



**INTEGRATED RESOURCE PLANNING FOR THE  
INTEGRATED WATER SUPPLY SCHEME  
FOR:  
EXPERT PANEL EXAMINING  
KIMBERLEY WATER SUPPLY OPTIONS**

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Client Report to WA Government

WATER FOR A HEALTHY COUNTRY

National Research Flagship

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## EXECUTIVE SUMMARY

Through the State Water Strategy the Government of Western Australia has committed to using Integrated Resource Planning (IRP) in its water allocation and licensing processes (Government of Western Australia, 2003).

There is currently limited experience in using IRP methods within the state and methods used elsewhere may need to be adapted to take account of the specific water environment within Western Australia, especially the relative complexity of the state's water sources, the high outdoor use component and self-supply options such as domestic bores. Improved management of existing water resources (e.g. catchment thinning, plantation management) to release more water are also not well covered in many past uses of the method.

The Water Services Association of Australia (WSAA) commissioned and recommends the use of an End Use Model (since renamed, the Supply and Demand Planning Model) to detail how water is used on both a customer sector (e.g. domestic, commercial) and end use basis (e.g. toilet flushing, garden watering). Such a model allows water suppliers to better predict future demand (forecasting) and to develop options to meet a future water supply demand balance (backcasting). Importantly, it allows water supply and demand management options to be compared on a consistent economic basis. Alternative methods of assessing supply and demand options often only consider the financial impact on the water service provider, whereas the government needs to also consider the impact on consumers and on the general community.

After considering how IRP has been applied in other jurisdictions, this report recommends the form of an integrated Supply and Demand Planning (iSDP) model to be developed for the IWSS, including eventually the Goldfields and Agricultural Water Scheme (GAWS) and the Great Southern Towns Water Scheme (GSTWS).

The existence of datasets such as the 1981-82 and the 1999–2001 Domestic Water Use Studies means that there is a sound basis for populating and calibrating such a model, improving its effectiveness in forecasting future demand, and estimating the impact of demand management options. The work on attitudes and behaviours by the Australian Research Centre for Water in Society (ARCWIS), and the recent review of the Water Corporation Demand Management Programs by the Institute for Sustainable Futures (Turner *et al.*, 2005c) are useful sources when comparing water supply and demand management options, including reuse and catchment management.

The model also provides a focus point for a number of existing and proposed studies to better define and understand supply and demand options.

Decisions on new sources or demand management also need to consider non-economic factors such as social, environmental and risk impacts. Over time the iSDP model can be used to assess the triple bottom line or sustainability impacts of all options using complementary methods.

The report recommends that on-going dedicated resources be allocated to ISDP model development and upkeep. Initially the model should concentrate on options facing the Water Corporation, the Office of Water Strategy, new Department of Water and the State Water Council, especially with the Kimberley water option to be assessed. However over time the model could be used to support decisions made by the Economic Regulation Authority and the Environmental Protection Authority.

## **1. INTRODUCTION**

### **1.1 Background**

An Expert Panel was formed in late 2004 to evaluate water supply options from the Kimberley to supplement the Integrated Water Supply Scheme (IWSS). A Context Report was prepared for the panel by CSIRO detailing south west water supply and demand management options (McFarlane, 2005). However it is difficult to assess the many competing options in the absence of an agreed framework.

In this regard, the State Water Strategy (Government of Western Australia, 2003) requires the state, amongst other things, to:

*Utilise the Integrated Resource Planning approach within the allocation and licensing process to drive appropriate consideration of, and appropriate investment in, conservation measures (p52).*

Integrated resource planning (IRP) is a process whereby the water service provider examines a series of water supply options and calculates which option will, at the least total cost, provide their customers with the *water-related services* they need, rather than the water itself (White, 1998; Water and Rivers Commission, 2002). This allows options that increase the efficiency of scheme water use or reduce demand for scheme water (e.g. leak reduction, retrofitting showerheads and installing domestic bores) to be compared on an equal footing with options that increase supply. Such comparisons should be carried out by considering the total costs and benefits to the water service provider and the customers and the general community rather than from the perspective of the water service provider alone.

This approach is compatible with the requirement under the *Rights in Water and Irrigation Act 1914* for the water resource manager to consider whether the water could be provided for by another source when considering a license application under Schedule 1 Clause 7(2)(f). Therefore the Board of the Water and Rivers Commission could benefit from IRP, as possibly, the Environmental Protection Authority (EPA) and the Economic Regulation Authority (ERA).

The report 'Perth's Water Future' (Water Authority of WA, 1995) was an early example of applying an IRP-type approach to the IWSS, although the method was not known by that name at the time. A similar approach was used in the study that led to the Kalgoorlie-Boulder Water Efficiency Program (White, 1994) and in Water and Rivers Commission-sponsored studies in relation to total water resource use for Exmouth, Esperance and Jindong-Broadwater (White and Fane, 1999).

### **1.2 Current approach**

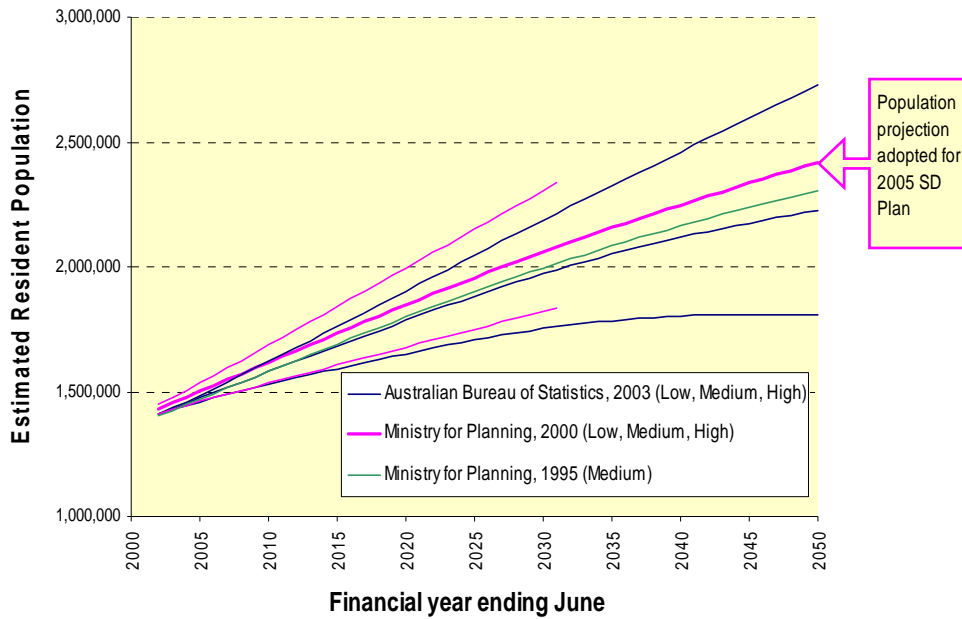
Water Corporation source development plans estimate the need for future water sources over time from projections of both population growth and per-capita consumption.

The medium population growth rate estimated by the Ministry for Planning (2000) is the estimate currently used which is slightly higher than an earlier growth rate estimated in 1995 by the same organisation, and a 2003 estimate by the Australian Bureau of Statistics (Figure 1.1).

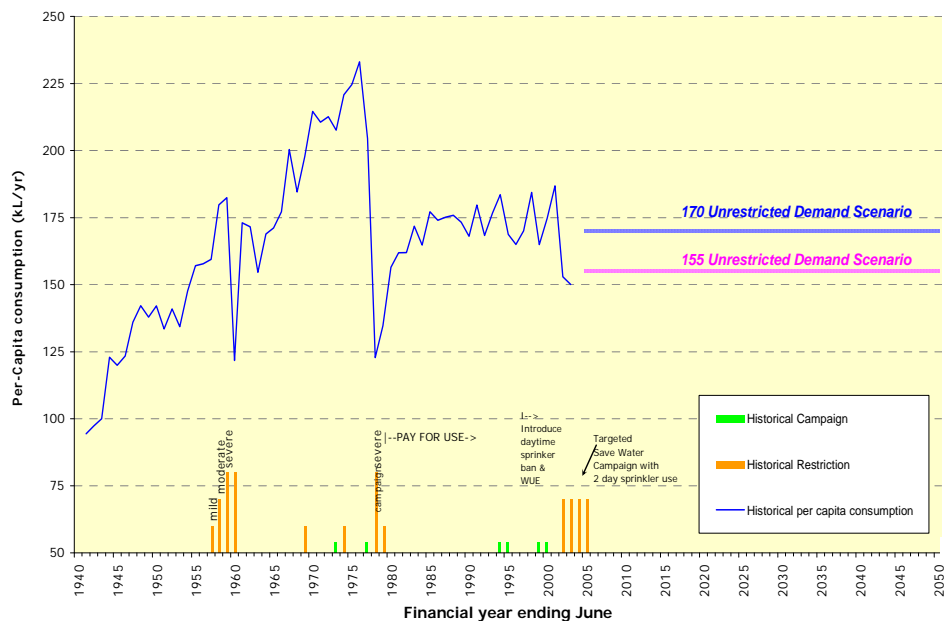
Per capita consumption of scheme water (which includes residential, non residential and non revenue water) has varied from below 100 to over 230 kL/person/yr (Figure 1.2). Consumption has been affected by education campaigns, restrictions, improved methods of charging for water

use and the widespread adoption of private bores as a result of a sprinkler ban in the late 1970s. In the past 20 years, unrestricted per capita consumption has averaged about 170 kL/yr.

In 2003 an unrestricted consumption target of 155 kL/person/yr by 2012 was adopted in the State Water Strategy. This equates to about 105 kL/person/yr when the commercial and industrial components are removed. The target has recently been achieved by implementing two-day-per-week sprinkler restrictions in late 2001 but would likely be exceeded were the restrictions to be lifted.



**Figure 1.1: Estimates of population in the Perth Statistical Division (Water Corporation, 2005)**



**Figure 1.2: Per capita water consumption for Perth 1941–2005 (Water Corporation 2005)**

Whether the “155 kL/person/yr by 2012” target is achievable, or even conservative, is determined by the likely baseline or reference case demand, and from the cost and impact of demand management programs. Generally it is not possible to assess these issues from the historical record, such as that shown in Figure 1.2. Future water demand, even in a baseline or reference case, is likely to be affected by a number of factors that will be different from the past and therefore a method which takes account of the main factors influencing consumption is likely to be an improvement.

About half of all scheme water use in the Perth Metropolitan Area is used outdoors on gardens and lawns (Loh and Coghlan, 2003). This use is more discretionary than indoor use, as evidenced by the per capita use of low, medium and high income earners being very similar over winter when outdoor use is minimal. Therefore factors that affect outdoor use are more likely to affect the achievement of the consumption target.

The following factors are likely to decrease future per capita consumption of scheme water:

- Residential lot sizes are progressively decreasing in the Perth to Peel region (which is supplied by the IWSS) with the median lot size in the 2005 March quarter being only 547m<sup>2</sup>, a decrease of 7% in 6 years (WAPC, 2005);
- Australian house sizes have increased by about 20% in the past 9 years, resulting in smaller lawn and garden areas requiring watering;
- 23% of new dwellings in Perth are now cluster developments (duplex to multiple units) and a further 9% are flats, units and apartments (ABS, 2002); and
- Long term behavioural changes as a result of prolonged sprinkler restrictions with people more likely to put in brick paving, have gardens better able to survive with less water and install backyard bores to supply their own outdoor water needs. Some of these practices are encouraged through a subsidy scheme that has resulted in increased uptake than would have occurred otherwise. Data on the actual reductions in scheme water use as a result of these subsidies are being gathered.

Some other factors that may result in an increased per capita consumption of water in future by some users include:

- increased rate of installation of reticulated sprinkler systems connected to scheme water;
- urbanisation of areas that are unsuited to bores (e.g. riverine floodplains, hills); and
- the possible inability of some areas to be able to accommodate extra bores given falling groundwater levels under parts of Perth (Smith *et al.*, in prep.).

These trends need to be better defined so that future demand estimates, and target setting, is based on accurate estimates of changes in demand.

In terms of water service options, Integrated Resource Planning requires that all options be considered in a comparable manner. In this regard, the Water Corporation have adopted a “Security through Diversity” strategy (Figure 1.3) which considers seven options to getting supply and demand into balance, at a level of supply reliability such that the annual probability of a complete sprinkler ban is less than 0.5% (or a 1 in 200 year occurrence).

Most jurisdictions consider three types of options: new sources, demand management and potable water substitution/reuse (e.g. Mitchell *et al.*, 2004). For the IWSS there is also the option of improving the performance of existing sources by managing pines and changing the burning regimes for native vegetation on Gnangara Mound, and by catchment thinning in the hills catchments.

