Centralised Potable Water ‘Business As Usual’ option for South East Water

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1. Background to project

Consistent with Oakley Greenwood's (OGW) proposal, the primary purpose of this project was to develop a "coarse assessment" as to the business as usual (BAU) costs associated with the delivery of a centralised potable water solution to South East Water's (SEW) geographic region.

OGW understands that SEW will primarily use this assessment to underpin its economic evaluation of its Integrated Water Management (IWM) Strategy. The IWM Strategy includes costs and volumes associated with the delivery of a number of different 'fit for purpose' water supply options across a number of discrete regions within SEW. These 'fit for purpose' supplies include, for example:

- Water efficiency;
- Infiltration systems steetscapes;
- Infiltration systems residential/industrial;
- Groundwater extraction and recycling;
- Rainwater tanks;
- Decentralised stormwater harvesting;
- Decentralised recycling; and
- Centralised recycling.

OGW observes that in the context of an IWM strategy that may displace a centralised potable water BAU case, two broad types of cost reductions to the potable water supply system could occur:

- A reduction in the overall amount of potable water that is used over the 50 year evaluation period, which leads to a reduction in the overall cost of procuring bulk water; and
- A reduction in the infrastructure needed to transfer bulk water from these bulk sources to the end customer being serviced by the IWM solution.

OGW further observes that both of these cost reductions may not automatically stem from an IWM solution that displaces a centralised potable water source. In particular, the latter (reduction in network infrastructure costs) will be dependent on the engineering solution employed by SEW, and more specifically, whether that IWM solution allows for a reduction in upstream potable water infrastructure. An example of this would be where the engineering solution provides for potable water to act as a back-up, in case there is an intermittent/longer term interruption to the IWM solution. SEW will need to ensure that it has regard for this issue when conducting its economic evaluation.

2. Overview of this Report

In its Proposal, OGW stated that it would produce a short report that outlines the modelling approach, key assumptions (including their source), key outputs of the model, and the outcomes of the sensitivity analysis undertaken. Consistent with its Proposal, OGW has undertaken the following sensitivity analysis:

- WACC;
- Desalinisation SRMC costs;
- LRMC of future augmentation options;
- Demand forecasts;

- Opportunity cost of raw water input; and
- Potable water network LRMC.

The remainder of this report outlines this information, along with certain caveats that should be placed on the outputs of this report, and its findings.

3. Caveats

OGW reaffirms that it was engaged by SEW to develop a ‘course’ BAU scenario with regards to the provision of a centralised potable water solution. Therefore, the work undertaken by OGW has not included:

- Derivation of BAU costs associated with the displacement of non-centralised potable water sources, for example, groundwater or recycled water;
- Derivation of BAU costs for downstream infrastructure or externalities that may be deferred or mitigated due to the adoption of one or more of South East Water’s proposed IWM options – for example:
    - Sewerage infrastructure, as a result of the adoption of centralised or decentralised recycled water projects; and
    - Stormwater infrastructure, as a result of the wide scale adoption of decentralised stormwater harvesting.

Further, given the constrained scope of work, OGW cautions that SEW will need to give careful consideration as to the construction of the final economic evaluation underpinning the IWM strategy, to ensure that:

- Only a like-for-like comparison is made between the BAU options and other options. For example:
    - Only IWM options that displace centralised potable water solutions are directly compared to the outputs contained in this report; and
    - If an IWM strategy displaces a centralised potable water solution, but the engineering solution does not allow for a reduction in the sizing or timing of the water network used to supply that customer’s (or group of customers) potable water supply, then this (absence of any network cost reduction) should be factored into the analysis by either removing the cost of the SEW network LRMC from the BAU base case, or including that amount in the costs of the IWM strategy;
- The IWM options that are compared against this base case have low (~zero) probability of restrictions, or alternatively, if they don’t, the economic cost of those restrictions (reduced security) should be costed against the IWM option in question; and
- There is no double counting of benefits or costs of certain options (e.g. it is assumed that the SRMC of the desalinisation plant in the BAU case includes the costs of offsetting its carbon emissions, therefore, the economic evaluation of the IWM options must be cognisant of this when determining the extent to which IWM options provide a net benefit with regards to greenhouse gas emissions relative to the BAU case).

4. Brief overview of Methodology

OGW constructed a BAU model that effectively has two core components:

1. The cost of the wholesale component of the water supply value chain (i.e. economic cost of procuring surface water; cost of procuring desalinated water; economic cost of restrictions where there is an imbalance between supply and demand; and the cost of augmenting the water supply system); and
2. The network costs of delivering potable water from that centralised potable water system to SEW's customers.

To do this, OGW firstly constructed a stochastic model of Melbourne's annual water supply/demand balance, in order to model the wholesale component of water. The model provided for a large number of simulations (1000 to be exact). For each simulation, OGW derived the:

- Amount of surface water used to meet demand in each year;
- Amount of desalinated water used to meet demand in each year;
- Level of restrictions that would have to be imposed in a year to balance supply with demand in that simulation[1];
- Level of storages at the end of each year, having regard to, amongst other things:
  - The amount of surface water that is carried over in storage, after meeting demand in that year, and given the assumed inflow in that year for that simulation;
  - The amount of desalinated water that is dispatched, but not used to meet demand in that year for that simulation; and
  - The timing and capacity of new potable water resources that is required in each simulation.

For completeness, it is noted that the model is an annual model, and is for a 50 year evaluation period.

There are three key steps in the model development:

1. Determine the water inflows assumed for each simulation;
2. Determine the dispatch rules:
   a) What water sources will be dispatched in what order;
   b) How will restrictions be dispatched in the model; and
   c) When will new water sources be dispatched in the model.
3. What is the cost of each of these specific sources of water (including restrictions).

Each is discussed in more detail below.

4.1. Determination of Water Inflows

OGW received 100 years of historical water inflows directly from SEW. After consultation with SEW, it was agreed that the inflows only over the last 13 years would be used as the basis for deriving the distribution of water inflows that would be assumed in the model.

