Gladstone Area Water Board

Response to QCA Draft Report
Review of Pontoon Pump Station Option

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Table of Contents

Appendices

Section 1 Introduction

1.1 Background

Gladstone Area Water Board (GAWB) is a Category 1 Water Authority under the Water Act 2000 and a registered service provider under the Water Supply (Safety & Reliability) Act 2008. GAWB owns and operates bulk treated (potable) and raw (non-potable) water storage and supply system and is the sole source of water for the Gladstone region of Central Queensland. Assets include:

- Awoonga Dam on the Boyne River and raw water pumping station;
- 121 km of raw water pipelines including raw water reservoirs at Gladstone (50ML and 16ML) and Toolooa (50ML);
- Water Treatment Plants at Gladstone and Yarwun; and
- 90 km of treated water pipeline including treated water reservoirs at Boyne Island, East End, Golegumma, South Gladstone, Mt Miller, Gladstone Clearwater and Yarwun Clearwater.

The current operating arrangement is to pump raw water from Awoonga Dam to Toolooa Reservoir and the water is then distributed throughout the network under gravity. There is a minimum 24 hours reserve storage capacity in the raw water system and as such there is limited time available for preventive or corrective maintenance, in response to an unforeseen event, without potentially causing significant interruption to supply.

Since 2009, GAWB has commissioned numerous studies to review supply risks and identify a practical and cost effective solution to mitigate this risk and improve the reliability of supply. The option identified is the proposed Offline Storage and Standby Pumping System. The intent of the system is to provide a short term water supply independent of Awoonga Dam and the associated outlet structure, critical pipe work and Awoonga Pump Station such that:

- Scheduled major maintenance can be implemented without numerous high risk and short duration shutdowns; and
- That in the event of a major failure of critical infrastructure (concentrated at Awoonga), water supply to Gladstone and Gladstone industries may be maintained.
- Obsolescence of the DN700 pipeline is addressed i.e. the risk profile of customers is maintained.
- The solution implemented is cost efficient and doesn't increase the risk profile of GAWB or customers.

1.2 Recommendation by QCA

The Queensland Competition Authority (QCA) in its Draft Report *Gladstone Area Water Board Price Monitoring 2015 – 2020* February 2015 assessed the off line storage and repump station as prudent as it will facilitate the undertaking of condition assessment and maintenance of critical assets. However the QCA assessed that a pontoon pump station on the Awoonga Dam reservoir which was one of the risk mitigating options considered by GAWB as a more efficient option. The pontoon pump station does address the condition assessment and maintenance risk however it does increase GAWB dam safety risk profile.

Since the previous QCA review (2010) there have been numerous minor flood events, one major flood (December 2010) and one extreme flood (January 2013) at Awoonga. There has also been recently (February 2015) a combined cyclone / flood event, which impacted Awoonga and resulted in an extreme flood event in adjoining catchments (e.g. Callide Creek and Kroombit Creek) and Callide Dam. As a result of these events GAWB has acquired significant corporate experience in emergency and incident management, and insight into what is and is not achievable in such situations. There has also been progress, since initial studies in 2009 & 2010, identifying the pontoon pump station option, in workplace health and safety management and associated operational risk management. GAWB has also gained further corporate experience in undertaking (in-house and with EPCM contractors) major capital projects.

The off line storage and repump option, being remote from the dam, does not change the dam safety risk profile and, in addition, it mitigates transmission line risks between Awoonga Dam and Toolooa Reservoir.

1.3 Scope

The GAWB has requested that CDM Smith Australia Pty Ltd review the pontoon pump station option, as currently scoped, and:

- Provide a more detailed assessment of the risks associated with the operation of a pontoon pump both during routine operations and significant flood events;
- Identify and cost appropriate risk mitigating strategies;
- Assess the adequacy of the concept design of the pontoon pump station as currently developed, identify and cost any additional features considered necessary; and
- Noting that the detail design of the off line storage and repump option is well advanced and that the pontoon pump station is at concept level design, recommend appropriate contingencies to be used in the respective cost estimates.

1.4 Reviewer

The review was undertaken by CDM Smith's Principal Engineer David Murray who has over 39 years' experience in the planning, design and construction phases of major water infrastructure projects in Queensland including dams, weirs and large diameter pipelines. He started his career as a Design Engineer and worked on a number of major projects including the mass concrete Burdekin Falls Dam; Queensland's largest dam. In 1985, he was appointed Site Engineer at the dam providing the unique opportunity to build designs he had developed. In 1987, David was appointed Resident Engineer and oversaw the completion of the construction of the main dam and the earth and rockfill saddle dams.

Since that time David has undertaken the roles of technical advisor, design manager, construction manager, project manager and project director on a number of major water infrastructure projects. More recently he has served on the Expert Review Panel for Cedar Grove Weir, Bromelton Offstream Storage and was Chairman of the Expert Review Panel for Wyaralong Dam.