Rather than compare options using methods such as levelised cost (Fane and White, 2003), the Government of Western Australia (2003) has currently adopted a consumption target of 155 kL/person/yr for the IWSS and a state-wide reuse target of 20% by 2012. Whether these are optimal or realistic targets remains to be determined by work currently underway and it is likely that both targets will be revised before the due date.

Professional judgement is used to decide on the relative effort to be made between the seven options shown in Figure 1.3. The attributes most relevant in making these judgements are:

- The amount of water that could result from the investment (GL/yr);
- The unit cost of the new water source, or of achieving the reduction in demand (\$/kL);
- The likelihood of success in attaining a long-term water supply, or of getting a long term permanent reduction in demand;
- The likely time lag in achieving the result;
- Whether the option complements the current investment in infrastructure or water supplies (e.g. groundwater treatment facilities, water quality mixes); and
- Whether there is a policy that influences the decision (e.g. a reuse target; per capita consumption target; “water for life” charging, a universal tariff policy to offset regional disadvantage).

Financial analyses carried out by the Water Corporation when comparing between options incorporates the estimation of the net present value for:

- capital and operating costs;
- revenue from water sales;
- savings from deferring capital expenditure as a result of reduced water demand;
- savings in water and wastewater costs; and
- implementation costs.

The Water Corporation has adopted a diversified approach to water conservation which looks at options which range from (harder) systems modifications to (softer) behavioural methods (Figure 1.4). This is very similar to the approach outlined in a review undertaken by the Institute for Sustainable Futures (White *et al.*, 2003a) for the Water Services Association of Australia (WSAA).

### 1.3 Objectives

This report aims to:

- Review what would be required to meet the State Water Strategy recommendation that Integrated Resource Planning be used in Western Australia;
- Briefly examine case studies from other jurisdictions to see what could be learned from them;
- Propose a framework and model which could be used to evaluate the options in the “Security through Diversity” policy (including Kimberley water supplies); and
- Provide recommendations for further work.

### 1.4 Scope

The funding for this work comes from the Western Australian Government’s study of the feasibility of developing a Kimberley water supply. The IRP process (framework) discussed could be used to assess the relative importance of a Kimberley source compared with other options available to water managers and suppliers. Given the work being currently carried out by the Expert Panel to assess the relative merits of these different Kimberley options, this study does not attempt to pre-empt these estimates. It does however build upon an earlier study for the Panel in which water resource options were reviewed in a non-comparative manner (McFarlane, 2005).

In addition, the Institute for Sustainable Futures at the University of Technology, Sydney, recently reviewed the current water efficiency programs being carried out in Western Australia for the Perth Metropolitan Area, analysed and modelled additional options using the IRP process and made a number of recommendations (Turner *et al.*, 2005c). The options developed by the Institute for Sustainable Futures for the Perth Metropolitan Area have been used to assist in the development of the broader suite of options required for the whole IWSS being assessed by this report. Many of the recommendations made in this report complement and build on those identified in the report prepared by the Institute for Sustainable Futures.

IRP compares options from a whole-of-government or community perspective, rather than from the water service provider only. If the option is beneficial for the community but not cost effective for the corporation, the possibility of pass through of any costs, or the provision of a Community Service Obligation, can be determined using this technique.

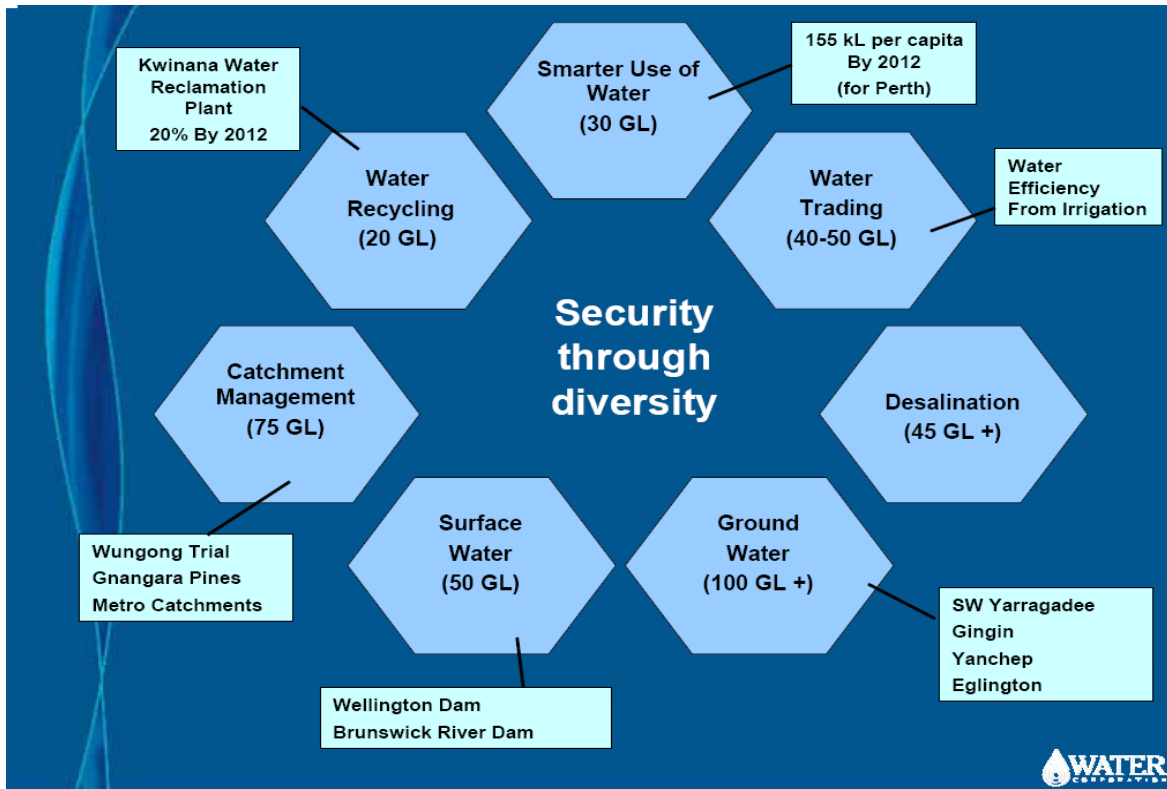


Figure 1.3 Security through Diversity for the IWSS (Water Corporation 2003)

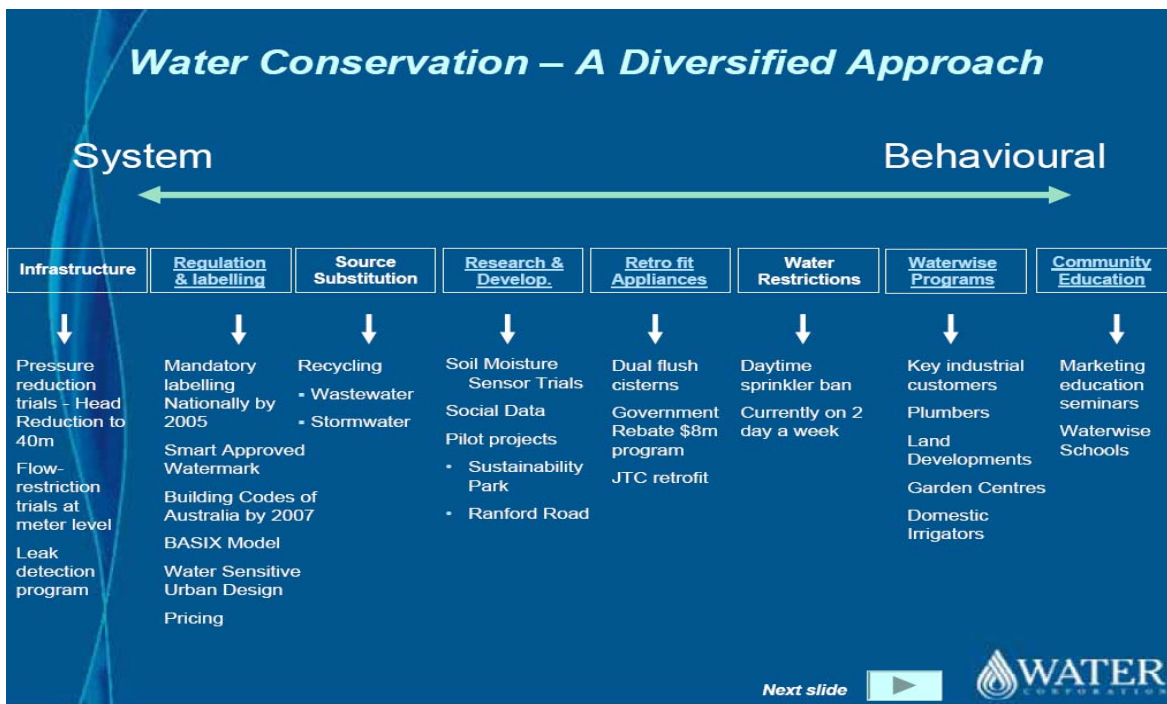


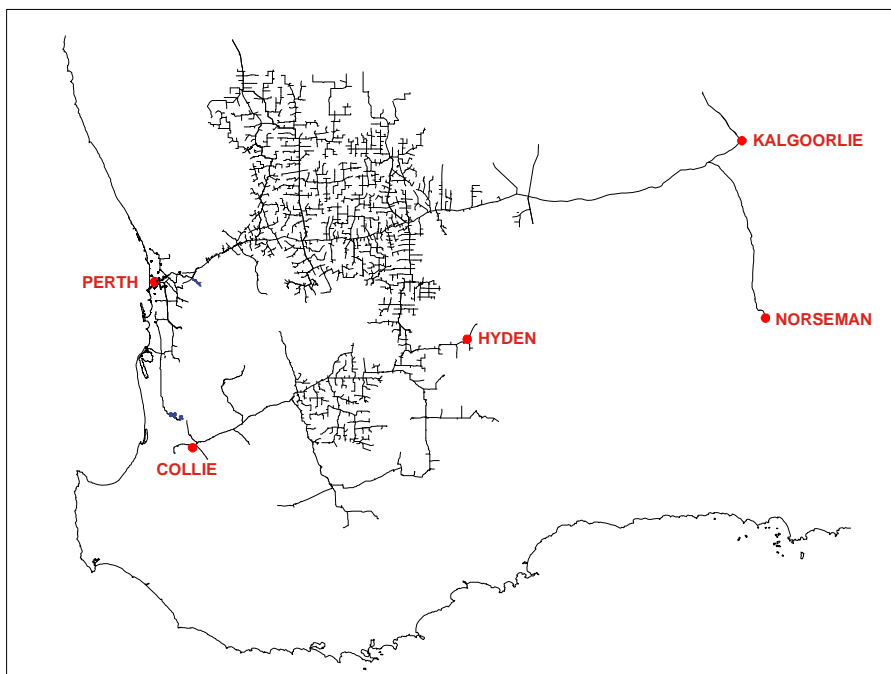
Figure 1.4 Water conservation options – Systems through to Behavioural changes (Water Corporation, 2004)

## 2. THE INTEGRATED WATER SUPPLY SCHEME

The Integrated Water Supply Scheme (IWSS) supplies drinking water for over 1.4M people in Western Australia and has features which make it unusual:

- By late 2006 it will include surface, groundwater and desalinated water sources;
- It has a supply network that stretches over 600 km west to east and over 150 km south to north – a feature made possible by the presence of a single water service provider – the Water Corporation;
- It has enabled the south west of WA to adapt to climate change, in which runoff into reservoirs has progressively decreased by 64% over a 30 year period, without the need for a complete sprinkler ban;
- There are realistic self-supply options for user groups (including bores for domestic households for example) which in many jurisdictions would be solely reliant on a public supply for their water; and
- Land use and land management decisions have a significant impact on both water supply and demand.

While the main part of the IWSS supplies the Perth Metropolitan Area and the Mandurah – Pinjarra area, it is also directly connected to the Goldfields and Agricultural Water Supply Scheme and indirectly influenced by the Great Southern Towns Water Scheme (Figure 2.1). Future developments may result in the scheme extending from south of Nannup and include a reticulated scheme to the Bridgetown – Balingup – Boyup Brook area.



