2017 Price Reset

Water Security

October 2016

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Project No: 26317 – 2017 Price Reset: Water Security

Rev	Description	Author	Review	Date
0.1	Draft	Euan Lay	Carly Price	August 2016
0.2	Final	Euan Lay Carly Price	David Beckett	20 September 2016
0.3	Final	Euan Lay Carly Price	David Beckett	21 October 2016

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Appendix List

Executive Summary

Following the 2002-2007 drought, the Sydney Desalination Plant (the plant) was constructed to provide the Sydney Metropolitan area with its only source of water not dependent on rainfall. The plant also provides water security for disruption elsewhere in the water supply network and is future proofed to support Sydney's projected population growth. Due to high rainfall levels the plant was placed into water security mode in July 2012 in accordance with the Operating Rules within the *2010 Metropolitan Water Plan*.

Unprecedented for a seawater desalination plant of this size, the plant has been in water security mode for four years. This long term water security mode results in a lack of plant operating data, which creates significant uncertainty upon restart about the plant performance. In addition, a number of the plant assets have long lead times (months), resulting in lengthy timeframes to rectify any issues identified during a restart. This creates a risk that the plant will be unable to meet its water security objective when required.

Demand levels for potable water in the Sydney area have not returned to their pre-drought levels. Ongoing demand reduction means that it is possible that the plant will continue to be in water security mode for extended periods of time, and beyond the original 5 year timeframe envisaged when the plant was built and the operations and maintenance contract was established. Therefore, it is incumbent on the plant owner, Sydney Desalination Plant Pty Ltd (SDP), to prepare for a range of future operating scenarios, and ensure asset management practices are modified to address risks resulting from extended water security mode in the most cost effective manner, in order to promote customers' long-term interests.

[redacted]

[redacted]

[redacted]

[redacted]

Additional drinking water pump

Inherent in the plant design, the drinking water pumping station capacity presents a risk that has the potential to impact on water security during operations.

The plant's drinking water pumping station was constructed by an Alliance between Sydney Water Corporation and other private sector constructors/designers and was designed to a lower availability than the overall plant. Therefore, the drinking water pumping station has a higher probability of failure than the overall plant which can potentially restrict the plant from achieving an average annual water production rate of 250ML/d. As such SDP is seeking to install a third drinking water pump to ensure water security via some redundancy in delivery pump capacity.

A pump with lower capacity than the existing two pumps is proposed as it can be accommodated within the existing building and would provide a cost effective solution. The smaller pump could also be used for low flow operations in the future.

Customer benefits

The investments proposed in this business case have been selected after detailed analysis of options, and are responsible, prudent, and cost efficient responses to the customer risks generated by the plant being placed, over an unprecedented duration, in water security mode. The ability to restart, and continue operating the plant, is essentially an insurance policy providing security of water supply to customers. In the long term interest of customers, maintaining the effectiveness of this policy will avoid the need for a repeat of the costly water restrictions imposed during the last drought.

Table 1 summarises the investment request from SDP in support of future water security.

Table 1 Investment required to support water security

Initiative	Risk 1: Restart	Risk 2: Operating	Investment ($AUD2016, non escalated)
1. [redacted]	✓	✓	[redacted]
2. Additional drinking water pump		✓	**$2.1M** (Capital investment) **$185K/year** (Operating investment)

1 Overview

The Sydney Desalination Plant (the plant) commenced supplying water in January 2010. The project was initiated in response to a deepening drought to provide the Sydney Metropolitan area with a source of water not dependent on rainfall.

Sydney Desalination Plant Pty Ltd (SDP) owns the plant. SDP has a 50 year contract with the NSW Government to provide water to Sydney Water's network. Veolia Water Australia Pty Ltd (Veolia) has a contract with SDP to operate and maintain the plant for 20 years from the commencement date in 2010.

At current capacity, the plant is able to support 15% of the Sydney Metropolitan area's water requirement and has been designed so that capacity can be doubled, future proofing the plant for future population growth. Critical to supporting water security, the plant provides supplementary water during a drought, provides supply to the network when required, and provides for Sydney's forecast population growth.

A series of interrelated influences and events have occurred since the plant was constructed, outlined in Figure 1, including:

- Plant placed in water security mode since July 2012.
- Higher dam levels.
- Low water consumption.

Notwithstanding these changes, SDP's water security obligation remains as important as it was when the plant was first approved.

Figure 1 Unanticipated influences and operating status

1

Plant placed in water security mode
SDP has been in long-term shutdown since July 2012

2

Dam levels are even higher
Rail fall is cyclical in NSW, but it is expected that dam levels will remain high for a number of years.

3

Low water consumption
Water consumption is expected to increase with population growth, but it will be slower than originally anticipated.

4

SDP's water security obligation remains
While it is expected that the plant may not be required for a number of years, customers are paying SDP for water security for the Sydney Metropolitan area.

Water security mode

Due to lower demand and adequate supply, the plant has been in water security mode since July 2012. In water security mode, many systems are shut down and the membranes within the reverse osmosis train are preserved using a preservation fluid. The aim of the preservation process is to minimise the deterioration of the membranes until the plant is restarted.

Given high dam storage levels, and low water demand growth, it is expected that the plant will not be required to respond to drought in the immediate future. This extended shutdown is unprecedented, with no other example of a desalination plant that has been in water security mode for this long, as shown in Table 2.

Table 2 Large municipal desalination plants

Maximum Shutdown Period	**Current Production**			
	Continuous Production (Operating continuously at reduced or full flow for the entire year)	**Periodic** (Full production for >50% of the year, in security or standby for the remainder)	**Standby** (Operated to maintain systems, not used as a significant water source)	**Deep Preservation** (Not in operation or standby)
Never shut down	**SSDP, Perth** *(reduced capacity)* **COWTP,** Carboneras *(62% design capacity)* **Torrevieja, Spain** *(Reduced to 20% production)* **Llobregat, Barcelona** *(Reduced capacity)* **Carlsbad, USA** *(Full operation)*	**ADP, Adelaide** *(Seasonal Standby, 3 months)*	**VDP**, **Dalyston** *(Intermittent testing, current preparing to deliver its first 50GL water order)*	
1-3 Months		**PSDP, Perth** *(Seasonal Standby, 3 months)* **Tampa, USA** *(Seasonal Standby, 3 months)*		
3 months – 5 Years			**GCDP, Gold Coast** *(4 Year shutdown, now operating 2 days per week operation, low flow)*	
>5 Years				**SDP, Sydney** *(Expected to be in shutdown for up to 10 years)*

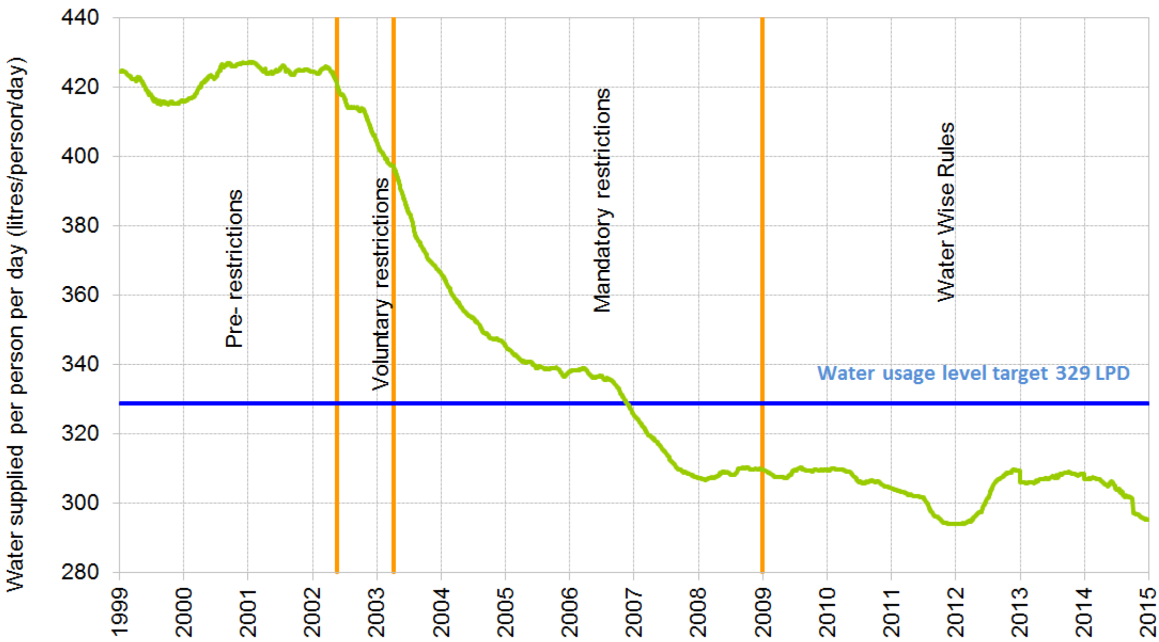
Source: Adapted from *Reduced Flow / Operation Mode Analysis* report, attached in Appendix A.

Nevertheless, SDP's *Water Supply Agreement* with Sydney Water requires the plant to be operational for 50 years, underpinning its critical role in ensuring future water security. The plant needs to be maintained within water security mode such that it can respond within a specified timeframe to a future security incident.

Low water consumption

Demand for water has not grown as expected due to the effectiveness of *Water Wise Rules* as shown in Figure 2. This has resulted in consumers not returning to water consumption habits prior to the drought, with a reduction in per person use greater than 25 per cent in 16 years.

