Waterwise Water Auditor Program

Guidelines and Criteria for Water Audit Analysis and Reporting

Introduction

Acknowledgement as a Waterwise Water Auditor (WWA) carries with it a customer expectation that services performed by the WWA will be executed to a high standard. The Water Corporation periodically assesses water audits carried out by a WWA to ensure this expectation is being met. The following criteria have been developed in order to assist the WWA. It is acknowledged some of the criteria may be unnecessary for some sites. In such cases the consultant may either retain the use of the section heading and report "Not applicable" against it, or drop the section altogether. The option adopted by each consultant is more a question of the normal style of reporting for their individual organisations.

It is envisaged that *most* of the section headings contained in these guidelines will be applicable to *most* of the sites audited by the WWA.

Aim

The accurate analysis of data is important as the whole of the financial analysis for the water efficiency audit flows from the water use model. Preparing a clear and concise report is vital to the success of a water audit. Poorly analysed data or a badly written or presented report may leave vital information inaccessible to your client. It has been noted that "*data only becomes information when it is shared*".

Essential Criteria

There are a number of criteria which are considered essential to a water efficiency audit report. These are:

1. Is the historical water use for the site examined?
2. Is there a commentary on the current water use, and water using hardware at the site?
3. Has there been an adequate investigation into potential leaks at the site?
4. Is current water use modelled?
5. Does the water use model account for historical water use to +/-10%?
6. Are any potential water saving measures itemised and discussed?
7. Has a cost benefit analysis been carried out on these recommendations?
8. Have payback periods been presented for the cost benefit analysis elements?

Desired Criteria

The following are not mandated, but are considered valuable additions to a water efficiency audit report.

1. Have rates of return on investment been presented for the cost benefit analysis elements?
2. Have other financial savings (meter size, discharge factors, major fixtures) been considered?
3. Have water management techniques such as sub-metering been considered?
4. Have staff involvement and self management techniques been considered?
5. Have potential company policies such as WELS related specifications for plumbing contractors been considered?
6. Does the report make good use of tables and figures?
7. Has essential but extraneous information been placed in appendices to keep the report clear and concise?
8. Does the report have clear and concise Executive Summary?

Explanatory Notes

The following are explanatory notes which have been prepared to guide those seeking acknowledgment as a WWA, and those seeking to write a comprehensive water efficiency audit report.

Historical data

The Water Corporation can email your client's water use history in MS Excel, once the client has given approval in writing. Data is sourced through the Water Corporation Customer Centre in Balcatta. This allows the auditor to become familiar with the site before the visit, and to make a list of water use trends, which need to be analysed during the investigation.

Study the historical water use data to get annual average consumption, trends in annual water use, and seasonal cycles in water use. It is also important to get the billing data to the highest possible resolution. That is, try to avoid using total annual data wherever possible.

It is important that WWA's do not attempt to calculate an annual average from a single account as it may be seasonally biased, or contain abnormal readings from one-off events such as a burst pipe, or filling a swimming pool.

The Bureau of Meteorology (BoM) now makes historical data available free on the Internet. These data are downloadable in CSV format for any weather station in Australia, going back to the start of records. This is a valuable and powerful source of data for the water auditor. It allows water use to be correlated against influencing factors such as temperature, rainfall, humidity and wind speed.

Water Use

Many commercial sites are a little different to domestic settings in that they consist mainly of toilets, showers, taps, evaporative air conditioners and so on. In such cases, the auditor needs only to get data from a cross section of readings rather than sample every appliance.

It is not uncommon for an office tower to have tanks on the roof, and/or water pressure boosters on a middle floor or in the basement. In this case, the auditor would visit several floors to ensure the water pressure and flow rates are similar throughout the building.

On a site with a large floor area but little height such as a shopping centre, the auditor would make sure the water delivery characteristics at the outer edges of the site are similar to those in the centre.

It is interesting to note that high water users are often the most efficient. The volume of water a site uses should not be confused with the amount it may be wasting. Businesses such as soft drink manufacturers often have management indices such as the volume of water in, compared to the volume of product out, and track water use carefully.

During the site visit it is critical the auditor be escorted through the site by a staff member who either knows the operation of the site, or knows the key personnel responsible for the operation of each section of the site. It is also important that the site guide has access to areas such as plant rooms, cooling towers, irrigation control stations and the like.

The site staff and/or the auditor may also need to coordinate key sub-contractors to be present on the day of the audit. These may include gardeners, air conditioning technicians, or maintenance plumbers.