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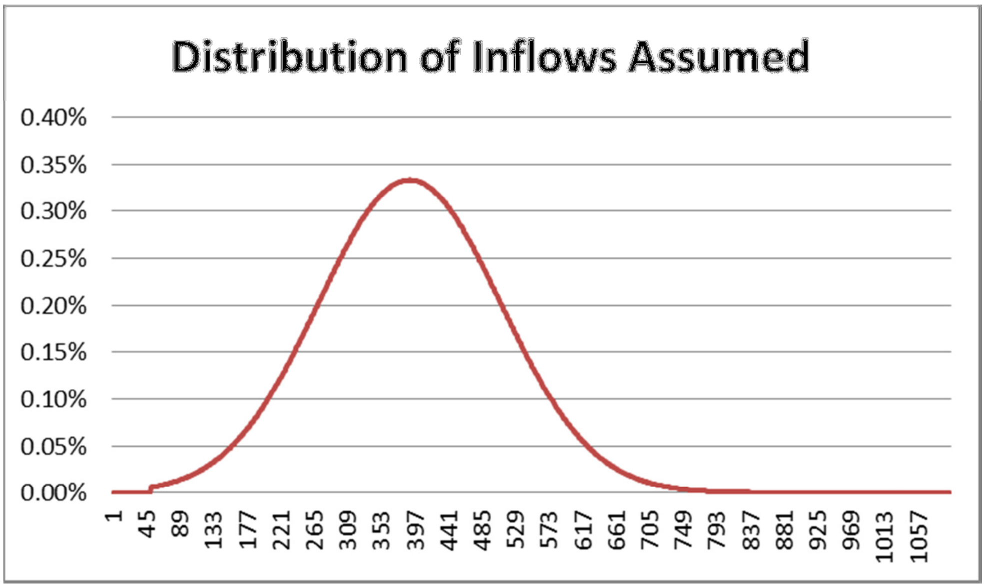
[1] It is noted that restrictions are assumed to be in place for a full 12 months, if enacted.

OGW used a distribution fitting program to test the properties of the data (both the 100 years, and the 13 year sub-sample) provided by SEW. In particular, this distribution fitting program tested the "goodness of fit" of the data against numerous common probability distribution functions. Having regard to a number of tests, a normal distribution was chosen, as it was one of only 3 distributions (out of 61) that recorded results in the top 10 for three common statistical tests.

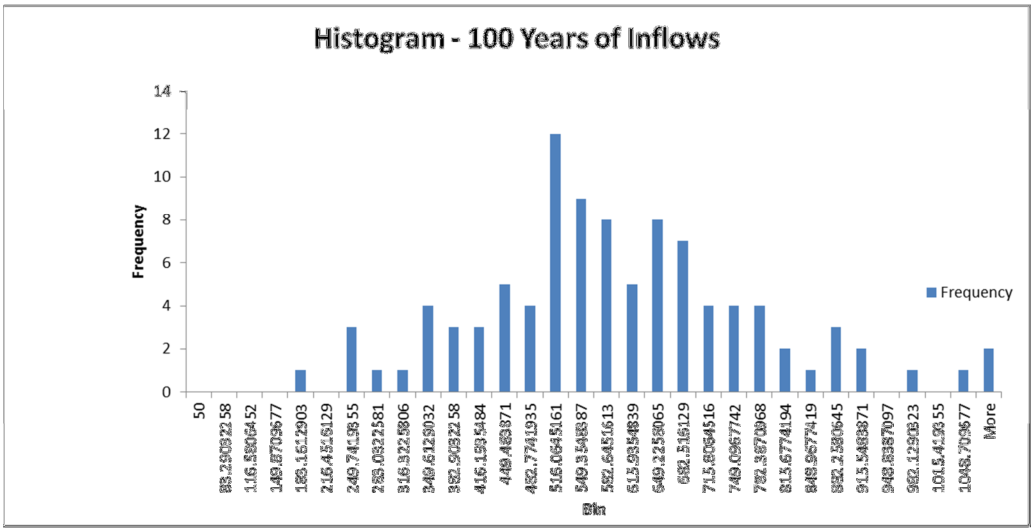
Subsequent to this, OGW estimated a probability density function for water inflows, based on adopting a normal distribution with a mean and standard deviation consistent with that derived from 13 year inflow sample provided by SEW (389GL and 119GL respectively). It is noted that OGW made some slight adjustments to that distribution to reflect known characteristics of water inflows (i.e., there can't be negative inflows in a year; there is no reasonable chance that inflows will be less than 50GL in any one year). The distribution fitted in the model run underpinning the results contained in this report is diagrammatically represented below.

Figure 1: Probability Distribution of water inflows



As a comparison, it is noted that the shape of the probability distribution is not dissimilar to that which would have been derived had the 100 years of data been used, although obviously it has a lower mean.

