This may require some changes in building design to dissipate heat more effectively from the structure, and to reflect heat more effectively;
iv. Cooling tower blow down practices may also need to be examined.

There are opportunities in other areas, but a focus on the areas highlighted would yield the biggest potential improvements in water use efficiency in this example.

6.3 Assessment of Individual Water Conservation Opportunities

In order to set meaningful water use targets, the amount of water that would potentially be saved through implementation of each individual water conservation opportunity has to be determined. Each opportunity can then be evaluated in terms of its viability, and those found to be viable can be planned for implementation. Implementation timelines will determine when the savings expected from planned conservation interventions can be built into targets.

A water conservation opportunity may be defined as a viable intervention which, when implemented, results in a reduced consumption of water relative to baseline water use. The viability of individual water conservation interventions should be ascertained using the standard methodologies used by individual organisations when justifying any project. While the details are outside the scope of this guideline, and will depend in part on the approach of individual organisations, the following are important considerations:

- The capability of the organisation and/or external service providers to sustain the intervention. For example, should new equipment be required, are the spares and skills required for routine maintenance available locally and at short notice?
- The financial viability of the intervention i.e. will savings in water, energy, chemicals etc. justify the capital and operating costs arising from the intervention?
- Risks arising from the intervention – a full risk assessment should be carried out on all modifications to ensure that unintended consequences of implementation are avoided. For example, de-commissioning of cooling towers and switching to stand-alone air conditioning units could save water on the site, but could lead to large increases in electricity consumption. This is an example of how water conservation initiatives should never be considered in isolation.
- The risks of NOT implementing the intervention should also be considered. For example, the risks of running out of water due to water scarcity in the area of the site, or of being subjected to water restrictions should be considered in the assessment of whether an initiative is viable or not.

There are two broad categories into which water conservation initiatives in the commercial sector may be divided:

i. Operational initiatives and;
ii. Capital projects

Operational initiatives are those which yield water savings through the modification of work practices and behaviour, or through the use of different materials/consumables. For example, cleaning staff may reduce the amount of water used for cleaning by employing brooms to sweep outside areas instead of hosing them down.

Capital projects are those initiatives in which changes to capital equipment are made. An example here would be the introduction of water-efficient appliances in the staff canteen.

What follows are brief examples of how opportunities may be assessed in the various water-use areas of a commercial installation.

6.3.1 Assessment of water conservation opportunities in staff amenity areas

Efficient plumbing devices and fittings are available in South Africa, as are efficient appliances. In order to ascertain potential water saving opportunities, the expected water consumption due to the installation of alternative devices must be compared to the water use due the devices currently installed. The difference is then the magnitude of the potential saving. The concept is illustrated in Table 3 below. In this example, the frequency and duration of use are assumed to be constant, but it is also possible to build in expected changes in the frequency and duration of use.

It is important to consult suppliers and manufacturers of efficient devices to discuss the specific requirements of each product at installation, to ensure that expected savings can indeed be realised. These devices require specific supply pressure conditions, for example, and care should be taken in ensuring that these conditions are either met by the commercial installation being evaluated, or that modifications can be made to meet these conditions. The cost of such modifications should be included in the overall capital costs involved when these products are evaluated for viability.

From an operational perspective, it is possible to estimate the amount of water that could be saved through changing attitudes and behaviour. Staff could be encouraged to run taps for shorter durations, or have shorter showers for example. The expected savings from such programmes can be built into targets.

Table 3: Assessment of Savings Due to Water-efficient Devices

Area	Fitting	Current Flow Rate (L/min)	Efficient Device Flow Rate (L/min)	Duration Per Use (min)	Current Volume Per Use (L)	Projected Volume Per Use (L)	No. of Uses per day	Current Volume Per Day (L)	Current Volume Per Annum (L)	Projected Volume Per day	Projected Volume Per Annum (L)	Projected Annual Savings (L)	Percentage Saving (%)
Kitchen	Tap 1	12	6	0.5	6	3	40	240	59,040	120	29,520	29,520	50.00
	Tap 2	10	6	0.5	5	2	50	250	61,500	100	24,600	36,900	60.00
	Tap 3	9	6	0.5	4.5	1.5	34	153	37,638	51	12,546	25,092	66.67
	Dishwasher				17	7	3	51	12,546	21	5,166	7,380	58.82
Change room	Tap 1	14	6	1	14	8	30	420	103,320	240	59,040	44,280	42.86
	Tap 2	14	6	1	14	8	30	420	103,320	240	59,040	44,280	42.86
	Tap 3	14	6	1	14	8	30	420	103,320	240	59,040	44,280	42.86
	Toilet 1				8	3	10	80	19,680	30	7,380	12,300	62.50
	Toilet 2				8	3	15	120	29,520	45	11,070	18,450	62.50
	Shower 1	16	5	5	80	55	13	1,040	255,840	715	175,890	79,950	31.25
	Shower 2	16	5	2	32	22	10	320	78,720	220	54,120	24,600	31.25
TOTALS								**3,514**	**864,444**	**2,022**	**497,412**	**367,032**	42.46