**Figure 2.1 The Integrated Water Supply Scheme (Swan Coastal Plain) and its connections with the Goldfields and Agricultural Water Scheme (connected to Kalgoorlie and Norseman) and the Great Southern Towns Water Scheme (from the Collie Catchment)**  
(Source: Water Corporation, 2005)

Aggregated water supply and demand estimates for the IWSS, GAWS and GSTWS in 2004 and 2030 under an eight year (1997–2004) climate regime are shown in Figure 2.2 and 2.3. Metropolitan demand is expected to grow by about 54% over this 26 year period with Mandurah and SW towns demand growing by about 118%. Demand in the GSTWS and GAWS schemes is expected to be modest (18 and 30% respectively). These projections are based on standard planning calculations (i.e. for urban areas, consumption in litres per person per day are multiplied by the estimated future population).

The largest increases in supply to meet this demand is expected to come from the seawater desalination plant and SW Yarragadee aquifers (each 45 GL/yr), a 46% increase in supply from the lower SW dams (mainly through trading and recovery of the Wellington Reservoir from salinity), increased runoff into metropolitan dams after catchment thinning (35%) and an expansion of the borefields to cater for growth in the NW urban corridor (27%).

The availability of treated wastewater and stormwater is also expected to help meet demand for non-potable supplies currently being sourced from drinking water sources. Figure 2.4 shows these wastewater streams in comparison with 2003/04 drinking water demand and sources, and self supply of groundwater in the Perth metropolitan area.

Currently about 100 GL of secondary treated wastewater is discharged to the Indian Ocean each year and a further 30 GL of stormwater enters the Ocean via main drains managed by the Water Corporation. The 66 GL of stormwater that enters the Swan Canning River Estuary and its upstream rivers can be seen as both a lost resource and an important source of nutrients that contribute to algal blooms and fish deaths. Local governments in the Cottesloe – Mosman area are planning to divert their stormwaters into the Superficial Aquifer to reduce this load as well as reduce the likelihood of seawater intrusion into the aquifer as a result of extraction by council and backyard bores and reduced recharge in the drying climate.

Self supply of groundwater is very important for garden bores (112 GL/yr), peri-urban horticulturalists (101 GL/yr), parks and oval irrigation by local government (42 GL/yr), industry (also 42 GL/yr) and for people with large rural lifestyle blocks who are not serviced by scheme supplies (32 GL/yr). As these are often substitutes for scheme water supplies, they need to be considered in water source and demand planning. There are an estimated 155,000 backyard bores which water about a third of the gardens in Perth. Currently the numbers are increasing at more than 5,000 per annum (government subsidy scheme) and could potentially represent a cost effective manner in reducing scheme consumption if there is sufficient groundwater for them to use and if each bore is shared by a number of households (Turner *et al.*, 2005c). However a failure of these alternative water sources may result in increased demand for scheme water and this may need to be factored into estimates of future demand.

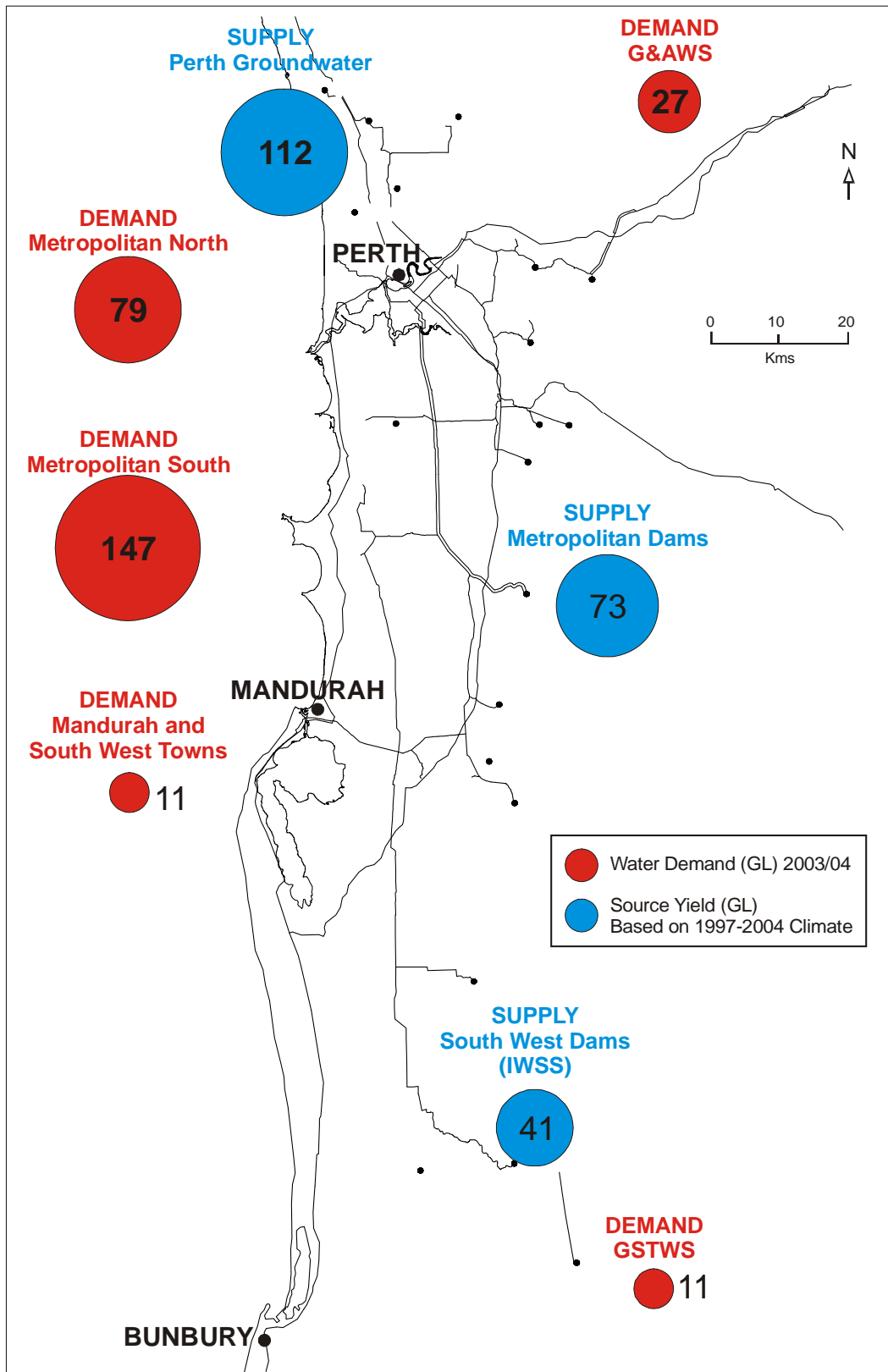


Figure 2.2 IWSS water demand for 2003/04 and source yield based on the 1997–2004 climate (Water Corporation, 2005)

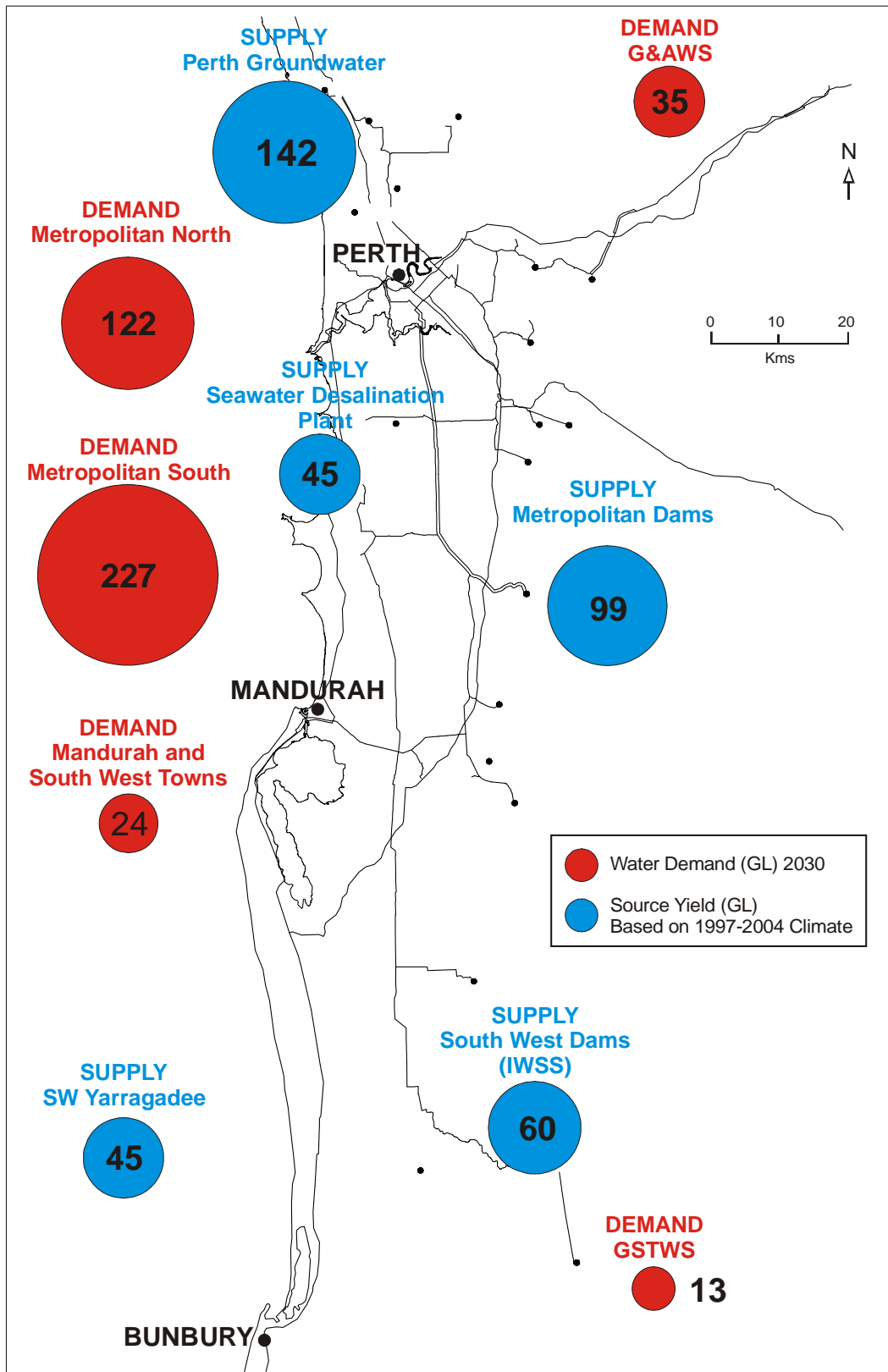


Figure 2.3 Estimated IWSS water demand for 2030 and source yield based on the 1997–2004 climate (Water Corporation, 2005)