Figure 2 Reduction in daily water use in greater Sydney since the drought

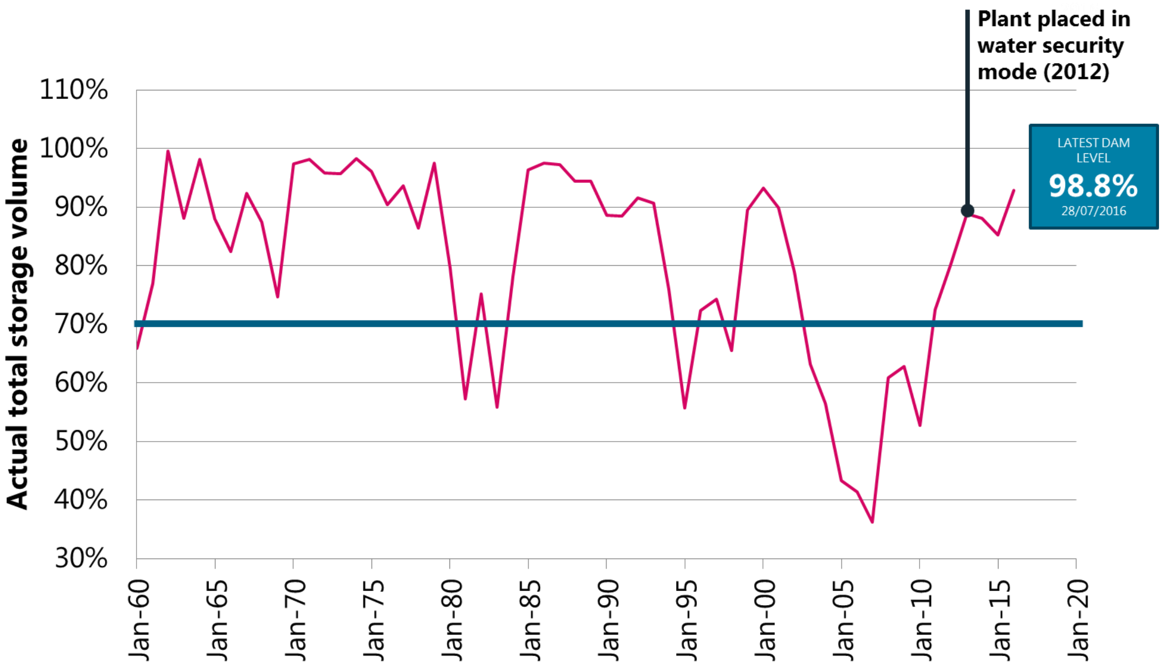


Source: Sydney Water Corporation, 2015, p.2.

Higher dam levels

High rainfall levels have resulted in high water storage levels, with total dam storage levels well over 90 per cent, as shown in Figure 3.

Figure 3 Total volume stored



Source: Data sourced from *Verified Storage and Supply spreadsheet* provided by SDP.

SDP's water security obligation

SDP's water security obligation is to ensure long term capability to provide customers with water:

- When Sydney's total dam storage levels drop below 70% and until they reach 80%.[1]
- At times when Sydney Water Corporation chooses to operate the plant to secure water supplies (for example if availability of water from other parts of the supply system were affected by technical or other problems).[2]

SDP has developed a cost effective response to support water security while minimising the impact on the state.

[1] *2010 Metropolitan Water Plan*, NSW Government (current rules that are under review) and the *Water Industry Competition Act 2006* Network Operator's Licence for SDP

[2] Water Supply Agreement with Sydney Water Corporation

2 Overarching Argument

A plant in water security mode over an unprecedented duration creates water security risks for the customers and SDP, and operations and maintenance risks for Veolia.

A desalination plant is a dynamic system where the operator uses data and testing to optimise plant performance and plan for asset renewal and replacement. Posing a risk for plant restart, when a plant is not operational, data is not available to manage the plant. Asset failures at restart become a greater risk the longer the plant is out of operation. An accumulation of asset procurement lead times would then increase the time for the plant to reach maximise production and commence supply of drinking water.

While the plant is in water security mode, elements of the plant still need to be overhauled for maintenance, and assets approaching obsolescence need to be replaced. [redacted]

Even after the plant is restarted, there is also the possibility that the performance of some assets will degrade more quickly than would have been the case before the extended water security mode. This is because the extended time of minimal or no use will have compromised the asset regardless of maintenance in line with good industry practice.

There are two main risks to water security for the customers and SDP:

1. **Ability to restart (restart risk)** – Ability to restart in eight months and achieve plant performance and drinking water quality.
2. **Maintaining supply after restart (operating risk)** – Ability to sustain supply to meet 266ML/d at 94% availability.

The proposed investments mitigate the restart risk and the operating risk, as shown in Table 3.

Table 3 Proposed initiatives to address water security risks

Initiative	Risk 1: Restart	Risk 2: Operating
1. [redacted]	✓	✓
2. Additional pump		✓

The investments proposed in this business case have been selected after detailed analysis of options, and are responsible, prudent, and cost efficient responses to the customer risks generated by the plant being placed, over an unprecedented duration, in water security mode. The ability to restart, and continue operating the plant, is essentially an insurance policy providing security of water supply to customers. In the long term interest of customers, maintaining the effectiveness of this policy will avoid the need for a repeat of the costly water restrictions imposed during the last drought.

4 Additional drinking water pump

4.1 Summary

Drinking water pumping station availability is a risk inherent in the original design of the desalination plant infrastructure with the potential to impact on water security during operations.

The drinking water pumping station was designed to a lower availability than the desalination plant. Despite this being addressed through the purchase of critical spares, the resultant higher probability of failure of the drinking water pumping station as compared to the desalination plant itself, can potentially restrict the plant from achieving an average water production rate of 250ML/d.

The owner, SDP, is seeking to install a third drinking water pump to ensure its water security obligations are met. A pump with lower capacity than the existing two pumps is proposed as it can be accommodated within the existing building and would provide a cost effective solution. The smaller pump could also be used for low flow operations in the future.

Value:

Capital investment: $2.1M

Operating investment: $185K/year

Delivery strategy:

2019: Veolia, the plant operator, will procure, install and commission the pump. Pricing will be market tested through a minimum of three quotations and transparent pricing.

The timetable to design, procure, supply, install and commission the identified works is estimated at 60 weeks. Durations may be subject to modification based on procurement methods, lead times for equipment and further scheduling refinement.

The delivery approach targets the middle of the 2017 Determination period, due to the current high water storage levels. The new pump is required before a plant restart to address the water security risk. It would not be possible to install the new pump when the drinking water pumping station is operating without interrupting supply due to the need to connect to the existing pipe work.

4.2 Case for change

Improved drinking water pumping station availability is necessary to fully achieve the obligations placed upon SDP through the WIC Act Licence of maximising the production of drinking water. It is also the most effective action to manage SDP's water security risk related to maintaining supply after restart, by reducing the potential for supply to fall below an annual average of 250ML/day.

The justification for this investment is based on the following factors:

- SDP is required under its Water Industry Competition Act (WICA) License to maximize the production of drinking water.
- SDP is subject to abatement of its Water Service Charge, as determined by IPART in 2011, if SDP fails to provide desalinated water when otherwise required to do so. The value of this abatement exceeds that recoverable from the Operator under the abatement of the O&M Contract Service Fee.
- Whilst the plant's functional requirements included 94% availability on a capacity of 266ML/day, the drinking water pumping station has two duty pumps only, that were designed to deliver a nominal flow of 85.3GL/year based on an availability of approximately 85%.
- An obligation was captured in the DWPS Deed established in 2009, to not lessen the plant's availability by result of it being in series with a pumping station of lessor availability reliability and this obligation was linked to the abatement of the Service Fee under the plant O&M Contract.
- The WICA license, including the obligation to maximize the production of drinking water, was created in 2010, after the functional requirements of the plant and drinking water pumping station were set. The resultant effect of the application of the License condition is to place an obligation onto SDP that exceeds the performance specifications embodied in the drinking water pumping station design.
- SDP is potentially exposed to net abatement to the value of approximately $33,000 for a 1 week outage one drinking water pump, assuming that the plant is able to return to production of 266ML/day after the outage.

If an additional drinking water pump was not implemented, the following events are likely and the associated risks exist:

- Full water security value of the plant unrealised for customers.
- Reputational risk to SDP and Government of plant not able to meet water security objective included in operating licence.
- Pump station failure would impact the ability to meet 94% availability and has a potential consequence to SDP of $33,000 for a 1 week outage.

SDP is required under its Water Industry Competition Act (WICA) License to maximize the production of drinking water when the storage in Sydney's water supply reservoirs falls below 70%, until it rises to 80%. This obligation is underpinned by a matching financial incentive via the abatement of the Water Service Charge, as determined by IPART, if SDP fails to provide desalinated water when otherwise required to do so under the Metropolitan Water Plan. This abatement applies if the average production of the preceding 365 days of full production is less than 250ML/day.

The performance specification of the plant required it to produce drinking water to an annual average of 250 ML/day. This was achieved via the nomination in the plant's functional requirements of 94% availability on a capacity of 266ML/day. By comparison, the drinking water pumping station has two duty pumps only, that were designed to deliver a nominal flow of 85.3GL/year based on an availability of approximately 85%[3]. In order to deliver this design flow, the drinking water pumping station was configured to achieve delivery of 275ML/day on the 310 days per year it was planned to operate.

The decision to not include an installed spare pump in the drinking water pumping station basis of design was recorded at the time by the Independent Reviewer of the Water Delivery Alliance, as being based on:

> *"the rationale that the overall Sydney water system had sufficient redundancy such that, in the event of an outage in the delivery system, there would be no impact on the supply of water to customers of Sydney Water".*

An obligation was captured in the DWPS Deed established in 2009, to not lessen the plants availability by result of it being in series with a pumping station of lessor availability. This obligation was combined with a mechanism under the DWPS Deed, that should the obligation not be achieved, abatement at the same rate as under the plant's O&M Contract would apply. The purchase of critical spares was included in the DWPS Deed in order to facilitate the inclusion of this availability obligation.

The WICA license, including the obligation to maximize the production of drinking water, was created in 2010 and last amended in 2013. The licence condition was therefore placed upon SDP after the functional requirements of the plant and drinking water pumping station were set and after the DWPS Deed was established with the obligation to maintain the plant's functional requirement of 94% availability. The resultant effect is to place an obligation onto SDP that exceeds the functional requirements embodied in the DPWS Deed.

