Natural Resources and Mines

Water Industry Compliance

Queensland Evaporative Airconditioning Water Usage

Report

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1. Executive Summary

An evaporative air conditioner is a unit that cools air by moisture evaporation. They provide effective cooling in dry climates, and their cooling effect is minimal in hot humid climates. Therefore, they are most commonly found in hot dry climates such as inland areas of Queensland.

They are predominantly installed in residential accommodation, which is estimated to make up over 95% of the Australian evaporative air conditioner market.

Evaporative air conditioners consume water in two ways; the evaporation of water from the pads which cools the air, and the dumping/bleeding-off of water to reduce the mineral concentration in the sump. Calculations indicate that the units use 10% to 25% of the total yearly water consumption per household in hot and dry climates. However, in peak summer months the units can use 40% to 75% of the daily indoor water consumption.

The options for reducing the water consumption due to evaporation are limited.

There are several options for reducing the dumping/bleed-off rates which have been calculated to be approximately 10% to 15% of the total water consumption of the evaporative air conditioners. This is equivalent to approximately 2% of the total household water consumption in hot and dry areas of Queensland.

The costs involved to reduce water consumption of the units is high in comparison to the potential water savings and is not considered economic for regional households.

Evaporative air conditioners are predicted to continue to be installed in new dwellings. Current trends indicate a shift towards installation of refrigerated air conditioning systems. This shift towards installation of refrigerated systems will reduce the annual water consumption per household in regional communities due to the substitution of evaporative air conditioners with refrigerated units which do not consume water. Energy consumption is expected to increase due to this shift.

2. Introduction

This report has been prepared for Water Industry Compliance which is a Division of the Queensland Government Department of Natural Resources and Mines. It presents the results of a review undertaken on evaporative air conditioners and their contribution to water consumption in Queensland.

2.1 Evaporative Airconditioners

An evaporative air conditioner is a unit which cools air by moisture evaporation, thereby lowering its temperature and raising its humidity. The unit consists of a fan, water pump and distribution piping, porous or fibrous pads and water tanks. They are simple devices which cool the air drawn through them by bringing the air into 'close' contact with water. The cooled air can then be delivered to the area requiring cooling. For large areas a ducted distribution system is often used.

Multi or variable speed fans are often available in larger capacity units. Tests show that units normally have humidifying efficiencies of between 70 and 80% however some units are available with a claimed efficiency of 95%. In arid areas the water consumption per 500 L/s of air would be expected to be between 10 and 15 L/hr.

Evaporative air conditioners consume water in two ways; the evaporation of water from the pads which cools the air, and the dumping/bleeding-off of water to reduce the mineral concentration in the sump.

In order to conserve water, most units recirculate water from the sump to the distributing trough along the tops of the evaporative pads. Evaporation of the water increases the concentration of magnesium and calcium salts in the sump water. Eventually these salts would accumulate on the evaporative pads and reduce the performance of the system.

The two main systems that control the mineral concentration of the sump water are 'bleed-off' and 'sump dump' systems. In a bleed-off system, a small amount of water is drained from the evaporative air conditioner whenever it is running. A sump dump system evacuates the water from the sump at set intervals. Bleed-off systems generally consume more water. Most units also incorporate a master dump valve actuated 1 hour after the unit is switched off to ensure the sump is voided of water, thus minimising the risk of contamination from Legionella.

They are effective in hot dry climates but less so in humid climates as they need to deliver considerably more air to achieve the same cooling effect.

2.2 Use of Evaporative Airconditioners in Queensland

Evaporative air conditioners provide effective cooling in dry climates. Their cooling effect is minimal in hot humid climates. For this reason they are most commonly found in hot dry climates such as inland areas of Queensland.

They are predominantly installed in residential accommodation. It is estimated from visual inspection that their application in residential houses is in the range 75 to 90% in regional Queensland. In the hot dry climate areas, the units may be operated up to 24 hrs a day, 7 days a week in the summer months.

Commercial evaporative coolers make up a small proportion of the total number installed in regional Queensland. In the case of Longreach the total number of commercial units is in the order of 2%.

2.3 Climate Zones

The variation in climate across an area the size of Queensland is considerable. Hot dry summers in the inland west, a monsoon season in the north, and warm temperate conditions along the coastal strip contrast with low minimum temperatures that can be experienced inland and about the southern ranges.

On the western side of the Great Divide, average maximum temperatures gradually increase with increasing distance from the coast.

Further to the west the land slowly flattens out to the dry inland plains, marked by cold nights. It is here that the hottest temperatures in the State most commonly occur during summer.

Using the Bureau of Meteorology classification of six main climatic regions or zones on the basis of air temperature and humidity Queensland contains three main areas. These include hot humid, warm humid and hot dry conditions.

In the case of Longreach, Mt Isa and Charleville the average January humidity is <30% Relative Humidity while the coastal strip along the east coast of Queensland (eg Brisbane, Gladstone, Townsville experiences >60% Relative Humidity. This illustrates the variation in climate between the inland areas of Queensland in comparison with the coastal strip.

3. Description of Evaporative Airconditioning Units

3.1 Relevant Standards

There are a number of standards which provide information on the design, installation and maintenance in relation to evaporative airconditioning units. These are reviewed below in more detail.

3.1.1 AS2913-2000 Evaporative airconditioning equipment.

This standard prescribes a basis for the performance rating of specified features of evaporative airconditoining equipment, and specifies the test procedures and equipment applicable for each form of rating. It also prescribes basic minimum requirements for construction.

It provides a list of definitions for terminology used for description of evaporative air conditioning systems.

Section 2 of this standard provides minimum requirements for the materials used for design and construction of the units. Topics include access for service, water carry over and evaporation efficiency.

This standard prescribes the method of expressing the performance requirements of units including airflow, evaporation efficiency, noise levels and electricity consumption.

A number of tests are required to be performed on the units to determine characteristics such as airflow, evaporative efficiency, sound output level and electricity consumption.

3.1.2 AS 3666 Series of Australian Standards

Two Australian Standards provide information on how to control the growth of Legionella for commercial operators of air conditioning systems. These are:

- AS3666.1- Maintenance of water systems in air conditioning systems.
- AS3666.2 - Design of water systems in air conditioning systems.

3.2 Types and sizes (commercial and domestic)

An extensive range of evaporative air conditioners is available, from small portable units for domestic use to large ducted systems for commercial and industrial use. Domestic units typically have sensible[1] cooling capacities ranging from 5 to 15 kW. Commercial units are generally classified as units with sensible cooling capacities ranging from 15 kW up to 50 kW. The domestic market is estimated to make up over 95% of the Australian evaporative air conditioner market. Therefore, the focus of this report will be on domestic evaporative air conditioners.

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[1] Sensible cooling is heat due to a temperature difference only. It does not take into account a change in the moisture content of air.

There are several evaporative air conditioner manufacturers and/or importers in Australia, such as Brivis, Seeley (which owns Braemar, Breezair, Coolair and Convair brands), Excelair and Celair. At present, just under a third of the annual market is imported with the majority of units originating in Taiwan.

Evaporative air conditioners can be classified according to the position of the unit in relation to the building. There are generally three types; down-draft (roof-mounted), side-draft (usually eave or window mounted), and up-draft (ground mounted). Roof mounted units are sometimes preferred as they are more easily connected to the duct system in the ceiling space, and are less obtrusive on the roof. However, eave mounted or ground mounted units are more accessible and can be more easily serviced.

Top of the range domestic units incorporate a range of features, including variable speed fans, high efficiency pads, remote controls, thermostat control, programmable timers, weather dampers, and water management systems. On some units, the water management system monitors the water quality and adjusts bleed/dump rates to minimise water usage. The more basic units generally consist of constant speed fans and constant bleed-off rates, which are set depending on the water quality.

Evaporative air conditioners require regular maintenance, with units in hard water areas generally requiring the pads to be replaced every season. Units in areas with good water quality may only require pad replacements every 5 to 8 years. The units should be inspected frequently for wear, damage and scale build-up.

Manufacturer's literature usually quotes evaporative air conditioner sizes in terms of sensible cooling capacities, so that they can be compared with refrigerative systems. However, the sensible cooling capacity of the units is dependent upon the ambient conditions and varies greatly between different climate zones. A better indication of size is the supply air quantity. Depending on the location, domestic evaporative air conditioners are generally selected to provide between 30 to 60 air changes per hour to the space being conditioned. For a typical 3 bedroom house, this equates to a supply air quantity of approximately 2500L/s to 4500L/s.

Water consumption is dependent upon the ambient conditions, the evaporative efficiency of the unit, the supply air quantity and also the water quality. Units in hot dry regions such as western Queensland have the highest evaporation rates, and therefore provide the highest cooling capacities per litre per second of supply air. The water in these regions is generally quite hard, so bleed/dump rates must be set higher. Units in humid regions have lower evaporation rates, and therefore provide less cooling capacity per litre per second of supply air. The units in these areas generally have higher supply air quantities to achieve the required cooling capacities.

3.3 Evaporative Airconditioner Pad Efficiency

Evaporative air conditioners use filter pads as the cooling medium. Water passes over this filter pad and evaporates, hence providing a cooling effect. The pads are typically manufactured from a fibrous material. Older filters use 'wood wool' in the filter pads. Modern pads are based on either cellulose fibre or plastic media.

Some of the significant differences in the types of pads available include:

- Efficiency in evaporating moisture. The evaporative efficiency of pads varies depending on their thickness and type of manufacture. Modern filter pads typically have a saturation efficiency of between 82% and 76% when new. The saturation efficiency will deteriorate over time due to scale build up in the filter pads.
- Expected lifetime. Filter pads can be treated with a surface coating which reduces the amount of scale build-up. This can increase their useful life prior to replacement.
- Resistance to airflow. Resistance to airflow has an effect on the energy consumption of the evaporative airconditioner. A variation of approximately 10% is quoted by manufacturers in the static resistance of filter pads.

3.4 Operation and Maintenance Requirements

Correct maintenance will increase the life of an evaporative air conditioner and maintain its efficiency. Manufacturer's directions should be followed for specific evaporative air conditioners.

3.4.1 Domestic Units

There are no specific code requirements for evaporative airconditioners regarding their operation and maintenance. The water basin in evaporative air conditioners can collect windblown dust and pollen. This will deposit in the basin leading to clogged filter pads, circulation pump or water distribution system. This may lead to more frequent cleaning.

The evaporative cooler should be cleaned before operation each summer. This involves electrical disconnection of the unit, cleaning of the filter pads with a hose and cleaning of the water distribution system including the basin and water bleed-off system. The fan should be inspected and any faulty parts replaced. The unit should also be disinfected before use of the system prior to Summer.

