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Gunns Limited

Northern Tasmanian Pulp Mill Project

Concept Design for Water Supply from Lake Trevallyn

Report – Revision 2

June 2006

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

Gunns Limited is preparing a draft IIS for a proposed pulp mill at Bell Bay.

The Scope Guidelines for the IIS require a description and assessment of water supply arrangements.

Four water supply options have been considered for the pulp mill – extracting water fro the Curries Dam/Pipers River system, extracting water from Lake Trevallyn and piping the water to the pulp mill site, domestic sewage reuse from Launceston City Council's waste water treatment plants, and installing and operating a desalination plant. The Trevallyn Lake option is preferred as the most cost effective and technically feasible option, with lesser potential environmental impacts than the other options. Consequently, this report reviews the feasibility and undertakes a concept design of a water supply scheme to the mill, sourcing its water from Trevallyn Dam – located west of Launceston. The proposal includes the construction of a new pump station located between the eastern abutment of the dam and Hydro Tasmania's intake tunnel, as well as the installation of a large bore rising main along Trevallyn Road, Reatta Road, Hydro Tasmania's Trevallyn Power Station Intake tunnel easement, across the Tamar River and along the East Tamar Highway to the Bell Bay Site.

The assessment concludes that, from an engineering perspective, it is feasible to construct a water supply scheme for the pulp mill from Lake Trevallyn. There are, however, a number of social and stakeholder issues that need to be considered and addressed to ensure the successful implementation of this proposal. The most important matters include:

1. Consultation with Hydro Tasmania to ensure that it will make water available from Lake Trevallyn;
2. Undertaking a review of the underground services along the proposed pipe corridor following the East Tamar Highway;
3. Undertaking survey and geotechnical investigations at the pump station site and along the pipeline route to verify cost estimates for ground conditions; and
4. Consultation and approval with the relevant authorities and landowners along the proposed pipeline route.

A brief description of the other water supply options considered by Gunns is also included in this report.

2. Existing System

2.1 Trevallyn Dam

The Trevallyn Dam and Trevallyn Power Station are owned and operated by Hydro Tasmania. The following is a summary of information obtained from Hydro Tasmania staff and from bulletins on their web site.

The Trevallyn power station forms part of the South Esk Hydro Scheme, which also includes the Poatina Power Station, flowing from the Great Lakes.

The South Esk catchment covers an area of 9,000 square kilometres (about 12 percent of the whole State). The river rises on the eastern slopes of Ben Lomond and flows for 190 kilometres in a wide sweep to the south. Two major tributaries, the Macquarie and Meander Rivers, join it before flowing into the Tamar Estuary at Launceston.

The Trevallyn Dam was constructed in 1955. It is a concrete gravity dam, located on the South Esk River, upstream of Cataract Gorge. The dam has a maximum height of 28 m and crest length of 130 m, with an operating top water level of RL 127 m and minimum operating level of RL 122 m. The 1,000 year recurrence interval flood level is at RL 137 m.

Trevallyn Dam is a true run-of-the-river station, having very little storage and making use of daily flows down the South Esk. Flow into the dam is partly controlled by discharge through the Poatina Power Station, which comprises six 50 MW generators in a large underground facility. The static head into the turbines is 830 m.

The following table summarises flow data between 1995 and 2004 for Trevallyn Dam as supplied by Hydro Tasmania.

Table 1 Summary of Trevallyn Dam Flow Data

	Average Daily Inflow to Lake Trevallyn	Average Daily Discharge to Cataract Gorge	Average Daily Outflow to Trevallyn Power Station	Daily Hours of Operation of Trevallyn Power Station
Average	50.9 m^3/s	24.8 m^3/s	51.7 m^3/s	22 hours
Median	25.1 m^3/s	0.43 m^3/s	51.9 m^3/s	24 hours
Minimum	-	0.070 m^3/s	0	0
Maximum	1,250 m^3/s	1,160 m^3/s	111 m^3/s	24 hours
10% ile	9.33 m^3/s	0.38 m^3/s	23.4 m^3/s	16.7 hours
90% ile	115 m^3/s	77.3 m^3/s	81.0 m^3/s	24 hours

This data is plotted in Figure 1.

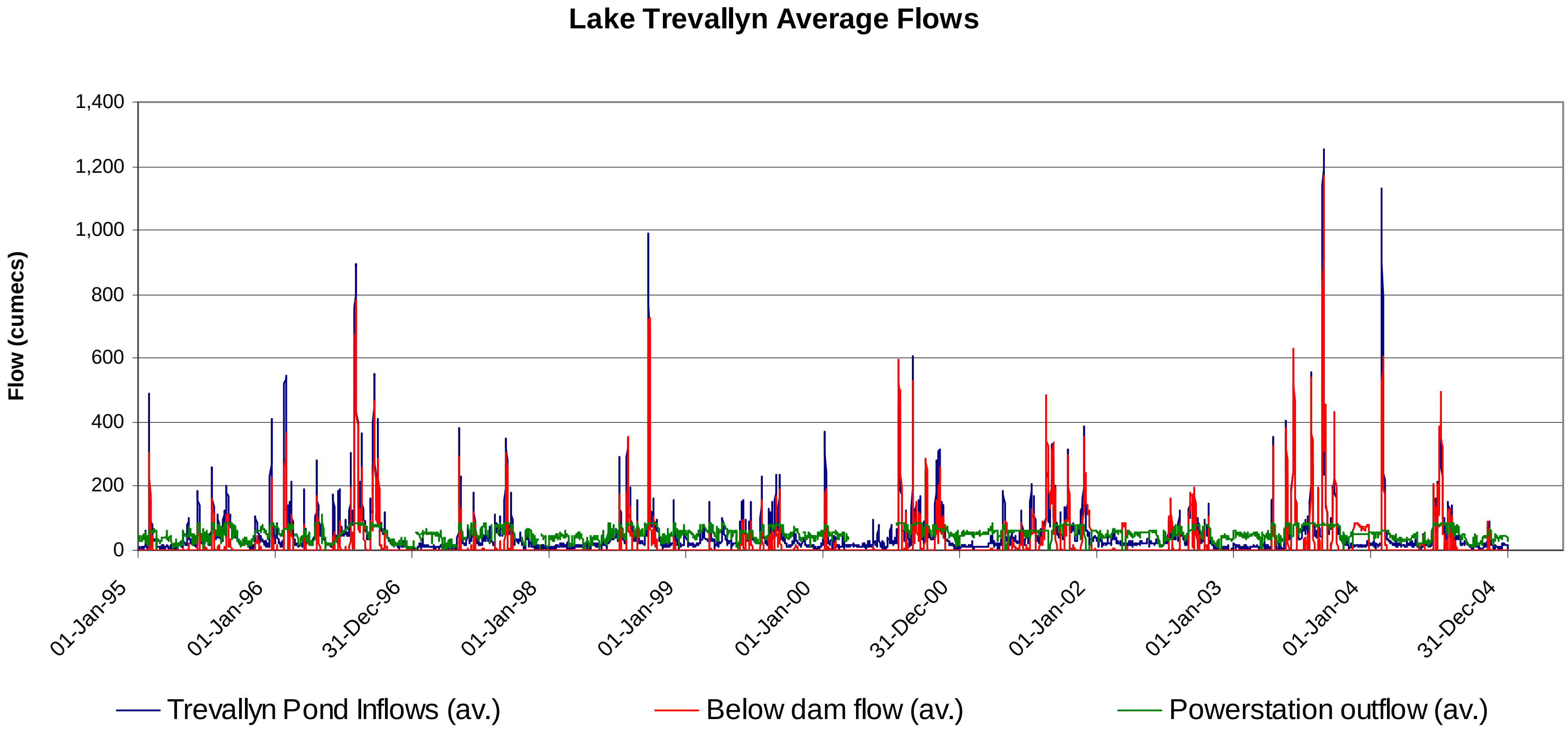


Figure 1 Lake Trevallyn Average Flows

Poatina Power Station sources its water from the Great Lake, which formerly was discharged into the Shannon and Waddamana Power Stations flowing to the south and into the Derwent scheme.

The other major tributary of the Trevallyn dam catchment is the Meander River. A 45GL dam is currently under construction on the Meander River near the confluence with Warners Creek with a scheduled completion date of December 2007. This dam will provide approximately 24 GL of water per year for irrigation.

The Trevallyn Dam is used for:

1. Regulating storage for hydro power generation;
2. Water source for part of Launceston City Water supply; and
3. Maintaining baseline environmental flows through Cataract Gorge

Gunns has been advised that planning should be based on Lake Trevallyn being drained down to RL 117m for maintenance of the trash racks at the power station intake tunnel twice a year for one week on each occasion. There are also planned major three month long shut downs every ten years, which last approximately three months, during which the water level will be dropped to RL 107 m AHD.

2.2 Trevallyn Power Station

There have been hydroelectric schemes in the Trevallyn area from as early as 1896, when the Launceston City Council constructed a small system at Duck Reach. This was destroyed during floods in 1929. It was rebuilt after the floods and sold to the Hydro Electric Commission in 1944.

The Trevallyn Power Station, which was commissioned in 1955, replaced the Duck Reach scheme and comprises:

1. A 3.2 km long tunnel from Lake Trevallyn to the Trevallyn Power Station, located on the western side of Ti Tree Bend on the River Tamar; and
2. A hydro electric power station comprising 4 turbines, each with capacity of 20 MW. The power station operates with a static head of 112 m, is capable of receiving 80 m^3/s of flow, and has an operating efficiency of 80%.

The power station discharges into the Tamar River at sea level, and is used intermittently during the day to provide peak demand. This intermittent operation will continue once Basslink is operational, as the Trevallyn Power Station is the closest facility to the Bass Strait crossing.

2.3 Launceston Water Supply

Lake Trevallyn is also a major source for Launceston's domestic water supply. Esk Water has a deep well vertical turbine pump station on the eastern abutment of Trevallyn Dam, which feeds water through two 450 mm diameter steel mains to the Prospect and Reatta Road WTP's. Prospect WTP has a capacity of 20 ML/day and feeds the western and south-western suburbs of Launceston. The Reatta Road WTP also has a capacity of 20 ML/day and serves the northwest suburbs of Launceston, as well as the population centres along the West Tamar Highway as far as Beaconsfield.

The Esk Water Pump Station is constrained in space and there is little scope to upgrade its capacity to any extent

2.4 Nominal Flow Below Dam

Downstream of Trevallyn Dam, the South Esk flows through Cataract Gorge, which is a popular tourist destination and is used extensively by locals as a swimming area during summer. There has been public concern regarding the small base flow (currently set at 1.5 m^3/s base line) and its impact on the gorge.

Downstream of the gorge, the South Esk flows into the Tamar River. This section of the Tamar is tidal and subject to siltation problems primarily from the North Esk River, which runs through large areas of farmland. The base flow (1.5 m^3/s) is being monitored by Hydro Tasmania for a five year period, starting in 2003, to assess the impact of this flow on the Tamar River.

3. Water Demands

Gunns provided the study team with the following water demand for the proposed pulp mill:

Table 2 Design Water Demand for the Pulp Mill

Production at Pulp Mill	1,100,000ADt/yr
Annual Water Demand	26.0 GL
350 days/year Operation**	75 ML/d

** A 350 day operating year due to 15 days non production per annum.

The pump station and pipeline will be sized for a flow of 40 GL/yr to allow for some future industrial growth in the area or other industries along the pipe corridor.

4. Proposed Trevallyn Source Water Supply Scheme

4.1 General Description

The proposed water supply scheme for the pulp mill from Lake Trevallyn will comprise the following key components:

1. A raw water pump station located between the eastern abutment of the dam and Hydro Tasmania's intake tunnel;
2. A pipeline following Trevallyn Road, Reatta Road and the Hydro power station intake tunnel route to the edge of the Tamar River;
3. A 3 ML balance/control tank at the top of the hills near the Reatta Water Treatment Plant;
4. A pipeline under the Tamar River to the East Tamar Highway;
5. A pipeline following the East Tamar Highway to the pulp mill site;
6. A 670 ML storage dam above the pulp mill site, including pipe connection;

The pump station and pipeline will be designed to accommodate future industrial growth in the area or along the pipe corridor with staging incorporated where practical. The pumps will be designed for a design flow of 26 GL/yr with provision for expansion by adding additional pumps. The pipeline will be sized for a nominal flow of 40 GL/yr.