Water Using Hardware
Besides the flow rate or volume, the auditor needs to be mindful of a range of fitting and fixture characteristics.

The trap type ("P" or "S" trap) of the toilet should be noted and the material the bowl and cistern are made of. In some cases even the colour of the suite, and the cost of matching wall and floor tiles also need to be included.

The auditor needs to be mindful of décor considerations. The prices quoted in the financial analysis need to allow for bringing the fitting and fixture back to how it looked before work started, or at least to the customer's satisfaction if decor is not an essential consideration.

The type of tap, and the presence or absence of an aerator should be noted. Water efficiency options for tap ware include fitting valves in the aerator or the body of the tap, or in the plumbing line behind the tap. Each of these options has cost and reliability implications and each needs to be factored in.

Aesthetics are also important with showers in some settings. Some sites will require the shower fittings to be left in place which means the water efficiency measure will have to be the installation of valves in the shower or the taps which feed it.

Some hot water systems will malfunction if flow-restricting devices are installed in tap ware fed by them. This text recommends not fitting any flow-controlling device to a tap or shower fed by an instantaneous hot water system.

Water quality may also need to be considered as some flow-controlling devices operate poorly in low water quality.

The percentage of each water use going to sewer needs to be estimated, as does the percentage of hot water being used by each type of appliance as hot water can cost up to $10/kL. Any savings of hot water will add significantly to the financial reward derived through water efficiency.

Leaks
Water leaks are a clear example of water being wasted, as the leak serves no constructive purpose. The WWA report must contain a commentary on leaks.

Water Use Modelling
The water use modelling process is the arithmetic treatment of the data gathered on site.

Typically water use/day is calculated for each outlet by the following formula:
Water use per day = water per use X time used X patronage X number of times per day

For ***volume dependent*** uses such as toilets, the cistern volume is used as the "*Water per Use*", and the "*Time Used*" is one per flush.

For ***flow dependent*** uses such as showers, the flow rate is used as the "*Water per Use*", and the "*Time Used*" is based on measurements or assumptions. A duration time of seven minutes is a figure that appears in the literature for domestic water use in Perth, although this may vary in the non-residential sector.

Each line is then multiplied out by the number of days/week of site operation, and then the number of week/year. For example, an office block will normally have an operation schedule of 5 days per week and 48 weeks per year. This builds in the assumption that everyone on site will be absent for four weeks per year for leave, illness and so forth.

A hotel will operate 7 days per week, 52 weeks per year. The figures for schools are 5 days per week, 40 weeks per year. In many cases, care needs to be taken with schools as they hire out halls and rooms for after hours adult classes, or for sporting clubs. This usage also needs to be factored in.

The above formula is also used as the basis to determine the discharge to sewer, and the potential hot water savings for each water use. The auditor can calculate these figures by recording the percentage of total water used which then enters the sewer and the percentage of hot water used.

Note that the formula does not take into consideration the number of fixtures. The water use on site will be a function of the usage rate and patronage and the broad assumption is that a set number of staff will have the same number of water uses (i.e. toilet flushes) regardless of whether they have 10, 20 or 30 fixtures through which they will use that water.

The next key piece of information is the flow rate or volume AFTER the retrofit. Using this sequence, a model can also calculate the water use (and therefore water savings) after the retrofit, the discharge factor after the retrofit, and the amount of hot water saved. An elaborate model will also have the potential to automatically derive summary data, such as that shown below.

Example
An office building has a change room area with five showers in it. The *flow rate* of the showers is measured at 12 litres per minute. Twenty staff (*patronage*) use the showers once each day (*uses per day*) for an average of seven minutes (*time used*) each.

Daily water use = 12 x 20 x 1 x 7
1,689 Litres

As it is an office building we assume it operates 5 days per week, 48 weeks per year.
Annual water use = 1,689 x 5 x 48
403,200 Litres

At this point we would normally convert our water use to kilolitres (kL), which are thousands of Litres.

Annual water use = 403.2 kL

An efficient showerhead has a *flow rate* of 9 litres per minute. This results in the *water saving* of 3 litres per minute. Using the same calculation steps we can arrive at an annual water savings figure.

Annual water savings = 100.8 kL

The water model is the sum of these calculations, with one being performed for each appliance, or group of appliances. A multi-story building may have identical ablution facilities on each floor in which case the whole of the building's occupancy can be modelled through one ablution block for each gender.

Sites such as long established universities may have buildings of significantly differing age, quality, and plumbing hardware. In these instances each building, and in some cases each area of each building, will need to be modelled separately.