Following the Summer cooling season the unit should again be disinfected and cleaned thoroughly including the basin and filter pad. The unit should be left dry when not in use.

In areas where the water is hard (containing minerals), frequent filter changes may be necessary. In severe cases of water hardness corrosion of the unit can occur. This is due to water evaporation inside the unit, allowing dissolved salts or minerals to leave a residue on the filters. To overcome this problem, most systems use excess water to flush the filter pads.

Cleaning and disinfecting the system every six months is recommended.

A more detailed description of a suggested maintenance routine for domestic evaporative air conditioners is as follows.

1. Isolate the electrical supply to the unit.

2. Replace pads: Remove side panels and install new evaporative media pads if required. Cooler pads become clogged with dust, pollen, mildew and minerals from evaporated water. Dirty media pads reduce cooling efficiency and overwork the motor. Clean debris out of the louvered side panels and water troughs.
3. Clean water reservoir: Remove the cooler overflow/drain tube in the reservoir pan and rinse out standing water, dissolved salts, silt, old pad fibres, etc., with a disinfecting solution.
4. Check water pump: Clean the pump screen of debris and make sure the water pump impeller turns freely. If the pump shaft is stuck, water will not be distributed to pad surfaces, so replace it.
5. Check fan-belt and oil bearings: Replace the fan belt if required. Adjust the belt tension. Oil the fan bearings on both sides.
6. Rotate motor and blower wheel: Turn the fan by hand a few revolutions. If the motor or blower wheel won't turn freely, the motor may require service or replacement.
7. Fill system with water, adjust float valve if required: Turn on water supply. If the float valve is not operating, it may need to be replaced. Check that the unit is level and there are no water leaks.
8. Turn on unit: Replace side panels, turn cooler on and examine water distribution to make sure water fills the basin and flows down all pads evenly. If water flow is restricted, remove the panel(s) and clear the blockage.

3.4.2 Commercial Units

Standards such as the AS 3666 series contain requirements in regard to cleaning of water systems for commercial operators of air conditioning systems.

A suggested preventative maintenance regime for evaporative air conditioners at commercial premises is shown below.

Monthly

- Check belt tension, adjust/replace where necessary.
- Check water level and ball cock operation.
- Check for undue noise and vibration and report.
- Check rotation and condition of fans and report.
- Check operation of variable speed drives and report.
- Check for water leakage and report.

3 Monthly

- Perform all service requirements as per monthly.
- Check for security of bolts and fittings, tighten and repair as required.
- Drain and clean tower and basin, clean all strainers and pads.

Annually

- Perform all service requirements as per monthly and quarterly.
- Inspect basin, structure of unit and supports, pads and all other fixtures for corrosion, treat rust and touch up paint as required and report.
- Check all electrical terminals for tightness.
- Visually check all electrical connections for overheating and report.

3.5 Energy Consumption

Evaporative airconditioners require electricity for operation of the air fan and water circulation pump. This consumption depends on the following factors:

- Unit capacity airflow capacity
- Fan type (eg axial fan, centrifugal fan, etc)
- Electric motor efficiencies
- Hours of operation for fan and circulation pump
- Fan speed (eg high/low/medium)

Compared to refrigerative air conditioning systems, evaporative air conditioners use considerably less electricity per kilowatt of cooling capacity. The capital cost of a unit is typically half that of refrigerative system, and the energy cost can be as much as 80% lower.

Using Longreach as a case study, the evaporative air conditioners are estimated to consume up to 3,200,000 kWh per annum in energy in the community.

The institutional evaporative cooling units installed in Longreach are also included in the above community energy consumption figure.

3.6 Operating Cost Comparison between Refrigerative and Evaporative Airconditioning

An operating cost comparison between refrigerative and evaporative air conditioning systems has been carried out. The analysis has been undertaken as a case study for a typical residential installation in Longreach.

Ducted air conditioning systems are assumed for both the evaporative and refrigerative systems. Airconditioning hours of operation are 24 hours per day for three months of the year during summer. An additional three months of operation for 12 hours per day during spring and autumn is included. Costing is based on 14 cents/kilowatt.hour for electricity and 55 cents/kilolitre for water.

Included in the operating costs are electricity and water consumption costs. Maintenance, repairs and installation costs are not included.

A cost summary is included in the table below.

Table 1 Airconditioning Cost Comparison

	Airconditioning Type	
Component	Refrigerative	Evaporative
Electricity	$2,288.00	$481.00
Water	Nil	$149.00
Total	**$2,288.00**	**$630.00**

Results of the analysis indicate refrigerative air conditioning systems have a significantly higher electricity consumption cost in comparison to the evaporative air conditioning for a regional Queensland community such as Longreach.

There are no water costs for the refrigerative air conditioning system while water consumption contributes 24% of the total running costs of an evaporative air conditioner.

Therefore evaporative air conditioners cost 72% less to operate in comparison to refrigerative air conditioners based on the above analysis.

3.7 Evaporative Airconditioner Water Consumption

An investigation into the use of evaporative air conditioners throughout the different climate zones of Queensland was conducted. Longreach, Winton and Mount Isa were chosen in the hot arid climate zone, Dalby and Toowoomba in the temperate climate zone, and Gladstone in the warm humid climate zone. Discussions with local manufacturers and contractors provided information on the type and size of units typically installed in these areas, the proportion of homes with evaporative air conditioners, and the hours of operation. This information was used to estimate the water consumption of evaporative air conditioners in the different climate zones, as discussed below.

Calculations indicate that evaporative air conditioners can use upwards of 75 L/hr of water in the summer months (see Figure 1). As discussed earlier, the water consumption is dependent upon the location, the season, the evaporative efficiency of the unit, the supply air quantity and the water quality. Units installed in drier climates will generally use more water due to the higher evaporation rates.

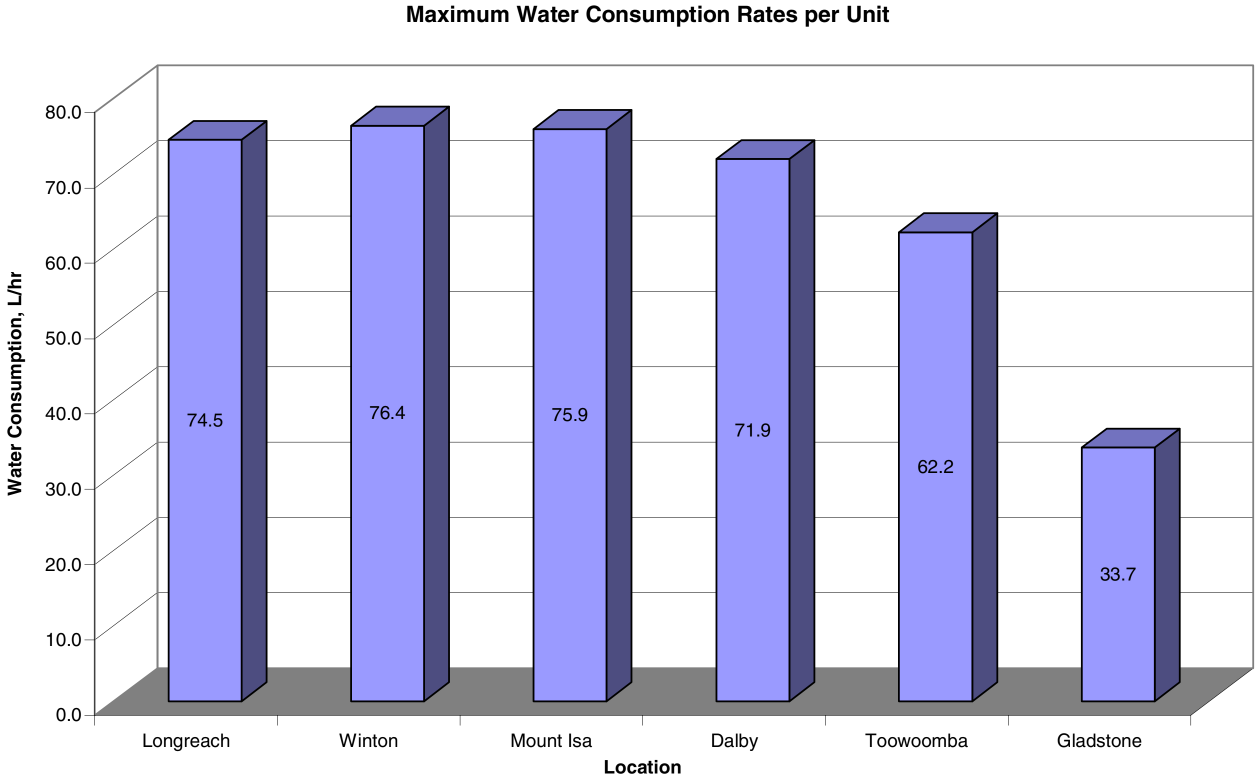

Figure 1: Maximum Water Consumption Rates per Unit

Based on local council domestic water allowances, the water consumption of evaporative air conditioners was calculated to be approximately 10% to 25% of the total yearly water consumption per household (see Figure 2), and approximately 40% to 75% of the daily indoor water consumption[2] in peak summer months (see Figure 3). The bleed water is only 2% of the annual community water consumption in hot dry areas where 75-85% of households have evaporative air conditioners. The total water consumption by evaporative air conditioners for each community was also calculated, as shown in Figure 4.

[2] Indoor Water Consumption estimated to be 200L per person per day. Number of persons per household obtained from Australian Bureau of Statistics.