Section 2 Features of Proposed Pontoon Pump Station

2.1 Proposed Features

The Pontoon Pump Station Concept Design developed by Aurecon and included as an attachment to the R2A report has the following features:

- The pontoon is 14 metres long by 8.5 metres wide and expected to have a total weight of approximately 78 tonnes;
- 105 metres of floating pipeline;
- Permanent 11kV grid based power supply;
- Dual skin, self-bunded diesel tank;
- Concrete pad hard stand for hire diesel generators;
- A land based Control Room;
- Floating pontoon moored in the Inlet next to Viewing Area 2;
- Two land-mounted anchor points and an underwater anchorage;
- Automatic control of the pontoon's position via a 24V winch on each of the three mooring lines;
- Three duty pumps, 11kv/415Vtransformer and main switchboard located on the pump pontoon;
- On board davits to move pumps and motors around the deck;
- PLC located on the land based Control Room with remote I/O on the floating pontoon;
- A land based underground discharge pipeline
- Remote monitoring of the pontoon's operation via SCADA and 4G network back to a main control room at GAWB; and
- Initially 415V, 450kW motors would be fitted to the pumps. As demand grows, the pumps would be upgraded with larger impellors and 600kW motors.

2.2 Proposed Mode of Operation

It is anticipated that the floating pontoon would be moored on the dam near to Viewing Area 2, and require repositioning as water levels in the dam changes. The various operating locations are:

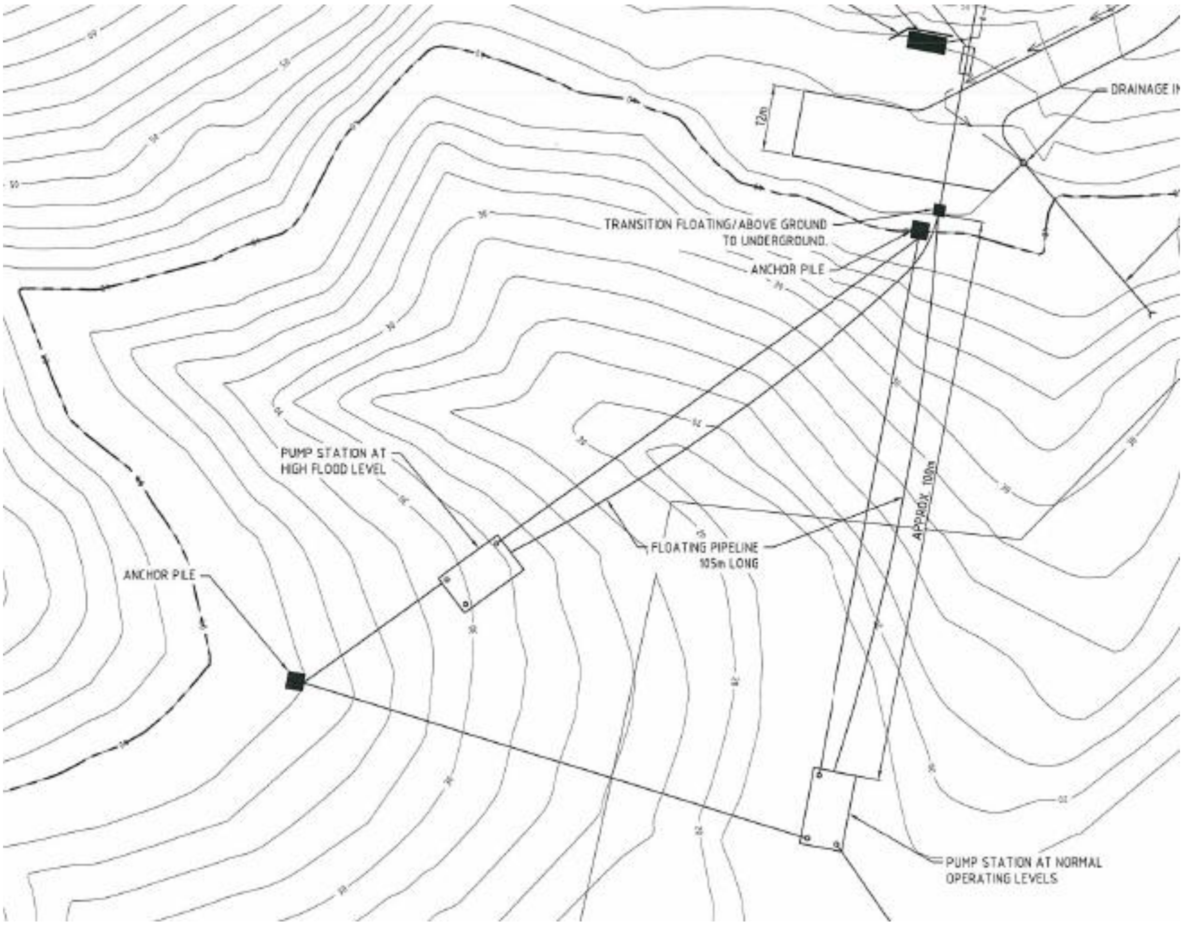
a) During normal weather and flow conditions the pontoon would be moored in water which has a depth to RL16;

b) During a high water/flood event, when water level rises up to and in excess of RL48, the pontoon would be winched to shallower water which has a depth to RL 30;

c) At extreme flood levels the pontoon would be moved in shore and hence, there would be no water production;

d) During low water levels RL 14 to RL 18 , the pontoon would be moved further out into the dam, and operate at a reduced duty point; and

e) Similarly, at very low levels, <RL 14, the pontoon would not operate, but it is not anticipated that this would eventuate in practice.