6.3.2 Assessment of water conservation opportunities in garden and lawn irrigation

It is useful to benchmark site water use for irrigation in mm, as this allows horticultural specialists to compare the water use of a site to a projected water use for a given mix of plants, taking the local environment (in terms of rainfall and evaporation) into account. To convert the volume required for irrigation determined earlier into mm, divide the irrigation volume by the area of the irrigated gardens and lawns on site.

Equation 6: Irrigation Water Use
Irrigation Water use (mm) = Irrigation Water Use (KL) x 1000 / Garden area (m^2)

It is best to use an annual figure for this assessment in order to account for seasonality.

Example 4:

How much water is required annually in mm for a garden on a commercial site with an area of 10,000 m^2 that uses 10,000 kL per annum?

Irrigation water use (mm) =10,000 x 1000 / 10,000 = 1000 mm

The types of capital investment opportunities that could be pursued in order to reduce irrigation water use include:

i. Installation of efficient irrigation systems;
ii. Rain sensors to shut off irrigation systems;
iii. Wind sensors to shut off irrigation systems;
iv. Soil moisture sensors and;
v. Use of indigenous plants and plants that use minimal amounts of water e.g. groundcover tends to use less water than lawn does.

From an operational point of view, the types of measures that could be taken include:

i. Watering only during cool periods;
ii. Watering no more than once a week;
iii. Ensuring that water is directed only at plants and not at paved areas;
iv. Changing watering patterns based on seasonal variations;
v. Mulching of flower beds;
vi. Removal of weeds/invading vegetation and;
vii. Control of mowing height for lawn areas.

The savings associated with each of these initiatives should be documented for possible inclusion in a water conservation plan, dependent on their viability.

6.3.3 Assessment of water conservation opportunities in cleaning or carwash

Work practice changes typically present a significant opportunity for savings in this regard e.g. the use of brooms instead of hoses for cleaning of walkways and paved areas. The savings are easily quantified in this instance, since the total volume of water that was used for cleaning becomes the saving.

Where hoses must be used, including use for car washing, water-efficient nozzles may be fitted to reduce the water flow rate. Such nozzles must however be designed in such a way that the hose remains effective, as where they are not, it is not uncommon for users to remove them.

6.3.4 Assessment of water conservation opportunities at cooling towers

Evaporative losses are the biggest component of cooling tower water use, and may be reduced only by reducing the heat load that the cooling tower has to reject to the environment. Opportunities of a capital nature which could reduce this heat load include:

i. Reduction of the heat load by modifying the building. A balance needs to be found between maintaining coolness during warm weather and retaining warmth during cold weather. Exploration of these options is best done in conjunction with a green building consultant.
ii. Reduction of the heat load by installing an air-cooled device, either to trim the water temperature before the water enters the cooling tower, or as a replacement for the cooling tower itself. The latter option can be expensive and will most likely require a forced-draft system, which could increase electrical costs, depending on demands relative to those of the existing cooling tower.

Cooling tower systems present a number of operational water conservation opportunities:

i. Bleed-off / blow down volumes should be carefully managed, specifically to ensure that blow down is not happening too frequently. The manufacturer’s specifications are important in this regard. It may be necessary to take a sample of the blowdown and have this analysed by an independent laboratory, and then to optimise work practices accordingly to minimise blow down volumes. Where TDS sensors are used for automatic blow down, these should be regularly serviced;
ii. Overflows of the cooling tower should be avoided. This can happen if the float valve that allows entry of make-up water to the tower becomes stuck in the open position;
iii. Leaks in the pipe-work, and of the tower itself should not be present;
iv. The tower should not be in too exposed a location, which would cause excessive drift/windage losses. Screens may be erected to reduce windage losses – these should not impede air flow into the tower;
v. Drift eliminators at the top of the tower should be working properly to ensure that water droplets are not carried out of the top of the tower and;
vi. The operating schedule of cooling towers is also important – for example, if a building is only occupied during the day, cooling towers may be switched off or placed on a reduced load regime at night.