Figure 2: Histrogram of 100 years of Inflows

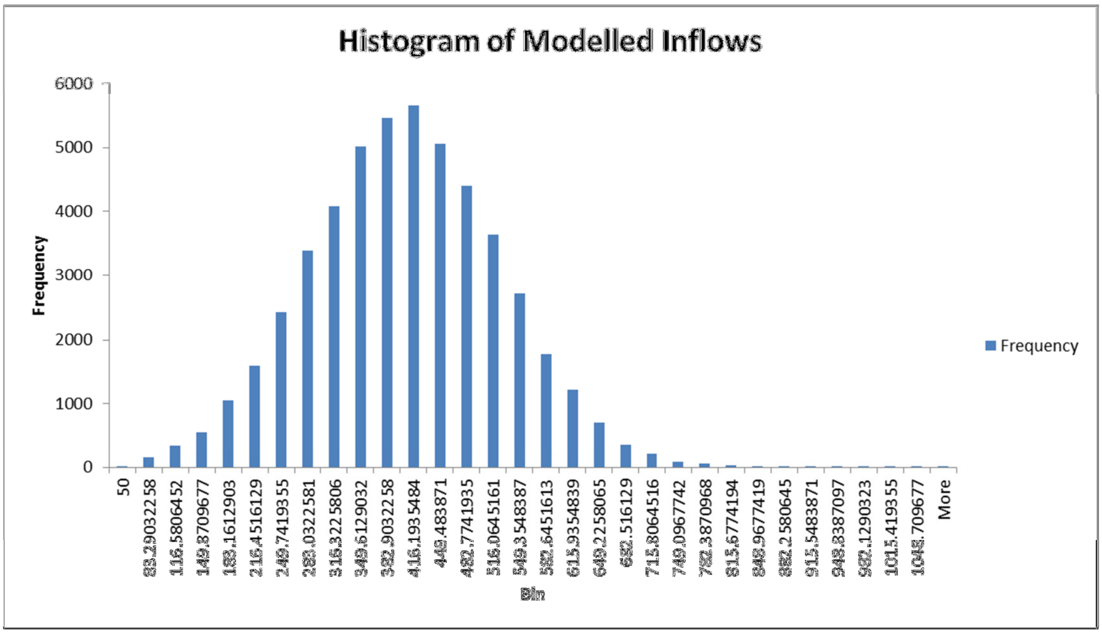


The key general features from the probability density function that OGW used in its model are that:

- There is zero probability placed on an inflow falling within the range of zero GL per annum and 50GL per annum. OGW considers this assumption reasonable and non-controversial, particularly given that from the histogram representing 100 years of data above, it can be seen that the lowest ever inflow recorded was 163GL, and the next lowest was 228GL;
- The most frequent data point (the 'mode') is 389, which is consistent with the average of the last 13 years; and
- There is a positive tail (to the right of the 'mode') representing the fact that there is a small probability (0.133%) that quite large inflows can occur (~800-1000GL) per annum. In saying this, it is noted that over the last 100 years, there have been 3 yearly inflows exceeding 1000GL, and a further 8 exceeding 800GL. Again, given the very low probability ascribed to this possible outcome in the model run (an inflow being greater than 800GL), OGW considers this both reasonable, and conservative.

OGW's probability density function was used to generate 1000 'random' inflow parameters for each of 50 variables (representing 50 years), using a random number generator (in excel). Therefore, in total, 50000 random numbers, representing 50000 water inflows, were derived. This leads to the following histogram of modelled inflows for the 1000 simulations that OGW ran in the model.

Figure 3: Histogram of Modelled Inflows



As can be seen from the above histogram, the most frequent inflow in the model is between 382GL and 416GL. This is consistent with the mean over the last 13 years, and it is noted, is materially lower than the mean of the full 100 year sample. Further, only 73 inflows data points out of the 50000 are assumed to exceed 800GL per annum. As inferred previously, this is considered very conservative, given historical flows (over the full 100 year sample).

Finally, it should be noted that as a simplification, OGW has assumed that each year is independent of earlier years. A useful next step would be to include the effects of serial correlation that are present in water inflows. In practice, this would have an effect on the outcomes, as the inflows would 'track' from one year to the next, and the difference between scenarios would be expected to increase, and reliability of supply would decrease, possibly resulting in some change in the augmentation timetable. OGW would be able to enhance the modelling of the water system if required by SEW as part of any future stages of work.

4.2. Dispatch Rules

Once water inflows have been established, there is a need to define, via the use of algorithims, how water is dispatched in the model. This allows the volume of water used to be derived. The two key drivers of this are that:

- Supply and demand must always match in each year, and supply can be provided by the following sources:
  - Surface water;
  - Desalinated water;
  - Restrictions;
  - New sources of water (augmentations).
- Certain minimum storage levels are attempted to be met in each year. This is discussed in further detail below.

To do this, the first aspect to note is that OGW has pre-defined the dispatch order in the model as:

- Surface water, then

- Desalinated water, then
- Restrictions, which are dispatched where, even after the maximum use of all other sources of water (surface water, desalinated, other augmentations), storage levels are still below the thresholds set out in drought response plan for when restrictions must be enacted[2].

Following on from the above, the model provides for new augmentations to be brought on-line 2 years after certain circumstances occur, namely:

- When stage 3 restrictions have been in place for 3 years; or
- When stage 4 restrictions have been enacted in any year.

These rules broadly reflect OGWs understanding of the rules that in theory, underpin Melbourne Water's management of the existing wholesale supply system.

Finally, as noted above, certain minimum storage levels are attempted to be met in each year. More specifically, the model maximises the use of existing water resources available in that simulation at that point in time (e.g., even new augmentations that have already been 'constructed' in that simulation) where storage levels will be below the minimum level for that year. Put another way, the model algorithms do not require that a new water source be built to meet those minimum storage levels, rather, it requires that all existing sources available for that simulation in that year will be used to their fullest in an attempt to meet the minimum storages applicable to that year. The minimum storage levels that OGW has included in the model are the greater of:

- 65% of total storage capacity (until the end of 2014 as per the Statement of Obligations); and
- 95% security of supply.

The former is based on verbal communications from SEW to OGW that this is a requirement set out in the Statement of Obligations. The latter is based on our understanding of the rules that are in theory, currently meant to apply. Further to the latter, the 95% security of supply level has been established for each year by assessing the starting storage level that must be in place in order to ensure that there is a 95% probability that at the end of that year, storage levels are such that they still exceed the threshold that would lead to stage one restrictions coming in. This calculation uses the same probability distribution as utilised to generate the random storage inflows in the model, in conjunction with the demand forecast for a particular year.

Finally, it is noted that whilst OGW has used these simplified dispatch rules as it considers that they are a reasonable representation of the rules actually applied in the industry, further analysis could be undertaken to strengthen the economics underpinning these rules.

4.3. Costs, Demands and other Key Assumptions

The key costs, and their source, are outlined in the table below.