2.3 Proposed Costs

The proposed CAPEX costs for the Pontoon Pump Station (in 2010 $) have been extracted from the Aurecon Report. These costs are:

SUMMARY

Item	Description	Amount
1	PRELIMINARIES	$145,000
2	STEELWORK	$512,325
3	ANCHORS AND WINCHES	$251,550
4	PUMPS AND MOTORS	$395,000
5	PIPEWORK AND VALVES	$3,584,405
6	CONTROL BUILDING & CIVIL WORKS	$159,710
7	ELECTRICAL WORKS	$1,319,970
8	ENGINEERING, PROCUREMET & CONSTRUCTION MANAGEMENT	$746,755
9	MISCELLANEOUS	$757,661
	SUBTOTAL	$7,872,376
	CONTINGENCY 30%	$2,361,713
	TOTAL	**$10,234,088**
9	PROVISIONAL COST ITEMS	$375,000
	SUBTOTAL	$8,247,376
	CONTINGENCY 30%	$2,474,213
	TOTAL (WORST CASE) WITH PC ITEMS	**$10,721,588**

The proposed OPEX costs for the Pontoon Pump Station (in 2010 $) are included in the NPV analysis which have been extracted from the Aurecon Report. These costs are:

	Capital	Electricity	Gensets hire	Divers	Operations	Maintenance	Refurbishment	Future Value	Present Value
Estimated cost	-$10,234,088	-$6,000	-$87,265	-$20,000	-$10,000	-$30,000	-$605,967		
Escalation (a^{-1})		5%	4%	6%	4%	4%	3%		
IRR									8%
Year									
0	-$10,234,088		-$87,265					-$10,321,353	-$10,321,353
1		-$6,300			-$10,400			-$16,700	-$15,463
2			-$94,386	-$22,472	-$10,816			-$127,674	-$109,460
3		-$6,946			-$11,249			-$18,194	-$14,443
4			-$102,088	-$25,250	-$11,699			-$139,036	-$102,195
5		-$7,658			-$12,167	-$36,500		-$56,324	-$38,333
6			-$110,418	-$28,370	-$12,653			-$151,442	-$95,434
7		-$8,443			-$13,159			-$21,602	-$12,605
8			-$119,428	-$31,877	-$13,686			-$164,991	-$89,139
9		-$9,308			-$14,233			-$23,541	-$11,776
10			-$129,174	-$35,817	-$14,802	-$44,407		-$224,200	-$103,848
11		-$10,262			-$15,395			-$25,657	-$11,004
12			-$139,714	-$40,244	-$16,010			-$195,968	-$77,822
13		-$11,314			-$16,651			-$27,965	-$10,283
14			-$151,115	-$45,218	-$17,317			-$213,650	-$72,739
15		-$12,474			-$18,009	-$54,028	-$944,077	-$1,028,589	-$324,254
16			-$163,446	-$50,807	-$18,730			-$232,983	-$68,005
17		-$13,752			-$19,479			-$33,231	-$8,981
18			-$176,783	-$57,087	-$20,258			-$254,128	-$63,595
19		-$15,162			-$21,068			-$36,230	-$8,395
20			-$191,208	-$64,143	-$21,911	-$65,734		-$342,996	-$73,589
21		-$16,716			-$22,788			-$39,503	-$7,848
22			-$206,811	-$72,071	-$23,699			-$302,581	-$55,657
23		-$18,429			-$24,647			-$43,076	-$7,337
24			-$223,687	-$80,979	-$25,633			-$330,298	-$52,088
25		-$20,318			-$26,658			-$46,976	-$6,859
								NPV	**-$11,762,506**

Assumptions

Electricity	Estimated cost exc PC items (rounded)
Gensets	Hire three gensets for one month every two years, 140L/hour diesel @$1.5/L *40 hours
Divers	Hire divers for inspections every two years, $10000 per day (inc equipment mobilisation and insurances)
Operations	100 hours labour per annum at $100 per hour, inc minor maintenance
Maintenance	Major maintenance pumps and corrosion protection, 200 hours every five years at $125 per hour, $5000 materials, $25,000 barge
Refurbishment	Replace or rebuild M & E components every 15 years: 75% pump / motor, 10% electrical, 5% pipework costs

Section 3 Review of Dam Safety and Flood Risks

3.1 Dam Safety Risk

The pontoon pump is 14 m long, 8.5 m wide weighing 78 tonnes and secured by two land-mounted anchor points and an underwater anchorage. There is a credible risk that the pontoon could become untethered during a flood event

The risk or likelihood of this occurring increases with the severity of the flood event in that the approach velocities, wave action and debris load will increase accordingly.