Despite the purchase of critical spares and the obligation on the Operator, a risk remains that unplanned outages will occur at the DPWS that cannot be aligned with plant outages within the 6% downtime provision. Such an occurrence would result in the average production of drinking water in the preceding 365 days of full production being less than the plant's nameplate capacity (i.e. 250ML/day) and SDP being abated by under its Water Service Charge as determined by IPART.

The risk of such an eventuality is borne by SDP and the NSW Government, via the water security objectives of maximising production failing to be achieved. Whilst SDP is able to partially offset any abatement of its Water Service Charge via abating the Operator under the Service Fee of the plant O&M Contract when production falls below an annual average of 250ML/day, SDP is further exposed to the significant differential in these two mechanisms, to the value of $33,000 for a 1 week outage one drinking water pump. This value assumes a production rate in the 26 days after the outage of 266ML/day, however minor variances in the post outage event production rate and therefore the duration the respective abatements apply for, have the potential to cause the net effect to SDP to be considerably higher. Where the cause of this abatement is a failure of the drinking water pumping station to achieve 94% availability, this is a cost SDP incurs as a result of the performance specification of the pumping station not incorporating an installed spare pump.

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[3] GHD Fichtner, 2012, p.159

Expansion to the ultimate plant capacity of 500ML/day and the pump station to 550ML/day, was intended at the time the functional requirements of the drinking water pump station were established to provide an opportunity to remove the reliability misalignment. However, given the present level of water available in the dams and forecast demand levels, it is not expected that the plant will be expanded in the near term. To address the residual risk and ensure SDP achieves the obligated water security objectives, SDP commissioned KBR to undertake a study of the options available to increase the availability of the drinking water station up the level of the overall plant. KBR determined that the best way to manage the risk is to install a third standby pump.

4.3 Option assessment

KBR assessed the options available to SDP to address the potential for the average capacity of the drinking water pumping station[4] to fall below that of the plant.

SDP set the following three criteria to assess the pump options:

1. **Capacity:** ability to meet the full flow rate of 266 ML/day in conjunction with another pump.
2. **Supply security:** ability to provide a minimum of 266 ML/day with one pump off line.
3. **Low flow capability:** the pump is able to accommodate flows down to 40 ML/day which is approximately minimum plant production. A new pump would make it possible to reduce the drinking water pumping station minimum capacity to match the plants minimum possible production for little or no additional cost.

KBR considered 11 different options that could ensure the average capacity of the drinking water pumping station was equivalent to that of the plant. Options considered included different operating scenarios for the existing pumps and replacing the existing pumps.

Following assessment against the criteria KBR selected four options to undertake a more detailed assessment of, including the status quo:

1. **Continue with critical spares.**
2. **Option 2:** install an additional third pump with low flow capacity within the existing building.
3. **Option 5:** install one additional third pump with low flow capacity and extend the building.
4. **Option 6:** install one additional third pump at the same capacity as the existing pumps and extend the building.

Further detail is available in Appendix B – *Drinking Water Pump Station Water Security Review*.

4.4 Value for money assessment

As shown in Table 6, Option 2 and 5 meet the capacity and supply security criteria and also can accommodate low flow operations. Option 6 allows for full redundancy of the system, so it meets

[4] Kellogg Brown & Root Pty Ltd, 2016

the capacity and water security criteria. Both Option 5 and 6 require the extension of the building making option 2 the most cost effective. Therefore option 2 has been selected as the preferred solution.

Table 6 Options assessment to meet SDP's water security requirements

Options*	Achieves 266ML/d	Supply security	Low flow	Cost[1] ($m)	Benefit	Disadvantage
Continue with critical spares				$0	▪ Lowest capital investment.	▪ Does not meet the 94% availability requirement with potential for abatement costs
(2) Install additional pump with low flow capacity in existing building	✓	✓	✓	$1.8	▪ Improves availability ▪ Allows for low flow operations in the future	▪ Fitting pump into existing building adds complexity
(5) Install additional pump with low flow capacity and extend building	✓	✓	✓	$2.6	▪ Improves availability ▪ Allows for low flow operations in the future	▪ Extension of building increases cost
(6) Install additional pump with similar capacity and building extension	✓	✓		$3.3	▪ Improves availability	▪ Does not provide for low flow capability

* Only options that provided low flow capability are considered. Other options were assessed and discounted
[1] Costs exclude SDP markups

4.4.1 Preferred option

The pump selected for option 2 allows SDP to achieve 266 ML/day of flow whenever the plant is operating and also allows for 40 ML/day if low flow is required. The pump will be installed in the existing drinking water pumping house. Although it will be a relatively tight fit, initial investigations show that the pump will fit into the available area. This will need to be confirmed through further detailed analysis.

The preferred option delivers the following benefits:

- Confirms water security for customers by ensuring drinking water pump station average capacity does not fall below the average capacity of the plant.
- Low flow pump allows for flexibility to provide low flow operations if required in future.

4.5 Delivery strategy

2019: Veolia, the plant operator and maintainer, will procure, install and commission the pump. Pricing will be market tested through a minimum of three quotations and transparent pricing.

The timetable to design, procure, supply, install and commission the identified works is estimated at 60 weeks. Refer to Table 7 for tasks and durations. Durations may be subject to modification based on procurement methods, lead times for equipment and further scheduling refinement.

The delivery approach targets the middle of the 2017 regulatory period, due to the current high water storage levels. The new pump is required before a plant restart in order to address the water security risk. It would not be possible to install the new pump when the drinking water pumping station is operating without interrupting supply due to the need to connect to the existing pump work. Given SDP expects to commence providing water into Sydney Water Corporation's system after about 4 months of restart (full ramp up of production will take 8 months), installing the pump whilst the plant is in water security mode provides the best opportunity to address the water security risk without affecting delivery.

Table 7 Implementation schedule for option 2

Tasks	Nominal duration
Detail design and specification	16 weeks
Procurement of supply and install contractor	8 weeks
Supply and installation	30 weeks
Testing and commissioning	6 weeks

Appendix A: Reduced Flow / Operation Mode Analysis, GHD

Appendix B: Drinking Water Pump Station Water Security Review, Kellogg Brown & Root

SYDNEY DESALINATION PLANT DRINKING WATER PUMP STATION WATER SECURITY REVIEW

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Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to identify potential pump works in the Drinking Water Pump Station at the Sydney Desalination Plant in accordance with the scope of services set out in the contract between KBR and Sydney Desalination Plant Pty Ltd ('the Client'). That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

KBR derived the data in this report primarily from records and documents supplied by the Client. The passage of time, manifestation of latent conditions or impacts of future events may require further exploration at the site and subsequent data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report.

In preparing this report, KBR has relied upon and presumed accurate certain information (or absence thereof) relative to existing structures provided by the Client and others identified herein. Except as otherwise stated in the report, KBR has not attempted to verify the accuracy or completeness of any such information.

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Revision	Date	Comment	Signatures		
			Originated by	Checked by	Authorised by
0	12 July 2016	Issued for Use	IW	RW	JB

CONTENTS

1 Introduction

Sydney Desalination Plant Pty Ltd (SDP) holds the 50 year lease for the Sydney Desalination Plant (the plant) as the sole supplier of desalinated drinking water to Sydney. The plant is based in Kurnell and at full capacity provides around 250 million litres of water per day which equates to approximately 15 % of Sydney's drinking water. SDP supplies all of its output when operating to Sydney Water, a NSW state owned corporation.

The plant is required to produce drinking water when Sydney's overall dam levels fall to below 70% of capacity. The plant will be turned off when the dam levels reach 80% (70:80 rule). The plant has been in a mothball mode of shutdown since 1 July 2012.

The plant is designed to produce 91.3GL/yr based on an availability of 94%. In order to produce this design output of 91.3GL/yr the plant is required to produce 266ML/d on the days it is planned to operate (343 days per year).

A critical component of the plant's delivery of water to Sydney's drinking water system is the Drinking Water Pump Station (DWPS). The DWPS transfers water from the plant's drinking water tank into Sydney Water's distribution network at Erskineville via the Desalination pipeline that runs from the plant at Kurnell, across Botany Bay to Sandringham, then Tempe and eventually Sydney Waters Shaft 11C on the City Tunnel at Erskineville.

The DWPS has two duty pumps that are designed to deliver a nominal flow of 85.3GL/yr based on an availability of 85%. In order to deliver this design flow of 85.3GL/yr the DWPS is required to deliver 275 ML/d on the days it is planned to operate (310 days per year). If the DWPS is restricted to a flow rate of 275ML/d then there is a 6GL/yr shortfall in delivery versus production.

In order to meet its drinking water supply of 91.3 GL/yr SDP needs to increase the design availability of the DWPS to align with that of the plant.

1.1 PURPOSE

SDP is reviewing the operating regime of the plant and pump station and assessing key risks of water security, start-up and reliability. KBR has been engaged to investigate options and feasibility of pumping solutions required to understand and address redundancy / standby capacity of the DWPS in its current configuration to address the supply security risk. The need to address water supply issues provides an opportunity to consider whether the operating range of the DWPS could accommodate future potential low flow productions modes of the plant whilst also securing water security. Consequently, KBR is investigating pumping solutions to provide security of supply as well as continuous reduced flows.

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The objective is to provide a solution for the DWPS that delivers a range of flows nominally 40 ML/day to 266 ML/day. This review is to be undertaken as part of the preparation of a business case for the implementation of the preferred option.

1.2 SCOPE

The scope of services for the DWPS feasibility review includes:

- Develop options and assess technical feasibility to provide standby pumping capacity that enables the DWPS to meet contractual water demands should one of the duty pumps be unavailable
- Develop options and assess technical feasibility to provide pumping capacity for flows in a reduced flow regime
- Review of hydraulic profile of pipeline and pump curve and identify a pump/s that can perform within the selected range
- Assessment of the pump station to confirm feasibility of layout and identify modifications and or additional building requirements
- Capital cost estimate of the recommended option.

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2 Background

2.1 OPERATING MODES

The Plant currently operates to certain rules that are tied to the Sydney's dam storage levels. These are known as the 70/80 Rule.