The proposed pipe corridor and resultant hydraulic grade line are depicted in Figures 4 and 5.

There are two significant vertical features of the proposed pipe corridor – the high point adjacent to Reatta Road WTP (RL 210 m approx), and the high point approximately 500 m north of the Magazine Road Junction (RL 155 m approx). These determine the hydraulic grade line of the pumping system for most design scenarios for realistic pipe sizes.

4.2 Water Balance

The impact of drawing water from Lake Trevallyn was assessed using historical flow data obtained from Hydro Tasmania for the period spanning 1994 to 2004.

The model assumed the following scenario for taking water from Lake Trevallyn:

1. Water will be taken from the portion of flow entering Cataract Gorge when the dam is surcharging (i.e. there would be no impact on the Trevallyn Power Station Operations) This occurs on average about 80 days/year.
2. On all other occasions the water will be taken from Lake Trevallyn.

The seasonal results of the water balance analysis are as shown in Table 3.

The approximate percentage average impact on the net power station and Cataract Gorge flows is minimal, as outlined in Tables 3 and 4.

4.2.1 Conclusions

The potential impact on water flows out of the Trevallyn Dam as a consequence of water usage by the pulp mill based on the past 10 years historical records (1994 to 2004) is as follows:

Table 3 Impact of Mill Water Extraction on Lake Trevallyn

	% Reduction (Approx.)
Flow Through Cataract Gorge	0.79%
Flow Through Power Station	1.28%

If all the flow were extracted from the Trevallyn Power Station allocation, then there would be no reduction in the Cataract Gorge flow and the power station flow would reduce by about 1.66%.

Base flows down the Cataract Gorge will be maintained.

Table 4 Percentage Average Seasonal Impact on Net Power Station and Cataract Gorge Flows

Season	Approximate Retention in Flow Through Trevallyn Power Station	Approximate Retention in Flow Through Cataract Gorge
	Pulp Mill demand 26 GL	Pulp Mill demand 26 GL
Autumn	98.0%	98.7%
Winter	99.1%	99.2%
Spring	99.1%	98.9%
Summer	98.4%	99.0%

Table 5 Lake Trevallyn Water Balance Analysis Seasonal Results

Year	Season	Power Station Average Flow		Cataract Gorge Average Flow	
		Before Pulp Mill [cumecs]	After Pulp Mill @ 26 GL/yr [cumecs]	Before Pulp Mill [cumecs]	After Pulp Mill @ 26GL/yr [cumecs]
1995	Autumn	36.0	35.2	0.8	0.8
	Winter	55.5	54.9	10.9	10.6
	Spring	45.3	44.6	4.3	4.1
	Summer	60.1	59.5	29.0	28.8
1996	Autumn	40.6	39.9	10.2	10.1
	Winter	65.6	65.2	88.3	87.7

	Spring	47.6	47.1	51.1	50.8
	Summer	28.2	27.4	0.4	0.4
1997	Autumn	32.9	32.1	9.9	9.8
	Winter	52.9	52.1	4.6	4.4
	Spring	43.1	42.3	18.9	18.7
	Summer	30.9	30.0	0.4	0.4
1998	Autumn	33.4	32.5	0.4	0.4
	Winter	62.7	62.0	26.3	26.1
	Spring	59.9	59.3	32.7	32.5
	Summer	57.7	56.9	0.7	0.6
1999	Autumn	58.6	57.8	3.2	3.1
	Winter	54.0	53.5	21.4	21.0
	Spring	51.9	51.2	8.7	8.5
	Summer	51.3	50.5	7.1	6.9
2000	Autumn	3.9	3.0	0.6	0.6
	Winter	38.1	37.4	59.1	58.8
	Spring	69.5	69.2	52.6	52.1
	Summer	48.6	47.7	0.4	0.4
2001	Autumn	54.6	54.0	11.8	11.5
	Winter	55.2	54.9	63.7	63.1
	Spring	74.8	74.4	68.5	68.0
	Summer	44.6	43.9	22.4	22.2
2002	Autumn	48.9	48.2	8.4	8.3
	Winter	46.7	45.9	11.1	10.9
	Spring	55.3	54.8	27.6	27.3
	Summer	45.1	44.2	0.4	0.4
2003	Autumn	50.0	49.3	29.0	28.9
	Winter	78.3	78.0	130.1	129.5
	Spring	58.1	57.7	62.4	62.0
	Summer	52.1	51.6	48.1	47.7
2004	Autumn	34.9	34.2	3.2	3.1
	Winter	66.5	66.1	63.7	63.2
	Spring	34.5	34.3	6.3	5.6
	Summer				
Average	**Autumn**	**39**	**39**	**8**	**8**
	Winter	**58**	**57**	**48**	**48**
	Spring	**54**	**53**	**33**	**33**
	Summer	**47**	**46**	**12**	**12**

4.3 Raw Water Pump Station

4.3.1 Options

It has been assumed Lake Trevallyn will normally fluctuate between a top water level of RL 127 m and a minimum water level of RL 122 m. Twice yearly, the water level in the dam may be lowered to RL 117 m to allow maintenance works to be carried out to Hydro Tasmania's intake tunnel. These works last about one week on each shut down. There are also planned to be major shut downs every ten years that last around three months where the water level will be lowered to RL 107 m.

The pump station electrical works will be located above RL 137 m, which Hydro Tasmania advise is the 1 in 1,000 year flood level.

This range of lake water levels is large and difficult to meet with a single pump station. Three options were examined as part of this study:

1. A deep wet well type pump station;
2. An inclined draft tube arrangement; and
3. A temporary low level pumping for the extreme low flow events.

A summary of these findings is outlined below.

4.3.2 Option 1 Deep Wet Well Pump Station

This arrangement would include a deep wet well, extending down below the lowest lake level (approximately 104 m) with long vertical turbine pumps contained in the well. Refer Figures 4 and 5.

Water will be drawn from Lake Trevallyn through twin 1,200 mm diameter intake pipes laid horizontally into the pump station wet well at 3 m below the lowest water level. The pipes will be at a level sufficient to ensure reliability of supply when the dam water level is at RL 107m.

The pump station will be located between the eastern abutment of the dam and Hydro Tasmania's intake tunnel, positioned to minimise the length of intake pipe required to reach the lowest point.

The floor of the pump station will be set at approximately RL 137m, which is 1m above the 1 in 1,000 year lake flood level.

There will be coarse bar screens to the intake pipes, as well as isolation valves and possibly a fine screen in the pump well.

The pump station building will be constructed from reinforced concrete and cavity block work. The roof will be a suspended concrete slab to attenuate noise. All doors will be acoustically rated. There will be a separate switch room for motor control centres, instrumentation and telemetry systems.

The pumps will comprise six (five duty and one standby) vertical turbine pumps, each with a capacity of 260 L/s. Initially only four pumps (3 No. duty / 1 No. standby) will be installed to achieve a flow of 26 GL/year, i.e. 290 L/s/pump. Additional pumps will be installed when demand requires them. The pumps will be required to pump a maximum static lift of about 88m, have an overall normal operating pump head of 100 m water and the estimated motor size will be 375 kW per pump, for a water level of RL 122m.

It is likely that excavation will be in rock, and as blasting will not be allowed by HYDRO, the cost and duration of construction will be very significant as it will be necessary to use excavator mounted rock breakers and pneumatic equipment.

This type of pump station can accommodate the range of operating water levels, but there are a number of major drawbacks as a consequence of the deep well arrangement:

1. There would be considerable expense involved in constructing a deep well over 30 metres deep (137 m – 104 m) in rock and constructing the extended intake piping;
2. Construction will involve lake drawdown for an extended period; and
3. Larger pump motors will also be required to allow for the occasional additional lift i.e. from 107 m.

For these reasons it is considered that this option is not suitable for the Lake Trevallyn pump station configuration.

4.3.3 Option 2 Inclined Draft Tube Arrangement

This type of pump station is shown in Figures 2 and 3 and would involve constructing long inclined draft tubes into Lake Trevallyn, and installing turbine submersible pumps within the tubes. The draft tubes will be located at a level to provide water during all Lake Trevallyn levels with the exception of the ten yearly event.

This arrangement would have some visual impact (6 surface mounted pipes) as well as the potential for damage from floating logs. Protective barriers could be installed to overcome this risk.

The pump station will be located between the eastern abutment of the dam and Hydro Tasmania's intake tunnel, positioned to minimise the length of draft tube required to reach the lowest point.

The pumps will comprise six (five duty and one standby) multi stage submersible pumps, each with a capacity of 260 L/s. Initially, only four pumps (3 No. duty / 1 No. standby) will be installed to achieve a flow of 26 GL/year, i.e. 290 L/s/pump, to be achieved. Additional pumps will be installed when demand requires them. The pumps will be required to pump a maximum static lift of 88 m, have an overall normal operating pump head of about 100 m and the estimated motor size will be 375 kW per pump for a water level of RL 122m.

This is a common type of installation for irrigation where lifts and the range of levels is less than what may be encountered at Lake Trevallyn. Comments were sought from pump suppliers regarding this configuration, and suppliers have advised that, while the pump capacity and head requirements are challenging, there are pump manufacturers overseas who can meet the duty head required. The pumps would be continuously monitored on line to detect any change in pump or motor condition so that problems can be detected and fixed prior to any significant environmental or operational problem occurring. The general layout for this option is shown on Figures 2 and 3 which indicates the following features:

- Excavation of a sump about 1 m deep to provide the necessary submergence at minimum reservoir water level. It is likely that the excavation would be into rock and this would be undertaken by a large excavator using a rock breaker. **No** blasting would be undertaken.

- Draft tube supports would comprise prefabricated steel supports which would be fixed to reinforced concrete footings anchored to the base rock material.
- An existing access track will be extended a short distance to the proposed pump station site to enable crane and other maintenance equipment access to lift pumps out of the draft tubes for maintenance.
- A concrete platform to locate and anchor the rising main and associated valves and fittings.

The water level in Lake Trevallyn would need to be lowered for a period of about 7 days to RL 107 m to carry out the sump and lower draft tube support footing excavations and to cast the concrete for the lower draft tube support footing.

This option would have a lower cost than the Options 1 and 3 and also have a lower impact as the water level would need to be lowered for a much shorter period to facilitate construction than Options 1 or 3.

4.3.4 Option 3 Temporary Low Level Pumping

For this type of facility, a conventional wet well pump station with vertical turbine pumps would be constructed such that it could operate between normal lake levels of RL 122 - 127 m. This option is shown on Figures 4 and 5.

Water will be drawn from Lake Trevallyn through twin 1,200 mm diameter intake pipes laid horizontally into the pump station wet well at 3 m below the lowest normal water level. The pipes will be at a level sufficient to ensure reliability of supply when the dam water level is at RL 122 m.

There will also be a second higher level intake for the low level pump station, when the storage is lowered to RL 107 m.

The pump station will be located between the eastern abutment of the dam and Hydro Tasmania's intake tunnel, positioned to minimise the length of intake pipe required to reach the lowest point.

The floor of the pump station will be set at approximately RL 137m, which is 1 m above the 1 in 1,000 year lake flood level.

There will be coarse bar screens in the intake pipes, as well as isolation valves and possibly a fine screen in the pump station.

The pump station building will be constructed from reinforced concrete and cavity block work. The roof will be a suspended concrete slab to attenuate noise. All doors will be acoustically rated. There will be a separate switch room for motor control centres, instrumentation and telemetry systems.

The intake pipes, which are approximately 3 m below the normal low water level in Lake Trevallyn, will need to be constructed when the water level has been lowered. It will be necessary to liaise with Hydro Tasmania to coordinate this.