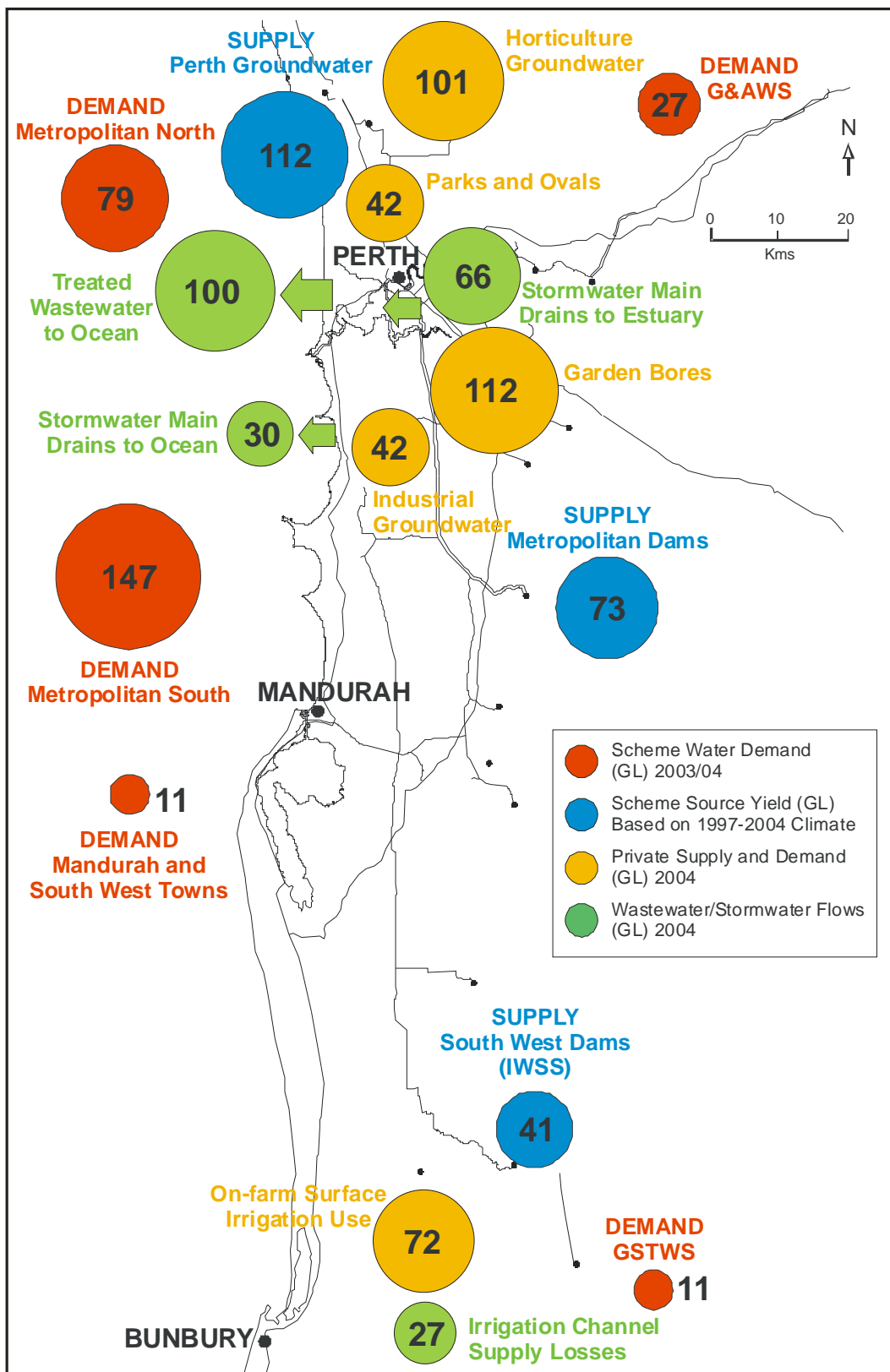


Figure 2.4 IWSS scheme demand and source yields (Water Corporation) compared with private self supply (DoE) and wastewater/stormwater flows (Water Corporation)

### 3. PRINCIPLES OF INTEGRATED RESOURCE PLANNING

#### 3.1 Definition and principles

Integrated Resource Planning (IRP) for water can be defined as the integration of demand management and water supply augmentation options to address a supply/demand deficit through a timely, cost-effective, environmentally sound and socially acceptable program of initiatives. The following principles are represented in this definition:

- A ML of water provided through a new source is equivalent to a ML of water saved through more efficient use. The focus shifts to provision of service rather than provision of a volume of water;
- The potential deficit between projected available supply and projected demand must be addressed over the short (5 years), medium (5 to 15 years) and long term (15+ years) – therefore data on water saved or supplied by an option must include a time dimension;
- Implementation costs for options must consider all contributors (water utilities, state and local government agencies, community groups and individual customers) – this is referred to as total resource cost or cost to the community; and
- Environmental and social impact data for options need to be included in the decision making process – these parameters and datasets can be monetised where appropriate cost data is available. Alternatively, environmental and social criteria can be considered as distinct components in the assessment of the sustainability of options.

Two other points are worth clarifying in the context of this definition:

- Impact on peak demand, or impact on sewage flows, can be captured as an output from the IRP process – however the water supply/demand deficit is typically considered first on the basis of monthly or annual average; and
- Short term climate variability is not considered in medium to long term IRP<sup>1</sup>. Climate change however, where sufficiently understood, can be incorporated into the supply/demand deficit through projected impact on yield (reduction in inflows with drier climate for example) and projected impact on demand (increased outdoor water use with drier climate for example).

These principles are not location specific and as such are widely transferable – this is evident from a number of examples within the Australian and international water industry. Equally, these principles, while presented here in the context of water, have been applied to other resources such as energy – consider a kWh provided through a new source as equivalent to a kWh of energy saved through demand management (Swisher *et al.*, 1997, Tellus Institute, 2000).

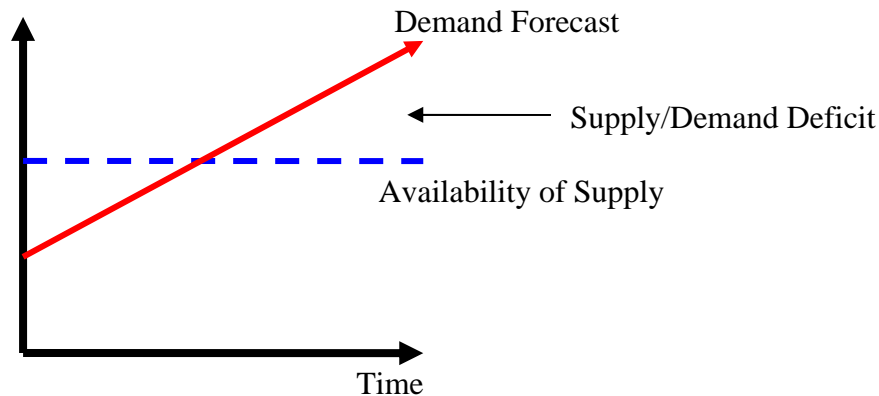
The key steps and information/data needs for IRP are detailed in the following sections.

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<sup>1</sup> Short term climate variability is an important consideration in ensuring that the starting point for projections of future water use is adjusted to average climate conditions (to reflect the fact that out-year forecasts are also considered as being on the basis of average climate conditions).

### 3.2 The gap

The first consideration in IRP is to forecast future requirements for water and estimate the future availability of water supplies. The objective of this step is to quantify the supply/demand deficit (or indeed surplus) in the short, medium and long term (Figure 3.1).



**Figure 3.1** Supply/Demand Deficit

Importantly, the demand forecast and availability of supply projection needs to be undertaken in the context of a ‘Business as Usual<sup>2</sup>’ approach. In this context, changes in demand and availability of supply that occur without active intervention (by government agencies and water utilities for example) should be incorporated into the Business as Usual datasets. The often quoted example is the changeover from single flush to dual flush toilets in Australia. As older single flush toilets are replaced, the only choice (effectively) for consumers is to purchase a dual flush toilet. This change increases the efficiency of use, reducing the demand for water – and yet is not generally considered as an active intervention.

The key information/data needs can be divided between determining availability of supplies and forecasting demand.

- Availability of Supply

This component is also referred to as allocation or yield. For major water storages (surface and subterranean), specialised modelling tools are typically utilised to determine allocation / yield. If an established program of environmental flows was in operation for surface water storages for example, then this data should be reflected in the yield / allocation component. If long term climate change impacts were projected to reduce (or indeed increase) the yield over time then, again, this data should be reflected in the yield / allocation component. So the availability of supply under ‘Business as Usual’ may not necessarily remain constant over the planning period. A report by WSAA entitled “Framework for Urban Water Resource Planning” (Erlanger and Neal, 2005) discusses the tension between levels of service and supply yield, factors affecting yield and the uncertainty around calculating yield.

#### *Key Dataset*

1/ ‘Business as Usual’ supply availability curve at the appropriate time step

All of this information is then provided to the IRP process as a referenced data set.

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<sup>2</sup> Often shortened to BAU or alternatively referred to as ‘Base Case’ or ‘Do Nothing’ or ‘Reference Case’

- Demand Forecast

Methodologies for the projection of future water requirements have become more sophisticated in recent years. Historically, projections of demand have been based on Equivalent Tenement (ET) where all future growth (residential and non-residential) is converted to ET's and an average demand per ET is then used to determine total demand. This approach, while generating a demand forecast, is not considered robust enough in the context of IRP.

Demand should be disaggregated to at least the key 'sectors' (agricultural, residential, commercial, industrial, institutional and non-revenue water for example – depending on the context) and growth projected for these same sectors. An assumption that all future growth can be represented as an ET does not respect the changes that are occurring throughout major urban areas as the density of development increases and in many cases, industrial companies are moving out – these changes highlight the need for a sector based approach to be the starting point for demand forecasts. Within the sector based approach a change in population, households (both single residential and multi residential dwellings), lot size and number of non residential properties are considered important factors that need to be taken into consideration.

An 'end use' approach should also be undertaken to further disaggregate the residential sector. This is of key importance to determine the relative contribution of indoor and outdoor demand as well as the major appliances/fixtures within a house (typically toilets, clothes washers and showers). This end use approach is necessary, for example, to quantify the impact of replacement of single flush toilets with dual flush.

Demand forecasts may also need to be developed for existing alternative water sources that are not provided by the municipal authority or water utility where such sources are in use. Rainwater tanks are an example, as is use of private groundwater bores. This data is not used directly in determining supply/demand deficit but rather to provide a complete picture of total water use requirements for a region.

#### *Key Datasets*

1/ 'Business as Usual' demand forecasts for major sectors with the residential sector further disaggregated where feasible into indoor demand associated with major appliances/fixtures and outdoor demand (i.e. an end use approach);

2/ Demand forecasts for existing alternative water sources (other than those operated by municipal or water utility) where such sources are in use [for use in association with total water use requirements rather than comparison with availability of existing (bulk) supplies];

3/ Demand forecasts for alternative water sources supplied by the water utility (e.g. major reticulated reuse scheme) where such sources are in use (again, to give a total water use perspective for the region).

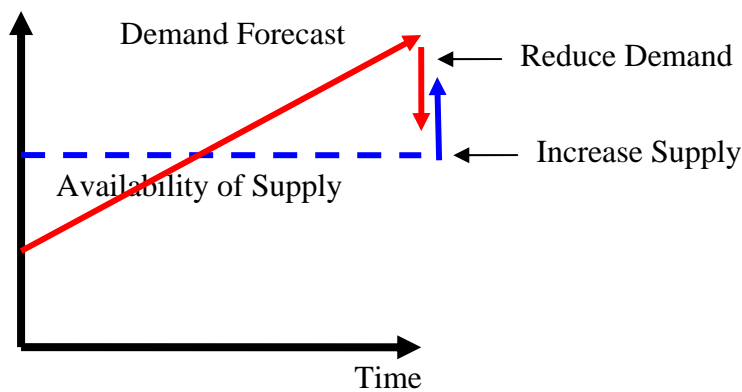
All of this information is then provided to the IRP process as a referenced data set.

### **3.3 The options**

Options to reduce the supply/demand deficit cover a very broad spectrum of projects, initiatives and ideas. Reducing the supply/demand deficit can be achieved either by increasing supply or reducing demand through efficiency improvements or substitution with alternative water

sources (Figure 3.2). Options could include supply augmentation through bulk infrastructure (desalination plants, inter-catchment transfers, catchment management initiatives); demand management through (distribution leakage repairs, water use audits for industrial/commercial properties, retrofitting of residential fixtures, pricing and performance standards for appliances); alternative water sources (third pipe recycled water systems for residential customers, rainwater tanks for toilet flushing plus outdoor usage, bores) and provision of recycled water to industrial customers).

The alternative water sources category covers sources that are both centralised (e.g. recycled water for industrial customers) and decentralised (e.g. rainwater tanks and private bores). These options can be considered as either demand or supply side measures. Ultimately, this will be determined by what key questions are being addressed through the IRP process. For example, if the planning objective is to manage the supply/demand deficit from the context of existing water sources then a recycling option will reduce demand from these existing storages. Conversely, if the planning objective is to manage total water use then recycling is considered as an offset - providing an additional water supply.



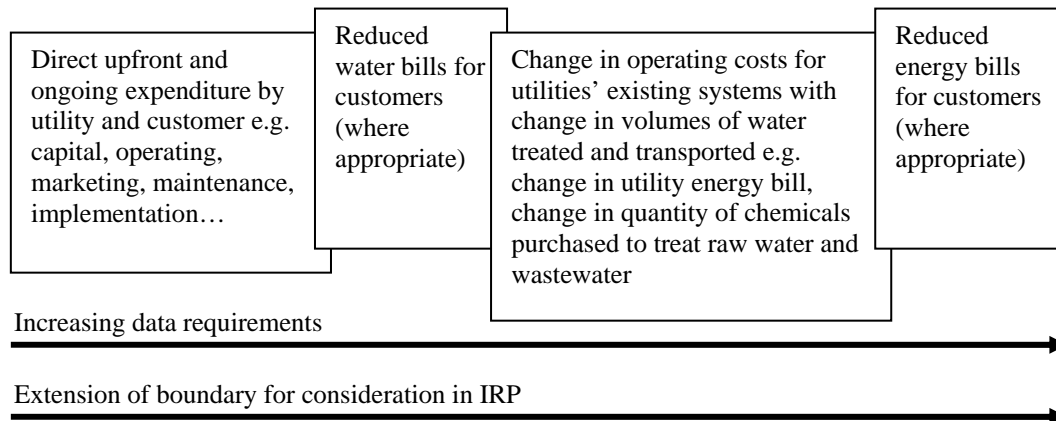
**Figure 3.2 Managing the Supply/Demand deficit**

Given this range of options, a consistent approach to managing data and information needs is necessary to ensure that each option is adequately described and can be compared with all other options. At this point of data collation, there also needs to be a clear understanding of the boundary for the IRP process. For example, what is the limit of analysis to be undertaken? Are costs simply limited to those incurred to establish and maintain the option? Should indirect costs and benefits generated by an option be considered?