An unsecured pontoon may result in the:

- partial blocking of the spillway which would cause a reduction in spillway capacity and may lead to overtopping of the dam and dam failure; or
- pontoon passing over the spillway creating the potential for significant physical damage to the spillway, associated services and downstream infrastructure.

In addition, 105 metres of floating pipeline, if not recovered, would result in a similar outcome although more likely to partially block the spillway.

If the pontoon did break free in an extreme flood event then it is likely that it would go over the spillway. It would likely float over the higher "ogee" spillway section and impact directly onto the lower spillway channel face, which is below the change in spillway gradient. The pontoon is also likely to impact on the spillway chute blocks at the base of the spillway face. The lower spillway face is a relatively thin concrete surface over rock. Depending on the size and location of the impact "crater", it is possible that this would lead to further un-ravelling of the spillway concrete, erosion of the rock sub-grade, and destabilising and ultimate failure of the spillway mass concrete structure above the lower spillway face.

Further:

- If the pontoon did break free and did not go over the spillway but impacted directly on the spillway or dam infrastructure then, aside from the damage that would directly occur, there is a real possibility that the direct impact and or build-up of debris and hydraulic pressure behind said impacted structure could destabilise the entire structure.
- If the pontoon did break free and go over the spillway (with or without damaging anything), bridge infrastructure downstream would be at risk. In all likelihood the GAWB spillway channel bridge (200m downstream) which supports the water supply delivery pipeline form the Awoonga pump stations would be severely damaged. This would prevent access to the right bank and pump station infrastructure and rupture the pipelines. Bridge infrastructure further downstream such as the North Coast Railway Bridge (8km downstream) could also be affected.

Notwithstanding it is difficult to quantify, the likelihood and consequence of this occurring is considered unacceptably high from a dam safety perspective. With an estimated Population at Risk of 500 to 750 people, the potential for loss of life is unacceptable.

There are two potential mitigating strategies which are discussed below:

1. Firmly anchoring the pontoon in place: and
2. Winching the pontoon to shore during a flood event.

Neither of these strategies is considered viable from a cost, WPH&S or dam safety perspective.

3.2 Anchoring the Pontoon

It is not possible to guarantee that the floating pontoon and the 105 metres of pipeline can be engineered to ensure that in times of flood, it will not become untethered. Hence, it will always pose a risk to the dam's infrastructure.

The only risk reduction approach that is considered possible for the pontoon is to have it rise and fall between piles driven into the dam floor. However, the operational range of the pontoon would be at least 34 m (EL14 to EL 48). The length of the pile would need to allow for the dead storage below EL 14 and water level rise above EL 48 and as such would be of the order of 50 m, say. Considering the flood induced velocities, operational range, wave action, wind loads and potential debris loads / impact piles would not be sufficiently rigid to support the pontoon and a more substantive support structures (four of) would be required.

A concept design for this has not been undertaken but the following summarises the requirement / features of each of these structures.

- To ensure that there is sufficient rigidity and the structure will not deflect or move under loading, a substantive column would be required, current "best guess" is 1.2 m to 1.5 m diameter column. The column may need to be thickened or strengthened with depth to maintain the rigidity;
- Secure anchoring and / or embedment of the structure in the floor of the reservoir would be required. This would need to be carried out under up to 30 m of water;
- To construct 20 to 35 metres of the structure underwater. This would require a substantial construction barge and the bulk of the structure would be constructed underwater; and
- Conversely, 15 m to 30 m of the structure would be constructed above water. Again, this would require a construction barge and there would be working over water and working at heights WPH&S challenges with this task that would need to be addressed.

This is not considered viable from a cost perspective and potentially a WPH&S perspective.

3.3 Operational Requirements during Dam Spill Conditions

The operational requirements to manage the pontoon in dam spill conditions involve:

a. Monitoring the dam's operation (1 hr/day for 3 days);
b. Deciding when the pontoon should be withdrawn from service (0.5 hrs);
c. Disconnect the discharge pipe from the pontoon & from its land connection, then hauling it on-shore whilst disassembling pipe spool by pipe spool (3 men x 12 hours);

d. Winching the pontoon into the shore line (will require a "Honda" type back-of-the-ute generator to operate the power pack for the winches should the power fail before or during the operation) (3 men x 2 hrs); and

e. Securing the pontoon once it is brought into shore. (3 men x 1 hr).

It will be necessary to temporarily store the pipes above maximum water level to ensure that the pipes are able to be recovered after the flood. A suitable temporary storage area has not been identified and as such the time for this task is not known but an allowance should be made for this.

This is a non-routine operation and these times could easily be extended during an emergency / flood event.