Figures 4 and 5 shows the need to excavate a wet well to RL 117 m AHD, and the installation of twin 1200 mm diameter intake pipes . It is likely that excavation will be in rock, and as blasting will not be allowed by HYDRO, the cost and duration of construction will be very significant as it will be necessary to use excavator mounted rock breakers and pneumatic equipment

The pumps will comprise six (five duty and one standby) vertical turbine pumps, each with a capacity of 260 L/s. Initially, only four pumps (3 No. duty / 1 No. standby) will be installed to achieve a flow of 26 GL/year, i.e. 290 L/s/pump, to be achieved. Additional pumps will be installed when demand requires them. The pumps will be required to pump a maximum static lift of 88 m, have an overall normal operating pump head of 100 m and the estimated motor size will be 375 kW per pump for a water level of RL 122m

To provide a low lift pump capacity during Hydro Tasmanian shut down periods, pontoon mounted pumps could be purchased and stored at site with appropriate pipe work etc, or an arrangement could be made for pump hire from a company such as Shorco. These low lift pumps would deliver water from the lower levels within the dam to the conventional pump station for pumping to the pulp mill.

The low lift discharge pipe could be fabricated from polyethylene and fixed to the ground using concrete anchor blocks. The last section would float or be suspended to the pump station pontoon.

This option has a lower capital cost than the deep well option, Option 1. The operating costs are similar, but may be lower for this option if the water level is not dropped as frequently as expected.

The main pump station would be designed to meet the normal duty, therefore avoiding many of the construction risks faced in the Option 1.

4.3.5 Environmental Impacts

The environmental issues most likely to impact on the pump station include the following:

- Visual
- Noise
- Construction period/activities
- Lake Trevallyn water level

(a) Visual.

The main visual impact will be to residences on the eastern shore of the lake and will occur during construction of the access road and pump station site clearing. Some trees will be removed and a bench will be excavated in the side of the hill for the road. This will be the same for all options.

The longer term visual impact of Options 1 and 3 would be the reinforced masonry building housing the motors, pipework/valves, switchboard, etc. The building would be about 19 m X 7 m X 4 m high.

The longer term visual impact of Option 2 would be a concrete ground slab and retaining wall upon which the control valves and pipework would be located. The slab would be about 19 m X 8 m with a switchboard located at one end. The draft tubes would also be visible above lake water level, being 6 No. 1 m diameter pipes.

(b) Noise.

The longer term noise impact will be negligible for Option 2 as the pumps and motors are submerged. For Options 1 and 3 noise will also be negligible as the motors will be hosed in a building which will include sound attenuating materials.

During pump station construction some noise will be generated via excavation equipment constructing the base sump and draft tube footings for Option 2, and the wet well and intake pipe tunnels for Options 1 and 3. The construction duration will be about 1 week for Option 2, but much longer for Options 1 and 3 as a large excavation in rock is required in which to locate the pumps. The excavated material would need to be removed from the site, hence a lot of truck traffic along the access road would result.

Some noise will be generated during construction of the access road, which will be the same for Options 1, 2 and 3. This would comprise noise from excavation equipment such as excavators, trucks, etc.

(c) Construction Period/Activities.

The main impacts of construction will be visual and noise, as discussed above, during construction of the access road and the pump station/pump well.

Construction activities will comprise excavation of the bench for the access road and subsequent pavement construction for Options 1, 2 and 3.

Options 1 and 3 will include excavation of the pump well and intake pipes/tunnels. This will involve considerable effort as the pump well is to be excavated largely in rock and the well dimensions are about 15 m long, 7 m wide and 37 m deep for Option 1 and 20 m deep for Option 3. A masonry building will be constructed over the well for Options 1 and 3. Blasting is not allowed by Hydro so excavation will be undertaken using excavator mounted rock breakers and pneumatic equipment. The construction period for Option 1 is likely to be of the order of 8 months and Option 3 would likely be the order of 6 months. Excavated material would be removed from the site via trucks.

Option 2 will include the excavation of a sump about 1 metre deep in the base of the lake and construction of support footings for the draft tubes. Construction is expected to take about 1 week. Material excavated from the sump will be left in the base of the lake in a location such that the operation of the lake is not adversely effected.

Construction of the slab and pipework/valves at the upper end of the draft tubes is expected to take about 2 months.

(d) Lake Trevallyn Water Levels

It will be necessary to lower the water level in Lake Trevallyn to construct the pump station.

Option 1 would require the lake to be emptied to construct the intake tunnels/pipes for a period of the order of 2-3 months, assuming excavation of the intake pipes is in solid impermeable rock.

Option 3 would require the lake water level to be lowered to below RL 117.0 m for a period of about 2 months, assuming excavation of the lower intake pipes is in solid impermeable rock. Hydro lower the lake water level to RL 117 m for a period of about 1 week twice per year for normal maintenance purposes, so this option would require the lake water level to be lowered for a much longer period.

Option 2 would require the lake to be emptied for about 1 week. Hydro lower the lake water level for a period of about 1 week every 10 years for normal maintenance purposes. Hence the water level would need to be lowered further than normal for this period. Existing pipe/valve facilities can enable the lake to be emptied.

(f) Environmental Impact Summary.

The above environmental impacts can be summarised as shown below:

IMPACT	OPTION 1	OPTION 2	OPTION 3
Visual – Construction	MEDIUM	LOW	MEDIUM
Visual – Long Term	LOW	MEDIUM	LOW
Noise - Construction	MEDIUM	LOW	MEDIUM
Noise – Long Term	LOW	NIL	LOW
Construction	HIGH	LOW	MEDIUM
Lake Water Level	HIGH	LOW	MEDIUM

As indicated above, Option 2 has the lowest overall environmental impact. Option 1 has the greatest impact and Option 3 has less impact than Option 1 with respect to construction and lake water level issues.

4.3.6 Summary

As indicated above Option 2 has the least environmental impact and Option 1 the greatest.

Of the pump station options considered, the inclined draft tube configuration , Option 2, has the lowest capital cost.

It is considered that the net present value (NPV) of Options 1 and 3 are similar, but there are higher operational and occupational health and safety risks with Option 1 due to the depth of the well and the water quality risks associated with an off take at the lowest level in the lake. These options should be reassessed at the detailed design stage when operating conditions in the lake and conditions of supply for the paper mill have been resolved, however it is likely that either Option 2 or 3 will be adopted.

At this stage, subject to geotechnical investigations and liaison with Hydro Tasmania, it is considered that either Option 2 being the draft tube option, or Option 3 being the temporary low level pumping station are the preferred options. With respect to Option 2 it will be necessary to confirm the availability of actual pumps and spare parts and also the training of local service agents to maintain/service the units.

It is recommended that both Option 2 and Option 3 be considered further and that investigations continue to ensure that Option 2 pumps can perform reliably. If this cannot be ‘guaranteed”, then Option 3 should be adopted. This report considers both options.

4.3.7 Pump Station Structure

Water will be drawn from Lake Trevallyn through twin 1,200 mm diameter intake pipes laid horizontally into the pump station wet well at 3 m below the lowest normal water level. The pipes will be at a level sufficient to ensure reliability of supply when the dam water level is at 122 m.

There will also be a second higher level intake for the low level pump station, when the storage is lowered to 107 m.

The pump station will be located between the eastern abutment of the dam and Hydro Tasmania’s intake tunnel, positioned to minimise the length of intake pipe required to reach the lowest point.

The floor of the pump station will be set at approximately RL 137m, which is 1 m above the 1 in 1,000 year lake flood level.

There will be coarse bar screens in the reservoir, as well as isolation valves and possibly a fine screen in the pump station. This screen is proposed to be installed on the intake pipes.

The pump station building will be constructed from reinforced concrete and cavity block work. The roof will be a suspended concrete slab to attenuate noise. All doors will be acoustically rated. There will be a separate switch room for motor control centres, instrumentation and telemetry systems.

The intake pipes, which are approximately 3 m below the normal low water level in Lake Trevallyn, will need to be constructed when the water level has been lowered. It will be necessary to liaise with Hydro Tasmania to coordinate this.

4.3.8 Pumps

The pumps will comprise six (five duty and one standby) vertical turbine pumps, each with a capacity of 260 L/s. Initially, only four pumps (3 No. duty / 1 No. standby) will be installed to achieve a flow of 26 GL/year, i.e. 290 L/s/pump. Additional pumps will be installed when demand requires them. The pumps will be required to pump a maximum static lift of 88 m, and have an overall normal operating pump head of 100 m. The estimated motor size will be 375 kW per pump. These values are based on a lake water level of RL 122m.