This boundary can also be considered in terms of the data requirements to undertake the planning process. In this way, as more data becomes available, the boundary for IRP may extend – however, any such change must be consistent across all options under consideration.

Figure 3.3 demonstrates the link between the boundary for consideration and the required data from an economic perspective.

### Cost Datasets



**Figure 3.3 Data requirements and IRP boundary**

By extending the boundary for consideration within IRP, additional and valuable perspectives can be added to the decision making process. The issue of consistency is paramount however – on a first pass through each option, only data associated with direct upfront and on-going costs should be collected. A second, subsequent pass through each option could then extend the boundary of the IRP process to incorporate data on indirect system and customer costs and benefits. It would be inappropriate, however, to incorporate indirect system costs and benefits data for only a subset of the options under consideration.

The same concept holds for environmental and social datasets. With appropriate data, the impact of demand and supply options could be measured in terms of pollution of aquatic environments or the volume of biosolids trucked to agricultural regions for land application. Clearly, additional data will provide a fuller perspective of the relative merits of each option – the primary limitation is, of course, data availability.

### 3.4 Selection of options

With an extensive range of potential options available to IRP decision makers, ranging from demand management to alternative sources and supply, there needs to be a clear rationale for choosing particular options or packages of options over another.

The principles of IRP include the need to address economic, environmental and social criteria as part of the decision making process. This can be achieved in several ways. For example, methods can be used which attempt to quantify the indirect costs and benefits, that is, the externalities. For some costs this is more straightforward than others. For example, greenhouse gas emissions can be estimated, and a monetary value based on existing markets, such as the European Trading Scheme, can be applied. Other criteria can be quantified using survey methods or deliberative valuation processes. Alternatively, option screening can be undertaken using multi-criteria assessment methods. Importantly, in some of the most recent examples of IRP in Australia, the full range of sustainability criteria have not been combined into a single parameter. Instead, options have been ranked on economic criteria, and then the additional criteria applied to screen or filter options.

Typically in the assessment process, the whole cost of an option is measured in terms of present value \$/ML or c/kL, known as the levelised or unit cost. This metric compares the total cost to

all contributors (government, community and customer) with the volume of water saved (or supplied) by the option. This calculation uses a discount rate not only for the costs but also for the 'service' provided by the volume of water, which, for two identically costed options, will favour that which supplies or saves the 'service' provided by the water earliest. Hence the levelised or unit cost calculation enables the costs, savings/supply of water and time dimension to be taken into consideration in one metric and all options can be compared on an economic criteria by using a straight-forward ranking process of unit cost (Fane *et al.*, 2003).

To further explore the sustainability assessment methods, assume a metric had been developed for river health, such as incidence of algal blooms. The two criteria (the whole of society unit cost, \$/ML, and river health) do not necessarily need to be amalgamated through a weighting process. Indeed, application of weighting procedures can simply introduce yet more assumptions to the decision making process. Instead, options can be ranked separately for \$/ML and river health. Once this has been done it then becomes apparent that options which have low \$/ML as well as high river health would be flagged as favourable (in this simplistic example of only two criteria). The last step is to review the timeliness of the most sustainable options in the context of changes to the supply/demand deficit over time.

The specific measures or criteria that are used in IRP for decision making will vary from location to location. Some examples are provided in Section 5 of this Report. The key point to make though is that IRP should cover the three tenets of sustainability – economy, society and environment. The level of detail to which each is addressed will be a function of the available data – again, this is addressed further in Section 5.

An additional set of criteria that has been utilised relates to risk and uncertainty. This might be as simple as an index of outcome certainty for each option – or be more complex such as results from a detailed risk assessment procedure.

The final package of options recommended through an IRP process must address the supply/demand deficit over the full planning horizon and should clearly demonstrate favourable outcomes across the range of criteria considered in the decision making process. The decision making process should, as far as possible, use participatory methods to develop the criteria, their weighting and associated values and engage relevant stakeholders such as the utility, government, regulator and citizens during the process.

## **4. IRP APPLICATIONS**

The concepts and principles of Integrated Resource Planning have been adopted in other parts of Australia. This section of the report presents some of the most recent examples.

### **4.1 Sydney Water Corporation<sup>3</sup>**

A strategic, 'whole of Government' approach has been adopted in Sydney involving relevant agencies and the entire community to address the demand / supply balance for the region. One of the key outcomes from this work is the Metropolitan Water Plan (NSW Government, 2004). In preparing this strategy, a range of options to reduce demand and increase supply are being considered with the objective of achieving a sustainable water balance and improve river health.

The strategy builds from Sydney Water's Demand Management Program – the largest of its kind ever delivered in Australian and comparable to the largest and most diverse programs elsewhere in the world.

The primary economic criteria used for IRP in Sydney is Total Resource Cost (as c/kL) which addresses the costs and benefits from the perspective of the Government (including agencies and utilities), private organisations and the customers that participate in the initiatives within the program. Additional non-economic, qualitative criteria are also utilised in the decision making process by Sydney Water – these include social, environmental and functional criteria related to implementation of the option.

The decision support tool used by Sydney Water to assist with development of the options to manage the demand/supply balance has recently been adopted by the Water Services Association of Australia (WSAA) for use amongst members (previously known as the End Use Model, EUM, this model is now called the integrated Supply and Demand Planning Model, iSDP to reflect the broad planning capabilities of the model and associated IRP framework).

### **4.2 Melbourne**

Long term planning for the future of metropolitan Melbourne has been developed recently with the release of *Melbourne 2030* (Department of Sustainability and Environment, 2005). This planning document looked to address anticipated population growth through a number of initiatives – however there was no specific emphasis on water management.

Planning for water management has been undertaken most recently through the Joint Water Conservation Plan (JWCP) for Melbourne. Key datasets from the *Melbourne 2030* documents such as population growth and areas for urban consolidation as well as land release have been adopted in the JWCP.

The emphasis has now shifted to the development of water supply/demand strategies by all urban water authorities – a requirement established under a recent Victorian Government White Paper (*Securing Our Water Future*). Integrated Resource Planning Principles are being adopted for the development of the supply/demand strategies.

Institute for Sustainable Futures (ISF) and CSIRO recently completed a major project with Melbourne Water, Yarra Valley Water, South East Water and City West Water to develop

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<sup>3</sup> This section was referenced from the Water Conservation & Recycling Implementation Report 2003–2004, Sydney Water, 2004

‘Business as Usual’ demand forecasts (Snelling *et al.*, 2005 a, b, c and d). This represents one of the first steps in assessing the potential shortfall between supply and demand. The decision support capabilities of the WSAA iSDP model are being utilised in this project. A multi-agency working group has been tasked with developing this planning process – importantly this will involve linking the demand/supply strategies for metropolitan Melbourne with the equivalent strategies for rural areas to ensure the water allocation is appropriately managed between the urban and rural areas.

### **4.3 Canberra**

A least cost planning study was completed for Canberra in 2003 by the Institute for Sustainable Futures as part of a 50 year Water Resources Strategy being developed by the ACT Government (Turner *et al.*, 2005a). The study established a demand reference case to 2053 using a sector based approach (due to time limits an end use approach could not be conducted). The water demand was estimated to grow by over 30% (more than 20 GL/yr) over the period analysed.

The Study aimed to determine how to achieve a 12% reduction in per capita demand target by 2013 and 25% by 2023. Demand management options were estimated to be able to meet the 2013 target at a levelised cost of only \$0.30/kL. Within 20 years the demand management options considered would be able to reduce demand by about 12.5 GL/yr. This would enable more time to be available to improve the estimates and to consider demand management, source substitution (alternative sources such as rainwater tanks and reuse) and supply options in more detail. Interestingly, adoption of the demand management and source substitution options would effectively cap average scheme demand at 70 GL/yr by 2053, the peak level of demand that has already been attained in the 1990s. As in Western Australia, the impact of climate change and burning regimes on future water supplies is still not well known and may impact significantly on the yield of the existing dams. The IRP process and demand management options recommended enables the ACT Government to use an adaptive management approach while determining the supply demand balance in more detail.

## **5. AN END USE/OPTIONS MODEL (iSDP MODEL) FOR THE IWSS**

It was provisionally agreed that a planning tool should be developed using Water Services Association of Australia's End Use Model (WSAA's EUM) for the Integrated Water Supply Scheme at a workshop held at CSIRO Floreat on 25 May 2005. The workshop was attended by representatives from the Water Corporation (Water Cycle Project; Infrastructure Planning Branch), DoE (Water Resources Branch, Office of the Director General), CSIRO (Land and Water, Manufacturing and Infrastructure Technology Divisions) and the Kimberley Expert Panel (Professor Reg Appleyard). This decision was confirmed at later meetings and a small working group has formed to guide its development.

A workshop held at CSIRO on 1/2 November 2005 developed further the understanding and structure of the iSDP model for the IWSS including the following:

- A list of advantages of adopting the iSDP approach for the IWSS (Appendix 1);
- The use of 1999/2000 as the reference year against which the impact of the introduction of 2 days per week sprinkler restrictions (2001) and rebates (2003) could be assessed;
- The need to track domestic bore usage because this complementary water source affects scheme water demand, in some cases is from the same aquifer (e.g. Gwelup, West Mirrabooka, Whitfords, Quinns) and provides similar water services; and.
- The options listed in Appendix 2A and 2B.

The key consideration for supporting the on-going process of IRP for the IWSS is the capability to develop scenarios that combine projections of water availability and demand with options developed to address demand management, alternative sources and bulk supply initiatives. The EUM (recently renamed the Supply and Demand Planning model or iSDP) offers the following advantages as a framework to support decision making for the IWSS:

- Flexible demand forecasting component that can combine detailed end use demand data with higher level sectoral datasets to produce an overall demand forecast;
- Spatial definition can be provided to distinguish between sub regions within the IWSS that have different demand components and different demand and supply options available to each region;
- Interactive scenario development capabilities to enable rapid testing of what-if scenarios in workshop environments;
- The tool has been used by other water utilities in Australia for similar planning exercises (Section 4) – a formal network of users across Australia is currently being established; and
- The tool is available through WSAA and training material has been developed for WSAA members.

In establishing a decision support tool for the IWSS, consideration needs to be given to the three key components of IRP presented in Section 3 of this report.

## 5.1 The Gap

Analysis of the potential shortfall between supply and demand should be developed up from the best available data sources and projected over at least 20 years. In establishing this projection, there are a number of important points to address with respect to both the definition of water availability and future water demand – these have been summarised below:

### A/ Defining water availability

- Several water availability projections should be developed that cover (as a minimum) conservative and optimistic estimates of changes to ‘Business as Usual’ water availability in the future. Inflow and recharge assumptions could represent one starting point for these projections.

### B/ Defining future water demand

- Water demand forecasts must be developed initially at a sectoral level for the different regions.
- In the major urban centres, end use analysis (EUA) should also be investigated to project residential outdoor water use as well as water use associated with the major indoor water appliances/fixtures. This information will be of significant importance to the development of demand management options and projections of the effectiveness of these options to achieve per capita water use targets.
- Again, optimistic and conservative estimates of future water use also need to be developed to provide a sensitivity analysis of the potential shortfall between supply and demand (e.g. the effects of low, medium and high population projections and sensitivity on how urban consolidation through flats and units may affect demand).

The Institute for Sustainable Futures (White *et al.*, 2003a) identified a number of factors affecting water demand for use in forecasting and demand management (Figure 5.1).

There already exists a demand prediction model based on maximum day temperature and rainfall (Data Analysis Australia model), information on water usage practices from the 1998-2001 Domestic Water Use Study (Loh and Coghlan, 2003) and information on residential lot sizes, housing type and bore ownership from the Water Corporation client database. Other data that are relevant to WA end uses can be sourced from the Australian Bureau of Statistics, industry sources, data consultancies and past studies. However, through the process of developing the iSDP for the IWSS further data/information needs that are not currently available are likely to become apparent.