Consideration must be given to:

Notification Time

In recent years there have been a number of extreme rainfall / flood events in Queensland such as the January 2013 flood at Awoonga Dam. One of the learnings from these events is that notification times may be quite short. For example in January 2013 the flood forecasting models, using BoM 4 day rainfall forecasts, did not predict that the water level in Awoonga Dam would rise above EL 48 (the proposed trigger point for winching the pontoon to shore) until the reservoir had reached EL 43.4.

Access

An important consideration is the time required and the ability to mobilise this workforce to site particularly during a significant rainfall / flood event.

Historically dam operators have been prevented from accessing site during significant flood events and as such the pontoon pump station may remain in place. For example during the recent emergency associated with Cyclone Marcia, it is understood that operators of the Callide Dam were unable to attend site as they were in lock down in advance of the oncoming cyclone. Other factors such as swollen river systems, communications failure may also prevent timely access. As another example the Oaky River Dam near Armidale in NSW failed by embankment overtopping in 2013. While the actual cause of failure is yet to be determined, it is understood that the telemetry / instrumentation system did not alert the operator of the rapidly rising flood waters. By the time the operator arrived on site the dam had failed, thus preventing any mitigating actions; a telecommunication failure. It should be noted that the Oakey River Dam is a low hazard dam and there was no population at risk.

WPH&S

Another important consideration is the WPH&S issues associated with working over water particularly in times of flood. This is becoming an increasingly critical issue for dam operators. While it is acknowledged that the WPH&S issues can be mitigated for routine operations of the pontoon and a suitable work management plan can be developed, this is a non-routine activity being undertaken in an emergency situation thus exacerbating an already significant WHP&S risk. Careful consideration of the issues that arise during a significant flood event such as velocities between 1 and 1.5 m/s, wind induced wave action and the presence of debris will be required to ensure that a safe work procedure can be developed that will comply with GAWB WPH&S policy.

A conclusive opinion as to whether it will be possible to develop such a procedure is not possible until the scope is further developed to gain a better understanding of the location, equipment and operational modes. However it should be noted that it may not be possible.

Return to service

The reverse set of actions would need to be implemented once the dam has effectively stopped spilling involving:

- Check the pontoon is undamaged, check communications, power supply, etc and clean off various debris (2 men x 0.5 days);
- The main task is connecting up the discharge hose/pipe. A Franna crane will probably be needed for this day. The time for this will largely be dependent on where the pipe is stored once it is removed from the storage.(4 men x 2days, minimum); and
- Get the pumps operational (2 men x 0.5 days)

From a WPH&S perspective this operation should not commence until the spillway has stopped spilling. This could take weeks. During this time the pontoon pump station will not be available for operation. If the Awoonga Dam Pump Station ceases activity (eg power failure, inundation) in an emergency event the pontoon pump will not be able to provide supply.

From a dam safety perspective the pontoon pump concept should not be relied on. It is also not considered desirable from a WPH&S perspective.

Section 4 Review of Pontoon Pump Station Concept Design

4.1 Construction and Operational Challenges for Pontoon Pump Stations

Almost all pontoon pump stations have the following challenges:

1) Articulation of the power cables at both the land and pontoon ends (unless on board diesel generators are used);
2) Articulation of the discharge pipe at both the land and pontoon ends;
3) Maintaining power supply during times of adverse weather;
4) Getting maintenance staff to and from the pontoon. Working over water is an increasingly critical WPH&S concern;
5) Lifting pumps, motors and pipework both around the pontoon and from the pontoon back to land;
6) Cleaning/maintaining inlet strainers;
7) Mooring loads due to change in water level and wind loading;
8) Excluding public access and vandalism;
9) Launching point for construction assistance/ maintenance boats.

4.2 Additional Challenges for Awoonga Dam Pontoon Pump Station

The proposed Awoonga Dam Pontoon Pump Station has the following additional challenges:

1. The need to move the pontoon around the dam to operate in different locations depending on dam levels/flood status (off-shore during droughts, in-shore during flood events);
2. Significant fetch generated wave action;
3. Buoyancy (and hence stability) changes during pontoon life as pumps are upsized from 450 to 600kW; and
4. Fully remote monitoring of pontoon operation.

4.3 Review of the Proposed Features

Some features of the Awoonga Dam Pontoon Pump Station Concept Design are less than optimal, and would benefit from the use of alternative arrangements. These are:

1. Locate the switchboard in a land based control room/switch room and then run individual power cables each motor (via local isolator). This will increase the cable cost but will reduce

over water maintenance and will simplify electrical maintenance work because work on the starter module/VSD can be undertaken in the 'comfort' of a land based switch room. Increase in cost would be in the order of $30,000.

2. Replace the proposed soft starters (current cost allocation is $150,000) by 18 pulse VSDs to achieve longer ramp-up times and run-down times but with minimal harmonics. Shielded cable and the additional floor space in the land based switch room will also be required. The increase in cost would be in the order of $390,000.

3. Water flush via a dedicated pump, self-cleaning filter and associated pipework to clean the inlet screens in lieu of engaging divers on a regular basis. The increase in cost would be in the order of $20,000, but will reduce maintenance costs.