2.1.1 Water Security Mode

In this state the Plant is in a deep state of preservation ("mothballed"). The ocean intake and outfalls are capped, pipelines disinfected and sealed and membranes filled with preservative solution. Basic maintenance is completed to maintain the plant ready for operation.

2.1.2 Water Supply Mode

When Sydney's dam levels drop below 70%, the plant must be ready in eight months to produce water and pump into Sydney Water's supply network at Shaft 11C Erskineville. The rate of production is set at 91.3 GL/yr. This has been determined based on the plant producing an average of 266ML/d for 94% of the year.

When dam levels rise above 80%, the plant reverts to Water Security Mode, the production of water ceases and the plant is placed back into preservation.

2.2 DRINKING WATER PUMPING STATION (DWPS)

The DWPS is required to transfer water from the plant's drinking water tank into Sydney Water's distribution network at Erskineville via the Desalination pipeline that runs from the plant at Kurnell, across Botany Bay to Sandringham, then Tempe and eventually Sydney Waters Shaft 11C on the City Tunnel at Erskineville.

The pipeline was designed for the ultimate capacity of the plant (500 ML/d), while the pump station has been designed to manage the existing nominal capacity of the plant 250 ML/d. During commissioning the DWPS was capable of pumping 310 ML/d when the two pumps operated in parallel.

The DWPS houses the following equipment in the Pump Station, Electrical Building Fan Room, HV Switchroom and Electrical Room.

Pump Station

- Two horizontal split case Nijhaus water pumps – nominal capacity 137 ML/d @ 67 m each
- Two water cooled electric motors – nominally 1350 kW
- Two cooling water systems – for each pump motor includes pump with motor and heat exchanger
- Two HV contactors
- SWC IICATS Panel and RTU

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- Two Ventilation Fans
- Two Sump Pumps

Electrical Building Fan Room

- 3 fans complete with filtration for electrical room ventilation

HV Switchroom

- HV Distribution Board
- Two air conditioning units

Electrical Room

- Two 11kV to 433 V transformers
- Two variable speed drives to control the speed of each pump

2.3 PUMP STATION CAPACITY

The Basis of Design Report for the DWPS states the following pumping capacities and availability.

Stage 1 flow capacity (present configuration)	250 ML/d (Nominal)
	275 ML/d (design)
Minimum flow rate capacity	90 ML/d
Pumping Demand	83.2 GL/yr at approximately 85% availability per year. The target is 87 GL/yr.
Availability	Approximately 85%

Following commissioning of the DWPS the Water Distribution Infrastructure Hydraulic Performance Report prepared by Water Delivery Alliance stated the DWPS was capable of the following performances.

	Maximum Flow (ML/d)		**Minimum Flow (ML/d)**	
	Single Pump	**Two Pumps**	**Single Pump**	**Two Pumps**
Maximum System Resistance	178	312	62	106
Minimum System Resistance	196	352	109	188
Future Maximum System Resistance	178	309	-	-

During commissioning the pumping station was able to deliver flows from approximately 130 ML/d to 310 ML/d by varying the pump speeds with one or both pump units operating.

When the plant is in a Water Supply Mode, SDP operates the plant at its maximum design capacity of 266ML/d or more. Planned plant maintenance, plant failures and / or Sydney Water operational constraints are the only reasons the capacity of the plant is downturned.

For water quality reasons SDP's preferred operation of the plant is at stable flow rates. Frequent changes in operation upset the chemical dosing processes and which could take the produced water out of specification.

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Likewise the DWPS is operated to match the plant production rate. This assists in the control of the final chemical dosing (chlorine and ammonia) downstream of the drinking water tank. The pump station has been designed with variable speed pumps to assist in managing the flow rates.

For discharge into the Sydney Water supply at Shaft 11C, KBR understands that for water quality and system control purposes Sydney Water prefer a constant rate of supply rather than varying discharge rates such as when delivering as a slug flow. It is noted that while the full flow capacity pumps could provide a reduced flow (40ML/d) by pumping down the drinking water tank, the flow would be delivered as a variable discharge.

2.4 DESIGN ISSUES

The plant has been designed to produce 91.3 GL/yr with an availability of 94%. The DWPS has been designed to provide 275 ML/d with an availability of 85% (this equates to 85.3 GL/yr).
[reference: Sydney Desalination Plant Technical Vendor Due Diligence Report, GHD Fichtner, February 2012].

Availability is defined by the time equipment is available to produce /pump water.

In the case of the plant, 94% availability means the plant is allowed 22 days of zero production based on assessment of reliability and maintenance requirements. Therefore the plant is required to produce 266 ML/d over 343 days to achieve 91.3 GL/yr.

Based on the DWPS current design availability of 85% it is required to deliver 294ML/d on its available days (310 days).

The Drinking Water Tank provides buffering between the DWPS and plant production. The tank has a working volume of 40ML which is not sufficient to overcome the differential between the DWPS delivery flow rate and plant production.

This mismatch in the design criteria presents a supply security risk to SDP. The design solution is to increase design availability and not flow rate. To reduce the risk of abatement in relation to the contractual requirement of 91.3 GL/yr the 85% availability of the DWPS needs to be increased. To increase the DWPS availability, provision of additional pumping capacity from supplementary and or new pump unit/s is required. Various options have been considered to install an additional pump that will operate as a standby pump to improve the availability of the DWPS.

2.5 MINIMUM PUMP STATION FLOW

The Construction Contract for the plant required the Contractor to provide 25% of the Minimum Daily Flow required to achieve 91.3G L/yr. This equates to 66 ML/d. The Water Distribution Infrastructure Hydraulic Performance Report for the DWPS states the minimum flow is 62 ML/d at Max head while running at min speed (750 RPM). During commissioning of the DWPS this low flow was not attempted. The minimum flow achieved was about 130 ML/d. Records show that the pumps have started vibrating at speeds between 750 RPM and 800 RPM so operating the pumps in the current arrangement at this low flow is not recommended.

In November 2011 EDTC completed a review for Veolia of the possible reduction in the minimum output of the DWPS. The report looked at reducing the speed of the pumps to achieve 45 ML/day (the basis for this flow target is not provided). The report concluded that flows were outside the pumps best efficiency range of 55 -130%. Operating outside of the Best Efficiency is not advisable as it may damage the pump. Therefore flows below 64 ML/d are not recommended due to potential pump damage. Refer to the Fig A.1 in Appendix A.

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If an additional pump is to be installed in the DWPS it should be sized to ensure minimum flow of about 40 ML/d (as defined in this report) is achievable to provide operating flexibility which is not currently available, if this can be achieved at little or no additional cost.

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3 DWPS Options

KBR have completed a basic risk identification to highlight failure methods that may stop the DWPS from delivering water per the stated requirements. This list does not cover plant or drinking water tank failure risks that may prevent water being produced for the DWPS to deliver, power supply interruptions to the DWPS or disruptions to the Sydney Water system as Shaft 11C that prevent the discharge of supply.

ID	Failure	Management
General		
G1	Pipe Failure	Low risk.
G2	Sump Pump Failure	Low risk. Flood alarm to alert operators and a portable sump pump could be installed if required
G3	NRV Failure to Open	Low risk.
G4	Isolation Valve failure to open	Low risk. Infrequently operated. Valve can be operated with actuator or manually.
Pump Failure		
P1	Pump Bearings	Possible. Monitored and planned Maintenance
P2	Pump Housing	Unlikely
P3	Pump Seal Rings	Possible. Monitored and planned Maintenance
P4	Pump Seals	Possible. Spares required.
Motor Failure		
M1	Motor bearings	Possible. Monitored and planned Maintenance
M2	Water cooling	Refer below
M3	Windings	Possible. Monitored and planned Maintenance
M4	Instrument Failure	Possible. Spares required
VSD Failure		
V1	Over Temp	Possible. Station ventilation required.
V2	Electronics	Possible. Spares to be kept
Motor Cooling System		
C1	Cooling Pump	Possible. Spare Pump
C2	Cooling Pump Motor	Possible. Spare Pump
C3	Pipe failure	Unlikely.

Based on this high level assessment it is possible for a pump to be off-line due to planned maintenance or equipment failure. Depending on the reason for being off line it is possible for a pump to be unavailable for up to a week (major overhaul) although this is not likely in the near future. If this is to occur, the plant's production would be reduced to match the reduced pumping capacity of the DWPS of about 185 ML/d.

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3.1 PUMPING OPTIONS

Based on the risk issues identified above, the current configuration of the DWPS poses a potential risk to the security of supply of drinking water to Sydney Water. Furthermore, if the DWPS is not capable of pumping 266 ML/d of flow on 343 days of the year then there is a risk that SDP will face substantial financial penalties.

KBR have listed below a set of options to reduce the risk of the DWPS not being able to achieve a minimum daily average flow of 266 ML/d.

As the Options were being reviewed for security of supply, KBR also looked at low flow scenarios. If a new pump was being proposed then it may also be possible to reduce the DWPS minimum capacity to match the plants minimum possible production for little or no additional cost. The development of options also considered the limited space available in the current DWPS.