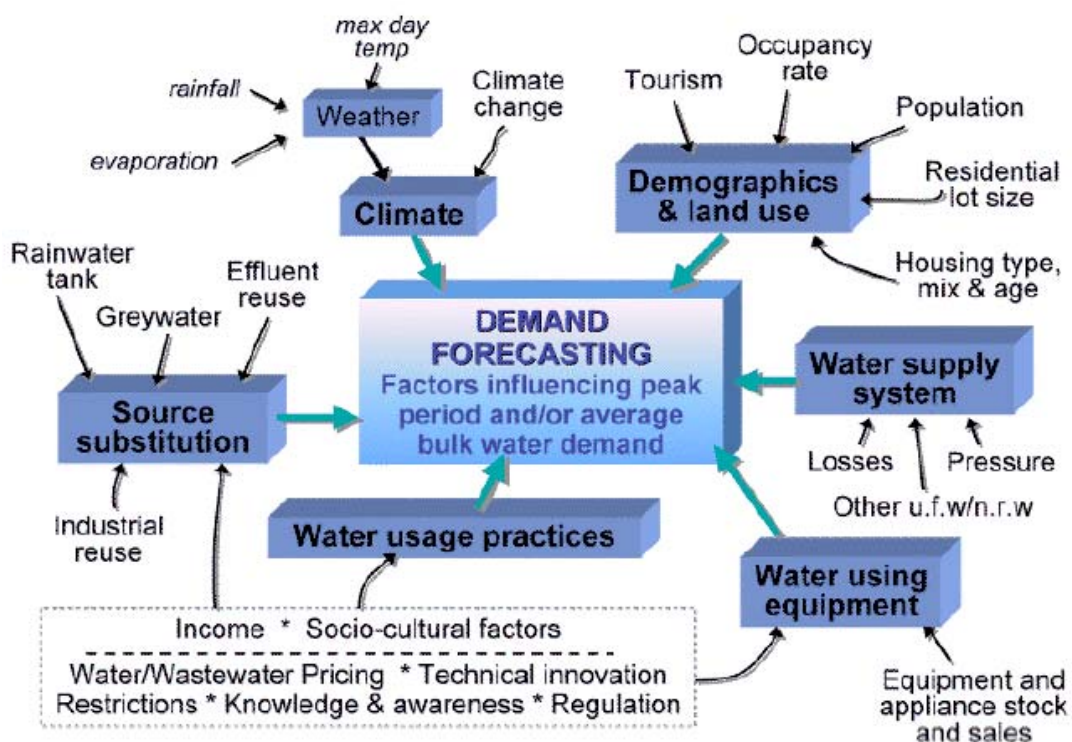


Figure 5.1: Direct and indirect factors influencing water demand (White *et al.*, 2003a)

## 5.2 The Options

Significant work has already been undertaken by Water Corporation and other agencies in Western Australia to define supply and demand side options (Turner *et al.*, 2005c). The first step in progressing this component of IRP would be to collate the range of existing data/information available including the assumptions and references. A number of additional steps should also be undertaken – these are listed below:

- Where possible, data collected from options that have already been implemented (even if only at pilot scale) need to be collected and evaluated to provide additional understanding of the effectiveness of that specific measure (i.e. measurement of the savings of a specific program using best practice statistical methods similar to those used for the Sydney Water Every Drop Counts Retrofit Program (Turner *et al.*, 2005b)).
- In addition, notes should be included to confirm that those options that have already been implemented are not to be considered as part of the ‘Business as Usual’ demand forecast but rather as specific initiatives that can be identified in the reports generated by the decision support tool.

## 5.3 Selection of Options

In undertaking IRP for the IWSS, specific criteria need to be selected across economic, social and environmental spheres to enable identification of the most appropriate options for implementation. Some of the key criteria recommended as a foundation for decision making are listed below:

#### A/ Economic

- Total Resource Cost (\$/ML or c/kL) – cost to government, community and customer in the context of water saved or supplied. A measure of the cost-effectiveness of an option when compared against the long run marginal cost of water.

#### B/ Social

- Community Acceptance – how acceptable is a specific option to the community?
- Community Health Risk – is there an increased or decreased risk to public health with the implementation of this option?
- Social Equity – is the broader community benefiting from this option?

#### C/ Environmental

- Energy consumption – is energy consumption expected to increase or decrease with the implementation of this option? This can be linked to greenhouse gas emissions.
- Wastewater discharge to waterways – will discharges from wastewater treatment plants increase or decrease with the implementation of this option?
- Stormwater discharges to waterways – will discharges from stormwater runoff increase or decrease with the implementation of this option?

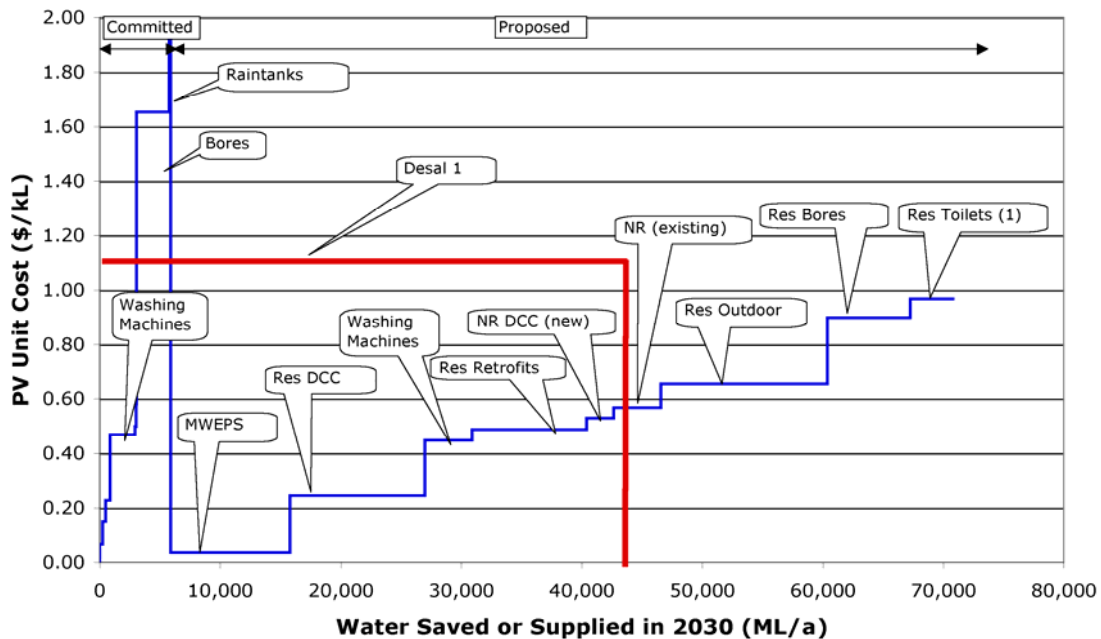
Additional criteria can also be developed around the functional aspects of the option – for example, risk; feasibility; stakeholder support; certainty of outcome; timeliness of the outcome; and scalability of the option.

### 5.4 Outputs

In planning for the use of a decision support tool, it is important to understand the key outputs that need to be generated by the tool in order to assist in answering the questions being raised by the IRP process. Some of the typical outputs that should be generated are listed below:

- *What is the extent of the gap between supply and demand today and in the future?* Projection of the potential shortfall between supply and demand and estimate of the sensitivity associated with both the estimate of water availability and the estimate of water demand under 'Business as Usual' assumptions.
- *What assumptions have been made to generate these estimates?* Report on assumptions underlying the estimate of water availability and future water use under 'Business as Usual' conditions.
- *What impact will the different options considered have on demand and available supplies over time?* Projection of the impact of the demand and supply options on the potential shortfall between supply and demand.

- *What assumptions have been made to develop up the datasets for the options? Report on assumptions underlying the definition of options.*
- *Which are the most cost-effective / least energy intensive / most socially acceptable options? Ranking of options based on specific criteria developed for the decision making process. See Figure 5.2 for an example of ranking of unit costs of options for the Perth Metropolitan area.*
- *What is the Present Value of the package for initiatives chosen though the IRP process? Projection of implementation costs for specific package of options for various stakeholders involved.*

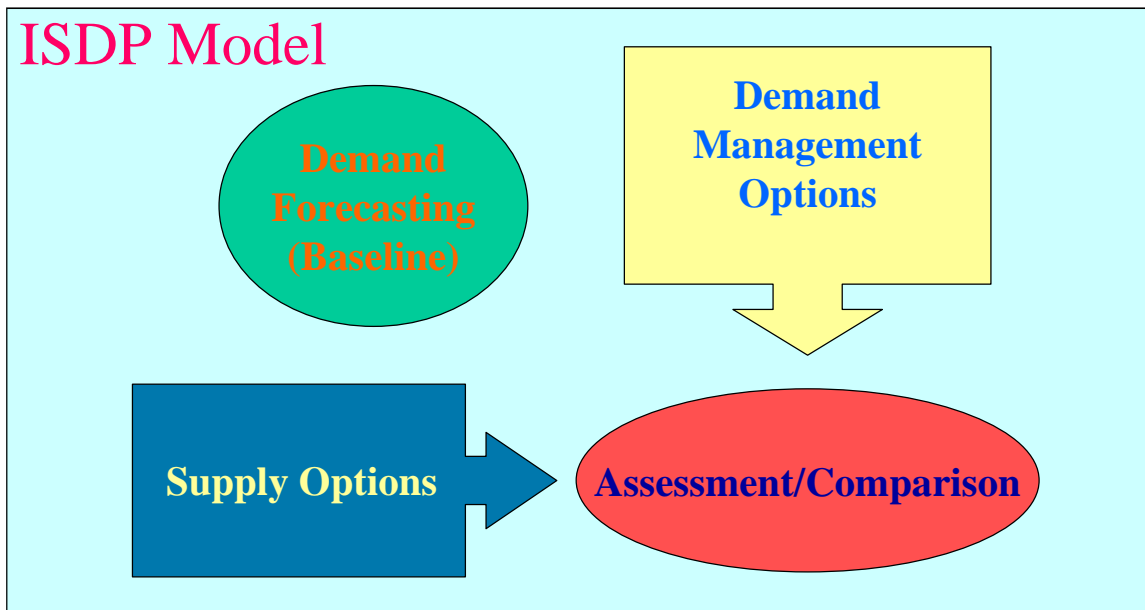


**Figure 5.2: Example of an IRP model ranking of unit costs of water efficiency options for the Perth Metropolitan Area (Turner *et al.*, 2005c)**

The iSDP model would need to suit the IWSS supply and demand profile. It could be expanded to be more complex where and when warranted. For example, the GAWS Scheme could be shown simply or broken down to target water consumption by expensive water uses. Industrial and commercial use could also be well defined if savings were thought to be possible through efficiency schemes. It may also be possible to identify how each surface, groundwater or desalination source is used to better match water quality with their use.

### 5.5 Previous experience with end use modelling by the Water Corporation

The integrated Supply and Demand Planning (iSDP) model (previously known as the End Use Model, EUM) was evaluated by the Corporation in 2004 and found to be potentially useful for comparing supply and demand options for the IWSS. The iSDP model can be represented diagrammatically in Figure 5.3.



**Figure 5.3 iSDP Model**

*Demand Forecasting*

One of the main reasons why the iSDP model was evaluated by the Water Corporation is its ability to model consumption demand based on end use as well as sectoral demand. The traditional way of forecasting demand based on historical consumption and population growth was no longer considered a valid way of predicting water consumption.

The introduction of water restrictions in 2001 dramatically changed the way people used water. The introduction of the rebate scheme also increased the availability and ownership level of water efficient appliances in the market, such as front loading washing machines and water efficient shower heads.

At the start of the rebate program in February 2003, there were only nine models of water efficient washing machines available for sale. However, there are now 178 models of water efficient machines available on the market for sale (John Brennan, Water Corporation, 2005). The rebate register kept by the Water Corporation shows that in a short span of two years, approximately 34,000 water efficient washing machines were purchased by consumers. Using water efficient washing machines can potentially save up to approximately 5 kL/person/year (Loh & Coghlan, 2003).

There are rebates for other water efficient products and thus water usage patterns have changed significantly. In addition, manufacturers are making a conscious decision to produce water efficient products and therefore further reducing water usage.

It is evident that traditional demand forecasting method is not applicable as the shift in usage pattern is drastic. This coupled with the restrictions and the intensive media campaign during summer cause a reduction in usage of over 40 GL per annum for the last two years.

In order to better model the demand for the future, the demand is categorised into different sectors and end uses (Table 5.1).