As with the previous example for assessment of opportunities for staff amenities, each of these opportunities would need to be assessed individually for possible implementation.

6.3.5 Assessment of water conservation opportunities at canteens / staff kitchens

This assessment is very similar to that for amenity areas. Extensive consultation with specialist suppliers is necessary to ascertain specific savings associated with particular appliances. From an operational point of view, the work practices of kitchen staff could potentially be changed to save water.

6.3.6 Assessment of water conservation opportunities due to grey water recycling

Lightly polluted water from showers and hand basins may be collected and reused. Typically such water would need to be settled to remove solids, and then subjected to further treatments such as disinfection. While collection would happen by gravity, the water would have to be pumped to point of use e.g. to gardens or for use in toilet flushing. In order to assess opportunities for recycling, the volume of water to be collected would have to be determined as well as precisely how this water will be treated and reused. The projected uses should be well matched to the volumes of grey water recovered. It is wise to designate uses that require water in excess of the grey water that will be recovered so that all recovered water is reused, making the capital investment more justifiable. Health-related risks need to be very carefully considered, and local regulations should be checked to assess whether recycling is permissible.

6.3.7 Assessment of water conservation opportunities due to black water recycling

The issues associated with black water recycling are similar to those for grey water recycling, with a higher degree of risk to be expected. Black water recycling in the commercial environment is not common in South Africa, but there are examples of industrial sites which use treated black water from on-site commercial buildings for industrial processes. Such sites have fully equipped wastewater treatment plants.

6.3.8 Assessment of water conservation opportunities due to rainwater harvesting

Rainwater harvesting is typically carried out by collecting rainwater from rooftops in commercial installations. The water is diverted to a tank, from which it is either pumped or fed by gravity to point of use, depending on the elevation of the tank relative to the elevation at the point of use. Some treatment may be required depending on user requirements, but for uses such as garden irrigation, the water may typically be used without treatment.

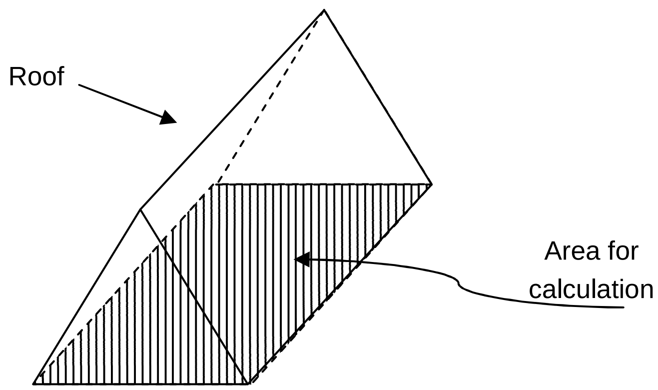
The amount of water that can potentially be harvested may be estimated from the average annual rainfall and measured area of the rooftop to be used from the relationship:

Equation 7: Potential Rainwater Harvest

Potential Rainwater Harvest (m^3) = Annual rainfall (mm) x Rooftop area (m^2) / 1000

The area to be used for this calculation is not the area of the surface of the roof, but the area that is covered by the roof. Figure 5 on the next page illustrates this point.

Figure 5: Area to be Used for the Calculation of Rainwater Harvest Potential



Example 5:

What is the annual potential volume of rainwater that could be harvested at a commercial installation with a roof area of 300 m^2 in a town with an average annual rainfall of 500 mm?

Potential rainfall harvest = 500 x 300 / 1000 = 150 m^3/annum

The actual tank size required would depend on shorter-term fluctuations in rainfall patterns and the matching of rainwater supply to the demands of the processes in which harvested rainwater is to be used.

6.3.9 The need for an integrated approach to target setting

The preceding sections of this guideline have examined individual water conservation opportunities. However, it is important that once these individual areas have each been examined, the entire site is evaluated as a single integrated system. This ensures that any changes made in one area which could have impacts for other areas are considered with these impacts in mind. This integrated approach can also assist in the prioritisation of the implementation of individual water conservation initiatives.

For example, consider the implementation of a grey water recycling system. The system may be based on a given volume of grey water, which may change significantly should water-efficient plumbing devices be installed. It is most likely prudent to consider the installation of the efficient devices (should these be a viable investment) and the grey water recycling initiative as an integrated project.