4. Using a floating walkway approximately 105m long to access the pontoon for routine maintenance in place of using boats. This will significantly reduce the working over water WPH&S risks and allow the use of hand trolleys to bring toolboxes and minor items onto the pontoon. The increase in cost would be in the order of $350,000.

5. Install load sensing hydraulic winches in place of the hand winches and the Provisional Cost Item 9.6 (Remote control and motorise winches) nominated in the report. The increase in cost would be in the order of $40,000.

6. Replacement of the serrated steel grating with sand impregnated fibreglass grating. This will contribute to a slightly lower overall pontoon weight and reduce the long term maintenance cost. The increase in cost would be in the order of $20,000.

Some key requirements for the Pontoon Pump Station appear to have been overlooked. It is recommended that the following features be added:

1. Preparation of a functional description for the pontoon's operation, preparation of a P&ID, communications schematic and agreement reached with the principal via a HAZOP. Currently, only $10,000 has been allowed. The increase in cost would be in the order of $40,000.

2. Preparation of 3D model of the pontoon, buoyancy check, piping design, detailed design, on-shore piping design, pipeline design, water hammer analysis and associated drafting. The current allowance of $20,000 for 'shop drawings' should be increased by $250,000.

3. There is no allowance for electrical design, liaison with the supply authority, PLC, SCADA & RTU programming, only $20,000 for minimal system integration. These extra tasks should be included. The increase in cost would be in the order of $120,000.

4. Construction of the pontoon will require access stairs on each side from the water up to the pontoon deck (for both divers and maintenance staff who may fall into the water), life buoys located at key locations and fenders at key points where maintenance boats may tie up. Additionally, a davit will be required to lift items out of a boat and up onto the deck of the pontoon. The increase in cost would be in the order of $25,000.

5. Installation of HDPE float chambers or equivalent (to contain the foam now that open sections have been nominated) as a more robust, versatile and flexible solution. These are a standard size, but of variable depth, so they can be changed out during the design or manufacturing stages of the project if there is a last minute design change. The increase in cost would be in the order of $40,000.

6. During manufacture, suitable QA systems need to be in place to ensure materials, weld procedures and fixings are correct. The increase in cost would be in the order of $30,000.

7. After manufacture, the pontoon needs to be pre-assembled prior to surface protection. This has not been allowed for. Suitable workshop facilities will be required. The increase in cost would be in the order of $50,000.

8. Construction of a crane pad to lift items into and out of the dam. Crane pad would set back from the edge of the bank and would require a suitable level of compaction for a crane of up to 500 tonnes. The crane pad would need to be constructed in conjunction with a land based winching system and a dredged out docking area to bring the pontoon inshore during periods of high flood and close to the crane pad to minimise the size of the crane needed. The concept design suggests using either the existing boat ramp (which has sealed access) or a temporary ramp (which will not have sealed access). Sealed access is essential and a ramp will not allow the pontoon be brought close to shore. Additionally, the size of the crane may be constrained by the clearance and load carrying capacity of the access roads to the dam site. In addition to the construction of the crane pad and the inshore bay, a geotechnical report and civil design costs will be incurred. The increase in cost would be in the order of $200,000.

9. A suitable laydown area is required adjacent to the crane pad to allow the various major components to be stored prior to their inclusion in the assembled pontoon. Storage containers, temporary power, basic site facilities and temporary fencing will also be required. The current allowance of $50,000 is based on minimal site works. The increase in cost will be in the order of $50,000.

10. Provision to dismantle the pump discharge pipe as the pontoon is winched into shore during periods of high flood levels. This will require regular flanging of the pipe and an onshore bay to receive and remove the pipe segments. A small winch and a pipe holding rack will also be required. Increase in cost would be in the order of $40,000

11. An onboard PTZ (pan tilt zoom) camera and a pair of shore mounted cameras would allow effective remote operation of the pontoon from the Gladstone control room. Increase in cost would be in the order of $15,000.

12. An on-board depth sensor to monitor the depth of water below the pontoon. This will be especially useful during extended periods of dry weather when dam levels will drop. Increase in cost will be in the order of $5,000.

13. Concrete slab for the dual skin, self-bunded diesel tank to supply temporary diesel generators. A similar allowance should be included as has been allocated for the generator slab. Further, a small external slab will be required for the air cooled transformer. The increase in cost will be in the order of $20,000.