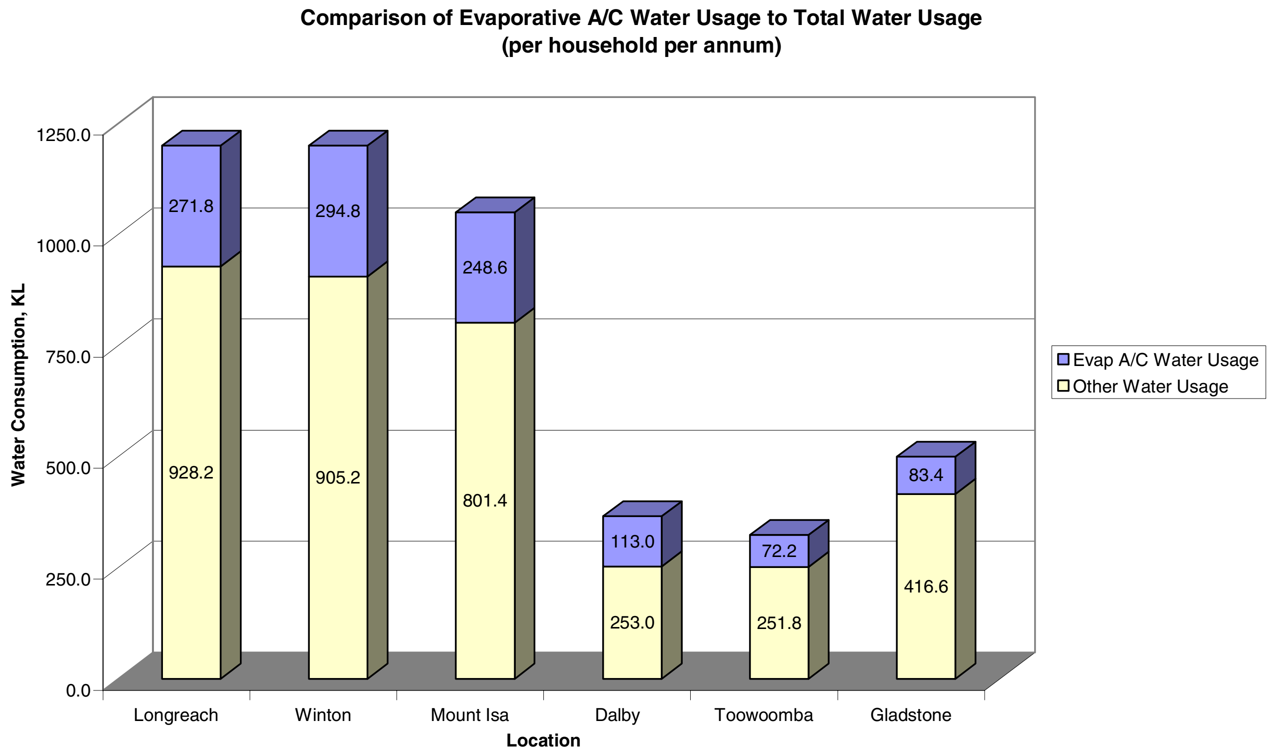

Figure 2: Comparison of Evaporative A/C Water Usage to Total Water Usage

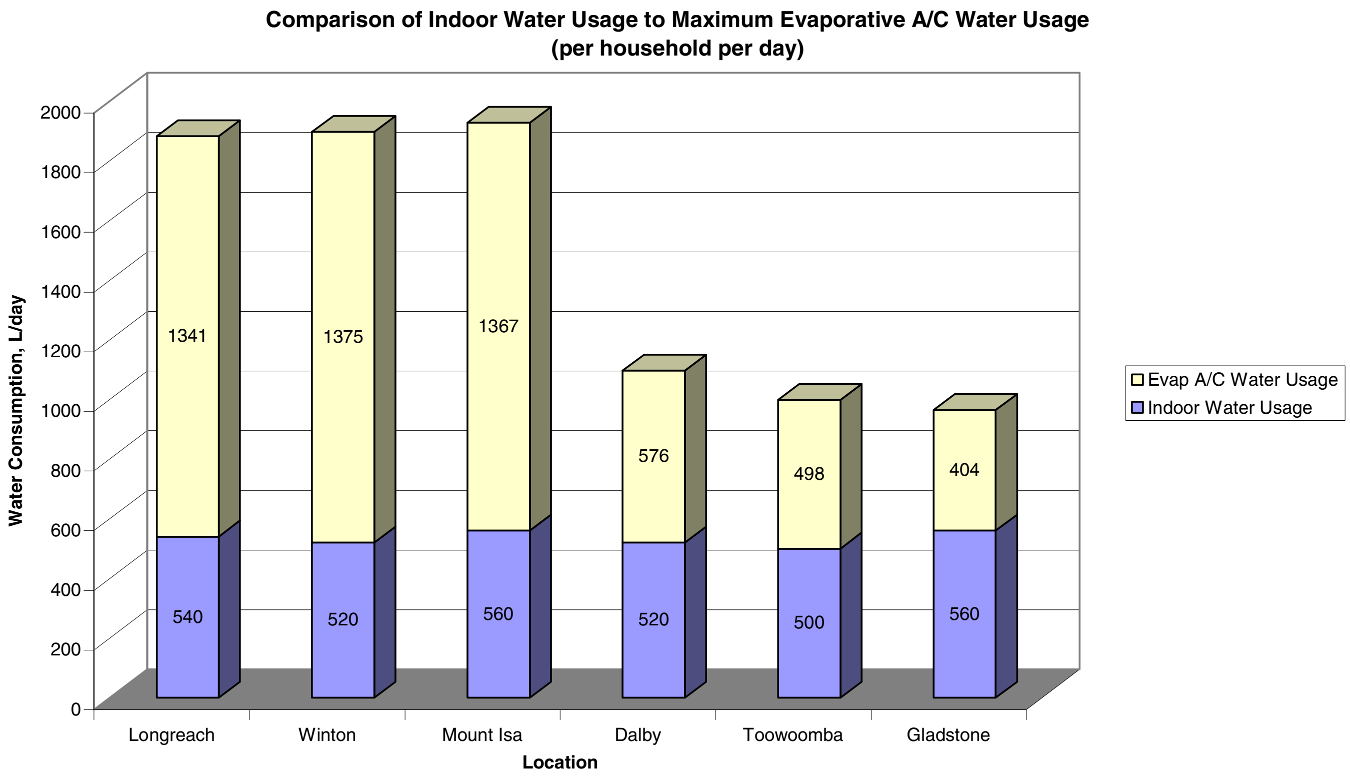

Figure 3: Comparison of Evaporative A/C Water Usage to Indoor Water Usage

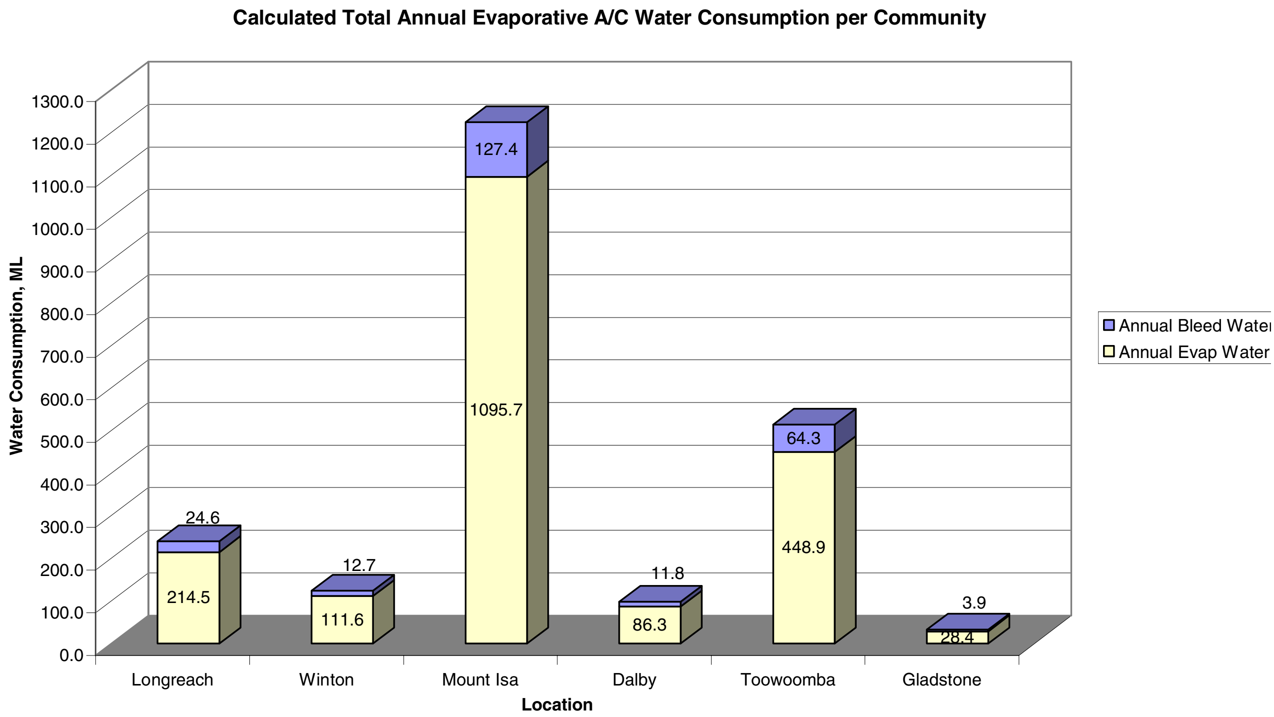

Figure 4: Calculated Total Annual Evaporative A/C Water Usage per Community

3.8 Additional Air Conditioning Water Consumption

Refrigerated air conditioning systems also contribute to water consumption in Queensland. These systems typically employ ‘cooling towers’ or ‘evaporative condensers’ as a method of heat rejection.

Refrigerated air conditioning systems with water cooled heat rejection are typically installed to serve buildings with large cooling requirements. In the case of regional communities these systems are limited to buildings such as Hospitals and large office buildings. Analysis of the water consumption of these air conditioning systems is in the order of 55 kL per annum for a community such as Winton which is estimated to have one cooling tower. This water consumption is considered to be very low in comparison with water consumption of evaporative air conditioners.

There is no evidence that Longreach has any water cooled air conditioning system installed.

3.9 Water Reduction

Evaporative air conditioners consume water in two ways; the evaporation of water from the pads which cools the air, and the dumping/bleeding-off of water to reduce the mineral concentration in the sump.

The amount of evaporation from the pads is dependent upon the ambient conditions, the supply air quantity, and the evaporative efficiency of the unit. High efficiency pads provide more evaporation and therefore, more cooling per litre per second of supply air than lower efficiency pads i.e. higher efficiency pads require less supply air to provide the same cooling capacity as lower efficiency pads. As the evaporation of water on the pads provides the cooling effect, reducing this would result in a reduction in the capacity of the unit. Therefore, there is little potential in reducing the water consumption with respect to the evaporation rate, without reducing the capacity of the units as well.

The amount of dump/bleed-off water is dependent upon the water quality supplied to the unit. Local manufacturers have advised that most domestic evaporative air conditioners are bleed-off systems, as the dumping systems are more expensive. Bleed-off systems generally waste more water than dumping systems. This is because the bleed-off rate is manually set when the unit is installed/serviced, whereas dumping systems generally monitor the water quality and modulate the dumping rate in order to minimise water consumption.

Where water quality is salty or relatively hard bleed-off rates must be set quite high to limit scale build-up on the pads and sump. In the past, the bleed-off water in towns such as Mount Isa was directed onto gardens and lawns to minimise waste. However, as the water has a high concentration of mineral salts, it may kill or damage the plants, and this is generally not done anymore.

3.9.1 Options for Reducing Water Usage

The options for reducing the evaporation rates are limited.