All conservation initiatives involving recycling should take a site-wide view that considers the quantity and quality of recycled water as compared to the individual demands (in terms of quantity and quality) of individual processes for which the recycled water is planned for use. Where there is a mismatch between supply and demand, that recycling initiative may need to be reviewed.

7 Setting Water Use Targets

7.1 Timeframes for water use targets

Water use targets should be reviewed at least annually, with a target determined for each year over a five year time horizon. Hence at any one time an organisation should have five targets, one for each of the next five years. In any given year, the target for the next year may be viewed as a short term target and the target in five years time as a long-term target. Repeating the process each year allows for current approaches in water conservation as well as current business strategy, or in the case of the public sector, current stakeholder priorities, to be incorporated into the process.

Continuous improvement is one of the drivers of target setting and performance monitoring, and hence the target for each year should demonstrate a progressive planned reduction in water intensity i.e. a progressive improvement in water use efficiency. These planned improvements should be based on opportunities that have been evaluated as described above. Over time however, it does become more and more difficult to continue to improve without significant capital investment. This is the law of diminishing returns as applied to water conservation. When the costs of implementing water conservation exceed the potential economic, social and environmental benefits to be gained, the focus should shift to the maintenance of efficient performance as opposed to the pursuit of increased efficiency levels.

7.2 The role of water use benchmarks

The use of water intensity trends as a means of reviewing water use efficiency performance has been discussed earlier, and is a means for an individual organisation to determine whether water use efficiency performance is improving or declining over time. An organisation’s water intensity may in addition be compared to other users in a sector through the use of benchmarks. Table 4 below outlines an example of benchmark water intensity performance in 132 office buildings in major Australian centres, corrected for climatic impacts on cooling tower evaporation.

Table 4: Office Building Water Use Benchmarks

Normalised Water Intensity ($kL/m^2/annum$)	% of Sample at this level or better
1.5	80%
1.25	63%
1.125	50%
1.0	36%
0.75	17%
0.5	5%

Source: Bannister, Munzinger and Bloomfield (2005)

It is not suggested that such benchmarks be directly used to set targets, since individual water users each have their own context within which water use has to be managed. Benchmarks do however provide an important reference point against which targets may be reviewed. If a water use target deviates significantly from a benchmark value, this may indicate that the target should be modified, specifically in cases where the water use target is at a far lower level of efficiency than the benchmark value.

The precise context of each benchmark should be understood before that benchmark is used in the target-setting process. The benchmark values achieved by a modern, state-of-the art building may simply be unachievable for an older building for example. By the same token, benchmark water use in a water-rich country may be higher than what is appropriate for a water-scarce country such as South Africa. Therefore, indiscriminate use of benchmarks is to be avoided, and their role is really to provide context for target-setting.

7.3 Development of a site water conservation plan and associated targets

Once potential opportunities have been identified and the volumes of water savings associated with each have been quantified, each of these opportunities now has to be analysed to a level of detail which will permit management to be able to make well-considered business decisions regarding implementation. The types of issues relevant to target setting with respect to each opportunity are as follows:

- The technical detail of what the opportunity entails;
- The costs of implementing the opportunity;
- The costs associated with operations as a direct result of implementation;
- The estimated time required to implement the opportunity;
- The life-cycle considerations associated with the opportunity e.g. a building that is to be demolished in 2 years time should not be the subject of extensive investment projects aimed at water conservation. The new replacement building should rather be fitted with the right technologies.
- Risks associated with the opportunity e.g. potential risks to human health, safety etc.
- The benefits of the opportunity, both in terms of water savings as well as other potential benefits e.g. electricity savings, site aesthetics etc;
- Capital and operating budgets available for implementation of the opportunity.

Ideally, the assessment of opportunities on the site should yield a wide suite of potential water saving options. Each of these options would have to be evaluated with respect to the considerations above, within each organisation's unique context. Of all the possible options, a number of viable options could then be determined. The viable options could be earmarked for implementation at specific times over the five year period following annual iterations of target setting. By subtracting the savings expected from the baseline water use level, and considering the timing of implementation, targets can then be set. It is recommended that since targets are set annually, initiatives planned for implementation in any one year be used to set the target for the following year.

What follows is an example of how opportunities are identified and used to set targets on a commercial site.