Table 1: Key cost assumptions

State	Description	Source
Opportunity Cost of	$0.185	The average price ($2140/ML) in 2009-10 for high-reliability water shares in Northern Victoria[3], with

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[2] Drought Response Plan for South East Water – approved by the Minister on the 30/8/2010

[3] National Water Commission - Australian Water Markets Report 2009-2010 – page 96

Raw Water Input		high reliability assumed to be 70%[4]. It is noted that this is very similar to the average price recorded in the 2008/09 year ($2165/ML), and only slightly lower than the price recorded in the Southern Region in 2009/10.
Operating costs of centralised surface water infrastructure	$0.1944	Melbourne Water's bulk headworks price in 2008, inflated to 2012. The 2008 price was chosen as it represents a LRMC prior to the desalinisation plant and north south pipeline being envisaged. To do otherwise would risk double counting desalinisation costs,
SRMC of Wonthaggi Desalinisation Plant	• Up to 50GL - $0.50/KL • 50GL to 75GL - $0.60/KL • 75GL - 100GL - $0.80/KL • 100GL - 125GL - $0.92/KL • 125GL - 150GL - $1.04/KL	Letter from PricewaterhouseCoopers to the Department of Sustainability and Environment titled: "Victorian Desalination Project Service Payments - Full project term". This was provided to OGW by SEW.
LRMC of MW's Bulk Water Transfer Network	• 2012 = $0.1751/KL • 2013 = $0,2677/KL • 2014 = $0.2762/KL • 2015 = $0.2851/KL • 2016 = $0.2942/KL • >=2017 = $0.3036/KL	Current bulk transfer cost charged by MW to SEW, as provided by SEW.
LRMC of SEW's Water Distribution Network	$0.30	Estimated based on information provided by Ian Johnson. There is significant uncertainty around this figure, therefore, this is specifically tested via sensitivity analysis.
Cost of Restrictions	• Stage 1 - $0.15/KL • Stage 2 - $0.58/KL • Stage 3 - $1.35/KL • Stage 4 - $1.75/KL	See further information below
Cost of new augmentations	$2.70/KL	See further information below
Demand Forecasts	• 2012 = 367GL • 2013 = 377GL • 2014 = 396GL • 2015 = 405GL • 2016 = 408GL • 2017 = 408GL • 2018 = 408GL • 1.5% per annum beyond 2018	Inputs to 2018 provided by South East Water. The 1.5% is an OGW assumption, which is based on the outcomes for customer number growth from the last Water Plan Final Decision. Customer number growth has been chosen as all existing forecasts of growth in water consumption are significantly influenced by restrictions assumptions.

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[4] Despite these in theory having a 95% security of supply (See http://waterregister.vic.gov.au/Public/Glossary.aspx), OGW considers it conservative to assume a lower security of 70%, consistent with the fact that it has effectively adopted a lower security of supply for the Metropolitan Melbourne system via the use of only 13 years of historical data, as opposed to the full 100 years of data.

Restriction Rules - Threshold / Percentage Reductions	• Early Warning 1182GL / 0% • VR 1021GL / 0% • Stage 1 940GL / 2.5% • Stage 2 800GL / 8% • Stage 3 660GL / 15% • Stage 4 520GL / 17.5%	Drought Response Plan for South East Water - approved by the Minister on the 30/8/2010 - Schedule 1 and Schedule 3 respectively
Starting volumes	958 GL	Melbourne Water website (18 April)
WACC	5.1%	Set such that it is consistent with figure used by GHD for IWM strategy (as per presentation titled: "Integrated Water Management in the South East Region - Project Update - 25 February 2011" - Slide 15, which was provided by Keith Johnson

In relation to the cost of restrictions, OGW has estimated the loss in consumer surplus experienced by water consumers as a result of water companies imposing restrictions to balance supply and demand. In particular, OGW notes that by combining estimates of the elasticity of demand for water, the current marginal price of water, and the percentage reductions estimates from the Drought Response Plan, allows the loss in consumer surplus to be estimated, which represents the economic loss associated with restricting levels of water demand below equilibrium levels. OGW has made the following assumptions to complete this calculation:

- Stage 1:
  - Elasticity of Demand = -0.15
  - Impact of restrictions = 2.50%
- Stage 2
  - Elasticity of Demand = -0.125
  - Impact of restrictions = 8.00%
- Stage 3
  - Elasticity of Demand = -0.10
  - Impact of restrictions = 15.00%
- Stage 4
  - Elasticity of Demand = -0.09
  - Impact of restrictions = 17.50%

It is noted that the average price of water assumed when undertaking this calculation was \$1.80/KL, which is consistent with the price for non-residential water and block 2 water (for residential customers) in SEW's area. OGW considers that the elasticity of demand estimates are within the range quoted in a number of sources, including:

- A number of studies cited by the Productivity Commission in their recent report into the urban water industry[5], including:
  - Graham and Scott, who estimated the price elasticity of residential water demand in the ACT region to be in the range of -0.15 to -0.39;

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[5] "Australia's Urban Water Sector" - Productivity Commission Draft Report - page 186

  - Abrams et al, who estimated a short-run price elasticity of demand of -0.09 at a nominal price of $2.00 per kL, and a long-run elasticity of -0.18.
  - Warner, who estimated a nominal price elasticity of -0.127; and
  - Grafton and Kompas estimated a nominal short-run price elasticity for Sydney of -0.352, and real short-run elasticity of -0.418.
- Information from a previous South East Water Water Plan (in 2005), which quotes the use of “*elasticity ratios of 0 for first block usage, -0.1 for 2nd block usage and -0.15 for 3rd block usage*” based on a KPMG report undertaken on behalf of the water industry at the time, which, according to SEW, estimated that “*over the range of bill increases (-0.40% to +160%), the demand for water in South East Water’s area is less elastic than for Melbourne, with elasticity varying between -0.068 for indoors and -0.151 for outdoors, with the average being -0.091*”[6].

Further, the slightly reducing elasticity of demand applied by OGW to each stage of restrictions reflects that fact that the more stringent the restriction that is applied, the less discretionary is the usage that is being restricted, which will in turn result in a greater proportion of affected demand exhibiting a lower elasticity of demand.