Several options are available for reducing the dumping/bleed-off rates. The dumping/bleed-off rates have been calculated to be approximately 10% to 15% of the total water consumption of the evaporative air conditioners. Local manufacturers have advised that bleed-off rates can be as high as 25% of the total water consumption for an evaporative air conditioner. For hot dry climates in Queensland this is equivalent to approximately 2% of the annual community water consumption. Therefore, there is potential to reduce the bleed/dump water consumption of the evaporative air conditioners.

The first option is to not bleed-off any water from the evaporative air conditioner, as is commonly done in Mount Isa. This results in the units having to be serviced and cleaned more regularly. This option would only recommended in areas with a good quality water supply, as hard water supplies would quickly produce unacceptable scale levels, and maintenance would be required too regularly.

The second option is to treat the water being supplied to the evaporative air conditioner. This will reduce scaling in the evaporative air conditioner. There are many water treatment companies claiming to have products suitable for this application, but contractors have expressed doubt on the effectiveness of the majority of these products. However, one particular product called the 'Scale Clear' system has had good reviews. The 'Scale Clear' system can significantly reduce the scale build-up inside the units, thereby keeping the pads clean and at optimum efficiency. The system works by generating a time variant magnetic field inside the pipe supplying the water, causing the scale particles to repel one another and not adhere to any surfaces. Therefore, dumping/bleed-off rates could be reduced or even stopped. The evaporative air conditioners still must be regularly serviced, but as the scale does not adhere to any surfaces, it is much easier to clean the units and the pads last much longer. This system has been tested in the Roma district on a bore water supply of very poor quality with excellent results. However, it is a relatively new product and further tests are being conducted on different types of water supply. Furthermore, it is quite expensive, costing around $500 which may deter the domestic market.

The third option investigated was treating the water dumped or bled from the evaporative air conditioner, so that it can either be re-used in the unit itself or used for some other application. A water softener could be connected to the dumping/bleed-off pipe. However, these units are quite large (typically 1.5m high) and cost approximately $1500. This high capital cost would deter the domestic market. This option is not recommended due to its high cost and the poor water quality discharged.

The charts below (Figure 5 and 6) indicate the potential water and cost savings per annum if bleed water reductions of 90% are achieved. As can be seen from Figure 5, the cost savings are insignificant when compared to the cost of installing the water treatment systems. Therefore, the reasons for bleed water reduction cannot be justified in terms of water cost savings or saving water.

The safe disposal of bleed-off water is important. It should not be discharged into a gutter which runs to drinking water tanks. The discharge water will contain high levels of mineral salts.

Water from constant bleed water management systems can be run onto lawns. This depends upon the requirement of the Local Authority. Local Authorities may require this water from an evaporative air conditioner to be discharged to sewer.The water consumption by evaporative air conditioning units could be reduced altogether replacement with refrigerated systems. This would however significantly increase energy consumption relative to evaporative air conditioning units.

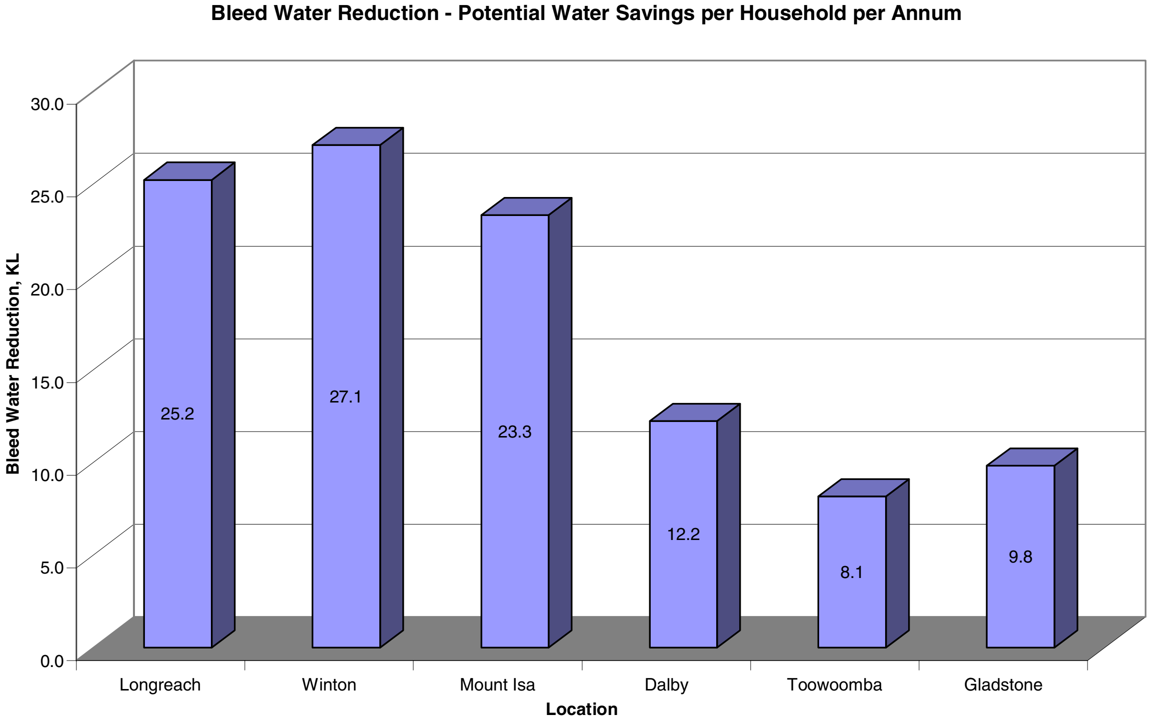

Figure 5:   Potential Annual Bleed Water Reduction

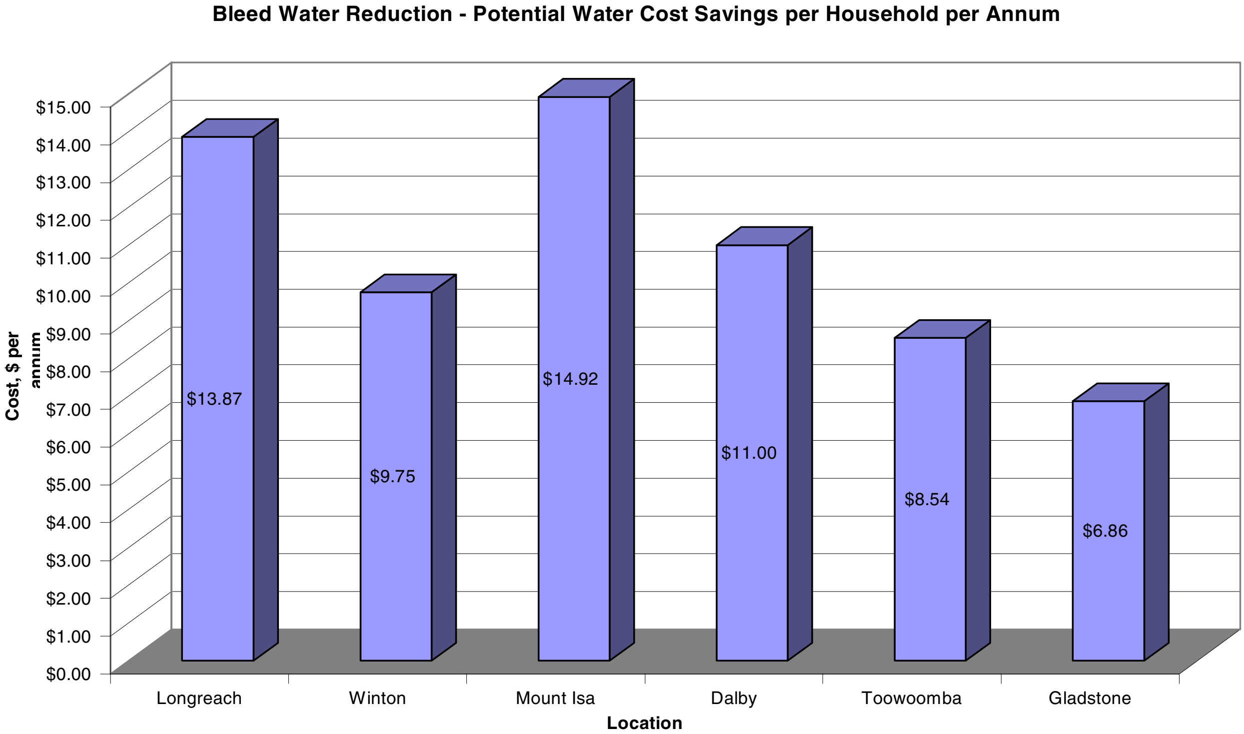

Figure 6: Potential Annual Bleed Water Cost Savings

3.10 Energy Reduction

Energy consumption by evaporative coolers consists of the fan motor and water circulating pump. The fan motor uses approx 95% of energy while the water pump uses the remaining 5%.

To reduce the energy consumption of evaporative coolers the following can be considered:

- Utilising higher efficiency fan motors. Manufacturers do not typically supply fan motor efficiencies for their units. There can be considerable variations in their efficiency. Higher efficiency motors represent a potential major reduction in energy usage of an evaporative cooler.
- Direct drive of the fan (rather than belt driven). This method of operating the fan is reduces the energy losses of the pulley and belt drive system.
- Fan technology. The fan can typically be a centrifugal or axial type fan. This depends on the manufacturer and type of unit. Variation in the fan technology alters the fan motor energy consumption.
- Air resistance of filter pads. A number of filter pad types are available for use in evaporative coolers. These filter pads have varying degrees of resistance to air

movement. This variation leads to higher fan energy consumption due to the air resistance to overcome. Scale or debri build up in the filter pads can also lead to increased air resistance. Regular maintenance and possible filter pad replacement is necessary to limit the fan energy consumption.

The above factors are mainly determined by the manufacturer or by the customer when choosing a particular model or manufacture of unit. Regular maintenance of the unit including cleaning or replacement of the filter pads has the potential to limit excess energy consumption by evaporative air conditioners and is within the control of the owner.

3.11 Health Issues

Legionnaires' disease (Legionellosis)

Evaporative airconditioners are a potential source of Legionella growth and generation of aerosols. Legionnaires' disease is caused by infection with Legionella bacteria. Legionnaires' disease is a serious and sometimes fatal form of pneumonia.

There is no evidence that evaporative air conditioners can cause Legionaires' disease however, maintenance is required to prevent odours or possible complaints occurring as a result of the accumulation of dirt and growth of slimes and moulds within an evaporative air conditioning unit. Conditions that promote growth of Legionella in water include:

- Stagnant water.
- Water temperatures between 25 and 50°C
- Sediment that tends to promote growth of Legionella.