**Table 5.1 iSDP Demand Modelling**

<b>Sector</b>	<b>End Use</b>
Residential	<ul style="list-style-type: none"> <li>• Toilets</li> <li>• Washing machines</li> <li>• Showers &amp; baths</li> <li>• Taps</li> <li>• Irrigation (outdoor water use)</li> <li>• Swimming pool, etc.</li> </ul>
Services	
Industrial	
Irrigation	
Stock	
Mining	
Parks & Gardens	
Losses	

The IWSS is split into four demand regions:

- Perth Metropolitan:
- IWSS (South West Region) – including Mandurah, Pinjarra;
- Goldfields and Agricultural Regions (Agricultural Region) [G&AWS (AR)]; and
- Goldfields and Agricultural Regions (Goldfields Region) [G&AWS (GR)]

The water consumption in Perth Metropolitan area is significantly larger than the other three regions. End use data for this area is also significantly better than those for the other three regions. This is due to the fact that there were two domestic water use studies carried out by the Water Corporation (1985, 2003) as well as Domestic Water Use Survey carried out by the Australian Bureau of Statistics (2003). Therefore, it is possible to model water consumption based on residential end use for the Perth Metropolitan region. In addition, approximately 70% of water used in the region is consumed by the residential sector and hence, it is important to model the residential end use.

The IWSS (SWR) may have similar information to enable a more detailed modeling of end use demands. However, due to the lack of information for the G&AWS (AR) and G&AWS (GR), only sectoral demand can be modelled for these regions.

#### *Supply Options*

The source development plan for the Corporation has been developed recently (2005). All available options are listed in the IWSS Source Development Plan 2005 (Water Corporation, 2005) and will be modelled using the iSDP model. In addition to the options proposed in the plan, Kimberley Pipe Options can be modelled in the IWSS iSDP model.

#### *Demand Options*

The Institute of Sustainable Futures (ISF) has produced a report reviewing the water efficiency programs in WA and has made several recommendations to the Corporation (Turner *et al.*, 2005c). The options recommended by the ISF will be included in the model. The Water Cycle Project will discuss the options which will be built into the model.

*Integrated Resource Planning (IRP) Process for the IWSS*

A working iSDP model for the IWSS system should be completed by the end of December 2005. The model will be used to assess the demand/supply options based on the IRP principal. A graphical representation of the model is as shown in Figure 5.4.

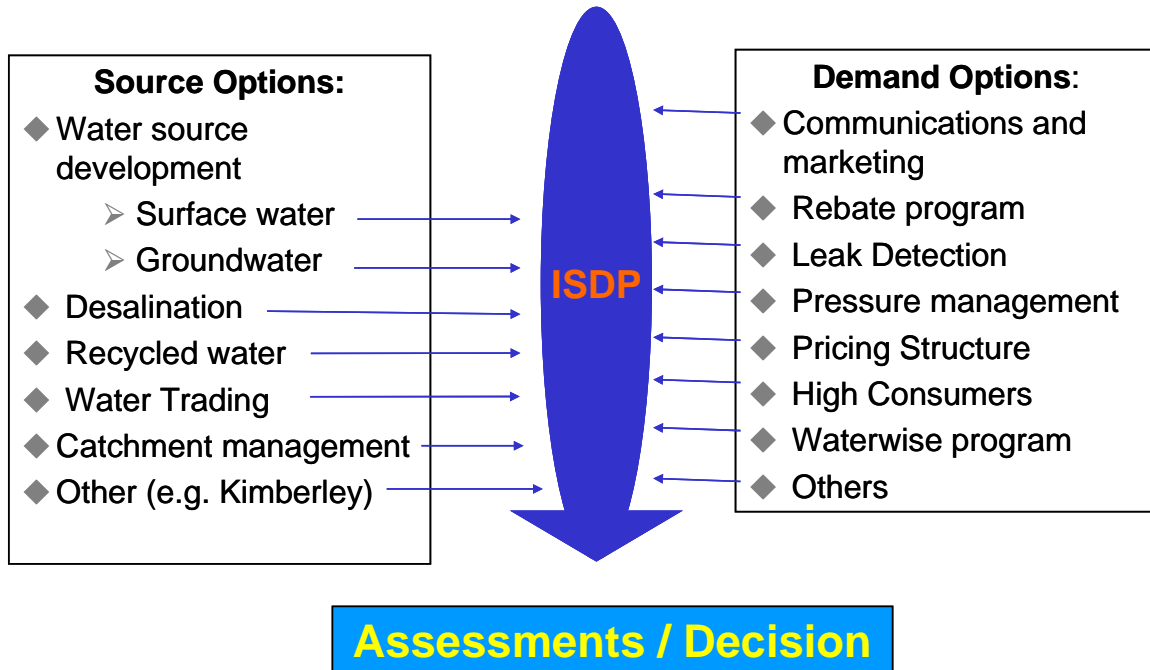


Figure 5.4 Graphical Representation of the iSDP Model

## **6. RESOURCING AND SUPPORT**

The development of a model to assess supply and demand management options on an on-going basis and the associated tasks of data/information collection, planning and implementation and measurement of water savings of implemented programs will require dedicated resources within the Water Corporation and support from expert groups within the state and nationally (WSAA, CSIRO, the Institute for Sustainable Futures etc).

Expertise in both the Water Cycle Project group and in the Infrastructure Planning Branch within the Corporation is required to ensure the right mix of supply and demand management planning is available.

The model will be of significant benefit to various stakeholders in terms of modelling options that are under their control. As such the training of various departments within the Water Corporation and other Government departments, in the capability of the model, will be essential to ensure multiple stakeholders benefit from a central planning model (the IWSS iSDP model). An End Use and Demand Management Training Package and associated two and a half day workshop has just been completed by the Institute for Sustainable Futures for WSAA which outlines the principles of IRP and how to use the WSAA iSDP model. This training package can be modified to fulfil the needs of the WA stakeholders.

Ultimate control of the model and inputs should be held by the Water Corporation to ensure strict quality control and customer database access/confidentiality. However, meetings held between stakeholders to determine how the model can be used to model options that fulfil policy requirements (i.e. actions under the State Water Strategy) will be of significant benefit on an ongoing basis. In addition this stakeholder group should as far as possible use participatory methods to evaluate the suite of options.

Advancements in end use analysis, water efficiency initiatives, modelling capability and associated knowledge across Australia are developing rapidly. The Institute for Sustainable Futures and CSIRO are developing a step-by-step Manual for WSAA and the Australian Water Industry that will collate available knowledge across Australia on IRP, water efficiency initiatives, associated studies on end use analysis, options analysis and planning of water services etc. This will include the collation of various data/information sources that could benefit the IWSS iSDP model. It will be essential for at least one member of the Water Corporation to become an active and ongoing member of the Steering Committee/Reference Group for the study to both provide input and obtain new information to include in the IWSS iSDP model. In addition, regular IWSS iSDP model meetings should be held to determine how the model should be advanced, what additional data/information is required to improve the model over time and how this can be achieved.

## 7. CONCLUSIONS AND RECOMMENDATIONS

As a planning tool, the integrated Supply and Demand Planning (iSDP) model brings together four key components of the demand / supply balance.

- Current allocation/yield/supply/water availability;
- Projection of baseline water demand requirements (the reference case or business as usual water demand);
- Options to increase water availability (supply side options); and
- Options to manage demand (demand side options).

In addition it brings together the costs of the broad spectrum of options considered and the associated benefits using a consistent boundary and assumptions to enable direct comparison.

The basic requirement for utilising an iSDP model is that data can be accessed to describe all of these components. One of the key issues in implementing the iSDP model for a given region is determining how much data and analysis is required for each of these components. This choice affects the effort required to establish the modelling framework and the capability of the model to provide insight into specific uses of water and their associated costs and benefits. In this way, staging of model development is an important consideration.

### **Recommended Approach:**

A two stage approach to incorporating Integrated Resource Planning (IRP), using the WSAA iSDP model is recommended for the Perth Integrated Water Supply System (IWSS).

#### *Stage 1: Emphasis on integration of options assessment*

The purpose of this stage is to fast track the integration of the assessment of demand and supply side options by the Water Corporation. This stage will concentrate on developing a ‘first cut’ sectoral based reference case (i.e. not developing a full end use focussed reference case at this stage) which will assist in refining the options and associated assumptions recently developed as part of the analysis conducted by the Institute for Sustainable Futures “*A Review of Water Efficiency Programs in Western Australia: Towards a Strategy for Best Practice*” (Turner *et al.*, 2005c).

Existing data on allocation/water availability will be combined with a sectoral based approach to projecting baseline water demand requirements. The sector based demand analysis will utilise the customer billing data collected by Water Corporation and associated bulk water production data. The initial sector based projections (e.g. single residential, multi residential, commercial, industrial, institutional, non-revenue water) will also rely upon a detailed analysis of demographic and land use data, as well as the climate corrected bulk production data and existing analysis of non revenue water. Using these initial projections, the gap between baseline demand and supply (that is, in the absence of intervention measures such as the water efficiency programs) will be estimated. The more refined sector based reference case will then be input to the WSAA iSDP model.

The analysis of demand and supply side options, undertaken for the Perth Metropolitan Area as part of the recently completed report by the Institute for Sustainable Futures (Turner *et al.*,

2005c) will then be refined and expanded based on the more accurate reference case demand analysis and also added to the WSAA iSDP model. By inputting the more refined reference case and suite of potential supply and demand side options into the model to close the gap between baseline supply and demand will assist in demonstrating the potential for integrated resource planning in the IWSS.

*Stage 2: Emphasis on forecasting future water use requirements using end use analysis*

The second stage of the model development process will look in more detail at refining the reference case demand by considering each sector component of the projection of future water use using an end use approach. This involves moving from a high level sectoral approach to an end use approach for key uses within sectors (e.g. in the residential sector disaggregating water demand into toilets, showers, washing machines etc. and the anticipated change in the proportion of efficient and non efficient stock over time which can significantly affect water usage for each end use). The objective of this stage is to reduce the uncertainty of the future water use projection and in doing so, reduce the uncertainty regarding the future shortfall between demand and supply balance. If this uncertainty can be reduced, then the scale or timing of options that may need to be implemented to meet that shortfall can also be reduced.

Additionally, the end use approach provides important data on the potential for demand management and the various supply, or source development options. Appliance-based residential water efficiency options require data on usage patterns, appliance adoption rate and performance in terms of water efficiency. Localised reuse and alternative supply/source substitution options require data on the volumes of water that could be provided for specific end uses by a non potable supply source (e.g. rainwater tanks for toilet flushing).

Once the appropriate end use data has been collected and analysed, which will build on the data already collected by the Water Corporation (i.e. the Domestic Water Use Study) and other utilities across Australia, this will be input to the WSAA iSDP model. This will then enable further refinement of the options under Stage 1.

*Benefits of this approach*

Early establishment of IRP principles through integration of demand and supply side options and demonstration of the application of the modelling technique to the Corporation.

Initial training program can target subset of model functionality rather than expose users to full suite of functionality at the outset.

Unit cost ranking of options and how to balance the supply demand balance can be used to assist in draft determination of WA Government budget assessment of options to be implemented 2005/06.

*Disadvantages of this approach*

A relatively high level of uncertainty will be associated with the baseline demand forecast which will only be addressed in more detail in Stage 2. As such, this uncertainty will also affect estimates of the future shortfall between demand and supply which will increase the number of potential options that may need to be considered until Stage 2 has been completed.

The sectoral based reference case will still be an improvement on the current Water Corporation water forecasting method and will be a vital first step to the analysis undertaken in Stage 2.

## **Timing**

Stage 1, with its emphasis on development of a sectoral based reference case water demand and option integration using the results from the work conducted by the Institute for Sustainable Futures (Turner *et al.*, 2005c) could be completed for Perth within 2 to 3 months. With this foundation established, additional data analysis and research could then be conducted as part of Stage 2 to reduce the uncertainty regarding the future shortfall between supply and demand and to improve the estimates of the impact that demand management and introduction of alternative water sources would have. Stage 2 would be undertaken over a 6 to 9 month period by which time the IRP approach would be firmly established in Water Corporation and emphasis would shift to researching specific questions to further inform the demand/supply planning process using the principles of IRP.

## **Steering Group**

To maximise collaboration between Water Corporation departments, capacity building and the eventual integration of the IRP process it is recommended that a Steering Group should be established within Water Corporation that brings together the departments that will be involved in the IRP process and development of the WSAA iSDP model for the Perth IWSS (e.g. Water Cycle Project, Infrastructure Planning Branch, Finance, Sustainability). The Steering Group would assign responsibilities for data collection and analysis and guide the design of the Perth iSDP model through both Stage 1 and Stage 2.