Overall, these assumptions lead to the following outcomes:

- The overall cost of Stage 3 restrictions is $74.4m, or $744m over 10 years. This is well within the range quoted by the Productivity Commission in their recent report into Australia’s Urban Water Sector: “*The economic modelling conducted by the Commission for this inquiry estimates that the equivalent of level 3a restrictions in Melbourne would cost that city between $400 million and $1.5 billion over a 10 year period*[7]*”;* and
- The incremental benefit to the community is estimated by OGW to be around $57m per annum from moving from Stage 3 restrictions back to Stage 2 restrictions. When divided by the estimated number of customers in metropolitan Melbourne (~1.28m[8]), this represents a benefit of around $44.80 per customer. This is consistent with other studies, including a report undertaken by URD for the Smart Water Fund into the “The Impact of Water Restrictions on Melbourne”, which estimated the “*mean WTP to go back to Stage 2 of water restrictions is $233 per household over 5 years or around $47 per year. When this estimate is extended to the whole population of 1,283,300 households, the overall benefit for the Melbourne community amount to an estimated $299 million (for a 5 years period)*[9]*.”*

Notwithstanding the above, OGW observes that the use of historical percentage reduction assumptions for different restriction levels should, ideally, be updated to account for the numerous material changes that have occurred that will affect the efficacy of these restrictions. These changes include:

- The increase in the marginal price of water since the percentage reductions were first derived. Based on OGW’s calculations, the increase in the marginal price of water is likely to have already led to a rationing in demand for certain water uses, that were otherwise assumed to be rationed by low level water restrictions in the current drought response plan; and

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[6] South East Water - Water Plan - 2005/06 to 2007/08 - page 128

[7] OpCit., page 201 and 202

[8] “The Impact of Water Restrictions on Melbooure” - URS - Prepared for the Smart Water Fund - page 24

[9] Ibid

- The impact of the introduction of permanent water restrictions, which again, may negate the impact that low level water restrictions have on overall demand.

In relation to the cost of new augmentations, OGW notes a number of issues that create significant uncertainty around the development of this particular input parameter, particularly given that OGW's model indicates that even under the worst case inflow scenario, no major augmentation will be required until 2030, with this, on average, occurring in 2047. OGW considers that this time period:

- Is beyond the horizon over which robust cost estimates are generally developed for specific future augmentation projects;
- Further exacerbates the risk that Government policies that influence the scale and scope of this augmentation may change - even more so for this investment than for investments in most other industries. All other things being equal, a change in the Government's position on the use of the North/South pipeline and more broadly, trading water between Northern Victoria and Metropolitan Melbourne, would significantly influence the scope and nature of the assumed next augmentation. Further, a change in the Government's position on the construction of new dams would also likely influence the scale and scope of future augmentations; and
- Magnifies the risk of making long term investments, which could be impacted by changes in inflows caused by climate change.

Having regard to the above, OGW considers it reasonable to assume that for the purposes of undertaking this modelling for SEW, the cost of the 2nd augmentation, and any augmentations following this one, should be assumed to be broadly similar to the LRMC of the Wonthaggi desalinisation plant augmentation. For the first (or next) augmentation, it is OGW's understanding that the Wonthaggi Desalinisation plant has the ability to be modularly upgraded by 50GL[10]. As such, OGW has calculated the long run marginal capital cost of the Wonthaggi Desalinisation plant, and discounted this by 50% - which is a broad estimate - to reflect that the fact that it is a modular upgrade of the existing treatment plant, as opposed to new plant. This has then been combined with the SRMC of the existing Wonthaggi plant, on the assumption that an upgrade would have the same marginal cost, to determine the overall LRMC of the plant.

Given the uncertainty around this input, the impact of changes in these assumptions has been tested as part of the sensitivity analysis.

Finally, it is noted that OGW has assumed that SEW would be liable for a constant availability charge for its contribution to the desalination plant, which would be unaffected by its proportionate use of the plant. However, if SEW were to invest in IWM, then its use of the desalination plant may decrease and it may be charged a lower availability charge for desalination as a result. If this was the outcome, then the BAU cost to SEW would increase over that noted in our Report, although, from an economic perspective, this is irrelevant, given this cost is sunk. OGW would be happy to take this into account and develop additional cost scenarios accordingly if required by SEW, in any future stage of work.

5. Results

The following table summarises the results of the analysis. In interpreting these results, two key things should be considered:

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[10] Based on verbal communications from Keith Johnson and Alan Watts at the original meeting to discuss this project

- The $ / KL are based on the levelised cost approach (NPV in costs / Net present volume discounted at the same rate as the costs); and
- The total $ / KL does not equal the summation of the individual water supply sources, as the latter represent the un-weighted cost of those discrete sources of supply, whereas the former represents the aggregation of each individual source, weighted by their overall contribution to the cost of supply. This means that some sources that have high $ / KL costs, may still have little impact on the overall BAU cost of supply.