Water stored below 20°C is generally not a source for Legionella. To proliferate to levels which are hazardous, requires water temperature of around 37°C or more together with a source of nutrients. An evaporative cooler operates with its water temperature close to the wet-bulb temperature which rarely exceeds 24°C.

To minimise the growth of Legionella bacteria requires the prevention of conditions that allow Legionella to grow to high levels. Commercial air conditioning cooling towers, evaporative air conditioners and evaporative condensers should be regularly maintained and cleaned in accordance with Australian Standard AS 3666.

Domestic evaporative air conditioners should be cleaned before summer. If the system has not been used for two weeks or longer it should be cleaned again before use.

Recycling of water within the unit should be avoided. An automatic dump valve is required. If this water is not regularly and automatically dumped then the chance for any Legionella in the reservoir to multiply to more pathogenic population levels is increased.

Recommendations to reduce the health risks of evaporative air conditioners include the following:

- Install evaporative air-conditioners in locations that minimise the risk of contamination from soil and organic matter (eg. on the roof);
- Design or install evaporative air-conditioning units to include an automatic reservoir dump valve that dumps the stored water regularly (eg daily when in use);
- Regularly clean units to prevent build up of soil, organic matter and scale. The frequency of cleaning depends on the location of the unit, usage and whether the particular unit is likely to be contaminated by dust, soil or organic matter;
- Where air conditioners are switched off for extended periods (eg during winter) all water should be drained from the unit and the reservoir and filter pads cleaned and dried: and
- Do not pour biocides or other hazardous substances into the unit's reservoir whilst it is being used for cooling as the air going into the room may contain hazardous chemicals from the biocides.

3.12 Comparison with Refrigerated Air conditioners

Evaporative coolers provide some key benefits over refrigerated air conditioning systems. These include:

- Lower capital cost (approx 50% lower).
- Reduced energy consumption (approx 80% lower) leading to reduced greenhouse gas emissions.
- No refrigerant gas required.
- 100% fresh air (rather than recirculation of room air with refrigerated system).
- Increased indoor humidity in very dry areas (refrigerated air conditioners can lower the humidity further in dry conditions).

Some disadvantages include high water usage, regular maintenance, high supply air volumes, and minimal filtration to the supply air. The use of evaporative air conditioners is generally also limited to the drier climate zones.

3.13 Future Trends in Evaporative Airconditioning

Evaporative airconditioning is a very effective method of cooling for regional areas of Queensland. Combined with its relatively low cost in comparison to other methods of cooling such as refrigerated air conditioning units and window/wall air conditioning units it can be expected that their installation will continue in the near future.

Historical data from the Australian Bureau of Statistics indicates the market for domestic evaporative air conditioners has been growing strongly over the period 1994 to 1999. Industry sources have varying opinions on the current growth and future prospects. Some industry sources predict that the market for evaporative air conditioners will fall over forthcoming years as refrigerated air conditioners become more cost competitive.

Energy Consumption

It can be expected that future evaporative air conditioners which are installed consume less energy in comparison to older models. This is due to the type of components used including the fan motor type, filter pads and fan type.

With the introduction of thermostat controls it can also be expected that there will be a slight reduction in the use of future evaporative air conditioners. By limiting the water circulation in the unit only to times when cooling is desired, the fan motor will consume less energy since the dry filter pads will have a lower resistance to airflow.

However, with the increasing popularity of refrigerated air conditioning in residential accommodation it can be expected that the energy consumption in the future will increase overall on a per household basis. This is due to the significantly higher energy consumption of refrigerated air conditioning systems in comparison to evaporative systems.

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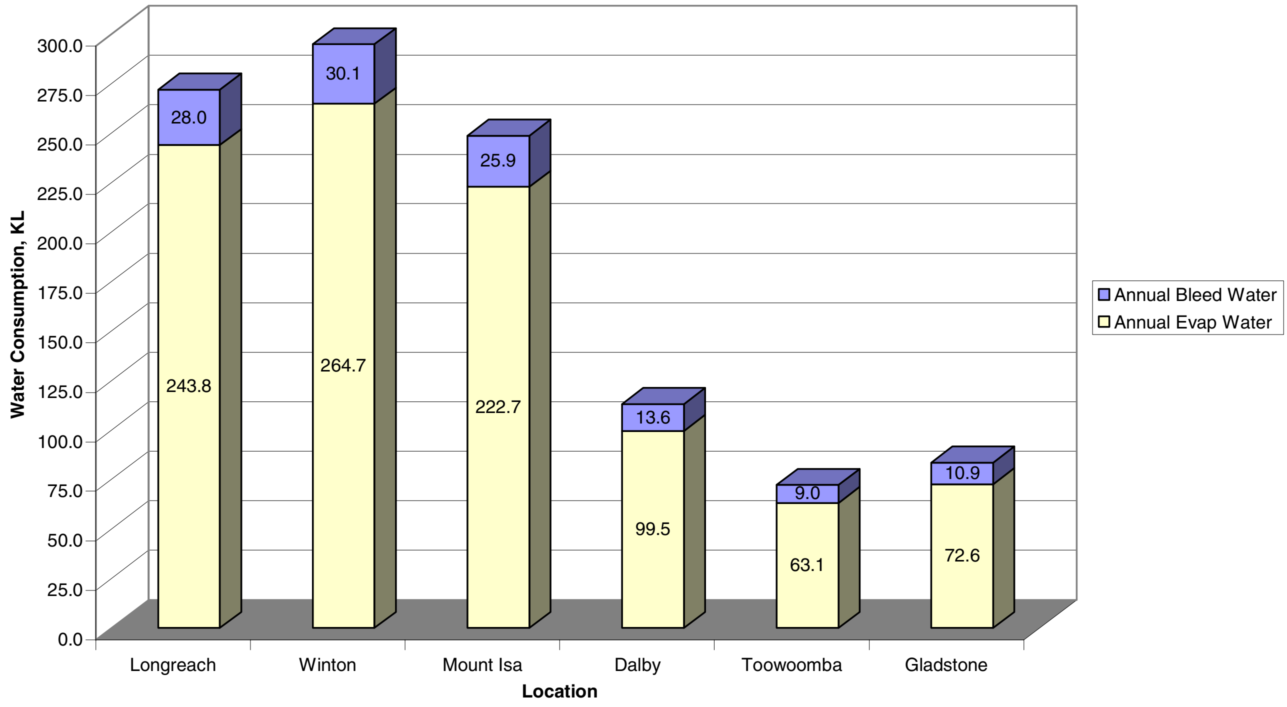
- Bonaire Website, www.bonaire, Accessed 21/03/2003
- Longreach Shire Council Website, www.longreach.qld.gov.au, Accessed 26/03/2003
- Mount Isa City Council Website, www.mountisa.qld.gov.au, Accessed 26/03/2003
- Dalby Town Council Website, www.dalby.qld.gov.au, Accessed 26/03/2003
- Toowoomba City Council Website, www.toowoomba.qld.gov.au, Accessed 26/03/2003
- Gladstone City Council Website, www.gladstonecc.qld.gov.au, Accessed 26/03/2003
- Australian Bureau of Statistics Website, www.abs.gov.au, Accessed 17/03/2003
- Bureau of Meteorology Website, www.bom.gov.au, Accessed 14/03/2003