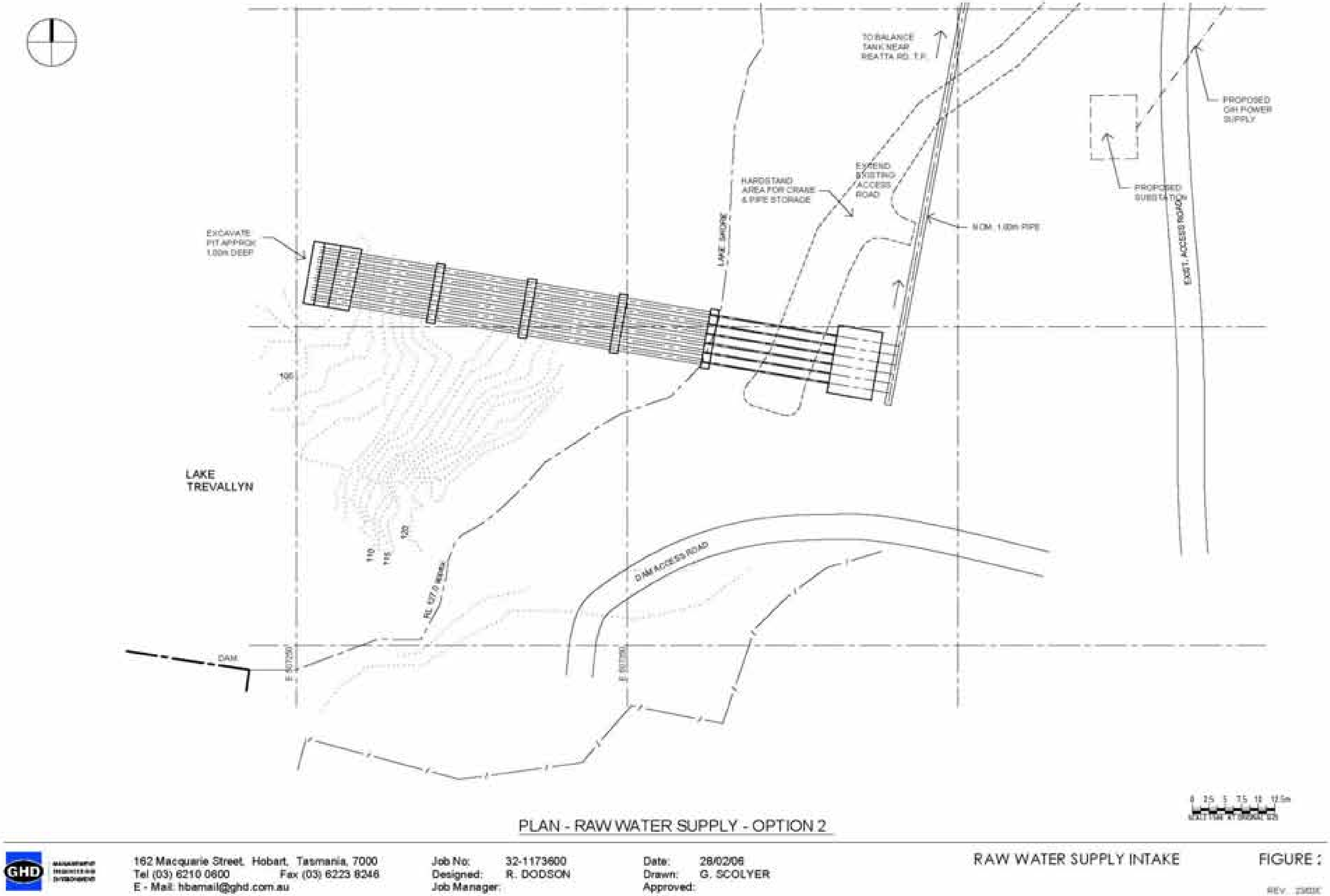


Figure 2 Trevallyn Water Pump Station – Option 2

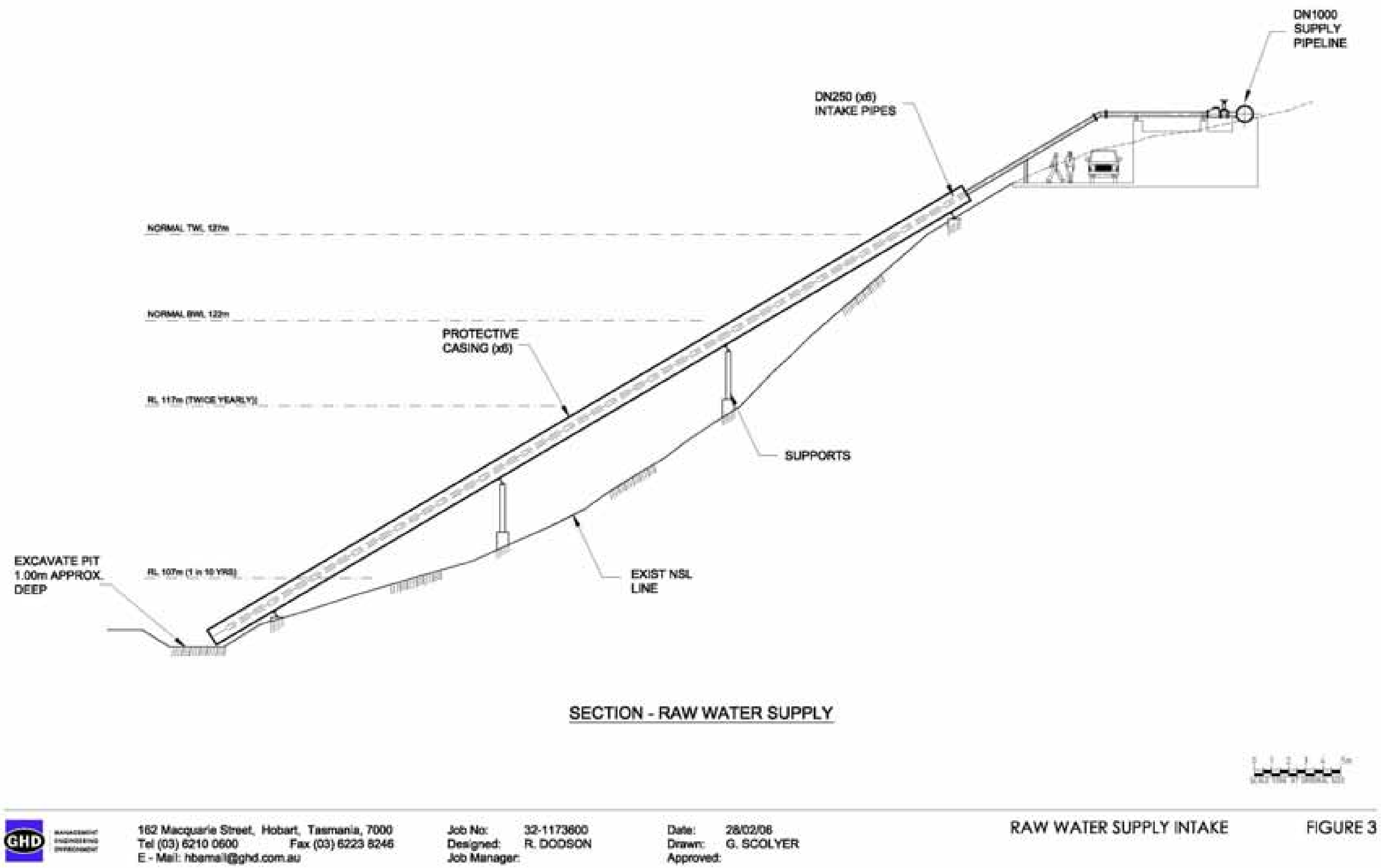


Figure 3 Trevallyn Water Pump Station – Option 2

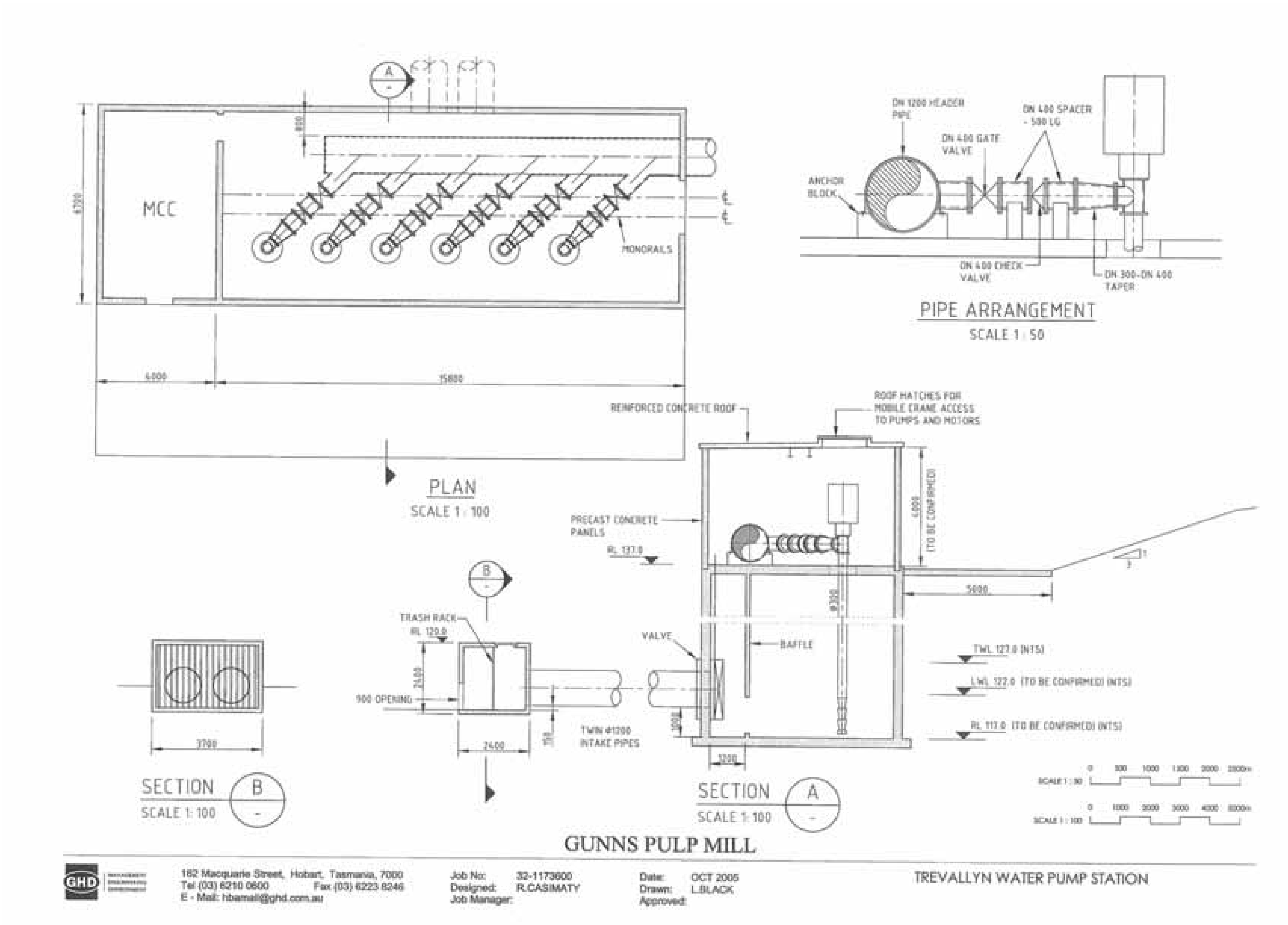


Figure 4 Trevallyn Water Pump Station – Options 1 and 3

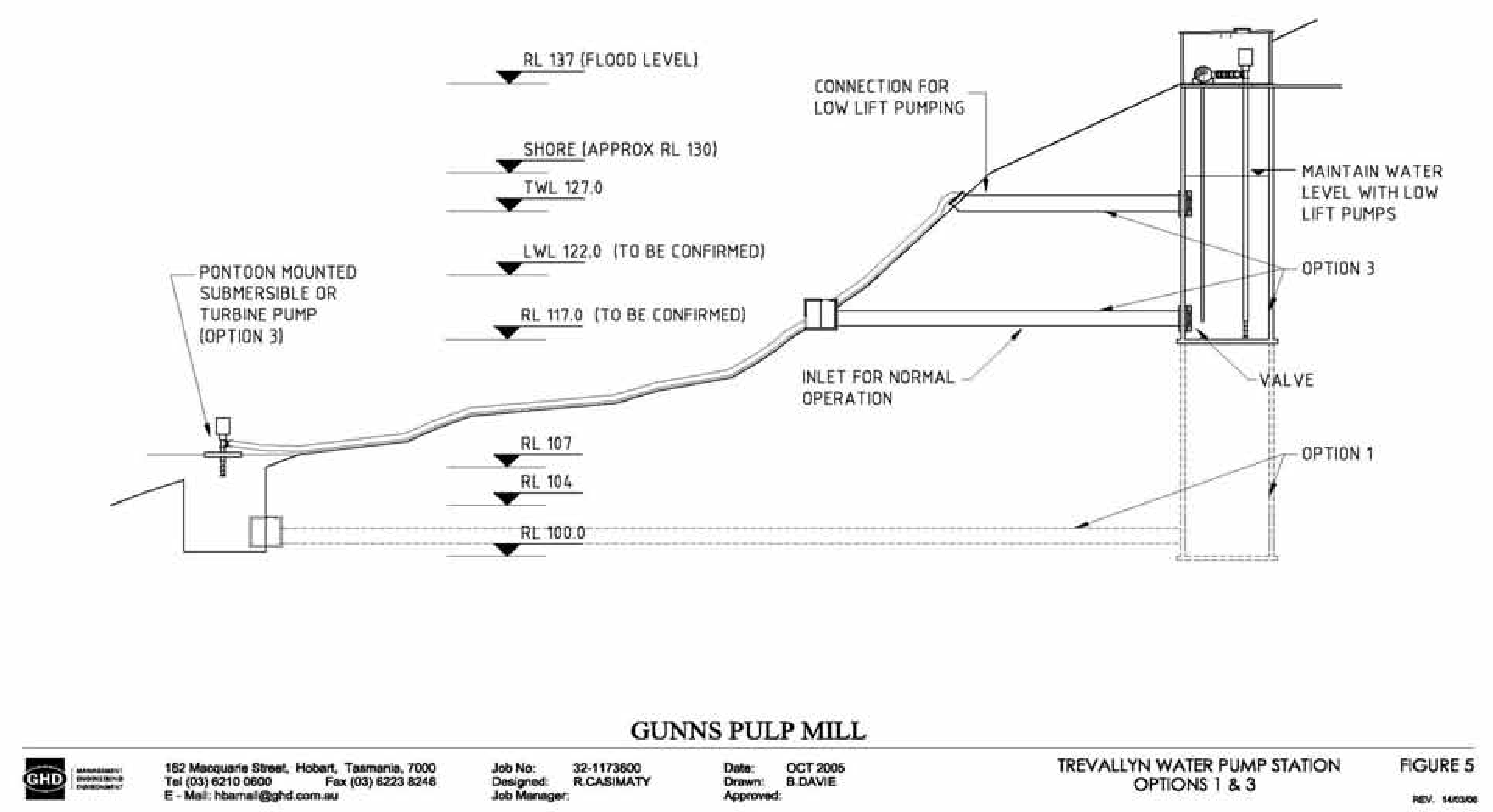


Figure 5 Trevallyn Water Pump Station – Section Through Dam Options 1 and 3

4.3.9 Instrumentation and Control

The pumps will be controlled by a telemetric signal from the 3 ML storage tank. The pumps will start and stop on level.