Each Option identified was tested against it capability to meet:

- Full Flow – 266 ML/d
- Supply Security - ability to provide a minimum of 266 ML/d with one pump off line
- Low Flow – ability to pump at flows down to 40 ML/d (this approximates minimum plant production)

	Options considered	Full Flow	Supply Security	Low Flow	Comments
0	Existing Pump Station (Base Case)	✓	×	×	Does not meet supply security issues or low flow
1	Intermittent operation of the existing Pumps in Low Flow (slug flow)	✓	×	✓*	Does not meet supply security issues. *Sydney Water prefer not to receive slug flows as a low flow solution
2	**Install 1-off additional Pump with LOW Flow capacity in existing building**	✓	✓	✓	**Supply security issues will be covered as a priority. Low flow will be covered**
3	Replace 1-off existing Delivery Pumps to a LOW flow capacity pump	✓	×	✓	Does not meet supply security issues and reduces current capacity
4	Replace 2-off existing Delivery Pumps with FULL flow capacity pumps	✓	✓	×	Does not meet low flow requirements
5	Install 1-off new Pump with LOW Flow capacity + building extension	✓	✓	✓	Supply security issues will be covered

	Options considered	Full Flow	Supply Security	Low Flow	Comments
6	Install 1-off new Pump with SIMILAR capacity to existing pumps + building extension	✓	✓	×	Meets supply security issues. There is insufficient space in the existing building to accommodate a pump similar in size to the existing pumps
7	Install 1-off new Pump with FULL capacity + building extension	✓	✓	×	Meets supply security issues. Extra capacity supplied not required
8	Install 2-off new Pumps with SIMILAR capacity + building extension	✓	✓	×	Meets supply security issues. Extra capacity supplied not required
9	Install Control Valve downstream of the existing Pumps to create LOW Flow	✓	×	✓	Does not meet supply security issues
10	Operating the existing pumps via Variable Speed Drive to the LOW flow duty point	✓	×	×	Does not meet supply security issues. Requires pumps to operate at lower than recommended minimum
11	Recirculate flow partially back to the Drinking Water Tank to create constant LOW Flow	✓	×	✓	Does not meet supply security issues. May be used with other options to provide low flow

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3.1.1 Preferred Option - Option 2

Option 2 is the preferred option as it delivers both security of supply and potential low flow operating modes. As discussed with SDP it was agreed if a pump could be identified that is capable of supplying approximately 104 ML/d @58 m, then when run in parallel with an existing pump, the DWPS could achieve 266ML/d flow. This would allow SDP to reach their target daily flow.

KBR has investigated the supply of suitable pumps and identified three potential suppliers (Xylem, Nijhaus and KSB). Discussions to date has been with pump supplier Xylem who have nominated a Bell & Gossett split case pump model VSH 18X20X22A will meet the required duty of 104 ML/d @ 58m and has a footprint of about 3.1m x 1.7 m. Refer to Appendix B for attached sketch of proposed location of pump.

Based on pump and system curves this same pump nominated by Xylem for Option 2 will also operate at the revised minimum target flow of 40 ML/d.

Although a relatively tight fit due to constrained space, on initial investigation based on as-built drawings and horizontal clearances of 900mm it appears the pump will fit into the available area. This observation would need further detailed analysis to ensure that access to any equipment is not hindered.

From an operational perspective the impact on power consumption will be minimal and may even be positive. Since the proposed new pump is smaller when operating with an existing pump the power consumption is expected to be less than existing. As only two pumps will operate at any one time there are no anticipated additional heat loads.

Works that would be required to install the pump would include:

- Construction of a pump foundation
- Excavation to install new suction and delivery pipework outside the pump station
- Supply and installation of new suction and delivery pipework including installation of suitable seals for new penetrations through DWPS sub-walls
- Supply and installation of actuated gate valves for pump suction and delivery
- Supply and installation of non-return valve
- Supply and installation of new pump
- Supply and installation of new VSD starter and control panel
- Modifications to the IICATs control system
- Modifications to existing platforms, ladders and stairs

In summary Option 2, which involves the supply and installation of a new pump in the existing pump building, is considered feasible. The estimate for Option 2 is in the order of $1.846M (refer Appendix C for detail of estimate).

3.1.2 Other Feasible Options

While not preferred, Options 4, 5 and 6 were also assessed as feasible for achieving supply security.

Option 4 replaces the existing DWPS pumps, motors and VSD units with pumps capable of supplying 266 ML/d alone. This will enable the pump station to provide security of supply but the pumps may not be capable of operating at low flows to match reduced production of the plant if that is to occur; i.e. a single pump would not be capable of delivering low flows. Option 4 has not been considered further due to the significant cost of supplying and installing larger pumps to replace the existing 2 duty pump units.

Options 5 and 6 are similar to each other in that they provide for a third pump to be installed in an extension of the pump building. Option 5 uses a smaller pump which will allow SDP to pump at flows close to a minimum of 40 ML/d, while Option 6 uses a pump that is the same as the two existing pumps. Option 6 will not achieve low flow. Both options will provide supply security.

As both options require the extension of the pump building they are more expensive than Option 2. If either of Options 5 or 6 are adopted, the additional works over Option 2 are as follows:

- Extension to the pump room building including piling, floor, walls, roof, ventilation, lighting, platforms.
- Demolition of the existing end wall.
- Extension of the existing crane rails.

Not considered in Options 5 and 6 is the future expansion of the DWPS to 500 ML/d.

For comparison purposes costs have been estimated for Options 5 and 6. The additional Building works are estimated to cost in the order of $750,000 above Option 2. Refer to

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table of cost comparisons in Section 4. Should either of Options 5 or 6 be considered further, a more detailed analysis of cost is required.

3.1.3 Option Discussion

Of the options considered those that achieve full flow and water security of 266 ML/d are Options 2, 4, 5, 6, 7 and 8.

As described above Options 2 and 5 were reviewed with SDP and identified as feasible options. It was confirmed if a pump could be located in the existing pump room that was capable of delivering approximately 104 ML/d @58m, then when run in parallel with one of the existing pumps the DWPS could achieve 266ML/d flow.

The advantages of Options 2 and 5 are that they are able to operate at a reduced flow of 40 ML/d.

Option 6 involves the installation of an additional pump of similar capacity to the two existing units in an extension of the existing pump building. By installing this additional pump there now standby capacity should one of the two duty pumps fail. This will achieve the water security requirement but not the low flow requirement. Due to the need to extend the pump building Option 6 was not considered further due to this additional capital cost of extending the pump building. A cost estimate cost is provided in Section 4 of this report.

Option 7 can be discounted as it is similar to Option 6 but proves a standby pump that can provide full flow by itself. This is more than required to meet the project requirements and adds no additional benefit for the extra cost.

Option 8 can be discounted as it is an extension of Option 6 where 2 new pumps of similar capacity to the existing are installed. This provides an additional back-up pump that would only be needed should 2 pumps fail. There is no justification for this scenario to be required.

It is also noted that the existing pumps have had issues with overheating of the VSD's in the HV switchroom. This project offers an opportunity to investigate heat loads of the existing equipment and determine if additional ventilation or air conditioning is required in the HV switchroom. An allowance has been included in the cost estimate.

3.1.4 Option 2 (Preferred Option) Design Considerations

The following items were considered when developing Option 2:

- Health and Safety

  Although a thorough HAZID will need to be completed during the development of this option, considered in developing Option 2 have been accessibility of existing and new plant and equipment for maintenance and operation (*HB59-1994 Ergonomics - The human factor. A practical approach to work systems design published by Standards Australia*), noise loads in the pump station, potential for flooding, access and egress from the pump floor and lighting making this option feasible.

- Pump Capacity

  The nominated pump has been determined capable of operating in parallel with one of the existing pumps to deliver at least 266 ML/d.

Based on Xylem's data the pump is also capable of operating at 40 ML/d at a reduced speed. This is within the operating limits advised by Xylem for the pump.

- Footprint

  The nominated pump has an overall footprint of 3.03m x 1.72 m for the pump and motor if installed horizontally. There is enough space between the suction pipes of the existing pump units to install this pump and have access a minimum 900mm clearance around the pup for maintenance access.

- Pump Power Requirements

  The nominal motor power required for the pump is 750kW. This is much lower than the existing pumps (1,350 kW). Since this new pump will only operate with one of the existing pumps at any time it is assumed there is adequate power available for the pump.

  The lower power draw also opens an opportunity for the power consumption of the pump station to be reduced when the new pump is operating.

  It is emphasised that there will never be three pumps running at one time.

- Heat Loads

  As reported in the Technical Vendor Due Diligence Report there is record of issues with overheating of the VSD's in the HV electrical building causing the pumps to trip. It is assumed that as the VSD for this pump will be substantially smaller and only operate with one of the existing pumps that this problem will not be exacerbated.

  As part of the detailed design works a ventilation study of the HV electrical building is required to determine what additional ventilation, building insulation or air conditioning should be installed.

- Pump Foundations

  As with the existing pumps, foundation plinths can be installed on the existing floor with starter bars grouted into floor. There is suitable space and it is assumed the floor can withstand the additional loads. A structural engineer will need to design the foundation to take into effect any loads including potential vibration issues considering there are no piles located in the vicinity of the planned pump.

- Building Foundations

  The current pump house is sealed against groundwater ingress. Installing a new pump in the existing pump building requires holes in the walls to allow pipework penetrations which will need to be carefully sealed to ensure they do not allow water ingress.

- Pump Spares

  The pump supplier has been asked to nominate critical spares for the pump to ensure they are available in an emergency. The supplier has also been asked to nominate existing users of similar pumps in Australia.

  Typically spares would include seals, bearings, seal rings, shaft and impeller. This list is subject to suppliers' advice on delivery times and location of spares. An allowance has been included in the estimate.

- VSD

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A VSD has not been designed however based on the nominated pump motor being substantially smaller than the existing units there is suitable space in the existing HV electrical room to install this equipment.

- Operational Issues

  Discussions may need to be held with Sydney Water to determine if their IICATS operational system can manage the connection of the new pump. It is anticipated that normal operation will see this new pump as the standby. This new pump will only ever operate with one existing pump operating not both. If two pumps are to run this new pump will need to start second to ensure its operation is not affected by the starting of an existing pump.

- Sump Pump

  As with the existing pumps the pump pipework will drain to the existing sump in the pump house. There is adequate capacity in the sump to manage this volume of water.

- Pipework

  The nominated pump has NB500 suction flange and a NB450 delivery flange. Although a detailed design is required to size the pipework it is not expected to be greater than NB750 tapering at the pump.

  On the suction side there is space to cut a new branch into the manifold pipework and adequate space to ensure flow is stabilised prior to the pump suction.

  In the delivery manifold a special branch would need to be designed and installed for connection of the new delivery pipe.

- Cathodic Protection

  The existing pump station has a Cathodic Protection system installed. The new design will need to consider allowance for insulation joints and possibly additional test points.

- Lighting

  Additional lighting may be required near the new pump. This will need to be assessed at detail design. It is expected it would be fluorescent tubing mounted off handrails similar to existing.