Table 2: Results of OGW's Analysis

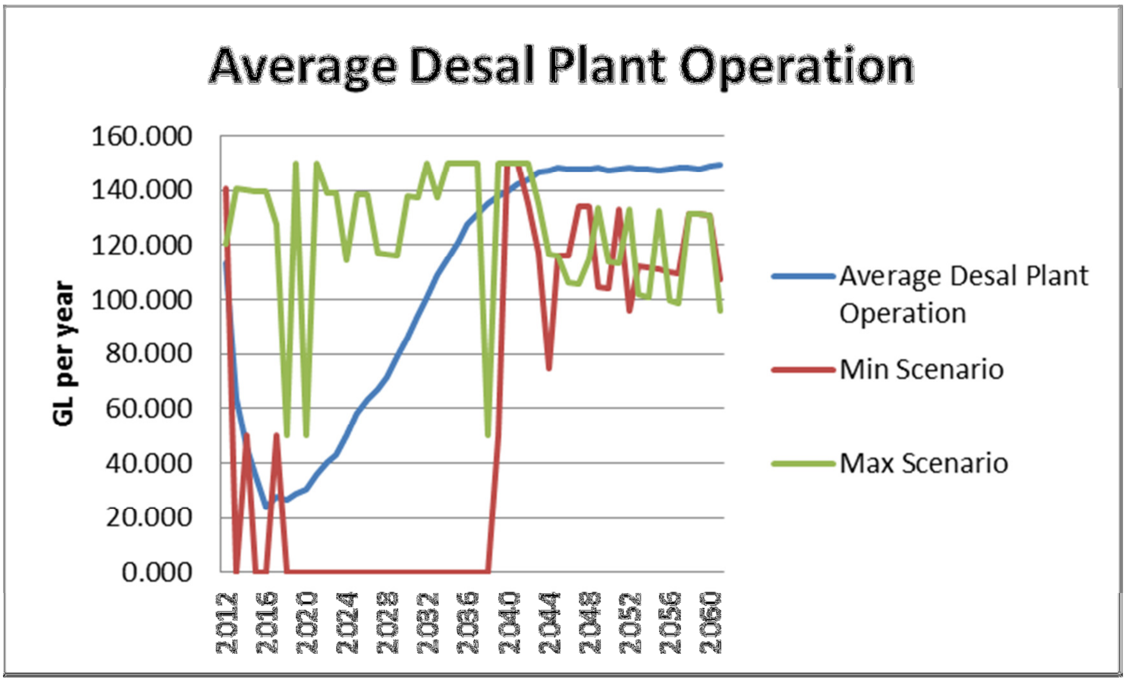
Water Supply Components	$ / KL (Mean, Max, Min)	Volumes Used (GL) (Mean, Max, Min)
Surface Water	• Mean = $0.3794 • Max = $0.3794 • Min = $0.3794	• Mean = 26469 • Max = 27165 • Min = 25169
Desalinated Water	• Mean = $0.69 • Max = $0.73 • Min = $0.63	• Mean = 5305 (capacity factor - 70.7%) • Max = 6254 (capacity factor = 83.4%) • Min = 2912 (capacity factor = 38.8%)
Water Networks	• Mean = $0.53 • Max = $0.59 • Min = $0.48	• Mean = NA • Max = NA • Min =NA
Restrictions	• Mean = $1.03 • Max = $1.68 • Min = $0.40	• Mean = 626 • Max = 1395 • Min = 252
Augmentation	• Mean = $2.27 • Max = $2.39 • Min = $1.63	• Mean = 2546 • Max =3706 • Min = 100
Total	• Mean = $1.18 • Max = $1.32 • Min = $1.07	27555

Key aspects of the results are:

- The average cost (based on a levelised cost approach) is $1.18 / KL. This should be the cornerstone of any BAU analysis undertaken by SEW to assess an IWM option that displaces a centralised potable water solution in the long-term. It is noted that this is at a point in time, and does not have regard for the dynamic aspects that may affect the market for water over time (i.e., the opportunity cost of raw surface water may theoretically change, once the desalination plant is finished);
- Notwithstanding the above, SEW should have regard to range (Maximum and Minimum) BAU costs outlined in the table above, as these reflect a reasonable range within which that BAU cost may sit, depending on the extent to which inflows are above or below average;

- Further, if SEW is seeking to assess the impact of certain, small scale technologies/options, then the cost / KL of individual water supply components could possibly be used under certain circumstances. For example, an alternate option may be proposed such that it displaces one of the higher cost water supply options (restrictions, new augmentations). Such a comparison could possibly be done, subject to:
  - Ensuring that the same security of supply is provided by the alternate option, relative to the one that it displaced (i.e., if an option was displacing desalinated water, that option would need to have a security of supply approaching 100%);
  - The overall volume of the alternate option should not exceed the volume of water provided by the BAU source (e.g., desalinated water), unless of course the BAU cost is weighted to reflect the fact that part of the usage is displacing lower (or higher) cost sources of water (e.g., surface water); and
  - The timing of the augmentation and the volumes delivered by the augmentation should be similar to the base line option. Alternatively, a revised BAU case could be developed, incorporating the proposed new option, to see if the total BAU cost is higher or lower than this original BAU case.
- There is significant volatility in the usage of most sources of supply, outside of surface water. For example, there is significant volatility in the extent to which the desalination plant might be used under various model simulations. The greater the volatility in potential usage of a water source, the greater the risk to investors (including Government owned water authorities) in committing large scale funds to that project, or projects that seek to displace that project (because of the greater volatility in returns). The volatility associated with the use of desalinated water is diagrammatically represented in the figure below.

Figure 4: Desalinated Water Usage – Max, Average and Minimum Case



As can be seen above, on average, the desalinisation plant does not run at or near full capacity until around 2040. However, in some cases, it runs at or near capacity virtually form the start, whereas for others, surface water inflows are at levels that allow storage levels to be above minimum levels for an extended period of time, at the most, up until 2037.

Not surprisingly, when assessing the scenarios, it was seen that the one that had the minimum use of the desalinisation plant had a materially higher suite of water inflows, relative to the average, whilst the maximum desalinisation use scenario had one of the lowest water inflows of the 1000 scenarios. To give this risk further context, the difference in the total cost of running the desalinisation plant between the maximum and minimum scenarios is over $2.6 billion over the 50 year period ($5.1986 billion versus $2.582 billion).

6. Sensitivity Analysis

The results of the sensitivity analysis are outlined in the table below.

Table 3: Sensitivity Analysis

Parameter	Impact on Average Surface Water Cost	Impact on Average Desalinated Water Cost	Impact on Average Cost of Restrictions	Impact on Average Cost of New Augmentations	Impact on Average Cost of New Network	Impact on Total Cost
Business As Usual	$0.3794	$0.69/KL	$1.11/KL	$2.27/KL	$0.53/KL	$1.18/KL
Demand forecasts change to 2% from 1.5%	No Change	$0.70/KL	$1.26/KL	$2.34/KL	$0.55/KL	$1.30/KL
Increase in SRMC of desal. plant by 20%	NA	$0.83/KL	NA	NA	NA	$1.20/KL
Increase in opportunity cost of water from $0.1825/KL to $0.40/KL	$0.5944	NA	NA	NA	NA	$1.39/KL
Increase in SEWL LRMC from $0.30/KL to $0.50/KL	No change	NA	NA	NA	$0.71/KL	$1.39/KL
Increase from $1.63/KL to $2.09/KL in first augmentation option (modular upgrade increases from 50% to 75% of existing desal. LRMCC)	NA	NA	NA	$2.41/KL	NA	$1.19/KL
Decrease from $1.63/KL to $1.164/KL in first augmentation option (modular upgrade decreases from 50% to 25% of existing desal. LRMCC)	NA	NA	NA	$2.13/KL	NA	$1.18/KL
Increase in 2nd augmentation option from $2.54/KL to	NA	NA	NA	$2.59/KL	NA	$1.19/KL