Model integrity

The model should have some level of rigour to ensure all parties that the site has been correctly interpreted. A tolerance of +/- 10% of the historical average water use for the site is considered a suitable benchmark for modelling. The historical average is derived from the billing data and may require some data manipulation or smoothing to account for one off anomalous water uses such as burst mains.

Obtaining an appropriate water balance is a key task of the modeller. There is always a temptation to continually adjust the model inputs until the water balance is achieved. This may lead to a distancing of the model from reality, which will weaken the analysis.

As a general principle, a first model return of greater than 110% of the historical average usually indicates an error in data collection or entry. These are often easily identified through a line by line inspection of the model outputs, as a single line may stand out as returning an unnaturally high water use.

First model runs, which return less than 90% of the historical average water use, can also be caused by bad data collection or entry. However, they may also be caused by the auditor missing part of the site, or by a cryptic water loss. This is a water loss that shows no evidence such as pooling of water. Cryptic water losses can occur through circumstances such as:

- Burst mains under structures such as buildings
- Jammed valves in appliances such as roof top air conditioners
- Theft of water after hours
- Unauthorised water uses by staff
- Faulty irrigation controllers

Once any discrepancies have been identified and a water balance has been reached, the financial analysis can be undertaken.

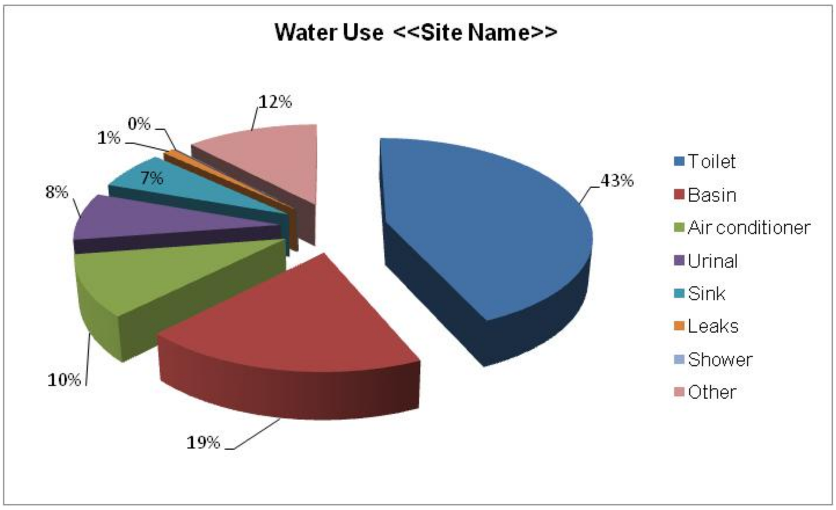
Water use model outputs

The clear interpretation and reporting of the model outputs will help the client understand their water use. This, in turn, will help them focus their attention on aspects of their water use most likely to yield water efficiency gains.

One of the key model outputs is the water use information in table and graph format. The table below has the information sorted from the highest water use to the lowest with the water use also presented as a percentage of the total.

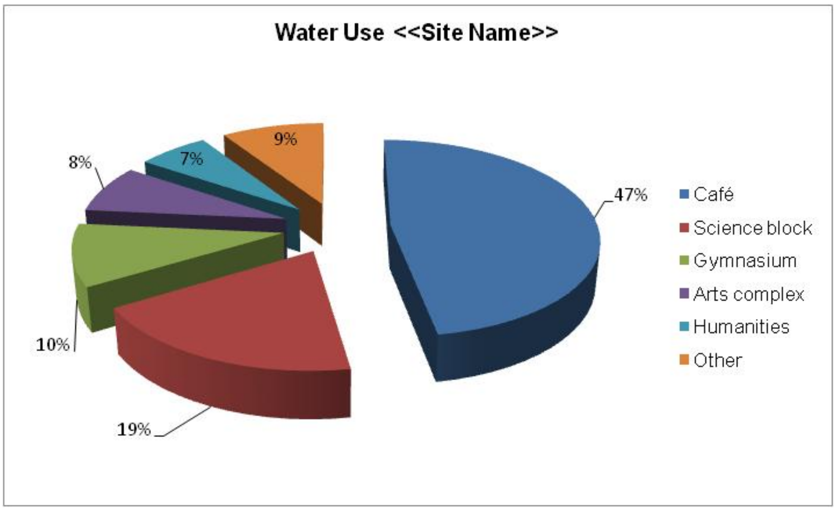
Water use	Demand (kL/a)	Percentage
Toilet	1,095	43
Basin	481	19
Air conditioner	255	10
Urinal	198	8
Sink	162	6
Leaks	26	1
Shower	2	0
Other	305	12
TOTAL	**2,524**	**100**

The graph is then based on this table and is also sorted from highest to lowest water use.