4.3.10 Power Supply

Aurora has agreed to provide power at 22 kV via the existing overhead line that feeds the Esk Water pumps at Trevallyn Dam and the Hydro intake tunnel. The conductors in the three phase power lines will need to be enlarged and a short branch extension made to the pump station location. The total ultimate power supply required for the pump station will be approximately 1.5 to 2 MW.

All pumps will have soft starters to reduce water hammer and current surge on start up.

4.4 Selection of Pump Station Location

There are a number of potential locations for the proposed pump station for the pulp mill water supply system. These are outlined in Table 6:

Table 6 Potential Pump Station Locations

Location	Description	Comments
Existing Esk Water Supply Pump Station	Upgrade existing pumps to meet combined pulp mill and Esk Water demand	Limited space in existing pump station structure makes pump upgrade impossible.
Between Dam and Hydro Intake Tunnel on Lake Trevallyn	Construct deep well vertical turbine pump station at this location.	Water available all year round, ensuring continuous operation.
Aquatic Point on Lake Trevallyn	Construct new pump station facility at Aquatic Point.	No water available during major shut down when intake penstock at Lake Trevallyn closed.
Trevallyn Power Station intake tunnel at Pitt Avenue	Tap into exposed power station pipe to west of Pitt Avenue and construct new pump station on adjacent parkland.	Proposal unacceptable to Hydro Tasmania. No water available during major shut down when intake penstock at Lake Trevallyn closed.
Install Pumps in Trevallyn Power Station intake tunnel surge chamber	Install deep vertical turbine pumps in surge chamber	Proposal appears viable and has Hydro Tasmania acceptance in principal. No water available during major shut down when intake penstock at Lake Trevallyn closed.
Install pumps in Trevallyn Power Station tail race	Construct new pump station just prior to where tail race meets Tamar River	There are issues with endangered fish species in this area No water would be available whenever power station stops operating.

From the above, it was concluded that a pump station at Lake Trevallyn located between the eastern abutment of the dam and Hydro Tasmania's intake tunnel was the preferred option.

4.5 Pipeline

4.5.1 Hydraulic Analysis

The optimum hydraulic pipe section was selected by undertaking a Net Present Value analysis based on the following key assumptions:

1. The pumps will operate for 350 days per year, delivering 26 GL per year initially, then up to 40 GL per year thereafter to provide for future industrial development along the corridor or in the Bell Bay area;
2. The pumps will operate at an efficiency of 80%;
3. The pipes will have a roughness coefficient of C = 130 (Hazen-Williams);
4. Power will cost 10c/kW.hr;
5. All capital costs are at year 0;
6. Supply of water from Lake Trevallyn by Hydro Tasmania will cost an average of $30 ML; and
7. An NPV factor of 7% per annum was used over 25 years operation.

The results of the NPV analysis are contained in Table 7.

Table 7 Results of NPV Analysis

Pipe Diameter [mm]	Maximum Velocity [m/s]	Capital Cost [x 1,000]	Year 1 Operating Cost [x 1,000]	Year 6 Operating Cost [x 1,000]	NPV [x 1,000]
800	2.53	$55,800	$1,530	$3,710	$84,300
850	2.24	$58,600	$1,510	$2,930	$81,300
900	2.00	$61,400	$1,500	$2,720	$82,400
950	1.80	$64,300	$1,490	$2,680	$84,800
1,000	1.62	$67,100	$1,490	$2,650	$87,200
1,050	1.47	$70,000	$1,480	$2,630	$89,700
1,100	1.34	$72,900	$1,480	$2,620	$92,300
1,150	1.23	$75,700	$1,480	$2,600	$94,800

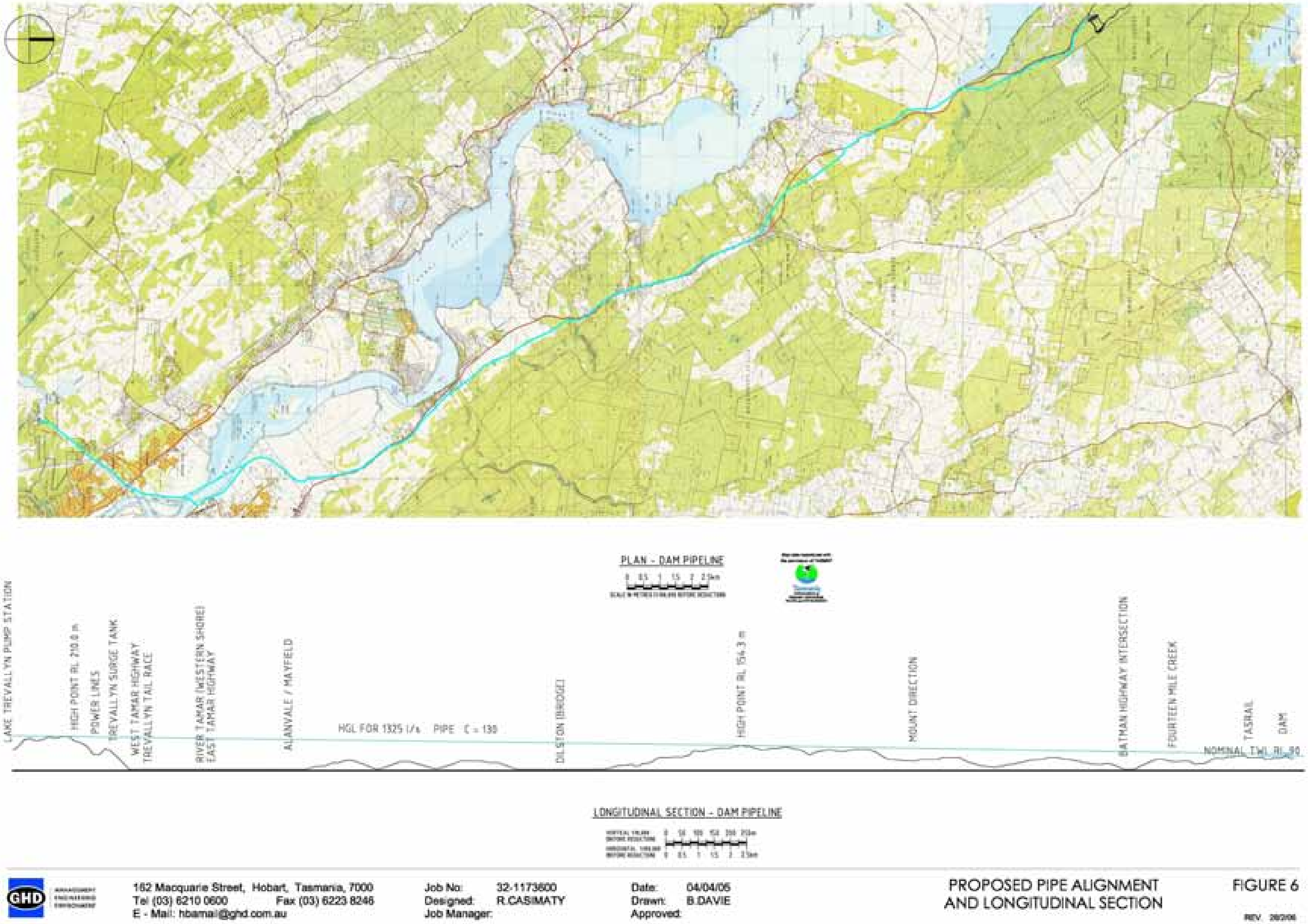


Figure 6 Proposed Pipe Alignment and Longitudinal Section

This analysis shows that there is very little difference in the NPV cost for pipes under 1,000 mm in diameter. This is because of the minimal difference in capital cost of the pipe and because of the high static head to pump the water over the ridge near Reatta Road WTP.

Based on a detailed hydraulic analysis of the proposed pipe route, from the preferred pump station location near the Lake Trevallyn Hydro intake, the pipe diameter is expected to vary as follows:

Table 8 Details of Proposed Pipe Diameter

Section of Pipeline	Proposed Pipe Size
Pump Station to Reatta Road WTP	813 m OD MSCL pipe
Reatta Road WTP to Mt Direction	1016 mm OD MSCL pipe
Mt Direction to Pulp Mill	972 mm OD MSCL pipe

The above estimates should be reviewed during detailed design.

4.5.2 Water Hammer Analysis

A preliminary water hammer analysis was carried out for the proposed pipeline using the computer analysis package *Watham.* The analysis looked at two different water hammer scenarios:

1. A continuous pipeline from Lake Trevallyn to the pulp mill site storage dam, with air valves installed at each of the two high points described above.
2. A buffer tank at the high point near Reatta Road WTP, holding at least 15 minutes storage at 1,325 L/s, and a control valve situated at the pulp mill site storage dam. These would be linked by telemetry to ensure that the pipeline remains full of water in the event of pump failure, avoiding air problems on restarting of the pumps.

The key recommendations from this analysis were:

1. The first section of pipeline, Chainage 0 m to Chainage 1.6 km, needs to be designed for a maximum positive pressure of 300 m and for a buckling pressure of 140 kPa;
2. If Scenario 1 is adopted, Chainage 1.6 km to 39.6 km of the pipeline needs to be designed for a positive pressure of 40 m;
3. If Scenario 2 is adopted, Chainage 1.6 km to 39.6 km needs to be designed for a positive pressure of 320 m or designed to ensure a rapid valve closure cannot occur; and
4. To enable the pipeline to perform to its hydraulic requirements, air valves should be installed at the significant high points along the route. It is particularly important that the high points that control the hydraulic grade be provided with air valves to purge the system of built up air.

Further details and graphical representations of the water hammer analysis are contained in Appendix A of this Report.

4.5.3 Balance / Control Tank

The above assessment of the hydraulics of the Trevallyn water supply pipeline indicates that the operation of the system will be less problematic if a storage reservoir or balance tank is constructed at the high point on the line (near Reatta Road WTP), and control valves are installed at the outlet points for the main.

Without this balance tank and the valves, each time the pump(s) stop, significant portions of the main would drain and fill with air. This would enable air to accumulate in the pipeline downstream of Mount Direction and in the short section of pipe downstream of the high point near Reatta Road WTP. It is estimated that a combined total of 3.3 ML of air could be present at these locations. When the pumps restart, it would take around 1.2 hours to expel the air at a design water flow of 765 L/s. This would mean that, not only would there be a 1.2 hour delay until full flow of water was received at the pulp mill, but that there would also be 1.2 hours of air release at the two high points. Such a situation would require a substantial muffler/silencer to reduce public nuisance over such a period of time.

In addition, in the early life of the system it is likely that the pipe friction will be lower than in later years. The system, however, has to be designed to allow for the expected future conditions. In this case, the grade lines are critical because most of the main will flow by gravity. It is likely that, for the first 5 – 10 years, the hydraulic grade line will be flatter and it is almost certain that air will be drawn into the main. Regardless of how many air valves are in place, it is also likely that the air will enter and expel at varying rates, thereby directly affecting the rates of delivery of water through the main. The varying air levels in the main will lead to "gulping" of flows.

With a reservoir and control valves in operation, the control logic for the system would be as follows:

1. a level indicator at the reservoir would send a signal to the pump station to stop and start the pumps; and
2. flow to the pulp mill storage and the pulp mill treatment plant would be by gravity from the reservoir and controlled/regulated by actuated valves at each destination.

The storage reservoir would need to contain sufficient volume to provide for around 800 – 1,000 seconds of continuing flow after the pumps stop. This would be necessary to allow for the time needed to close the control valve in such a manner to minimise the risk of developing significant surges. In practice, it would include an allowance for two closely spaced stops, requiring at least 20 to 30 minutes of flow or approximately 3 ML of storage. Such a tank would be around 30 m diameter and 4.5 m high (including 300 mm of freeboard). There is no requirement to construct a roof on this tank to maintain water quality, but there may be some security benefits from this. The reservoir would need to be constructed above the high point on the pipe route near Reatta Road WTP (that is, above the RL 210 m contour).