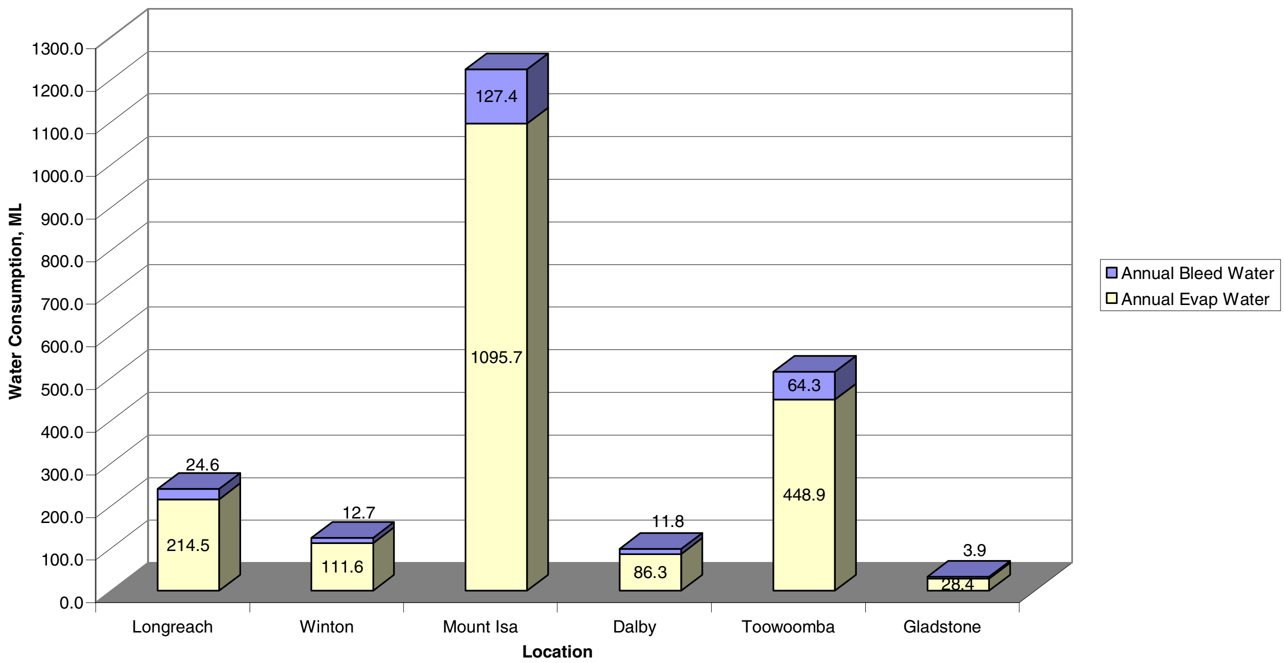
Appendix A

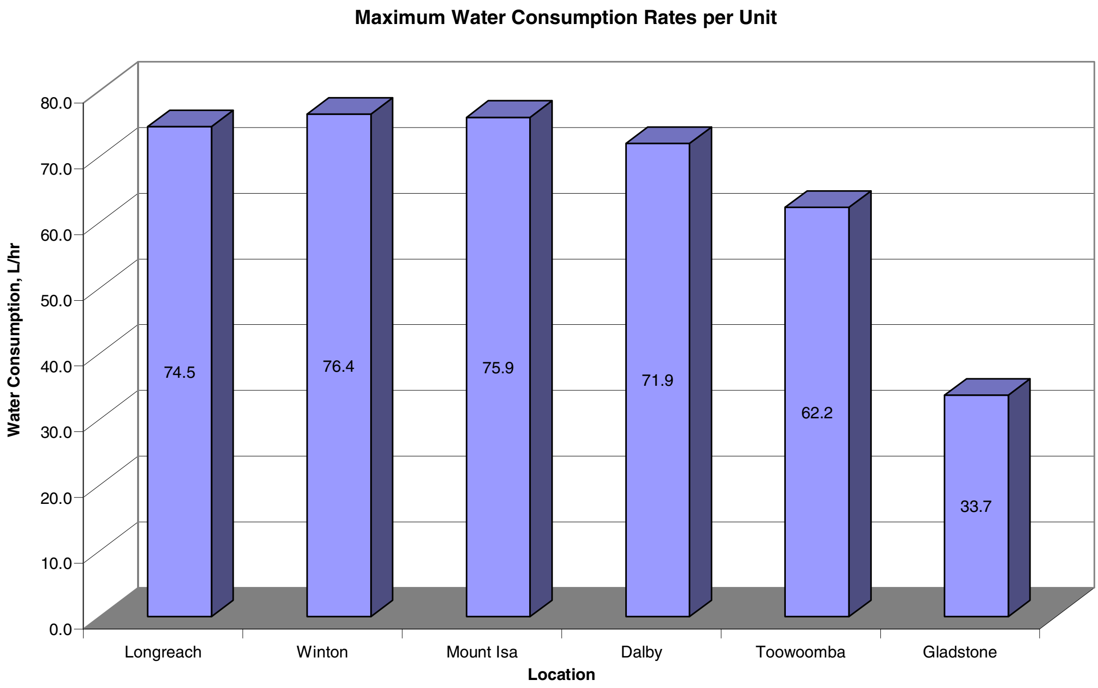
Charts

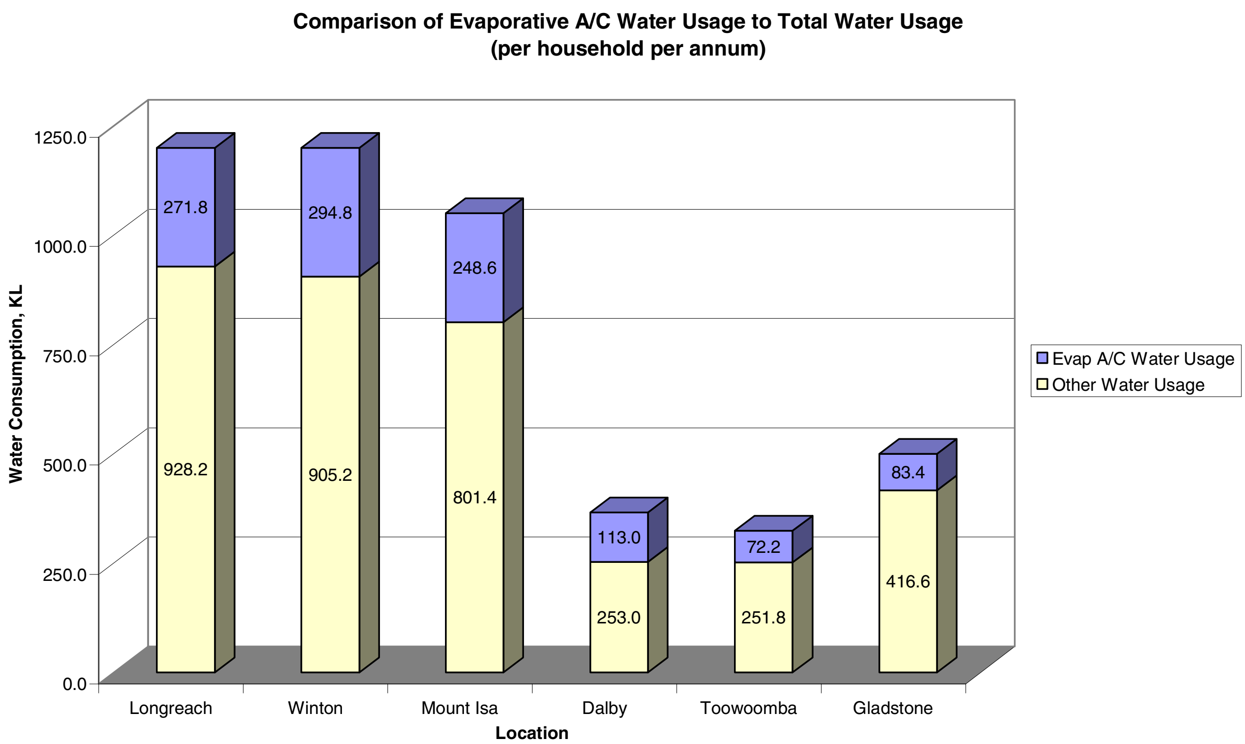
Calculated Annual Evaporative A/C Water Consumption per Household



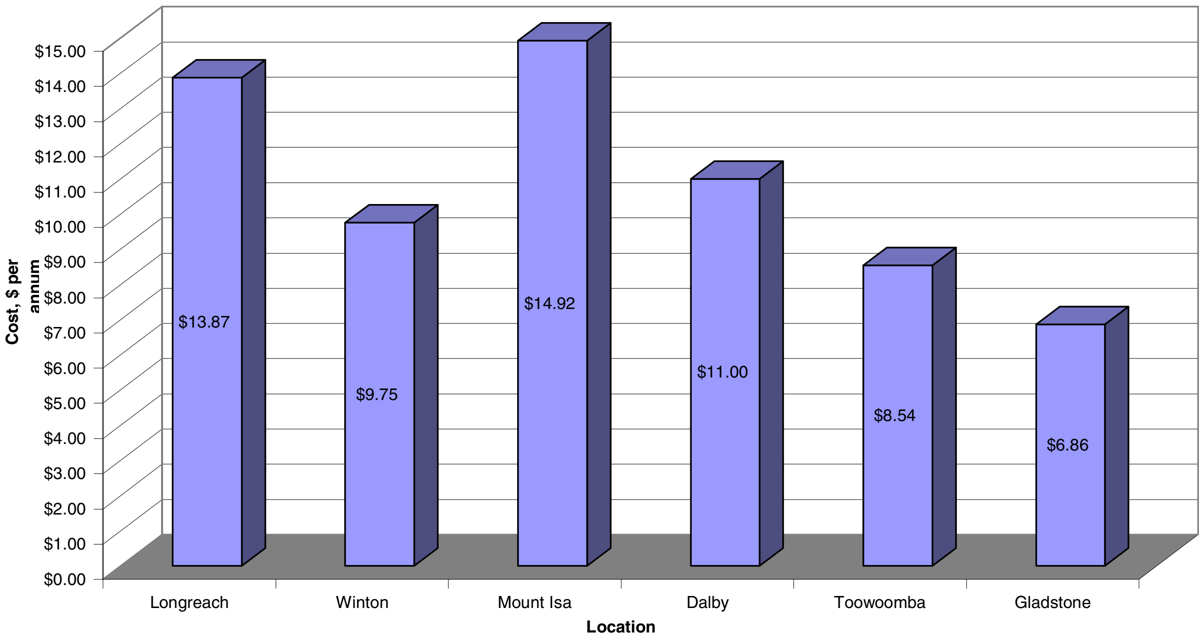
Calculated Total Annual Evaporative A/C Water Consumption per Community



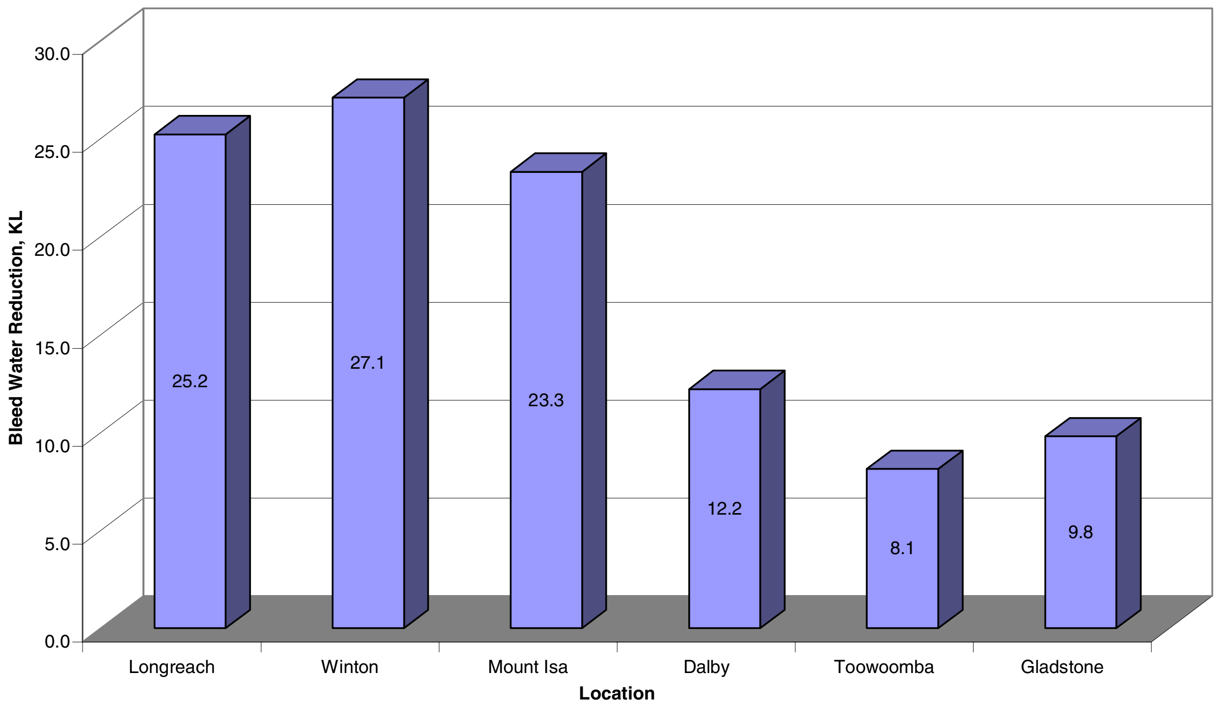

Maximum Water Consumption Rates per Unit
Water Consumption, L/hr
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
74.5
76.4
75.9
71.9
62.2
33.7
Longreach
Winton
Mount Isa
Dalby
Toowoomba
Gladstone
Location


Comparison of Evaporative A/C Water Usage to Total Water Usage
(per household per annum)
Water Consumption, KL
1250.0
1000.0
750.0
500.0
250.0
0.0
271.8
294.8
248.6
928.2
905.2
801.4
113.0
72.2
83.4
253.0
251.8
416.6
Longreach
Winton
Mount Isa
Dalby
Toowoomba
Gladstone
Location
Evap A/C Water Usage
Other Water Usage

Bleed Water Reduction - Potential Water Cost Savings per Household per Annum



Bleed Water Reduction - Potential Water Savings per Household per Annum



Appendix B

Tables

LONGREACH EVAPORATIVE A/C WATER CONSUMPTION CALCULATION

Assumptions	
S/A Quantity =	3000 L/s
Air Density =	1.2 kg/m3
Water Density =	0.997 kg/L
Evap. Efficiency =	80%
Tank Capacity =	15 L
Tank Refill Rate =	20 refills, tank emptied

Notes:
(1) Evaporative air conditioner selection based on typical unit serving a 3 bedroom house.
(2) Assumed evaporative a/c unit incorporates a water dumping system.
(3) Tank completely emptied and refilled after 20 half-tank refills.
(4) Tank completely emptied 1 hr after unit switched off. Refilled when unit switched on again.