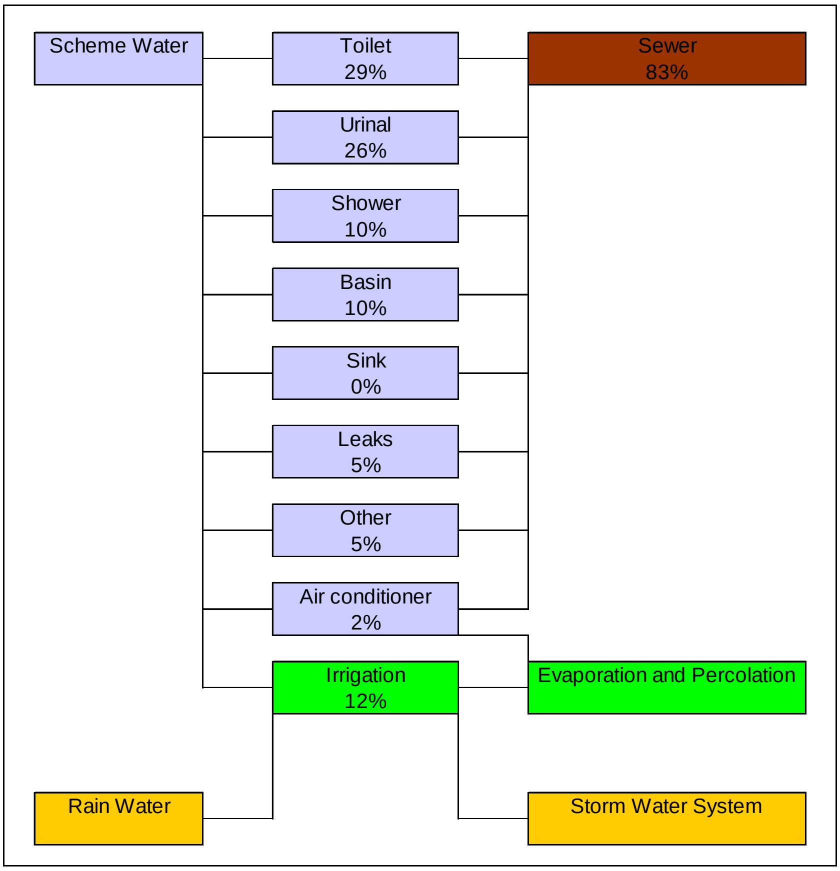


The data can also be presented by site area if that is a more meaningful analysis for the client. The following are the same hypothetical data based on what might be found at a teaching institution.

Water use	Demand (kL/a)	Percentage
Café	1,195	43
Science block	481	19
Gymnasium	255	10
Arts complex	198	8
Humanities	162	6
Other	233	1
TOTAL	**2,524**	**100**



Water use data can also be represented as a flow chart as seen below.



Here all the water sources and "sumps" are shown. Water sumps are pathways to water disposal and can be as simple as the storm water system, which is then connected to the municipal system.

This format is particularly helpful for planning water re-use as it allows for secondary water loads to be matched with wastewater volumes. For example, in the chart above the shower output could nearly compensate for the irrigation load.

It is important to remember to also consider the time of year the water loads are either created, or needed. The above example is likely to produce the shower water load evenly across 12 months whereas the irrigation demand may only be spread over four or five months.

It is sometimes also useful to remember that the sources of secondary water, or the demand for it, may occur across property boundaries. A commercial laundry in a light industrial area may be producing "wastewater" which could be used by an adjacent concrete batching plant for dust control.

Discharge factor
A well-crafted water use model will also produce the data on the volume of waste entering the sewer before and after proposed works. This figure is then used to gauge whether the site's discharge factor has been calculated accurately.

Financial analysis
Financial savings flowing from a water efficiency audit are primarily generated through reduced:

- Water use
- Energy consumption from less hot water use
- Discharge to sewer.

Other sources of financial savings may include:

- The elimination of leaks
- The development of appropriate leak detection and maintenance protocols
- Reduced meter sizes
- Amended discharge factors (where the original factor was incorrect)
- Reduced numbers of major fixtures (where excess fixtures can be decommissioned).