4.5.4 Pipeline from the Pump Station to the Tamar River

The proposed pipe alignment from the pump station to the Tamar River will follow the Hydro Tasmania's Trevallyn Power Station intake tunnel alignment. It will follow this line, across Pitt Avenue, the West Tamar Highway and Hydro's Trevallyn Offices to the Tamar River. A detailed description of the proposed route for this section of pipe is contained in Table 9.

Table 9 Details of Proposed Pipe Route – Pump Station to Tamar River

Chainage	Description	Pipe Route	Comments
0	Pump Station		
0.0 km to 0.30 km	Hydro Tasmania Easement	Pipe to run north east up over the hill	Hydro have been consulted
0.30 km to 0.66 km	Trevallyn State Recreation Area	Pipe to run north east up over the hill	Pipe to run around RL 200 m contour
0.66 km	Intersection with Lake Trevallyn Road	Pipe to run under Lake Trevallyn Road	West Tamar Council have been consulted.
0.66 km to 1.22 km	Small Vehicular Track	Pipe to run along north-western side of vehicular track.	
1.22 km	Intersection with Reatta Road	Pipe to run under Reatta Road	West Tamar Council have been consulted.
1.22 km to 1.59 km	Trevallyn State Recreation Area	Pipe to run north east towards Reatta Road Treatment Plant	
1.59 km	Balance Tank	Pipe to connect into 3 ML balance tank, situated on eastern side of Esk Water easement.	
1.59 km to 1.81 km	Trevallyn State Recreation Area	Pipe to run northeast down the hill.	
1.81 km	Intersection with Reatta Road	Pipe to run under Reatta Road	West Tamar Council have been consulted.
1.81 km to 2.64 km	Trevallyn State Recreation Area	Pipe to run northeast down the hill.	

Chainage	Description	Pipe Route	Comments
2.64 km	Intersection with Pitt Avenue	Pipe to run under Pitt Avenue	West Tamar Council have been consulted.
2.64 km to 3.51 km	Hydro Power Station Intake Pipe Corridor	Pipe to run along northern side of Hydro Power Station intake pipe corridor	
3.51 km	Intersection with West Tamar Highway	Pipe crossing of north bound lane of West Tamar Highway	DIER have been consulted.
3.51 km to 3.64 km	Hydro premises	Pipe to-pass around northern side of Hydro Building	Hydro have been consulted.
3.64 km	Intersection with West Tamar Highway	Pipe crossing of south bound lane of West Tamar Highway	DIER have been consulted.
3.64 km to 5.53 km	Tamar Cut	Pipe to follow northern side of power station outlet and the western side of the Tamar Cut	Pipeline commences on West Tamar Council land.
5.60 km	Western Shore of Tamar River		

4.5.5 Crossing of Tamar River

It is proposed that the crossing be installed on the stretch of the Tamar River opposite Newnham. This is seen to have a number of advantages, including:

1. It is a narrow section of the river, reducing the length of the crossing;
2. There is a large area of flat land on both sides of the river to enable construction to take place; and
3. It avoids tight spots in the East Tamar Highway road easement between Mowbray and Newnham.

The length of this part of the pipeline (including river and river flats) will be approximately 400 m. This alignment is based on the pipe jacking construction method. An alternative route diagonally across the Tamar River is also being considered subject to the findings of geotechnical investigations currently being undertaken.

There were a number of drill holes undertaken by BFP Consultants in September 2003 at the Ti Tree Bend Waste Water Treatment Plant. In summary, the results of these investigations are as follows:

Table 10 Summary of Geotechnical Information at Tamar River Crossing

Bore Hole 1	Bore Hole 2
Located near Digester No. 3	Located near Sludge Building
0 – 2.0 sandy gravel fill	0 – 2.4m sandy gravel fill
2.0 – 12.4m high plasticity clayey silt	2.4m – 10.0m high plasticity clayey silt
12.4 – 14.0m high plasticity silty clay	10.0m – 12.0m medium to high plasticity sandy clay
14.0m – 16.0m low plasticity fines clayey silt	12.0m – 15.0m low plasticity fines clayey sand
16.0m – 17.2m medium plasticity sandy clay / clayey sand	16.0m – 18.0m medium to high plasticity silty clay
17.2m – 29.2m medium plasticity sandy clay	18.0m – 21.7m medium plasticity sandy clay with low to medium plasticity clayey sand layers
29.2m bore hole terminated	21.7m bore hole refusal

These results are typical of the reactive clays encountered in the area, and it is expected that similar materials would be encountered up to and beyond the Tamar Cut. Geotechnical investigations of the river bed will be completed shortly and these results will enable a decision to be made on the most appropriate route.

There are a number of possible means to construct this pipe crossing:

1. Laying the pipe across the bed of the river and anchoring it in place using weights;
2. Pipe jacking a sleeve (say 1,500 mm diameter) across the river and laying the pipe within the sleeve and grouting it in place; or
3. Directional drilling the pipe.

Selection of the most suitable process will need to take into account that the pressures in the pipe at the point of the crossing will be at least 1,500 kPa plus any dynamic effects. This means that the pipe will definitely be constructed from mild steel. The pipe diameter will be up to 1,016 mm for a 40 GL/year supply. A comparison of the three alternative construction methods is contained in Table 11.

Table 11 Comparison of Data Requirements for Various River Crossing Construction Techniques

Construction Method	Issue	Action
Laying on River Bed River bed is dredged for pipe trench to ensure top of pipe will be below bed level for protection. The pipe is floated across the river and then sunk and laid in the pipe trench. Concrete weights are then strapped across the pipe to anchor it in place.	Would need Maritime approval	Need to contact Launceston Ports Authority
	Need to assess whether flow rate is low enough to allow submerged dredging. If submerged dredging is practical the excavated material will be used to refill the trench. Excess material would be deposited into the current LCC dredging disposal ponds subject to their agreement.	Need to obtain flow records for this part of the Tamar River for at least ten years
	Profile of river bed needs to be flat enough to enable a steel pipe to be laid along its profile without being excessively stressed	Need survey of river bed
	Need geotechnical data to determine pipe anchorage	Need to drill bore holes mid stream
Pipe Jacking Involves construction of caissons at either end of run to jack and receive the pipe. Caissons will need to be sufficiently deep to enable a horizontal run under the Tamar (and will require dewatering). A larger bore sleeve is then jacked between the caissons and the pressure main is slid through the sleeve and grouted in place.	Profile of river bed at point of crossing is required so that the depth of the caissons can be determined	Need survey of river bed
	Ground conditions need to be determined from more detailed geotechnical data. Excavated material would be stored on site and replaced once the caissons are no longer required.	Need to drill holes on either side of bank plus two mid stream

Construction Method	Issue	Action
Directional Drilling The pipe is drilled under the riverbed with an automatically controlled boring machine. The profile of the drilled pipe (catenary) is determined by the stiffness of the pipe and material. The drilling profile will need to be deep enough to pass through silts of a reasonable quality. There is no requirement for a receiving caisson and so the environmental impact is minimised.	The catenary profile of the drill will be dependent on the river bed profile and this will determine the length of the run	Need survey of river bed
	The depth of the catenary is also dependent on the geotechnical conditions of the silts in the river bed at the point of the crossing	Need to drill holes on either side of bank plus two mid stream
	Area adjacent to the golf course needs to be suitable to mount directional drilling equipment	Need geotechnical assessment of river flats area
	There will need to be a bentonite slurry holding dam and the used bentonite (clay) will also need to be disposed of.	Need to construct a temporary holding dam near the drilling activities. Used bentonite (clay) may be disposed of to land (sandy soil) provided no contamination occurs. Tests would be undertaken to confirm land disposal suitability.
	Need to store and dispose of material excavated from the pipe “tunnel”.	Material is likely to be silty clay which could be used for local site filling, subject to contamination testing.

4.5.6 Pipeline along East Tamar Highway

The proposed pipe alignment from the Tamar River to the Pulp Mill site will loosely follow the East Tamar Highway, with several sections in private land or along the side of the Esk Water easement. A detailed description of the proposed route for this section of pipe is contained in Table 12.

Relevant stakeholders such as DIER, Esk Water and private landowners are yet to confirm their approval to this proposal, but are working with Gunns to resolve their issues and concerns.

Services on this alignment have been collated and generally consist of underground telecommunications and Esk Water branch lines.

4.5.7 Mill Storage Inlet Controls

The control system for the water supply system is complicated by the need to prevent air entering the line at the balance control tank and at the high point at Mount Direction. To manage this, it is proposed to operate the supply by two separate control loops, one for the Lake Trevallyn Pumps and the other for the discharge to the local site storage.

1. Lake Trevallyn Pumps

   The Lake Trevallyn Pumps will be operated by a level sensor and telemetry link at the balance/control tank. Pumps will start/stop depending on the level in the tank, which is a function of the outflow to the pulp mill and the pumped inflow (number of pumps operating). A minimum operating volume of 60 kL per pump (approximately 100 mm change in depth) will be required to ensure a maximum of four starts per hour.

2. Local Site Storage

   The local site storage will be filled by gravity from the balance/control tank. Successful operation of this section will depend on air being prevented from entering the pipeline from the balance/control tank. This is best achieved by throttling the flow at the local site storage so that the pipeline is always flowing full. It is proposed that an outlet flow control manifold be installed just upstream of the local site storage. This valve will be actuated/regulated by a signal from the balance/control tank water level, or from a pressure sensor in the outlet pipe just downstream of the balance tank. An alternative means of control would involve installing a flow meter just upstream of the valve manifold and regulating its setting based on a preset flow to achieve a fully drowned hydraulic grade line.

The above signals would be linked to a central Pulp Mill SCADA System.

Table 12 Details of Proposed Pipe Route – East Tamar Highway

Chainage	Description	Pipe Route	Comments
6.00 km to 6.44 km	East Tamar Highway	Pipe to run in shoulder of western side of East Tamar Highway	Very little space to east of this – continue to liaise with DIER.
6.44 km to 11.39 km	Private Property	Pipe to Loop around western extents of Allanvale	Liaise with private landowner(s).
11.39 km	Barnard's Creek	Pipe to run parallel to Esk Water main on similar type of pipe bridge structure	
11.39 km to 13.02 km	East Tamar Highway	Pipe to run along open verge on western side of highway	
13.02 km	East Tamar Highway	Cross under East Tamar Highway	Continue to liaise with DIER.
13.02 km to 15.77 km	Private Property	Pipe to follow highway route	Liaise with private landowner(s).
15.77 km	Large Creek	Cross under creek downstream of large culvert	
15.77 km to 20.00 km	Private Property	Pipe to follow highway route	Liaise with private landowner(s).
20.00 km	Doctors Flat Pump Station	Pipe to run on eastern side of Esk Water Easement	Need to liaise with Esk Water regarding access
20.00 km to 20.65 km	East Tamar Highway	Run pipe along eastern side of highway	
20.65 km	East Tamar Highway	Cross under East Tamar Highway	Continue to liaise with DIER
20.65 km to 21.13 km	Private Property	Pipe to cut corner on East Tamar Highway	Liaise with private landowner(s).
21.13 km to 22.05 km	East Tamar Highway	Run pipe along verge on western side of highway	

Chainage	Description	Pipe Route	Comments
22.05 km	Swan Bay Junction (Windmere Road)	Pipe to run under junction	Continue to Liaise with DIER and Council for approval
22.05 km to 23.31 km	East Tamar Highway	Run pipe along verge on western side of highway	
23.31 km	Swan Bay Creek	Pipe to run under creek	Need to manage sediment and erosion during construction
23.31 km to 24.74 km	East Tamar Highway	Run pipe along verge on western side of highway	
24.74 km	Faheys Creek	Fix pipe to new pipe bridge support spanning embankments	
24.74 km to 26.35 km	East Tamar Highway	Run pipe along verge on western side of highway	
26.35 km	Tavern	Pipe to run under tavern driveway	Need to liaise with operators to ensure access during construction
26.35 km to 26.86 km	Private Property	Follows Esk Water pipeline.	Liaise with private landowner(s).
26.86 km	Hillwood Road	Cross under Hillwood Road	Continue to liaise with Council
26.86 km to 28.13 km	Private Property	Pipe to follow Esk Water Main Route	Liaise with private landowner(s).
28.13 km	East Tamar Highway	Cross under East Tamar Highway	Continue to liaise with DIER
28.13 km to 30.48 km	Private Property	Pipe to follow Esk Water Main Route	Liaise with private landowner(s).
30.48 km	Culvert	Pipe to run under culvert	
30.48 km to 32.08 km	East Tamar Highway	Pipe to run along table drain on western side of pavement	
32.08 km to 33.39 km	Private Property	Pipe to follow highway route	Liaise with private landowner(s).