$3.00/KL						
WACC - increase by 1%	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal

In interpreting these results, it is important to reinforce a few points:

- The timing of expenditure is important: Increases in the cost of future augmentations have little effect on the overall average economic cost of supply over the evaluation period, as these costs are all very much skewed towards being incurred towards the end of the period. As mentioned previously, out of 1000 scenarios, the earliest year that an augmentation is required is in 18 years' time (2030), and the average timing is 2047. Notwithstanding this, if SEW's share of the fixed costs of the headworks system reduce, as centralised potable water is replaced, then this represents a financial benefit to SEW, not captured in this economic model;
- The proportion of overall costs is important: Whilst new augmentations contribute around 15% of the total cost of supplying water over the period on average, again, the fact that these are weighted towards the end of the period means they have a substantially lower impact on the overall NPV of costs. For example, increasing the cost of the 2nd and all following augmentations to $3.00/KL, relative to the BAU case of $2.54, leads to the NPV of total costs increasing by only 2.2%; and
- The outcomes are most sensitive to changes in the value of surface water headworks (e.g., opportunity cost of water; changes in the LRMC of the network system) and demand forecasts. The former results from the fact that it has a material impact on cashflows that are at the front end of the model, whilst the latter results from the compounding effect that a small increase in demand can have over the evaluation period (e.g., under a 1.5% growth scenario, demand in year 50 is 775 GL, whereas, this increases to 957 GL when the growth rate increases to 2%).

It is noted that in changing the WACC, there is minimal direct impact on the total cost / kl calculated, or any of the components of that cost per KL for that matter. This is because the WACC is used to discount both the numerator and the denominator of the equation, and the timing of expenses and volumes is broadly similar as the costs in the model generally are based on the SRMC. The only exception is in relation to new augmentations, where the WACC does have an indirect impact on the LRMC calculated for new augmentation options. For example, increasing the WACC by 1% increases the cost of the 2nd augmentation, and all of the following augmentations to $2.84/KL, relative to the BAU case of $2.54. However, as shown in the sensitivity analysis, increases of this magnitude for this source of water have little impact on the overall average cost of supply.

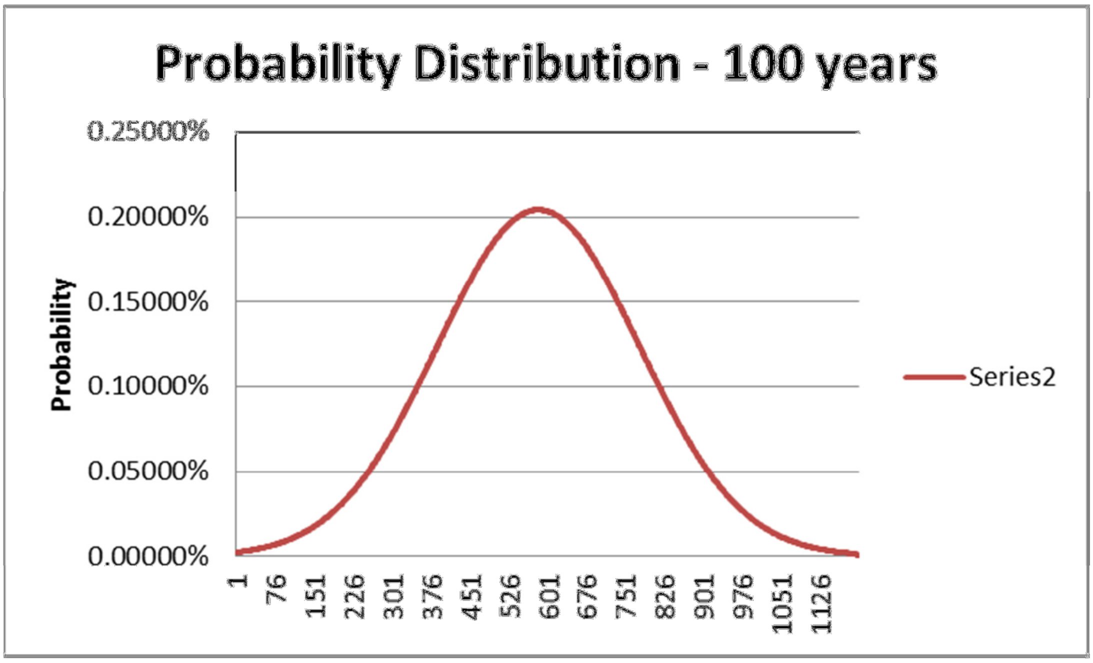
7. Impact of Different Inflow Assumptions

OGW undertook a very simple test to assess the magnitude of the potential impact on the cost of a centralised potable water supply over the evaluation period, if inflows were:

- Assumed to revert back to a 'normal' pattern (i.e., inflows experience over the last 100 years); and
- Continue at levels consistent with 2006-2008.