These cost increases are summarised in the table below:

Item	**Description**	**Cost Allowance**
Upgrade 1	Locate switchboard and transformer on land	$ 30,000
Upgrade 2	Replace Soft Starters with VSDs	$390,000
Upgrade 3	Provide a dedicated water flush system for the inlet strainers	$ 20,000
Upgrade 4	Floating walkway out to pontoon	$350,000
Upgrade 5	Upgrade hand winches to hydraulic winches	$ 40,000

Upgrade 6	Replace steel grating with fibreglass grating	$ 20,000
Addition 1	Prepare formal Func Spec, P&ID, HAZOP and reach agreement	$ 40,000
Addition 2	Engineer the pontoon and pipework both on-shore & off-shore	$250,000
Addition 3	Comprehensive electrical design HV, LV and comms	$120,000
Addition 4	Add access stairs, fenders and life buoys to pontoon	$ 25,000
Addition 5	Add HDPE float chambers to pontoon	$ 40,000
Addition 6	Ensure a QA system is in place for pontoon manufacture	$ 30,000
Addition 7	Trial assembly of pontoon at workshop	$ 50,000
Addition 8	Crane pad and in-shore docking bay	$200,000
Addition 9	Larger laydown area and site facilities	$ 50,000
Addition 10	Discharge pipe dismantling equipment on-shore	$ 40,000
Addition 11	Cameras to monitor pontoon operation	$ 15,000
Addition 12	Depth sounder and GPS to monitor pontoon depth	$ 5,000
Addition 13	Slab for fuel tank & transformer	$ 20,000
	Total	**$1,735,000**

4.4 Comparison to Pontoon Pump Station on Eungella Dam

The proposed Awoonga Dam Pontoon Pump Station concept is based on the existing pontoon pump station on Eungella Dam that was manufactured and commissioned in 1997. The pump station supplies water to the 122 km pipeline to Moranbah that supplies the resource sector.

In assessing the relevance of this design to the Awoonga Dam proposal, there are two key differences in the projects that should be noted:

1. Eungella Dam is a considerably smaller dam with a significantly lower dam safety risk profile. Eungella Dam stores 112,400 ML of water compared to Awoonga Dam that stores 777,000 ML Eungella Dam is approximately 200 km upstream of the nearest built up area in the western part of the Burdekin Irrigation area near Ayr compared to Awoonga Dam which is just 30 km from Gladstone; and

2. The decision to accept the risks associated with a pontoon pump station at Eungella Dam was based in part on the fact that two backup storages near Moranbah were in included the project. These storages provide 2+ weeks supply to mitigate supply associated with the operation of the pipeline including the pump station.

It is understood that based on operational experience with pump station, modifications to the system are now being proposed that will address some of the issues identified above.

While it is a reasonable benchmark, the risk profile at Awoonga Dam and hence the appropriateness of the pontoon pump station is quite different to that at Eungella.

Section 5 Review of Pontoon Location

5.1 Variations in Water Levels

The pontoon location is not ideal since there are a number of competing factors. The main driver is pontoon security during major flood events. It is critical to ensure that the pontoon is kept or moved to a safe location during a flood or severe storm event so that it does not break away from one or more of its mooring points. If it did break away, the pontoon would block or damage the dam spillway resulting in severe consequences.

A location (Site 3) has been selected in the R2A/Aurecon report which provides a good compromise in terms of security during floods, access to water depth, and at the same time minimising exposure to wind generated wave action.

It seems possible to move the pontoon, via the winches, from one location to another to take advantage of the variation in water depth. However, the range of movement is limited by the length of the pump discharge pipe and its relative inflexibility. HDPE pipes have minimal flexibility.

Consequently, it does not appear to be feasible to move the pontoon from above RL 16 to above RL 30 as indicated on the layout drawing. It seems possible to move the pontoon marginally to adjust for the varying dam water level. To allow this to be done remotely, cameras would be required and load sensing on the winches. Consequently, hydraulic type winches are needed to enable load sensing to take place.

Bringing the pontoon into an inshore position would appear to be a very difficult task. As the pontoon approaches shore, progressive segments of the discharge pipe would have to be removed to allow the pontoon keep moving forward. This is labour intensive and time consuming. Additionally it would have to be undertaken during adverse weather conditions. It does not appear to be a viable scenario.

5.2 Maintenance Safety and Efficiency

Undertaking maintenance on the pontoon has both safety and efficiency concerns. These include:

1. Most WHS regimes would require two people to be in attendance when working over water. So tasks normally undertaken by one person (e.g. basic maintenance checks) now have to be scheduled with two people in attendance. Unless a floating walkway is installed, a boat would have to be taken to site, launched, manoeuvred to alongside the pontoon and then staff would have to climb from the boat onto the pontoon. Additionally, these boat and transfer arrangements limit the size and weight of tools, spare parts and equipment which can be taken to or from the pontoon. A floating walkway avoids the need to get into or out of boats however it is also another asset that will need to be removed in a flood event. It also allows the use of hand trolleys to move objects to and from the pontoon.

2. The current configuration which has the transformer and main switchboard on board the pontoon necessitates that much of the electrical maintenance has to be carried out over water. Relocating these items to a land based switchroom provides the switchboard with weather protection and greatly improves maintenance safety and efficiency.

3. Major maintenance (e.g. replacement of an electric motor, etc) would require the pontoon to be brought into shore where a crane can be arranged to lift it of the pontoon. As

mentioned previously, the discharge line would have to be disconnected pipe spool by pipe spool, or the discharge line disconnected from the pontoon and 'set adrift' so that the pontoon can be brought ashore. This turns a big task into a major task. An alternative design, by one pump vendor, has floating pump modules which attached to a pontoon. To undertake major pump maintenance, the pump is disconnected electrically, a spool is removed from the discharge pipework then the pump module is released for towing back to shore. A smaller mobile crane can then lift the pump and or pump module out of the dam so it can be taken away by truck for workshop repairs. This seems like a more flexible and easier way to proceed.