Retrofit costs
These are reasonably self-explanatory. The water efficiency auditor needs to be aware of factors such as:

- *Toilets* - material from which the bowl and cistern are fabricated, colour of the suite, and issues of matching wall and floor tiles.
- *Taps* - the type of tap, and the presence or absence of an aerator.
- *Showers* - aesthetics are once again important with showers in environments such as hotel rooms.

Prices for some items such as flow control valves will not vary from site to site. Prices for other fixtures may. It is important to use prices, which are relevant to the area of operation, and to the site-specific considerations such as décor.

Other costs might include factors such as freight to a remote location. In some cases, more expensive hardware may be needed to overcome water quality issues. Such hardware might include water filters, or water treatment plant.

Water, sewer and energy tariff savings

Some jurisdictions have also published anticipated tariff price rises over time. It is legitimate to add these to your financial analysis when calculating financial savings for future years.

In WA the first 200 kL per year of sewerage is not charged. It is important to consider this, especially on sites with a small discharge to sewer.

Other Savings

Fixed fees for meters range between $366 per annum and $112,000 per annum. Comments on appropriate meter sizing can be included in the WWA report.

Other savings include calculating the number of major fittings at a site that discharge to the sewer network and recalculating this information if there has been any downsizing, etc.

Our rates and charges can be found on our Website

Payback Period

The payback period is simply, the cost of the water efficiency measures divided by the savings they will generate. Payback periods are typically expressed in years, but months are sometimes used for actions with low payback periods.

Care should be taken when calculating a financial analysis flowing from an audit. There is no firm rationale for including “other savings” such as reduced meter costs along with avoided water use. Similarly, there is no firm rational for bundling these disparate financial savings.

It is recommended that the auditor makes a clear distinction between the costs and benefits of the retrofit, and those of other factors. The other factors may include costs to fund and repair leaks as these might legitimately be considered maintenance as opposed to being a “water efficiency measure” per se.

The payback periods for the various water efficiency measures for a site can be “*bundled”* together to make a “*water efficiency package”*. For example, the following table shows a range of water efficiency options for a site, presented from the most financially attractive to the least. The final column of the table shows the running total of the payback period as each of the options are sequentially bundled with those before it.

Water saving action	Cost ($)	Savings ($/a)	Payback period (years)	Cumulative payback (years)
Shower retrofit	$220	$274	0.8	0.8
Sink retrofit	$135	$115	1.2	0.9
Basin retrofit	$765	$502	1.5	1.3
Urinal retrofit	$540	$130	4.2	1.6
Toilet retrofit	$14,820	$1,147	12.9	7.6
TOTAL	**$16,480**	**$2,169**	**7.6**	**7.6**

Note that the urinal retrofit alone has a payback of 4.2 years but this is reduced to 1.6 years when bundled with the options before it. Similarly, the toilet retrofit has an individual payback of 12.9 years but the whole water efficiency package would have a reduced payback of 7.6 years.

It is always important to show individual payback calculations but presenting this additional analysis can increase the likelihood of more options being implemented. It also decreases the likelihood of a practice known as "*cream skimming*". This is when only the best options are implemented. The risk from cream skimming is that the less attractive options may never be implemented if they are not done with the cross subsidisation from the better options. These options would then be lost to the business forever.

Choosing an analysis horizon
It is important that the auditor chooses an appropriate time horizon to calculate costs, benefits and estimates such as payback periods.

The time horizon needs to be mindful of the value of "today's dollar". Inflation constantly erodes the "net present value" of today's dollar so that future costs will be higher (what costs $10 today may cost $12 in two year's time), and savings will be lower (what can be bought for $10 today may not be able to be bought for $10 in a few year's time).

Generally speaking, the prevailing inflation rate in Australia is such that a time horizon of approximately 10 years can be valid without compensating for net present value considerations.

The time horizon should also reflect, or at least consider the expected lifespan of the hardware being installed. For example, one might expect a toilet suite to have an almost indefinite lifespan but that a flow control valve may wear and need to be replaced every five years or so. The auditor may settle on an analysis time horizon of 10 years.

In cases such as this, the costs of the flow control valves would need to be entered twice to keep the analysis accurate. Similarly, items such as oil cartridges for waterless urinals would also need to be added as appropriate.

It is important to note the only recurring costs that need to be included are those peculiar to the hardware being installed. The valves and seals in a toilet suite may need replacing in an efficient toilet every five years but they would also have needed replacing in the existing inefficient toilet so the costs are not new. Tap washers in efficient and inefficient taps also fall into this category of self-negating recurring costs.