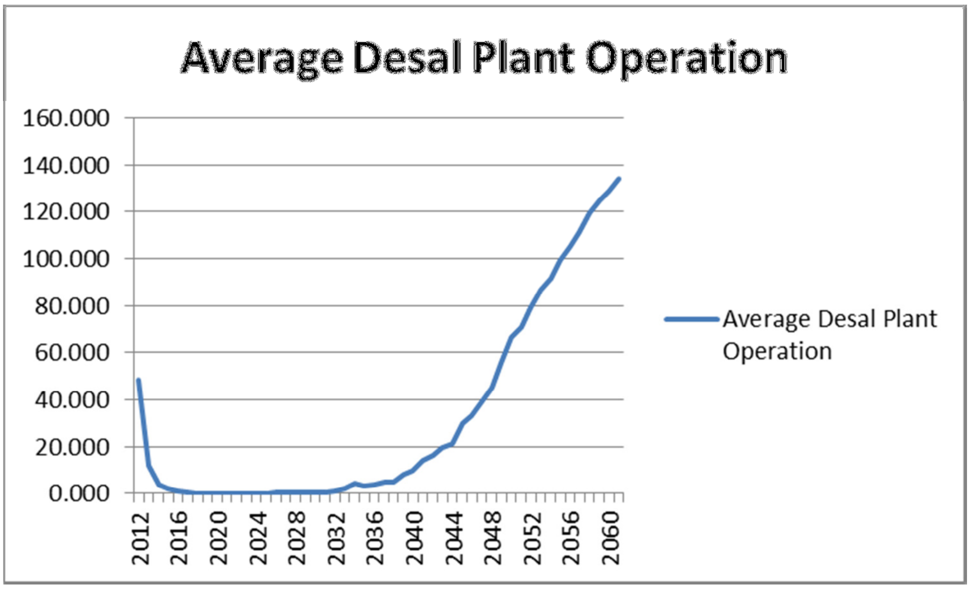
In relation to the first model run, OGW developed a very simple probability distribution reflecting the mean and standard deviation of inflows over the last 100 years, based on a normal distribution.

Figure 5: Probability Distribution using 100 years of inflows



In summary, the average cost of supply if such inflows were assumed to occur would be \$0.99/KL, which is around \$0.20/KL lower than that which is derived if inflows are based on the last 13 years of data. Another interesting aspect of this is that whilst it does reduce the volume of desalinated water required, and therefore the total BAU economic cost, it does not materially impact the average marginal cost of desalinated water (again, because both the numerator and denominator are discounted).

Figure 6: Use of Desalinated Water if 100 year inflows assumed



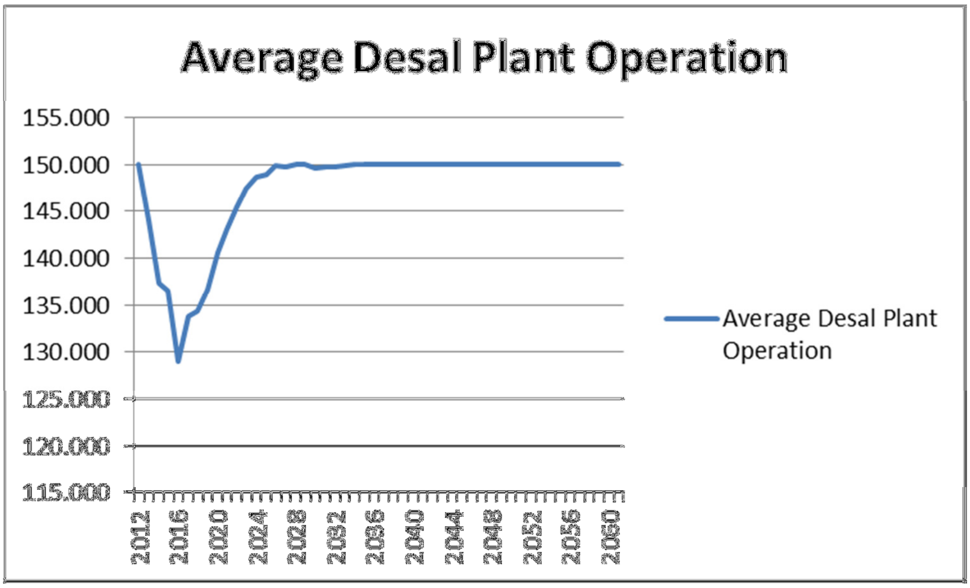
In addition, the volume and average cost of restrictions fall away dramatically, as greater reliance is placed on lower level restrictions than higher level restrictions. Further, new augmentation costs fall away to virtually zero too, as most scenarios (87%) do not require additional capacity to be built.

Notwithstanding the above, OGW cautions SEW in relation to the use of the outputs based on 100 years of flow data, given the clear focus by most stakeholders in the Melbourne water industry on shorter term historical inflows, as opposed to the longer term historical inflows.

In relation to the second model run, OGW generated a set of random water inflows, constrained by a minimum water inflow figure of 163GL, which equates to 2006 water inflows, and a maximum water inflow figure of 372GL, which equates to 2007 water inflows[11]. It is noted that each water inflow value between these two outliers was uniformly distributed (i.e., each value between the two outliers had the same probability of being selected).

In summary, the average cost of supply if such inflows were assumed to occur would be $1.52/KL, which is around $0.34/KL higher than that which is derived if inflows are based on the last 13 years of data. Not surprisingly, the lower surface water inflows in this model run increases the volume of desalinated water required, but it also marginally increases the average cost of desalinated water (to $0.72/KL, from $0.69/KL). This is because the average desalinated water used is above 125GL in all years; therefore, it breaches the highest cost bracket for desalinated water each year. This can be seen from the graph below,

Figure 7: Use of Desalinated Water if 2006-2008 inflows assumed



Other than the slight increase in the average cost of desalinated water, the key drivers of the increase in the average cost under the BAU case is the fact that a much greater reliance is placed on higher cost sources of water over the 50 year horizon. In particular, the average volume of restrictions in this low inflow model run is 1033GL, whereas, under the 13 year inflow model run, the average is 626GL. Further, the average volume of augmentation water utilised under this low inflow model run is 6054GL, whereas it is 2546GL under the 13 year model run. Further to this, the earliest that a new augmentation is brought on is 2022, compared with 2030 in the 13 year inflow model run, and the first augmentation occurs on average in 2031 in this low inflow model run, instead of 2047 in the 13 year inflow model run.

Like for the 100 year model run, OGW cautions SEW in relation to the use of these outputs, as they are based on such a small sample of data, and moreover, the fact that there is a significant disconnect between that data and longer term historical data.

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[11] Note: 2008 water inflows are within this range, therefore, they are implicitly captured by the random water inflow generation process.