Example 6:

A commercial office park with a building floor area of 20,000 m^2 and a baseline annual water use of 55,000 m^3/annum had a water use distribution as outlined in Table 5 below.

Table 5: Water Use by Area on a Commercial Site

Area	Water Use (m^3)	% of Total
Amenities	24,750	45%
Cooling towers	19,250	35%
Leaks	5,500	10%
Irrigation	3,300	6%
Canteen	1,650	3%
Cleaning/carwash	550	1%

The water intensity of the park was therefore 55,000 m^3/a / 20,000 m^2 = 2.75 m^3/m^2/a

Water conservation opportunities were identified and rough water savings were quantified for each opportunity. Detailed investigations by maintenance staff located on the site supported by specialist contractors yielded a number of viable conservation projects based on savings in water (among other benefits) relative to implementation costs and the risks associated with implementation. The initial focus was placed on the elimination of leaks, followed closely by modifications to plumbing and operational changes to the cooling towers. Planned reductions in consumption associated with these individual projects were calculated to be as indicated in Table 6 below for each year over a five year period following the year in which the baseline was determined.

Table 6: Projected Annual Savings from Water Conservation Projects

Area of Site	Baseline	% of Total Consumption	Expected annual savings of projects implemented in Year 1	Expected annual savings of projects implemented in Year 2	Expected annual savings of projects implemented in Year 3	Expected annual savings of projects implemented in Year 4	Expected annual savings of projects implemented in Year 5
Cooling Towers	19,250	35	500	0	2,300	0	0
Amenities	24,750	45	1,200	2,000	0	0	0
Leaks	5,500	10	3,500	1,000	0	0	0
Irrigation	3,300	6	0	0	0	1,000	0
Cleaning/carwash	550	1	50	0	50	0	0
Canteen	1,650	3	300	0	0	0	400
		TOTALS	5,550	3,000	2,350	1,000	400

Targets for each of the five years were therefore agreed, on the principle that this process would be reviewed annually. Projects planned for implementation in any given year were only incorporated into the following year's target in order to allow time for the new initiatives to be properly integrated into operations and to deal with teething problems. For example, the target for year 1 was maintained at the baseline level, but the target for year 2 comprised the measured baseline less water savings anticipated through implementation of savings in year 1. The agreed water use targets are outlined in Table 7.

Total savings over the five year period would be 5,550 + 3,000 + 2,350 + 1,000 = 11,900 m^3/annum, which would reduce the water intensity of the office park from 2.75 $m^3/m^2/a$ to 2.155 $m^3/m^2/a$, a reduction of 21.63% over five years.

Benchmark performance for office parks in the area was documented as being 2.21 $m^3/m^2/a$, with most of these having already completed water conservation programmes. Management therefore felt that as a five year programme of action, the proposed water conservation initiatives were adequate. Had there been a significant performance gap to the benchmark, the programme may have had to be revised.

Table 7: Annual Water Use Targets Example

Year	Target (m^3)	Target ($m^3/m^2/a$)	Comment
Baseline	55,000	2.75	
Year 1	55,000	2.75	Target = baseline
Year 2	49,450	2.47	Target = baseline - annual savings in year 1.
Year 3	46,450	2.32	Target = baseline – (annual savings in year 1 + annual savings in year 2)
Year 4	44,100	2.21	Target = baseline – (annual savings in year 1 + annual savings in year 2 + annual savings in year 3)
Year 5	43,100	2.16	Target = baseline – (annual savings in year 1 + annual savings in year 2 + annual savings in year 3 + annual savings in year 4)

Individual users are free to decide on whether they would like to incorporate savings into targets more rapidly. For example, if there is confidence as to implementation timelines and the volumes to be saved, pro-rata savings can be incorporated into annual targets based on precisely when initiatives are to be implemented. Hence the target for a given year could even incorporate projects to be implemented in that same year. The approach outlined in Tables 6 and 7 is however the recommended approach, as it incorporates more certainty into the target setting process

8 CONCLUSIONS

This guideline represents a point of departure for baseline determination and water use target-setting in the commercial sector. Over time, it is expected that this guideline be improved, possibly incorporating details on specific sub-sectors within the commercial sector. In its current format, it can however be applied to any sub-sector within the commercial sector, provided that the principles illustrated here are adapted to account for any unique sub-sector characteristics.

In closing, this guideline is for the benefit of users, and its ongoing improvement and development is welcome. Comments and suggestions for improvement of this guideline should be communicated to your sector representative.

9 REFERENCES

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