Chainage	Description	Pipe Route	Comments
33.39 km	Batman Highway	Cross under Batman Highway	Liaise with DIER
33.39 km to 34.53 km	Private Property	Pipe to cut corner on East Tamar Highway following the Esk Water pipeline.	Liaise with private landowner(s).
34.53 km	Archers Road	Cross under intersection	Liaise with Council
34.53 km to 34.75 km	Fourteen Mile Creek	Suspend pipe from pipe bridge similar to Esk Water main	
34.75 km	East Tamar Highway	Cross under East Tamar Highway	Liaise with DIER
34.75 km to 36.32 km	Private Property	Private Property to east of highway	Liaise with private landowner(s).
36.32 km	Rail Bridge	Cross under rail line behind eastern abutment	Liaise with TasRail
36.32 km to 39.71 km	Private Property / Gunns Property	Pipe to follow highway route	Liaise with private landowner(s).
41.4 km	Intersection of Access Road to Site Storage Dam		

5. Contingency Planning

5.1 Introduction

A secure and reliable water supply is fundamental to the operation of the pulp mill and it is proposed to incorporate provision of an on site storage near the mill to provide for pump and pipe breakages along the main pipeline.

5.2 Local Site Storage

5.2.1 General

A local water storage with a capacity of 670 ML will be provided above the pulp mill site. This will contain about one (1) weeks water consumption.

The storage will comprise an earth embankment constructed across a valley in the Tippogoree Hills, immediately to the east of the mill site. This is depicted in Figure 7

Table 13 summarises the design basis for this site storage.

Table 13 Summary of the Pulp Mill Site Storage Dam

Item	Design Basis
Embankment Level	To RL 92.0 m maximum (to avoid overtopping to the east of the saddle)
Dam Top Water Level	RL 90 m – providing 2.0 m freeboard
Lowest Operating Levels	RL 85 m
Embankment Crest Lengths	460 m East and 370 m West
Embankment Crest Width	5.0 m
Maximum Wall Height	17.0 m (toe level at RL 75 m)
Upstream Wall Batter	1 vertical to 3 horizontal
Downstream Wall Batter	1 vertical to 2.5 horizontal
Construction Method	Earth/rockfill embankment with 5.0m wide central clay core
Storage Capacity	Up to 670 ML
Embankment Volume	200,000 m^3
Spillway Invert Level	RL 90 m
Spillway Width	5 m
Design Flow	6.325 m^3/s (0.8 m head)

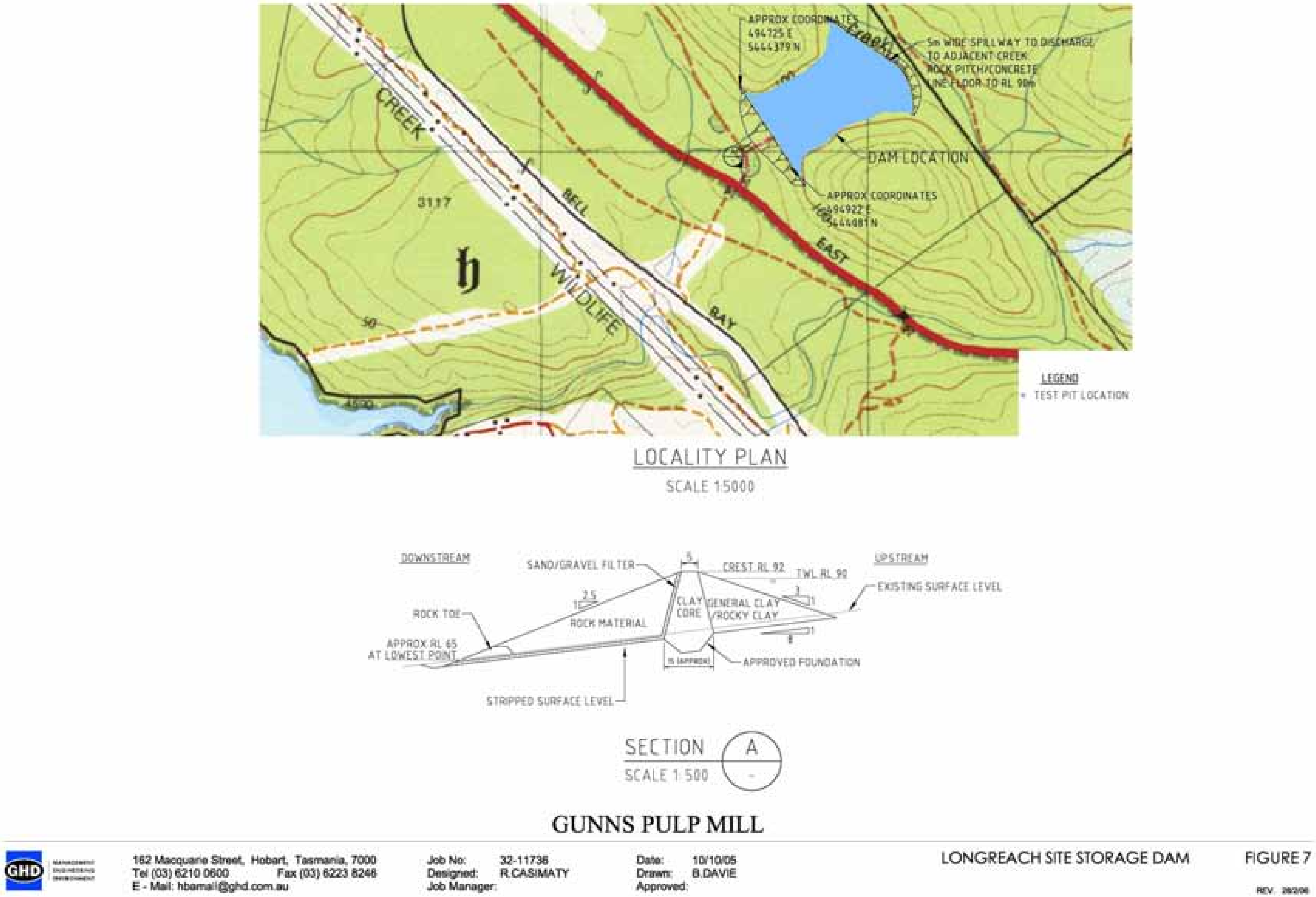


Figure 7 Storage Dam Location Plan

Final design of the dam will be subject to a detailed geotechnical investigation of the area, particularly with regards to sourcing clay and rock material.

A gravity pipeline will transfer water from the storage to the pulp mill.

The hydraulic grade of the pipe from the storage to the mill treatment plant has been determined using the following key design parameters:

1. Design flow of 1,310 L/s
2. Approximate pipe length of 1,000 m;
3. Optimum pipe diameter of 1,000 mm nominal bore;
4. Headloss through the plant control valve of 2.0 m;
5. A pipe roughness of k = 0.30 mm.

This provides a total head loss through the water supply pipe of just under 5.0 m, or a top water level at the treatment plant inlet of RL 80 m.

A more detailed analysis of the above hydraulic profile will be required as part of the water treatment plant design, particularly in relation to the inflow control valve.

5.2.2 Estimated Hazard Category

A preliminary assessment of the consequences of failure of the local site storage was undertaken as part of this study. The preliminary assessment identified that the following key issues would relate to the likely hazard category of this proposed dam:

1. Potential flooding of the East Tamar Highway, which is runs parallel to the proposed dam embankment, some 200 m downstream of the toe;
2. Potential flooding of the pulp mill site;
3. Potential flooding of the Bell Bay Rail Line; and
4. Potential flooding of the major overhead power transmission lines.

The storage dam is relatively small, the potential damage from a failure is not considered to be high even when taking into account the close proximity (of the dam) to the East Tamar Highway, rail corridor and proposed pulp mill.

The preliminary assessment of the consequences of dam failure suggested that there is a population at risk of between 11 and 100 persons (being closer to 11 than 100) and, in accordance with Appendix D of ANCOLD Guidelines on Assessment of Consequences of Dam Failure, the likely damage and loss would be Major. This indicates that the dam is likely to be assigned a hazard category of High B. The "Water Management (Safety of Dams) Regulations 2003" require dam design and construction to be undertaken by an "expert team".

This assessment is only preliminary and has been used to determine likely design parameters for the dam at concept stage only. It is recommended that a more thorough assessment of the consequences of dam failure, using the processes outlined by ANCOLD (May, 2000), be undertaken prior to committing substantial funds to this project.

5.2.3 Site Storage Spillway Design

A desktop assessment of the likely spillway design flow was undertaken using Sections 4 and 6 and Bulletin 53 of Australian Rainfall and Runoff. This process uses statistical data from throughout Australia to develop predicted rainfall events for various critical durations and recurrence intervals. The dam will not be constructed on a continuing watercourse.

The key assumptions for this assessment included:

1. Calculation of the critical storm duration using the Bransby Williams formula (Australian Rainfall and Runoff, Volume 1, Section 1.3.2);
2. Use of the approximate formulas in Table 9, Section 6 of Australian Rainfall and Runoff to determine the storm intensity; and
3. Adoption of a blanket coefficient of runoff of 0.9 for the entire catchment (assuming the catchment was supersaturated during the storm event).

The recurrent interval storm was set at the Probable Maximum Precipitation (PMP) in accordance with an estimated population at risk of 10 to 100, and a severity of damage of Major.

Based on this assessment, the spillway should consist of a 5 m wide concrete lined channel. This would mean that the maximum water level over the spillway for the PMP storm event would be 0.8 m.

5.2.4 Determination of Reservoir Wave Height

The reservoir wave height was determined in accordance with ANCOLD guidelines. The wave run-up freeboard requirement is 0.6 m using an 85 km/hr design wind speed (or 1 in 1,000 year return period). Wave set-up was also computed for a 1 in 1,000 year event. However, it is below 10 mm and consequently was disregarded in calculations.

5.2.5 Preliminary Geotechnical Investigation

A preliminary site investigation of the proposed storage dam was undertaken as part of this study in June 2005.

The site is a small, extremely weathered dolerite valley between two dolerite hills, with a saddle to the northeast end. The hills and saddle exhibit varying degrees of weathering. The northern side supports more vegetation, typically eucalypt bush. The southern side exhibits more extensive outcrops of hard rock with scattered she oak scrub. The valley is densely vegetated with ti-tree and paper bark, with an access track skirting the southern side of this vegetation.

A level traverse was undertaken to establish the top water level limits of the site, and a number of test holes were excavated around the perimeter. These test holes could only be excavated to an average depth of 0.7 m deep with some reaching refusal at 0.5 m depth. The test holes confirmed varying degrees of weathering of the dolerite, predominantly consisting of cobbles and boulders in a clay matrix. No samples were taken for laboratory testing from these test holes.

A number of test holes were excavated across the site where existing access permitted, thus minimising site disturbance. All the test holes on the slopes were consistent, with the only variable being the depth of refusal. The test holes in the valley revealed a good depth of clay, being over 3 m deep in some areas. Four samples were taken at different depths from two of the test holes that were excavated in the valley (see Figure 6). Table 14 shows the test pit and sample locations and depths.

Table 14 Details of Test Holes

Test Hole	Easting (m)	Northing (m)	Depth of Excavation (m)	Depth of Topsoil (m)
TP1	494888	5444286	3.5	0.3
TP2	494997	5444355	2.0	0.3
S1	-	-	0.6	-
S2	-	-	3.5	-
S3	-	-	1.0	-
S4	-	-	2.0	-

BFP Consultants tested the samples for Sieve Analysis, Atterberg Limits, Linear Shrinkage and Emerson Class Number. Results from this are contained in Table 15.