Supply Air Temperatures

Month	9am		12pm		3pm	
	$t_{S/A}$ °C	W g/kg	$t_{S/A}$ °C	W g/kg	$t_{S/A}$ °C	W g/kg
Jan	26.2	17.6	27.8	18.9	29.4	19.9
Feb	25.8	17.7	27.4	18.7	29.0	19.7
Mar	24.8	17.5	26.5	18.5	28.1	19.4
Apr	22.5	14.6	24.1	15.5	25.8	16.4
May	19.1	12.2	20.9	13.0	22.6	13.9
Jun	17.8	11.7	19.6	12.6	21.3	13.4
Jul	17.3	11.0	19.2	11.9	20.9	12.7
Aug	18.5	11.4	20.3	12.3	22.1	13.2
Sep	22.8	15.4	24.4	16.3	26.1	17.2
Oct	22.0	13.2	23.8	14.1	25.5	15.1
Nov	25.1	16.0	26.7	17.0	28.3	17.9
Dec	24.2	15.2	25.9	16.2	27.5	17.1

Water Consumption Rates per House

Month	9am		12pm		3pm		Average L/hr	Hrs of Operation	Daily Water Consumption (L)	Monthly Water Consumption (L)
	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr				
Jan	39.0	4.5	55.9	6.2	68.9	7.5	60.7	24	1092	45146
Feb	40.3	4.7	53.3	6.0	66.3	7.3	59.3	24	1067	39816
Mar	29.9	4.2	42.9	5.5	54.6	6.7	48.0	12	576	17841
Apr	33.8	4.6	45.5	5.8	57.2	7.0	51.3	12	616	18467
May	28.6	0.0	39.0	0.0	50.7	0.0	39.4	0	0	0
Jun	16.9	0.0	28.6	0.0	39.0	0.0	28.2	0	0	0
Jul	22.1	0.0	33.8	0.0	44.2	0.0	33.4	0	0	0
Aug	31.2	0.0	42.9	0.0	54.6	0.0	42.9	0	0	0
Sep	29.9	4.2	41.6	5.4	53.3	6.6	47.0	12	564	16922
Oct	52.0	6.4	63.7	7.6	76.7	8.9	71.8	12	861	26706
Nov	54.6	6.1	67.6	7.4	79.3	8.6	74.5	24	1341	53642
Dec	52.0	5.8	65.0	7.1	76.7	8.3	71.6	24	1290	53302
						Max	74.5	Total Yearly (L)		271843

Longreach Yearly Water Consumption

Longreach Population =	4368
Number of Separate Houses =	1173
% of Houses with Evap. AC =	75%
No. of Houses with Evap. AC =	880
Yearly Water Consumption =	239 ML

GHD

WINTON EVAPORATIVE A/C WATER CONSUMPTION CALCULATION

Assumptions	
S/A Quantity =	3000 L/s
Air Density =	1.2 kg/m3
Water Density =	0.997 kg/L
Evap. Efficiency =	80%
Tank Capacity =	15 L
Tank Refill Rate =	20 refills, tank emptied

Notes:
(1) Evaporative air conditioner selection based on typical unit serving a 3 bedroom house.
(2) Assumed evaporative a/c unit incorporates a water dumping system.
(3) Tank completely emptied and refilled after 20 half-tank refills.
(4) Tank completely emptied 1 hr after unit switched off. Refilled when unit switched on again.

Supply Air Temperatures

Month	9am		12pm		3pm	
	$t_{S/A}$ °C	W g/kg	$t_{S/A}$ °C	W g/kg	$t_{S/A}$ °C	W g/kg
Jan	26.5	18.3	28.1	19.3	29.6	20.3
Feb	26.4	18.4	27.9	19.4	29.5	20.4
Mar	24.8	17.0	26.3	17.9	27.9	18.9
Apr	22.7	14.7	24.3	15.6	25.9	16.5
May	20.6	13.4	22.3	14.3	23.9	15.2
Jun	18.1	11.5	19.9	12.3	21.6	13.1
Jul	17.8	11.1	19.6	11.9	21.3	12.7
Aug	18.3	10.7	20.0	11.5	21.8	12.4
Sep	20.8	12.4	22.5	13.3	24.2	14.2
Oct	22.3	13.5	23.9	14.3	25.6	15.2
Nov	25.1	16.3	26.7	17.3	28.3	18.2
Dec	26.3	17.4	27.8	18.4	29.4	19.4

Water Consumption Rates per House

Month	9am		12pm		3pm		Average L/hr	Hrs of Operation	Daily Water Consumption (L)	Monthly Water Consumption (L)
	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr				
Jan	48.1	5.4	61.1	6.7	74.1	8.0	67.8	24	1221	50465
Feb	45.5	5.2	58.5	6.5	71.5	7.8	65.0	24	1169	43660
Mar	36.4	4.9	48.1	6.1	61.1	7.4	54.6	12	656	20323
Apr	39.0	5.1	50.7	6.3	62.4	7.5	57.0	12	684	20526
May	27.3	0.0	39.0	0.0	50.7	0.0	39.0	0	0	0
Jun	27.3	0.0	37.7	0.0	48.1	0.0	37.7	0	0	0
Jul	27.3	0.0	37.7	0.0	48.1	0.0	37.7	0	0	0
Aug	42.9	0.0	53.3	0.0	65.0	0.0	53.7	0	0	0
Sep	46.8	5.9	58.5	7.1	70.2	8.3	65.6	12	787	23614
Oct	53.3	6.6	63.7	7.6	75.4	8.8	71.8	12	861	26706
Nov	53.3	6.0	66.3	7.3	78.0	8.4	73.1	24	1315	52612
Dec	55.9	6.2	68.9	7.5	81.9	8.8	76.4	24	1375	56848
						Max	76.4	Total Yearly (L)		294756

Winton Yearly Water Consumption

Winton Population = 1956
Number of Separate Houses = 496
% of Houses with Evap. AC = 85%
No. of Houses with Evap. AC = 422

Yearly Water Consumption = 124 ML

MOUNT ISA EVAPORATIVE A/C WATER CONSUMPTION CALCULATION

Assumptions	
S/A Quantity =	3000 L/s
Air Density =	1.2 kg/m3
Water Density =	0.997 kg/L
Evap. Efficiency =	80%
Tank Capacity =	15 L
Tank Refill Rate =	20 refills, tank emptied

Notes:

(1) Evaporative air conditioner selection based on typical unit serving a 3 bedroom house.
(2) Assumed evaporative a/c unit incorporates a water dumping system.
(3) Tank completely emptied and refilled after 20 half-tank refills.
(4) Tank completely emptied 1 hr after unit switched off. Refilled when unit switched on again.

Supply Air Temperatures

Month	9am			12pm			3pm		
	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg
Jan	29.2	27.8	23.0	30.6	28.6	23.9	32.0	29.5	25.1
Feb	25.2	23.1	16.8	26.8	24.1	17.7	28.3	25.1	18.7
Mar	25.0	23.5	17.5	26.4	24.4	18.4	28.0	25.4	19.3
Apr	22.7	20.8	14.6	24.3	21.9	15.4	25.8	22.9	16.3
May	19.6	18.1	12.3	21.3	19.3	13.1	22.9	20.4	13.9
Jun	19.0	17.5	11.8	20.7	18.7	12.6	22.3	19.8	13.4
Jul	17.8	16.3	10.9	19.6	17.6	11.7	21.3	18.8	12.5
Aug	18.3	16.5	10.9	20.1	17.8	11.7	21.8	19.0	12.5
Sep	21.7	19.9	13.8	23.3	21.0	14.6	24.9	22.0	15.3
Oct	22.7	20.3	13.9	24.3	21.4	14.7	25.8	22.4	15.5
Nov	24.1	21.5	14.9	25.6	22.5	15.8	27.2	23.5	16.6
Dec	26.1	23.8	17.5	27.6	24.8	18.5	29.0	25.7	19.4

Water Consumption Rates per House

Month	9am		12pm		3pm		Average L/hr	Hrs of Operation	Daily Water Consumption (L)	Monthly Water Consumption (L)
	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr				
Jan	32.5	3.9	44.2	5.0	59.8	6.6	50.7	24	912	37699
Feb	48.1	5.4	59.8	6.6	72.8	7.9	66.9	24	1204	44941
Mar	32.5	5.1	44.2	6.3	55.9	7.5	50.5	8	404	12522
Apr	42.9	6.2	53.3	7.2	65.0	8.4	61.0	8	488	14635
May	32.5	0.0	42.9	0.0	53.3	0.0	42.9	0	0	0
Jun	32.5	0.0	42.9	0.0	53.3	0.0	42.9	0	0	0
Jul	33.8	0.0	44.2	0.0	54.6	0.0	44.2	0	0	0
Aug	40.3	0.0	50.7	0.0	61.1	0.0	50.7	0	0	0
Sep	41.6	6.0	52.0	7.1	61.1	8.0	58.6	8	469	14063
Oct	53.3	7.2	63.7	8.2	74.1	9.3	71.9	8	576	17841
Nov	57.2	6.3	68.9	7.5	79.3	8.6	75.9	24	1367	54671
Dec	50.7	5.7	63.7	7.0	75.4	8.2	70.2	24	1264	52238
						Max	75.9	Total Yearly (L)		248610

Mount Isa Yearly Water Consumption

Mount Isa Population =	21187
Number of Separate Houses =	5788
% of Houses with Evap. AC =	85%
No. of Houses with Evap. AC =	4920
Yearly Water Consumption =	**1223 ML**

GHD

DALBY EVAPORATIVE A/C WATER CONSUMPTION CALCULATION

Assumptions	
S/A Quantity =	3500 L/s
Air Density =	1.2 kg/m3
Water Density =	0.997 kg/L
Evap. Efficiency =	80%
Tank Capacity =	15 L
Tank Refill Rate =	20 refills, tank emptied

Notes:

(1) Evaporative air conditioner selection based on typical unit serving a 3 bedroom house.
(2) Assumed evaporative a/c unit incorporates a water dumping system.
(3) Tank completely emptied and refilled after 20 half-tank refills.
(4) Tank completely emptied 1 hr after unit switched off. Refilled when unit switched on again.