5.3 Cost Impact of Infrastructure Requirements

The cost of the infrastructure requirements listed above has been included in the cost summary at the end of the Review of the Pontoon Pump Station Concept Design.

Section 6 Review of Maintenance Timeframes & Cost

The pontoon structure, with adequate surface protection would be expected to last 25 years, with major coating maintenance expected after 15 years. This would mean removal from water and re-coating.

Mechanical and electrical equipment would be expected to have a service life of 15 years with bearing and seal replacements typically programmed every 5 years. This may be extended since the pontoon is only anticipated to be standby pump. It may see very little use, perhaps a short run each week and a week or two continuous operation each year.

A cost allowance of around 2.5% of the capital cost should be allocated for ongoing maintenance. This would provide a sinking fund from which major services could be paid.

Section 7 Review of OPEX Costs from R2A report

The R2A report listed 5% of the pump capital cost and the piping cost for spare parts. This seems high for the piping costs, given that only the articulated joints are expected to need servicing. Labour costs have to be included as well.

Power costs would be reliant on the duration of operation each month/year (to be determined) and the power purchase cost (to be advised).

Until further information becomes available, then the values in the NPV analysis given in the Aurecon Concept Design which is attached to the R2A report are suitable benchmarks.

Section 8 Contingency and Adjusted Cost Estimates

Contingency is the assessment of dollar value of the uncertainty and risks associated with the project at the stage of development when the cost estimate is prepared. It is commonly calculated as a percentage of the known costs.

The contingencies used in the estimates for off line storage and pump infrastructure and pontoon pump station have been reviewed based on extensive experience with the type of infrastructure and reference to *Association for the Advancement of Cost Engineering International TCM Framework: 7.3 – Cost Estimating and Budgeting November 29, 2011*.

The design of the off line storage and pump infrastructure is significantly further advanced when compared to the pontoon pump station. As such there is more certainty regarding the scope of the offline storage and pump infrastructure than the pontoon pump station. For example the exact location of the pontoon and where and how it connects to the existing pipe network are still not resolved. As such the contingency used in the pontoon pump station estimate should be significantly higher than the offline storage and pump infrastructure estimate to reflect the greater certainty of scope.

The cost estimates, dated 31/1/2014, for the off line storage and pump infrastructure is $20.3 M and includes a contingency 30%. A contingency of 30%, is typical for a project of this nature that has reached Preliminary Design stage. Notwithstanding that as of 31/1/2014 the detail design of this project including geotechnical investigations was well advanced, an initial review of the detail design drawings suggests that a peer review will require further refinement of the design including the filter detail particularly around the outlet structure and as such the 30% contingency is considered appropriate albeit conservative.

The cost estimate for the pontoon pump station, based on a concept level design prepared in 14/9/2010 is $10.7 M and includes a contingency of 30%. However as discussed above a detail review of the original concept has identified a number of design and operational deficiencies. The cost estimate has been adjusted to include provisions to address these deficiencies. These provisions, totalling $1.7 M are "best guess" estimates based on experience with similar infrastructure. Generally a 50% contingency would be considered appropriate for a feasibility / concept level of design. While noting the major unknowns and deficiencies in the concept design discussed above, a 50% contingency is considered appropriate in this instance. The adjusted estimate for the pontoon pump station is $14.8 M.

Section 9 Summary and Conclusions

The following summarises the strengths and weaknesses of the pontoon pump station option when compared to the offline storage and pump infrastructure option.

9.1 Strength

Lower CAPEX – The pontoon pump is approximately $5.5 M cheaper;

The pontoon pump station can provide water for periods longer that 2 weeks.

9.2 Weakness

The pontoon pump station does not mitigate risk to the transmission pipeline between the Dam and Toolooa Reservoir;

The presence of the pontoon pump station near the spillway creates an unacceptable dam safety risk. Potential mitigating strategies are not considered viable or reliable from a dam safety perspective;

Operation of the pontoon particularly during a flood event creates a WPH&S risk. Based on the current information it may not be possible to develop a work procedure which will comply with GAWB's WPH&S policy that will satisfactorily mitigate this risk;

The proposed operation of the pontoon involves moving the location to minimise the dam safety risk. This is not considered viable due to the relative inflexibility of the HDPE delivery pipe;

A review of the proposed concept has identified a number of deficiencies with the design as currently assessed. High level cost estimates to address these issues have been assessed and the cost estimate including contingency allowance has been updated accordingly. Notwithstanding clearly there is more certainty in cost estimate for the off line storage and repump option than the pontoon cost estimate.

Considering the dam safety and WPH&S issues, the uncertainty with the proposed design and operation and hence cost, it recommended that the pontoon pump station not be adopted.

Appendix A - Disclaimer and Limitations

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