3.1.5 Option 2 (Preferred Option) Design Risks

The following items have been identified as design risks that could potentially add to the final scope of the preferred option:

- Structural strengthening of the floor slab - it has been assumed that existing pump station floor will support the new pump and motor
- Suction and discharge manifold cut-ins - no major constructability issues have been identified, however design and constructability risks remain
- Pump station wall penetrations - it has been assumed that penetrations in the pump station walls can be achieved without significant constructability issues
- Pump building certification – it is assumed re-certification will not be required for the modified pump building which may require unforseen scope.

Contingency in the cost estimate has been included to account for these risks.

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3.1.6 Option 2 (Preferred Option) Design, Installation and Commissioning Timeframe

The timetable to design, procure, supply, install and commission the identified works is estimated at 60 weeks. Refer to the following table of tasks and durations.

Durations may be subject to modification based on procurement methods, lead times for equipment and further scheduling refinement.

Tasks	**Nominal Duration**
Detail design and specification	16 weeks
Procurement of supply and install contractor	8 weeks
Supply and installation	30 weeks
Testing and commissioning	6 weeks

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4 Capital Estimate

An estimate for Option 2 the preferred option has been developed (refer to Appendix C). The estimate is for the supply and installation of one new Bell & Gossett horizontal split case pump Model VSX-VSH 18X20X22A with a 511 mm diameter impellor. This pump will achieve 104 ML/d @ 58m head to ensure the DWPS can provide 266 ML/d of water using any combination of two of the three available pumps. This pump is also capable of achieving 40 ML/d on its own if operated at reduced speed.

Works allowed for in the estimate include the following:

- Construction of a pump foundation
- Excavation to install new suction and delivery pipework outside the pump station
- Supply and installation of new suction and delivery pipework
- Supply and installation of actuated gate valves for pump suction and delivery
- Supply and installation of non-return valve
- Supply and installation of new pump
- Supply and installation of new VSD starter and control panel
- Modifications to the IICATs control system
- Modifications to existing platforms, ladders and stairs
- Modifications to the lighting and CP system
- Provision for modifications to the ventilation system
- Detailed design of the works
- Construction and Project Management

The estimate is non-binding with a contingency of 30%. The estimate is based on a non-binding quote for the pump and motor supply from Xylem and while mechanical and electrical installation and civil and building works are based on similar jobs recently completed.

It should be noted that SDP will incur additional maintenance costs associated with the new pump, however these costs are not included as part of this report.

The next lowest cost options that meet the supply security requirement, are options 5 and 6. The order of cost estimates for all three options are included in the following table:

Option	Capital Cost
Option 2 (new pump capable of low flow)	$1.846m
Option 5 (new pump capable of low flow in building extension)	$2.605m

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Option 6 (new pump similar to existing pump in building extension)	$3.321m

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5 Recommendations

In order to achieve security of supply and a pumping solution that can deliver that range of flows nominally 40 ML/day to 266 ML/day the following is recommended:

1. Option 2, being both technically feasible and the lowest cost option, should be developed further. Option 2 is for a Bell & Gossett VSH 18X20X22A split case pump which will meet the flow requirements of the existing system (266 ML/d) when operated in parallel with an existing pump and based on as- built drawings and pump dimensions will fit within the existing pump building. It is also noted that a new VSD and HV switchgear will fit within the existing HV electrical rooms.

   Works required to further develop the concept prior to a detailed estimate will include:

   - Development of the concept design.
   - Operational review with SDP and Veolia to review the developed concept design.
   - HAZID study to identify risks.

   It is currently estimated that the Capital cost of Option 2 will be in the order of $1.846M.