Supply Air Temperatures

Month	9am			12pm			3pm		
	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg
Jan	26.1	24.4	18.5	27.5	25.3	19.4	28.9	26.2	20.3
Feb	24.2	22.8	16.8	25.6	23.8	17.7	27.0	24.7	18.6
Mar	22.9	21.7	15.7	24.3	22.6	16.5	25.8	23.6	17.3
Apr	21.8	20.6	14.7	23.2	21.6	15.5	24.7	22.6	16.3
May	17.3	16.6	11.5	19.0	17.8	12.2	20.5	18.9	13.0
Jun	14.8	14.2	9.8	16.5	15.5	10.5	18.2	16.7	11.2
Jul	14.7	13.9	9.5	16.4	15.2	10.2	18.1	16.5	11.0
Aug	16.0	15.3	10.5	17.8	16.6	11.3	19.3	17.7	11.9
Sep	19.5	17.8	12.0	21.2	19.0	12.8	22.7	20.1	13.6
Oct	20.9	19.4	13.4	22.5	20.5	14.2	24.0	21.5	15.0
Nov	23.8	22.4	16.4	25.2	23.4	17.3	26.6	24.3	18.1
Dec	24.0	22.1	15.9	25.5	23.1	16.7	26.9	24.0	17.5

Water Consumption Rates per House

Month	9am		12pm		3pm		Average L/hr	Hrs of Operation	Daily Water Consumption (L)	Monthly Water Consumption (L)
	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr				
Jan	44.0	6.3	57.6	7.6	71.3	9.0	65.3	8	522	16186
Feb	34.9	5.4	48.5	6.7	62.2	8.1	55.3	8	442	12378
Mar	30.3	4.9	42.5	6.1	54.6	7.3	48.6	8	389	12049
Apr	30.3	4.9	42.5	6.1	54.6	7.3	48.6	8	389	11660
May	19.7	0.0	30.3	0.0	42.5	0.0	30.8	0	0	0
Jun	15.2	0.0	25.8	0.0	36.4	0.0	25.8	0	0	0
Jul	19.7	0.0	30.3	0.0	42.5	0.0	30.8	0	0	0
Aug	18.2	0.0	30.3	0.0	39.4	0.0	29.3	0	0	0
Sep	44.0	6.3	56.1	7.5	68.2	8.7	63.6	8	509	15264
Oct	39.4	5.8	51.6	7.0	63.7	8.2	58.6	8	469	14531
Nov	34.9	5.4	48.5	6.7	60.7	7.9	54.7	8	438	13128
Dec	51.6	7.0	63.7	8.2	75.8	9.5	71.9	8	576	17841
						Max	71.9	Total Yearly (L)		113038

Dalby Yearly Water Consumption

Dalby Population = 10130
Number of Separate Houses = 3470
% of Houses with Evap. AC = 25%
No. of Houses with Evap. AC = 868

Yearly Water Consumption = 98 ML

GHD

TOOWOOMBA EVAPORATIVE A/C WATER CONSUMPTION CALCULATION

Assumptions	
S/A Quantity =	4000 L/s
Air Density =	1.2 kg/m3
Water Density =	0.997 kg/L
Evap. Efficiency =	80%
Tank Capacity =	15 L
Tank Refill Rate =	20 refills, tank emptied

Notes:

(1) Evaporative air conditioner selection based on typical unit serving a 3 bedroom house.
(2) Assumed evaporative a/c unit incorporates a water dumping system.
(3) Tank completely emptied and refilled after 20 half-tank refills.
(4) Tank completely emptied 1 hr after unit switched off. Refilled when unit switched on again.

Supply Air Temperatures									
Month	9am			12pm			3pm		
	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg
Jan	24.9	23.6	17.7	26.3	24.5	18.6	27.5	25.3	19.4
Feb	23.6	23.1	17.5	25.0	24.0	18.3	26.2	24.8	19.1
Mar	22.4	21.8	16.1	23.8	22.7	16.8	25.1	23.6	17.7
Apr	19.7	19.0	13.4	21.1	20.0	14.1	22.4	20.9	14.8
May	17.1	16.8	11.8	18.6	17.9	12.5	20.0	18.9	13.2
Jun	14.0	14.0	9.9	15.8	15.4	10.7	17.3	16.5	11.4
Jul	14.0	13.9	9.8	15.6	15.1	10.5	17.1	16.2	11.1
Aug	14.6	13.9	9.6	16.2	15.1	10.2	17.7	16.2	10.8
Sep	16.9	15.6	10.5	18.4	16.7	11.1	19.9	17.8	11.8
Oct	20.9	19.5	13.6	22.3	20.5	14.3	23.6	21.4	15.0
Nov	21.7	20.6	14.7	23.0	21.5	15.4	24.4	22.4	16.1
Dec	24.0	23.0	17.2	25.3	23.9	18.0	26.6	24.7	18.8

Water Consumption Rates per House										
Month	9am		12pm		3pm		Average L/hr	Hrs of Operation	Daily Water Consumption (L)	Monthly Water Consumption (L)
	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr				
Jan	39.9	5.9	55.5	7.4	69.3	8.8	62.2	8	498	15438
Feb	15.6	3.4	29.5	4.8	43.3	6.2	34.3	8	274	7680
Mar	19.1	3.8	31.2	5.0	46.8	6.6	37.5	8	300	9291
Apr	19.1	0.0	31.2	0.0	43.3	0.0	31.2	0	0	0
May	8.7	0.0	20.8	0.0	32.9	0.0	20.8	0	0	0
Jun	0.0	0.0	13.9	0.0	26.0	0.0	13.3	0	0	0
Jul	3.5	0.0	15.6	0.0	26.0	0.0	15.0	0	0	0
Aug	20.8	0.0	31.2	0.0	41.6	0.0	31.2	0	0	0
Sep	36.4	0.0	46.8	0.0	58.9	0.0	47.4	0	0	0
Oct	41.6	6.0	53.7	7.2	65.9	8.5	61.0	8	488	15122
Nov	32.9	5.2	45.1	6.4	57.2	7.6	51.4	8	412	12347
Dec	29.5	4.8	43.3	6.2	57.2	7.6	49.5	8	396	12285
						Max	62.2	Total Yearly (L)		72163

Toowoomba Yearly Water Consumption

Toowoomba Population = 89928
Number of Separate Houses = 28445
% of Houses with Evap. AC = 25%
No. of Houses with Evap. AC = 7111

Yearly Water Consumption = 513 ML

GLADSTONE EVAPORATIVE A/C WATER CONSUMPTION CALCULATION

Assumptions	
S/A Quantity =	4000 L/s
Air Density =	1.2 kg/m3
Water Density =	0.997 kg/L
Evap. Efficiency =	80%
Tank Capacity =	15 L
Tank Refill Rate =	20 refills, tank emptied

Notes:

(1) Evaporative air conditioner selection based on typical unit serving a 3 bedroom house.
(2) Assumed evaporative a/c unit incorporates a water dumping system.
(3) Tank completely emptied and refilled after 20 half-tank refills.
(4) Tank completely emptied 1 hr after unit switched off. Refilled when unit switched on again.

Supply Air Temperatures

Month	9am			12pm			3pm		
	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg	$t_{S/A}$ °C DB	$t_{S/A}$ °C WB	W g/kg
Jan	26.8	26.4	21.6	27.6	26.9	22.1	28.9	27.7	23.0
Feb	26.2	26.0	21.1	27.2	26.6	21.7	28.4	27.4	22.6
Mar	25.1	24.7	19.4	26.1	25.3	20.0	27.3	26.1	20.8
Apr	23.6	23.2	17.7	24.7	23.9	18.3	25.9	24.7	19.1
May	21.4	21.3	15.8	22.5	22.0	16.4	23.8	22.9	17.1
Jun	19.4	19.3	13.9	20.6	20.1	14.5	21.9	21.0	15.2
Jul	19.4	19.2	13.8	20.5	20.0	14.4	21.9	20.9	15.0
Aug	19.6	19.1	13.6	20.7	19.9	14.2	22.0	20.8	14.9
Sep	21.7	21.2	15.5	22.7	21.9	16.1	24.0	22.8	16.9
Oct	23.6	23.1	17.5	24.7	23.8	18.1	25.9	24.6	18.9
Nov	24.4	23.8	18.3	25.4	24.5	19.0	26.7	25.3	19.7
Dec	26.4	25.9	20.9	27.4	26.5	21.5	28.6	27.3	22.4

Water Consumption Rates per House

Month	9am		12pm		3pm		Average L/hr	Hrs of Operation	Daily Water Consumption (L)	Monthly Water Consumption (L)
	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr	Evap. Rate L/hr	Dump Rate L/hr				
Jan	12.1	2.5	20.8	3.3	36.4	4.9	26.7	12	320	9921
Feb	5.2	1.8	15.6	2.8	31.2	4.4	20.3	12	244	6826
Mar	12.1	2.5	22.5	3.5	36.4	4.9	27.3	12	328	10158
Apr	13.9	2.6	24.3	3.7	38.1	5.1	29.2	12	351	10516
May	3.5	0.0	13.9	0.0	26.0	0.0	14.4	0	0	0
Jun	3.5	0.0	13.9	0.0	26.0	0.0	14.4	0	0	0
Jul	6.9	0.0	17.3	0.0	27.7	0.0	17.3	0	0	0
Aug	13.9	0.0	24.3	0.0	36.4	0.0	24.8	0	0	0
Sep	13.9	2.6	24.3	3.7	38.1	5.1	29.2	12	351	10516
Oct	15.6	2.8	26.0	3.8	39.9	5.2	31.1	12	373	11576
Nov	17.3	3.0	29.5	4.2	41.6	5.4	33.7	12	404	12118
Dec	15.6	2.8	26.0	3.8	41.6	5.4	31.8	12	381	11813
						Max	33.7	Total Yearly (L)		83445

Gladstone Yearly Water Consumption

Gladstone Popoulation = 26873
Number of Separate Houses = 7835
% of Houses with Evap. AC = 5%
No. of Houses with Evap. AC = 392

Yearly Water Consumption = 33 ML

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