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## APPENDIX 1: ADVANTAGES OF USING A SUPPLY AND DEMAND PLANNING MODEL

	<b>Knowledge</b>	<b>Purpose</b>	<b>How is this currently done ?</b>	<b>How would it be better with a iSDP ?</b>
1	Future water demand estimates	Source development program meets needs in a timely manner	Population projection (Ministry for Planning median projection, 2000) and two per capita consumption estimates (155 and 170 KL/yr)	Per capita consumption estimated for sectors and end uses, and takes account of trends (e.g. block sizes; aging population; technology). Future use is not solely based on past consumption patterns
2	Supply and demand management options compared using an agreed method	To decide the best option for the community, government and utility.	Cost to utility / government of each option (and the impact on water prices) are estimated	The total levelised cost (or unit cost) from the combined perspective of the utility, government and customer of all options (supply augmentation, source substitution and demand management) would enable transparent decision making and improved investment decisions.
3	How water is actually used (e.g. showering, lawns, evaporative coolers)	Targeting of educational, subsidy and regulatory schemes; tariff impact and equity assessments	Domestic Water Use Studies (1981/82, 1998/2000) identified main in-house uses. Outdoor use is relatively poorly known	iSDP model and associated database would capture available data and be updated with time.
4	How water is used on a sectoral basis – single + multiple residential; industrial; commercial	Targeting of educational, subsidy and regulatory schemes; tariff impact and equity assessments	Billing system gives the breakdown but is not analysed thoroughly	Trends in water use of residential types and sectoral use can be tracked, predicted and reported
5	Setting realistic targets for future per capita use	To avoid setting unrealistically high or low targets	Past restricted and unrestricted consumption levels are used as a guide to set targets	Targets are set based on a better knowledge of trends affecting use and what is required to obtain the best economic, environmental and social outcomes
6	Depiction of options to aid decision making and communications	Improved understanding of why particular decisions have been chosen	“Security through Diversity” provides a suite of options but it is hard to discern their relative importance	Graphical comparison of options is a clear communication tool and IRP process enables transparent decision making process.
7	Impacts of source and demand management decisions on wastewater flows, energy use, greenhouse gas emissions and self supply options	Avoid undesirable side effects (e.g. bore overuse). Synergy between benefits (e.g. low flow showerheads save both water and energy)	Greenhouse gas implications made for large investments (e.g. desalination, SW Yarragadee).	Model can be used to depict impacts other than water quantity thereby clearly showing the multiple benefits/impacts of the options developed

**APPENDIX 2A: DEMAND MANAGEMENT OPTIONS FOR THE ISDP MODEL BASED  
MAINLY ON OPTIONS IN TURNER *ET AL.* 2005C. NOVEMBER WORKSHOP**

<b>Option</b>	<b>Option Name</b>	<b>Option Description</b>	<b>Priority and Comments</b>
<b>1</b>	General Retrofit	Similar to the program in Sydney. Retrofit: <ul style="list-style-type: none"> <li>• Flow control valve</li> <li>• Shower heads</li> <li>• Fixing visible leaks</li> <li>• Identified hidden leaks</li> </ul>	<ul style="list-style-type: none"> <li>• Need to know how much it costs and the likely savings given that a variation on the Sydney option is being considered (no cistern displacement device)</li> <li>• High priority for input to model</li> </ul>
<b>2a</b>	General Retrofit (include toilet cistern)	As above, include retrofitting toilet cistern from single flush to dual flush.	<ul style="list-style-type: none"> <li>• Will consider retrofitting to 9/4.5 rather than 6/3 litres due to issues with single flush pan design</li> <li>• High priority for input to model</li> </ul>
<b>2b</b>	General Retrofit (include toilet)	Same as Option 1, include retrofitting of 4.5/3 dual flush toilet (cistern and bowl).	<ul style="list-style-type: none"> <li>• Will consider 4.5/3 litres dual flush rather than 6/3</li> <li>• High Priority for input to model</li> </ul>
<b>3a</b>	Garden Retrofit (Waterwise garden)	Changing the lawn area to Waterwise garden – rebate from the Corporation. Issues to consider: <ul style="list-style-type: none"> <li>• How much incentive is required for people to pull out their lawn?</li> <li>• How do we ensure that people applying for garden retrofit rebate actually carries out the work?</li> </ul>	<ul style="list-style-type: none"> <li>• Medium priority for input to the model</li> </ul>
<b>3b</b>	Garden Retrofit (Paving)	Changing the lawn to pavement. Similar issues to consider as above.	<ul style="list-style-type: none"> <li>• Medium priority for input to the model</li> </ul>
<b>3c</b>	Efficient irrigation	<ul style="list-style-type: none"> <li>• Irrigation tune up</li> </ul>	<ul style="list-style-type: none"> <li>• 80 % of the irrigation systems inspected were poorly setup according to a study of high water users (Total Eden)</li> <li>• High priority for input to model</li> <li>• Might need to include a component for on-going check ups</li> <li>• WSAA is developing a best practice garden and irrigation guide</li> </ul>
<b>4</b>	Individual Marketing (Social Data)	Rolling out Social Data to all of Perth metro area. Targeting individual household.	<ul style="list-style-type: none"> <li>• Existing option already implemented – Andrea Turner has modeled this option but the assumptions behind the calculations need to be confirmed – will run for another 6 to 8 months (from Nov 2005)</li> <li>• High priority for input to model</li> </ul>
<b>5</b>	Rebate – Bore		<ul style="list-style-type: none"> <li>• High Priority for input to model</li> </ul>
<b>6</b>	Rebate – Washing Machine		<ul style="list-style-type: none"> <li>• High Priority for input to model</li> </ul>
<b>7</b>	Rebate – Shower head		<ul style="list-style-type: none"> <li>• High Priority for input to model</li> </ul>
<b>8</b>	Rebate – Grey water recycling		<ul style="list-style-type: none"> <li>• Low Priority for input to model</li> </ul>

<b>Option</b>	<b>Option Name</b>	<b>Option Description</b>	<b>Priority and Comments</b>
<b>9</b>	Rebate – Rainwater tank	Rainwater tank usage for toilet flushing.	<ul style="list-style-type: none"> <li>• Needs some more data to quantify the savings and cost</li> <li>• High priority for input to model to demonstrate limitations of this option in comparison to other options for Perth</li> </ul>
<b>10</b>	Rebate – Pool blanket		<ul style="list-style-type: none"> <li>• Medium priority for input to model</li> <li>• Need to assess if we creating a micro-biological risk – apparently some data exists on this issue</li> </ul>
<b>11</b>	Rebate – Soil moisture sensor		<ul style="list-style-type: none"> <li>• Low priority for input to model</li> </ul>
<b>12</b>	Leak detection		<ul style="list-style-type: none"> <li>• Network loss detection</li> <li>• This option needs to be investigated – high priority for input to model</li> <li>• Rod is looking after this data – also old data might be available</li> </ul>
<b>13</b>	Pressure management		<ul style="list-style-type: none"> <li>• This option needs to be investigated – high priority for input to model</li> <li>• Rod is looking after this data with Evan</li> </ul>
<b>14</b>	Mandatory Waterwise Land Development Condition		<ul style="list-style-type: none"> <li>• METRIX (extension of BASIX)</li> <li>• Premiers Water Foundation data should be available</li> <li>• Medium priority for input to model</li> </ul>
<b>15</b>	Non-residential program		<ul style="list-style-type: none"> <li>• High priority for input to model</li> <li>• Analysis to be undertaken of top water using non-residential customers</li> <li>• Use information from Sydney Water’s EDC Business Program</li> </ul>
<b>16</b>	3 day a week restrictions		<ul style="list-style-type: none"> <li>• Ease restrictions but not remove entirely</li> <li>• Will there be any change to policing costs?</li> <li>• Medium priority for input to model</li> </ul>
<b>17</b>	Water saving education campaign		<ul style="list-style-type: none"> <li>• Some work done by university (UWA). Donna has access to this research</li> <li>• Low priority for input to model</li> </ul>

**APPENDIX 2B: ADDITIONAL DEMAND AND SUPPLY OPTIONS FOR THE ISDP –  
NOVEMBER WORKSHOP**

<b>Option</b>	<b>Option Name</b>	<b>Option Description</b>	<b>Priority and Comments</b>
<b>A</b>	Tariff rebalance – drinking water	Impact on demand, and levelised costs, of introducing a tariff regime which reduces fixed charges as a percentage of water bills	<ul style="list-style-type: none"> <li>• Use Donna’s work on pricing tariff – current estimates suggest 23 GL per annum saving</li> <li>• High priority for input to model</li> </ul>
<b>B</b>	Sewerage pricing reform – pay for service	Changing the current property rating system to one based more on the wastewater services provided, providing more incentive to reduce in-house water use.	<ul style="list-style-type: none"> <li>• Low priority for input to model</li> </ul>
<b>C</b>	BASIX for greenfield developments and major renovations	Same as 14 in the Water Corp. list?	<ul style="list-style-type: none"> <li>• Medium priority for input to model</li> </ul>
<b>4D</b>	Impact of demographic and other changes above and beyond the base case (sensitivity analyses)	<ul style="list-style-type: none"> <li>○ cluster dwellings</li> <li>○ block size</li> <li>○ people per household</li> <li>○ house sizes</li> <li>○ urban growth boundary</li> <li>○ urban growth in areas not suitable for domestic bores</li> </ul>	<ul style="list-style-type: none"> <li>• Block sizes decreasing;</li> <li>• More higher density dwellings;</li> <li>• House size increasing</li> <li>• Medium priority for input to model</li> </ul>
<b>E</b>	Loss of domestic bores in selected areas	Impact on scheme demand and ability to supply <ul style="list-style-type: none"> <li>○ river suburbs</li> <li>○ coastal suburbs</li> <li>○ wellfield suburbs (Whitfords, Quinns,)</li> <li>○ wetlands, ASS risk areas</li> </ul>	<ul style="list-style-type: none"> <li>• High priority option that would add to demand rather than reduce demand</li> </ul>
<b>F</b>	De-rating of current water sources	<ul style="list-style-type: none"> <li>○ Hills catchments (2005 runoff &lt; 8 year average despite above average rainfall)</li> <li>○ Coastal borefields (SWI, horticultural / urban / ASS pollution)</li> </ul>	<ul style="list-style-type: none"> <li>• High priority for inclusion in model</li> <li>• Assessment of groundwater component more difficult</li> </ul>
<b>G</b>	Managed Aquifer Recharge	<ul style="list-style-type: none"> <li>○ Neerabup Industrial area</li> <li>○ Mosman Peninsula</li> <li>○ Mandurah - Peel</li> </ul>	<ul style="list-style-type: none"> <li>• Should add this – need to be careful that there will be a benefit in terms of reduction in scheme water requirements</li> <li>• Medium priority for input to model</li> </ul>
<b>H</b>	Pine thinning and /or removal near wellfields	<ul style="list-style-type: none"> <li>○ Mirrabooka (north of Gnangara Road)</li> <li>○ Lexia</li> <li>○ Wanneroo</li> <li>○ Pinjar</li> </ul>	<ul style="list-style-type: none"> <li>• Should add this – high priority</li> </ul>
<b>I</b>	Native vegetation burning regimes	<ul style="list-style-type: none"> <li>○ 1:7 years base case</li> <li>○ 1:4 years enhanced burning</li> <li>○ Defence Department land burning</li> </ul>	<ul style="list-style-type: none"> <li>• Should add this – high priority</li> </ul>
<b>J</b>	Urbanisation	<ul style="list-style-type: none"> <li>○ East Wanneroo horticultural land</li> <li>○ North of Gnangara Road</li> </ul>	<ul style="list-style-type: none"> <li>• Low priority for input to model</li> </ul>

<b>Option</b>	<b>Option Name</b>	<b>Option Description</b>	<b>Priority and Comments</b>
<b>K</b>	Non-potable reticulated supplies (third pipe schemes)	<ul style="list-style-type: none"> <li>○ Community bores (Ranford Road, Brighton)</li> <li>○ Treated wastewater (Mandurah)</li> </ul>	<ul style="list-style-type: none"> <li>● Low priority for input to model</li> </ul>
<b>L</b>	WELS and minimum performance standards		<ul style="list-style-type: none"> <li>● Labelling needs to be added using modeling approach adopted for other cities – but low priority</li> <li>● Minimum performance standards probably a higher priority – and easier to model</li> </ul>
<b>M</b>	Kimberley supply options	<ul style="list-style-type: none"> <li>○ Canal</li> <li>○ Piped systems</li> <li>○ Ocean transport</li> </ul>	<ul style="list-style-type: none"> <li>● Template to be developed so that consultants can provide the information required for assessment by the iSDP</li> </ul>