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Appendix A

PUMP AND SYSTEM CURVES

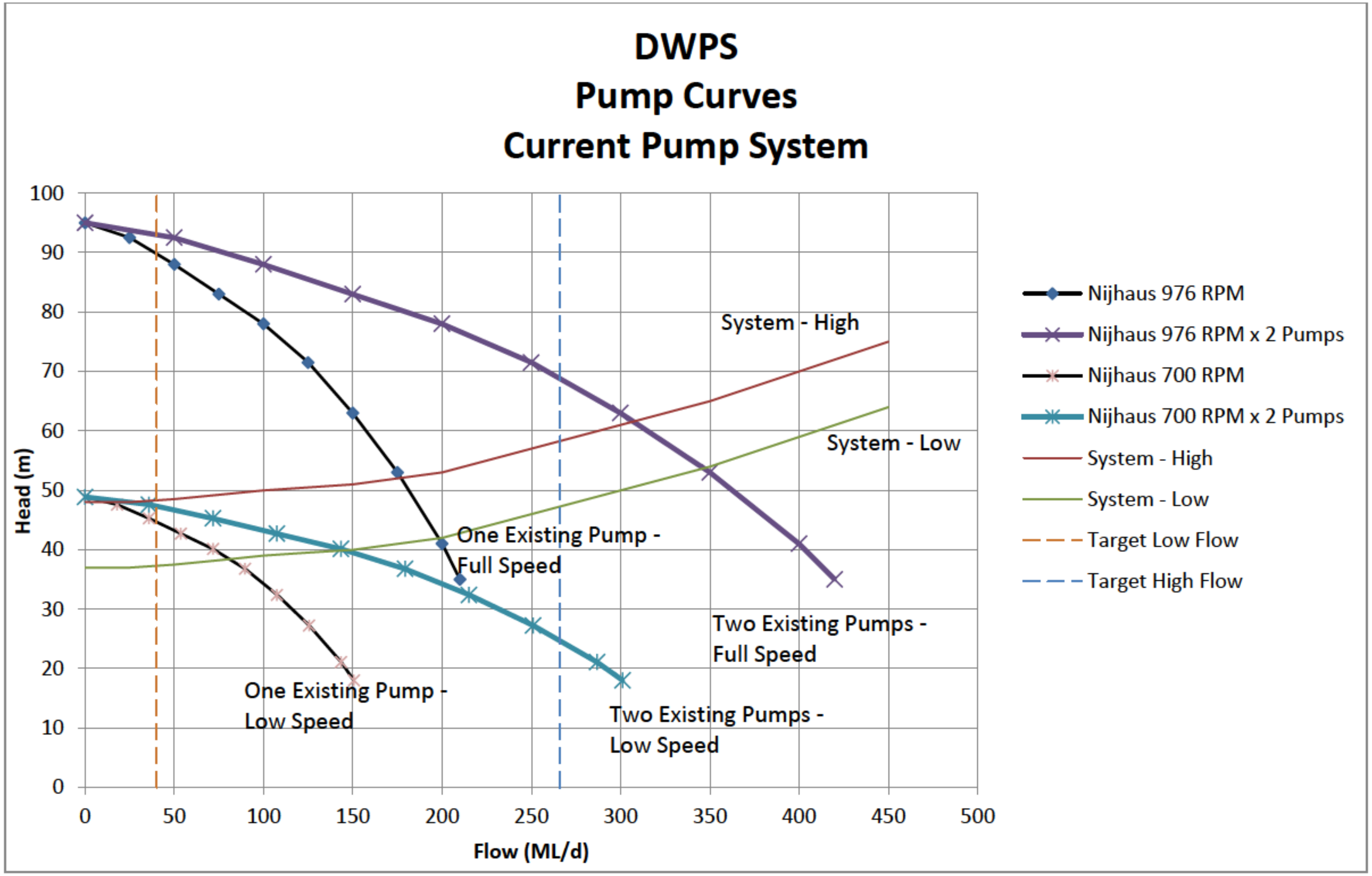

Fig A.1 Current System Curves

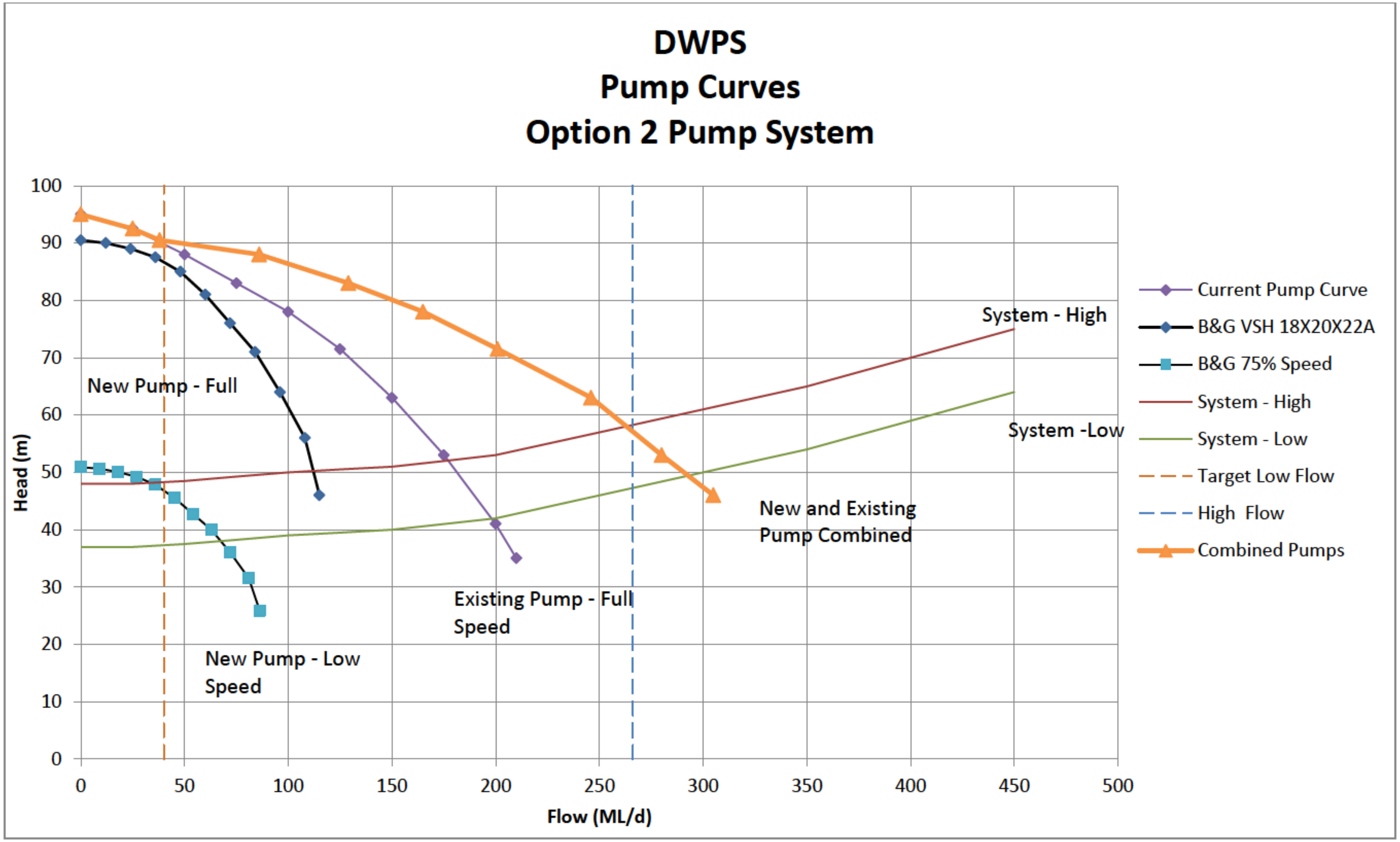

Fig A.2 Option 2 Pump Curves

Appendix B

OPTION 2 DETAILS

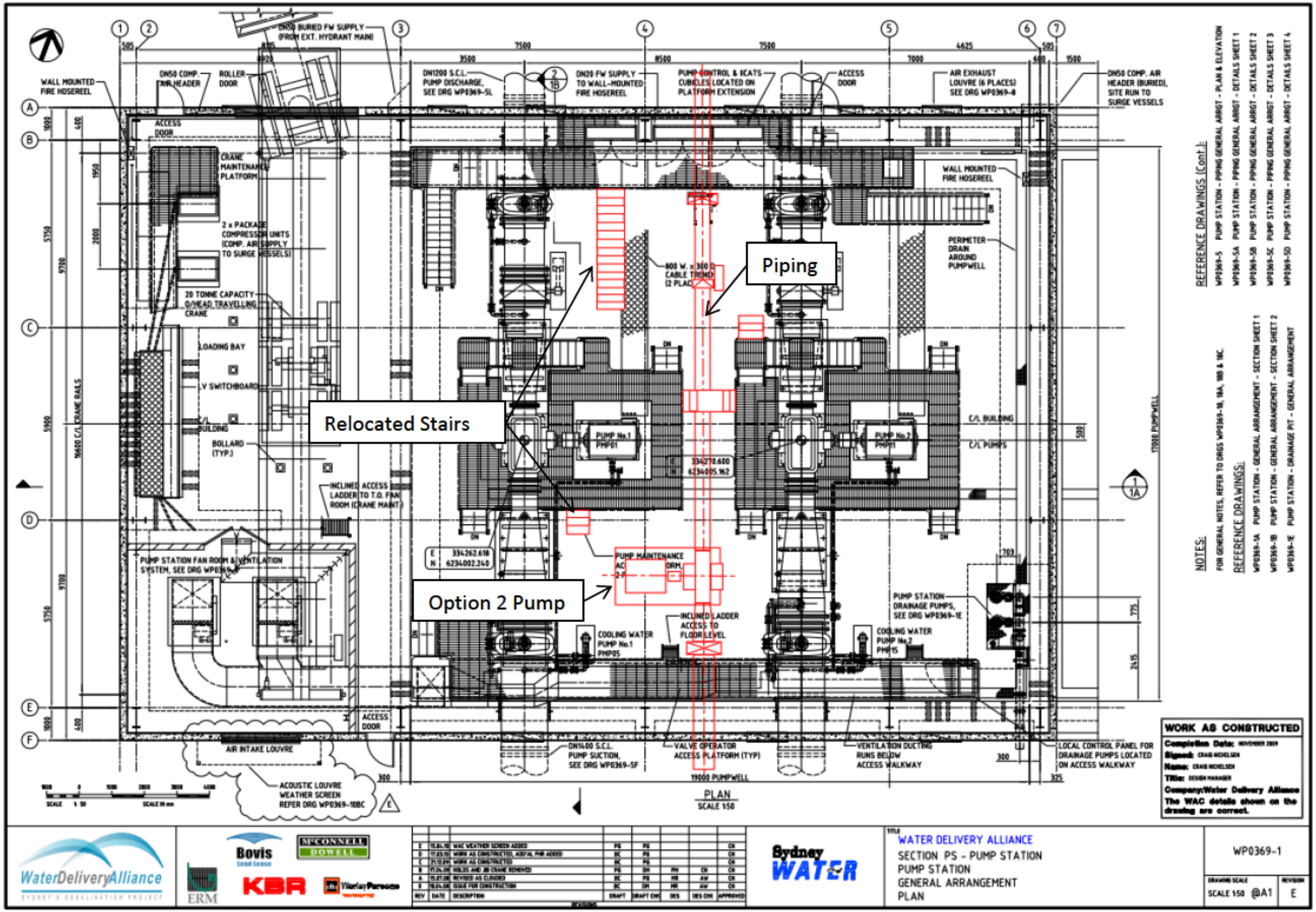

Fig B.1 Option 2 Pump Station Layout Plan

Appendix C

COST ESTIMATE

SYDNEY DESALINATION PLANT PTY LTD

COST ESTIMATE SUMMARY

Project Title : **SDP DWPS Pump Installation** Project No: SEG605
Group responsible for Est : **KBR** Type of Estimate : 30% Group : SDP
Prepared by : **I Watts** Date: **9-Jun-16**
Checked By : **R Wilson** Approved By : Checked by :
Signature .... Signature

SECTION	DESCRIPTION	TOTAL $	BUILDINGS $	CAPITAL $	OTHERS $
1	PURCHASE OF NEW PUMP	$267,100			
2	CIVIL CONSTRUCTION COSTS	$316,250			
3	MECHANICAL INSTALLATION	$332,200			
4	E/I INSTALLATION	$192,500			
5	COMPUTER/PLC	$30,000			
6	CONSTRUCTION FACILITIES	$81,740			
7	CONSULTANTS	$9,960			
8	OTHERS	$5,000			
	SPARES				
	UNALLOCATED ITEMS				
	CONTINGENCIES (allowance of 30%)	$425,989			
TOTAL PHYSICAL PLANT		$1,660,739			
ENGINEERING	BY GROUP (SDP)				
	BY KBR (Incl site management works) 15%	$185,213			
TOTAL present day costs		$1,845,952			
Exchange Rate Variations					
TOTAL FIXED CAPITAL (FCC) including Escalation		$1,845,952			

Degree of Accuracy +/-	30%	Basis of costing (% of Physical plant)		DEMOLITION	-
		Firm Quotations	0%	Amounts included above:	
		Indicative Quotations	100%	Subject to Investment Allowance	-
		Specific Achieved Costs	Nil	For Leasehold Improvements	
		General Estimating Costs	Nil	in Engineering	-
				For Preliminary Charges	Nil
				For Commissioning by Group	Nil

Source of Technical Information & Other Remarks

Non binding pump cost from Xylem in email 3/6/16 Includes supply of pump motor base testing and documentation
Prices for plant and labour based on similar project in 2013 and adjusted by 5%
Spare parts for Pump and VSD allowed in item 1
Cost of VSD and electrical equipment based on similar job in 2016
Contingency includes Capital costs and Engineering
No allowance has been made for Client costs
No allowance has been made for exchange rate variations

Quarter Date end										
Expenditure										

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
1		**PURCHASE OF NEW PUMP**							
	1.1	An estimate was received from Xylem for the supply of a Bell & Gossett VSH 18x20x22A horizontal split cas pump c/w base plate and	**INFORMAL**	**1**	**$117,000**				**$117,000**
		WEG W22 1000kw 415v 3 phase 50Hz Electric Motor with a nominal duty point of 84 ML/d @ 57m	**QUOTATION**						
		Copies of this quotation is contained within this cost estimate.							
	1.2	Allowance for delivery to site(from USA) - ***This is an estimate from KBR***	**ALLOWANCE**	**1**	**$50,000**				**$50,000**
	1.3	Allowance for on-site commissioning start up support (based on 2 weeks + travel + accommodation + expenses) - allow 20% of cost	**ALLOWANCE**	**0.2**	**$167,000**				**$33,400**
	1.4	Allowance for Pump Spares	**ALLOWANCE**	**0.1**	**$117,000**				**$11,700**
	1.5	Allowance for the supply of a new VSD to suit the pump and motor above.	**ALLOWANCE**	**1**	**$50,000**				**$50,000**
	1.6	Allowance for VSD spares - 10%	**ALLOWANCE**	**0.1**	**$50,000**				**$5,000**
		TOTAL						**$0**	**$267,100**

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**Pump Purchase**

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
2		**CIVIL CONSTRUCTION COSTS**							
	2.1	Site Establishment - Land sheds and connect temp power and water.	Below	0					$0
	4.2	Supply and erect temporary fencing	ESTIMATE	20	$500				$10,000
		=20wks @$500							
	2.3	Excavate suction and delivery pipework	ESTIMATE	2	$36,000				$72,000
		Assume 180m3 per manifold							
	2.4	Install piles and pipe supports for external pipework	ESTIMATE	3	$10,000				$30,000
		Assume $10000 / support							
	2.5	Construct pipe supports (inside PS)	ESTIMATE	4	$2,000				$8,000
		Assume $2000 per support							
	2.6	Ground Water Management	ESTIMATE	10	$2,000				$20,000
	2.7	Construct pump plinth	ESTIMATE	1	$15,000				$15,000
	2.8	Stitch cut pipe holes and seal after pipework installed	ESTIMATE	2	$10,000				$20,000
		Assume $10000 per hole							
	2.9	Import fill (allowance)	ESTIMATE	2	$36,000				$72,000
		assume 180m3 per manifold							
	2.10	Site Disestablishment	Below	0					$0
	2.11	Shoring	ESTIMATE	8	$2,000				$16,000
		Assume 8w @ $12,250/wk							
	2.12	Plant	ESTIMATE	2	$12,250				$24,500
		Assume 2w @ $22,000/wk (excavator, tipper, roller)							
	2.13	Contractors Margin - 10%	ESTIMATE	1	$28,750				$28,750
		TOTAL						$0	$316,250