Return on investment
The costs and benefits from a water efficient retrofit can also be expressed in terms of annual rate on investment.

The following table shows the annual return on investment for the options outlined above. Presenting this information may be important for some customers, as large enterprises often have a formal investment policy, which prohibits spending on investments with rates of return less than about 20%. In this case, that policy would result in the retrofit of all but the toilet options which has a return of 2%. Implementing the whole package would not be an option there as it only returns 10%.

Water saving action	Annual return on investment
Shower retrofit	125%
Sink retrofit	85%
Basin retrofit	66%
Urinal retrofit	23%
Toilet retrofit	2%
TOTAL	**10%**

Report presentation
It is important that the findings of the water audit are clearly and simply conveyed. In some cases, the report may be forwarded to a regional, state or national manager who may not be familiar with the site. The report, therefore, needs to "paint a picture" of key aspects of the site including:

- Physical site characteristics
- The main water uses
- The existing water using hardware
- Proposed retrofits and other recommendations.

Within some sites there may be several people who will be called upon to review the report and make judgements on it. These people may be viewing different aspects of the recommendations and the auditor needs to be aware of this.

Within a five star hotel there will be a maintenance engineer who will be concerned with the quality of the hardware and its reliability. The accountant will be interested in the financial analysis. The General Manager will need to be reassured that the quality of the hotel "experience" will not be diminished for the guests staying in house.

Cover Page
While largely self-explanatory, the cover page should include the obvious information such as the site audited, and the date of the report. Digital cameras make it easy for the cover to also include a picture of the site.

Executive Summary
As is the case with most reports, it should have an executive summary. This needs to convey:

- The key findings in terms of water use, resource and financial savings.
- The options and recommendations for water efficiency (usually rated from highest priority to lowest).
- Other recommendations such as maintenance schedules, asset replacement policies and data gathering protocols.

Site management and tradespeople will use the executive summary so it needs to be quite explicit when identifying the tasks necessary in the retrofit. It may also be distributed to all staff and, therefore, needs to be written in a manner that can be widely understood.

The executive summary can be renamed to make it more eye catching if appropriate. Terms such as *Water Efficiency Plan*, or *Summary of Water Audit Findings* are appropriate alternatives to *Executive Summary*.

Introduction

The introductory sections will contain information such as the:

- Auditor details
- Contributing staff members from the audited site
- Scope of investigations, which were undertaken.

Water Use Summary

The water use summary describes the various water sources and sumps, and the main water uses at the site. Historical water use data can be obtained from either the utility or the company files and this should be analysed as outlined in the *Data Collection* chapter.
Current water use can be broken down by end use (taps, toilets) or by sectors of the site (science labs, gymnasium, retail shops). The key water using hardware should also be described. This can include, but need not be limited to:

- The water efficiency characteristics of appliances such as toilets and taps
- The apparent age and/or efficiency of fixed appliances such as washing machines and dishwashers
- Evidence of maintenance and servicing of large water using devices such as cooling towers and laundries
- Observations on vegetation condition and irrigation systems.

Potential water savings

The format of the *Water Use Summary* can then be mimicked when describing the *Potential Water Savings* for the site. Here the nature of the savings are described, not necessarily their quantum.

Water use model

This section deals with the various inputs to, and outputs from the water use model. This section will typically include the table and pie chart shown in the *Model Outputs* section of this chapter, as well as the flow chart of water sinks and sumps.

Financial analysis

Having explained and shown the quantitative Water Use Model, the auditor then goes on to show the Financial Analysis for the water efficiency audit as detailed in the previous section of this chapter.

Non-financial recommendations

Here the auditor is free to make observations and recommendations on aspects of the site and its operations, which affect water efficiency. As outlined in the introductory chapter, these may include:

- Starting a site based data collection process using regular reads of the water meter
- Initiating a regular leak inspection protocol
- Involving staff in water efficiency measures
- An asset replacement policy for fixed water using capital items such as washing machines
- Plumbing specifications for indoor water using hardware
- The establishment of a climate sensitive irrigation schedule
- Plant selection and landscaping observations.

Recommendations
The summary of recommendations can either be presented in the order they appear in the report, or by order of priority to the water efficiency of the site.
In either case, it is standard procedure to reference each recommendation with the page number to enable the reader to examine the full text preceding the recommendation, if desired.

Appendices
Efforts should be made to keep the main body of the report simple and direct. All extraneous information should be shifted to the appendices of the report. Thus the interested reader can pursue this level of detail *if they require all the information*.