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**CIVIL CONSTRUCTION**

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material: Delivered to Site Cost	Site Labour	Capital Content	TOTAL
3		**MECHANICAL INSTALLATION**							
	3.1	Site Establishment	Below	0					$0
	3.2	Install pump	ESTIMATE	1	$13,000				$13,000
	3.3	Supply valves	ESTIMATE	3	$20,000				$60,000
		Assume $20000 per valve incl actuator							
	3.4	Supply pipework	ESTIMATE	1	$60,000				$60,000
		Estimate $6000/12m +delivery and special pipes							
	3.5	Install pipework and valves	ESTIMATE	1	$36,000				$36,000
	3.6	Install Suction Tee	ESTIMATE	1	$10,000				$10,000
	3.6	Install Delivery Tee	ESTIMATE	1	$10,000				$10,000
	3.8	Supply and install platforms and stairs	ESTIMATE	1	$50,000				$50,000
	3.9	Check pump alignment	ESTIMATE	1	$10,000				$10,000
	3.10	Commissioning Assistance	ESTIMATE	1	$6,000				$6,000
	3.11	Electrical Room Ventilation	ESTIMATE	1	$25,000				$25,000
	3.12	Scaffold	ESTIMATE	6	$1,000				$6,000
		Assume 6 weeks @ $1000							
	3.13	Cranage	ESTIMATE	8	$2,000				$16,000
		Assume 8 Days @ $2000							
	3.14	Contractors Margin - 10%	ESTIMATE	1	$30,200				$30,200
		TOTAL						$0	$332,200

Project	SDP DWPS Pump Installation	Project No	SEG605
Location	SDP	Date	9-Jun-16
Prepared By	I WATTS	Section Title	MECH INSTALLATION

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
4		**E/I INSTALLATION**							
	4.1	Site Establishment	Below	1					
	4.2	Supply cable and tray	ESTIMATE	1	$50,000				$50,000
	4.3	Supply and install control panel	ESTIMATE	1	$25,000				$25,000
	4.4	Supply and install HV switch module	ESTIMATE	1	$40,000				$40,000
	4.5	Install VSD	ESTIMATE	1	$20,000				$20,000
	4.6	Connect Motor	ESTIMATE	1	$12,000				$12,000
	4.7	Supply and install instrumentation	ESTIMATE	1	$10,000				$10,000
	4.8	Set Operating parameters - overloads and instrumentation	ESTIMATE	1	$6,000				$6,000
	4.9	Testing	ESTIMATE	1	$6,000				$6,000
	4.10	Commissioning Assistance	ESTIMATE	1	$6,000				$6,000
	4.11	Contractors Margin - 10%	ESTIMATE	1	$17,500				$17,500
		TOTAL						$0	$192,500

Project	SDP DWPS Pump Installation	Project No	SEG605
Location	SDP	Date	9-Jun-16
Prepared By	I WATTS	Section Title	E/I INSTALLATION

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
5		**COMPUTER/PLC**							
	5.1	Allowance has been made for the changes necessary for the PLC changes to accommodate the new pump, using the current	**ESTIMATE**	**1**	**$30,000**			**$30,000**	**$30,000**
		SDP PLC engineer at SDP.							
	5.2	No allowance has been included for any other PLC changes, including hardware changes.							
		TOTAL						**$30,000**	**$30,000**

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**COMPUTER/PLC**

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material			
						Delivered to Site Cost	Site Labour	Capital Content	TOTAL
6		**CONSTRUCTION FACILITIES**							
	6.1	**SITE SHED HIRE**							
		Email quotation obtained from Coates (quote dd 21.11.13) for the hire of the following items:							
	6.1.1	Two x 6.0 m x 3.0 m Lunch rooms (unit hire rate $65 per week)	ALLOWANCE	20	$130				$2,600
	6.1.2	Two x 6.0 m x 3.0 m Change rooms (unit hire rate $56 per week)	ALLOWANCE	20	$112				$2,240
	6.1.3	One x Ablution Block (unit hire rate $112 per week)	ALLOWANCE	20	$112				$2,240
	6.1.4	Two x Site shed (unit hire rate $50 per week)	ALLOWANCE	20	$100				$2,000
	6.1.5	Delivery (delivery is each way via tilt tray - total of 14 deliveries - unit rate $200 per trip)	ALLOWANCE	14	$200				$2,800
	6.1.6	Cleaning on return (one charge of $90 per building item)	ALLOWANCE	7	$90				$630
	6.1.7	LTD Waiver charge (12 5% of hire costs)	ALLOWANCE	0.125	$9,080				$1,135
	6.1.8	Escalation Allowance - 10%	ALLOWANCE	1	$1,365				$1,365
		Note: Estimated hire duration (18 weeks construction duration + 2 weeks) is 20 Weeks							
	6.2	**SITE SHED ESTABLISHMENT - ELECTRICAL**	ALLOWANCE	1	$5,000				$5,000
	6.3	**SITE SHED ESTABLISHMENT - CIVIL**							
		Quotation was obtained off BCP Complete (quote # E21556 dd 13.11.13) for the following activities associated with the site establishment of							
		and disestablishment of the Contractors compound at Port Botany.							
	6.3.1	Install, level and plumb the six site sheds in to location	ALLOWANCE	1	$30,000			$30,000	$30,000
	6.3.2	Disestablish all site sheds	ALLOWANCE	1	Included				
	6.4	**DAILY CLEANING OF SITE SHEDS**							
	6.4.1	Allowance for the daily cleaning of site sheds ($550 per week - Mon to Fri only - for 14 weeks)	ALLOWANCE	20	$550			$8,250	$11,000
	6.4.2	Allowance for the stocking of cleaning equipment and materials ($600 per month for 5 months)	ALLOWANCE	5	$600			$2,400	$3,000
		Costs are based on previous works (similar Contractor's compound size).							
	6.5	**SKIP BIN HIRE**	ALLOWANCE	1	$300			$300	$300
		Allowance for the weekly hire of a 2 m3 skip bin for general cleaning waste (excluding demolition waste), including tipping fees.							
	6.6	**SITE SHED ESTABLISHMENT - ADDITIONAL ITEMS**	ALLOWANCE	1	$10,000			$10,000	$10,000
		Allowance for completing additional items associated with the establishment and dis-establishment of the Contractors compound (such							
		as signage; temporary fencing (star pickets and plastic barrier mesh); minor civil works; external lighting; plus extra site shed; etc.).							
	6.7	**SITE SECURITY PERSONNEL**	ALLOWANCE						$0
		No allowance							
	6.8	Contractors Margin - 10%	ESTIMATE	1	$7,431				$7,431
		TOTAL						$50,950	$81,740

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**CONST'N FACILITIES**

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
7		**CONSULTANTS**							
	7.1	**QA INSPECTION**							
		Piping Allowance for the engagement of external QA Inspection company (DJ B Inspections) to complete off-site and	**ALLOWANCE**	**36**	**$110**			**$3,960**	**$3,960**
		on-site inspections of new pipework being fabricated and installed for the new pump. Inspection rate for 2016 is $110 per hour							
		with no travel costs for Sydney Metro area. Allow 4 hours per visit + travel x 2 visits per week for a 3 week (both fabrication & installation timing).							
	7.2	**SAFETY CONSULTANTS**							
		INDEPENDENT HAZOP LEADER							
		Allowance for the engagement of an approved independent HAZOP leader to conduct the HAZOP for the works and issue a report.	**ALLOWANCE**	**1**	**$6,000**			**$6,000**	**$6,000**
		Cost based on recent proposal by Sherpa (Aug 2013).							
		TOTAL						**$9,960**	**$9,960**

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**CONSULTANTS**

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
8		**OTHERS**							
	8.1	**STATUTORY PAYMENTS**							
		Allowance for the payment of the following statutory fees incurred in the approval of this project:							
	8.1.1	Development Application Fee	ALLOWANCE	1	$0				$0
	8.1.2	Construction Certificate	ALLOWANCE	1	$0				$0
	8.1.3	Long Service Levy	ALLOWANCE	1	$0				$0
		Qenos to advise these costs							
	8.2	**SAFETY PROGRAM**							
		Allowance for the implementation of a safety program during the on-site construction and demolition project phases	ALLOWANCE	1	$0				$0
		Qenos to advise this costs							
	8.3	**COMMISSIONING EQUIPMENT**							
		Allowance for commissioning equipment and materials required for the commissioning of the new pump - unspecified.	ALLOWANCE	1	$5,000			$5,000	$5,000
		TOTAL						$5,000	$5,000

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**OTHERS**

Section Number	Item No.	ITEM DESCRIPTION	Unit	No. of Units	Unit Price	Equipment & Material Delivered to Site Cost	Site Labour	Capital Content	TOTAL
9		**SPARES**							
		No allowance has been made for the purchase of any spare parts except as noted.							
10		**UN-ALLOCATED ITEMS**							
		No allowance has been made for UAIs							
11		**CONTINGENCIES**							
		An allowance of 30% for total physical plant and engineering costs has been allocated on the summary page.							
12		**FACTORY ENGINEERING**							
		No allowance has been made for Factory engineering. SDP to add their costs separately.							
13		**KBR ENGINEERING**							
		Allowance for engineering and Project Managementof 15% has been included in summary page							
14		**ESCALATION**							
		No escalation allowance have been included within this cost estimate other than noted							

Project	**SDP DWPS Pump Installation**	**Project No**	**SEG605**
Location	**SDP**	**Date**	**9-Jun-16**
Prepared By	**I WATTS**	**Section Title**	**SPARES & ENG'G**

Appendix C: Estimate of Costs