Table 15 Results of Local Storage Clay Analysis

Sample	S1	S2	S3	S4
Sieve Analysis				
75 mm				
37.5 mm				
26.5 mm				
19 mm	100			
9.5 mm	98		100	100
4.75 mm	94	100	99	99
2.36 mm	90	99	97	97

Sample	S1	S2	S3	S4
0.425 mm	84	95	90	90
0.075 mm	66	56	72	64
Atterberg Limits				
Liquid Limit	103	75	83	65
Plastic Limit	32	34	32	32
PI	71	41	51	33
LS	23	17.5	19	13
Emerson Class No	6	6	6	6

The preliminary work undertaken as part of this study indicates that this site should be suitable for water storage with a substantial clay deposit for the embankment core sourced within the impounded area. Further, clay deposits should be found in the adjoining valley immediately east of the saddle. Rock for the embankment would be sourced from the pulp mill site works.

6. Conclusions

The above assessment has concluded that it is feasible to construct a water supply system for the proposed Northern Tasmanian Pulp Mill Project by sourcing water from the Trevallyn Dam. To progress this proposal to a stage suitable for inclusion in the IIS, it is recommended that the following additional work also be undertaken:

1. Topographic Survey
    a. Undertake a survey of the Tamar River and surrounds at the proposed point of the pipe crossing.
2. Geotechnical Investigations
    a. Undertake a drilling investigation of the area in the vicinity of the proposed Tamar River pipe crossing and the 670 ML storage dam at the mill,
    b. It may also be prudent to arrange some test holes along the pipe route to determine the amount of rock excavation that will be required.
3. Liaison with Hydro Tasmania
    a. Obtain confirmation in writing that Hydro Tasmania is prepared to make water available from Trevallyn Dam for this Project,
    b. Consult with Hydro Tasmania regarding lowering of the dam water level to construct the pump station intake pipe work.
4. Liaison with Hydro Tasmania
    a. Obtain approval to pass the pipe through their property at Trevallyn,
    b. Determine the cost and constraints to provide power to the pump stations at Trevallyn Dam.
5. Liaison with West Tamar and Launceston City Councils.
    a. Obtain approval to construct the water main across Trevallyn Road, Reatta Road and Pitt Avenue,
    b. Obtain construction requirements and approval to cross various Council intersections along the East Tamar Highway.
6. Liaison with DIER
    a. Obtain construction requirements and approval to cross the north and south bound lanes of the West Tamar Highway,
    b. Obtain approval to construct the pipe in the East Tamar Highway corridor – particularly in areas where the pipe will need to be placed in the road shoulder.

c. Obtain construction requirements and approval to cross various DIER intersections along the East Tamar Highway – particularly the Batman Highway,

d. Obtain approval to construct crossings of the East Tamar Highway at Barnard's Creek, just before Magazine Road and at the Mill Site.

7. Liaison with other stakeholders to be considered:

a. Esk Water, with regards to the alignment of their Chimney Saddle to Bell Bay Water Main and any potential impact this new pipeline may have on it,

b. Telstra, with regards to the location of their underground cables along the pipe route,

c. TasRail, with regards to crossing their line just before the pulp mill site,

d. Aurora, with regards to the maintenance of their poles during construction of the pipe line,

e. Other stakeholders that may have access to their property interrupted during construction of the pipeline.

7. Alternative Water Supply Schemes

7.1 Curries Dam/Pipers River Scheme

The current water supply system to Bell Bay is owned and operated by Esk Water and comprises a reservoir on the Curries River, a pumping station located at the Curries River Dam, a 25 ML storage (known as the Duck Pond) and a rising main following Bridport Main Road to Bell Bay.

The Curries River Dam is a clay core rock fill dam with a capacity of 12 GL.

The Curries Dam was constructed in 1974 as part of a long-term water supply strategy for the Bell Bay/Georgetown area, involving a second dam on the Pipers River and a pump station and rising main delivering water to Curries Dam to supplement its yield. Up until this point in time, this second dam has not been required.

A proposed scheme to provide water from the Curries Dam and Pipers River to the pulp mill would involve:

1. A dam to be constructed on Pipers River in the vicinity of the existing weir;
2. A pumping station at the foot of the dam to pump to the Curries River dam;
3. A rising main from the Pipers River pumping station to the Curries River dam; and
4. Upgrading the existing Curries pumping station, by-passing the 25 ML storage (the Duck Pond) and pumping water through the existing 840 mm steel pipeline to Bell Bay (vicinity of East Tamar Highway and Bridport Road) with a new pipeline to convey water south to the Pulp Mill.

The estimated capital cost for this option is between $60 and $65 million, with pumping consumption from Pipers River to Curries Dam around 10.4 million kWhr/yr, and pumping costs from Curries Dam to the pulp mill around 5.5 million kWhr/yr.

A daily water balance analysis was prepared for this option using daily flow data for the Pipers River from April 1972 to June 2004. This data was obtained from a gauging site downstream of Yarrow Creek, near the proposed dam site.

The release of environmental flows was modelled in accordance with information provided to Gunns by DPIWE. The assessment undertaken by DPIWE was consistent with their recent studies for the Little Swanport River, and involves providing a base environmental flow to maintain the freshwater ecology of the river and a series of peaks (pulse flows) to maintain sediment flow and riparian wetting.

The figures given by DPIWE for the required base environmental flows in the Pipers River were:

1. Nov to April: 23 ML/d
2. May to Oct: 66 ML/d

Table 16 Summary of Peak or Pulse Environmental Flow Events

Flow Event	Magnitude (ML/day)	Duration	Ramping (not including duration)	Frequency	Timing	Total Volume per yr (approx) (ML)
Small pulse	125	3 days	Down – half day	5 per 1 yr	3 summer 2 winter	2200
Intermediate pulse	800	1.5 days	Up – 1.5 days Down – 3 days	2 per 1 yr	Winter	3900
Large pulse	1500	1 day	Up – 3 days Down – 6 days	5 per 2 yrs	Winter	7500
Spring trigger	1700	1 day	Up – 3 days Down – 6 days	1 per 1 yr	October	3200
Autumn trigger	1000	1 day	Up – 2 days Down – 4 days	1 per 1 yr	May	2000
Riparian flood	2500	3 days	Up – 4 days Down – 8 days	1 per 1 yr	July or August	9500
1 in 2 yr flood	4600	1 day	Up – 6 days Down – 12 days	2 per 5 yrs	January to December	3000
1 in 5 yr flood	7700	2 days	Up – 8 days Down – 14 days	1 per 5 yrs	January to December	4000

DPIWE indicated that the winter base flow of 66 ML/day might be conservative, but further ecological assessment of the river system would be required to justify a lower value.

The river flow modelling assumed that if the dam inflow were less than the base environmental flow, only the inflow would be released downstream.

As well as the base flows; high flow events were also incorporated into the model.

The river modelling assumed that these flows must be released from the Pipers River dam only if they are present in the inflow. If these events do not occur naturally, then they do not need to be released.

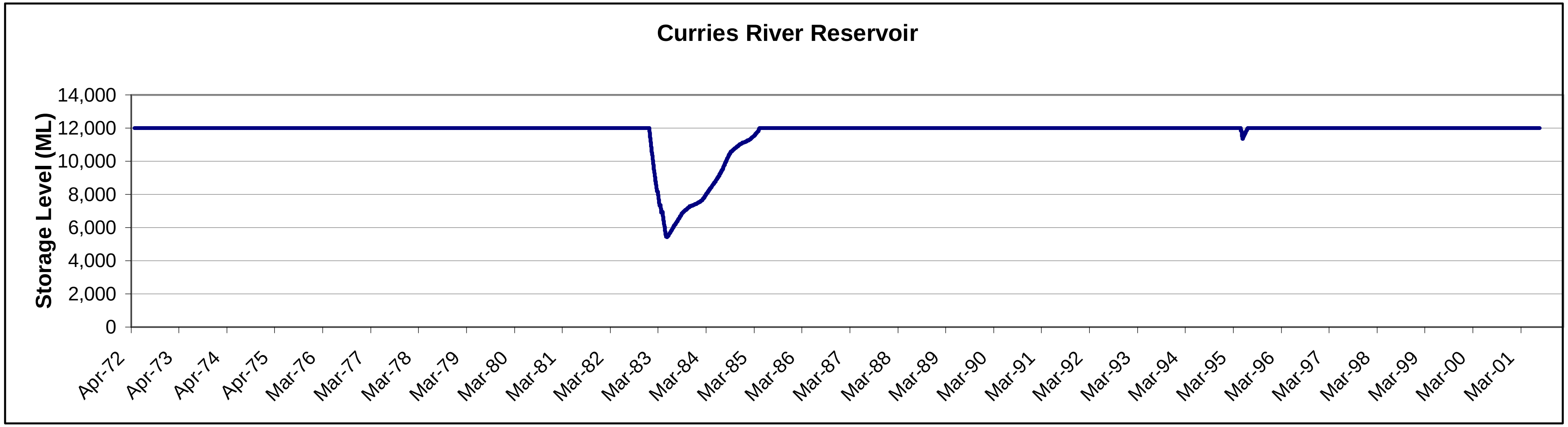
To quantify the required storage and pump rate on the Pipers River, the model was run for a number of combinations assuming an annual water demand of 26 GL.

These indicate that the reliability of water is mainly dependant on the storage capacity of the dam on Pipers River. In particular, it is critical that the storage be at least 15 GL, with 20 GL being more desirable.

The following tracks of the storage in both the Pipers and Curries Storages indicate that 1982 would be the critical period for supply, and that Pipers Dam would regularly empty. Security of supply is considered marginal at best, with little scope for upgrading the system to cater for the Stage 2 flow of 40 GL/year.

In summary, the Curries Dam can only supply approximately 3 ML/d due to the small catchment, small dam, and weather patterns.

A new Pipers River Dam (20 GL) would meet first stage demands, but could not meet future demands. It would be also more expensive and less environmentally acceptable than alternative schemes.



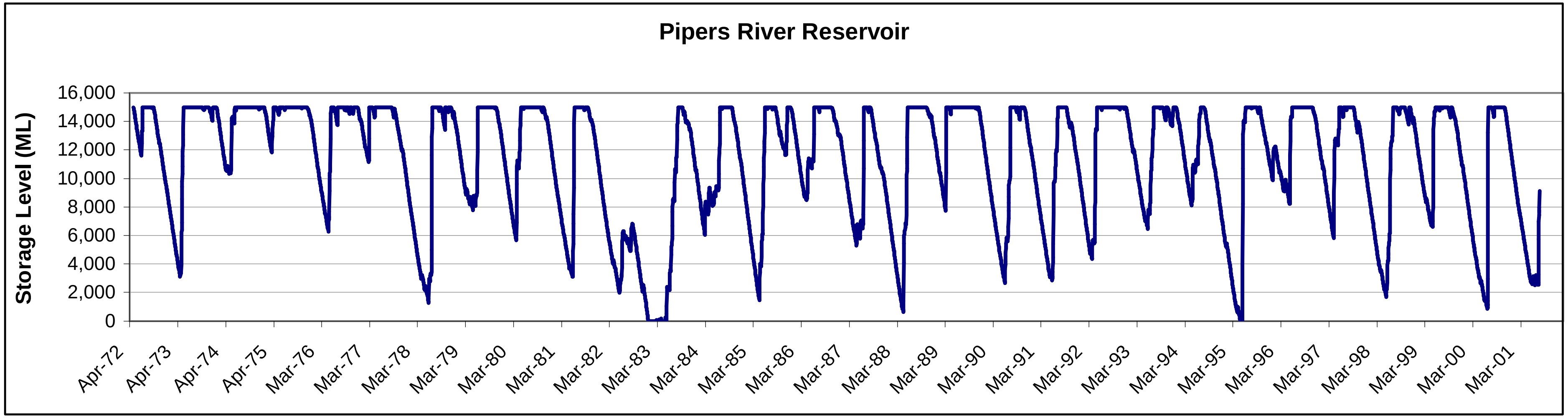


Figure 8 Tracking of Pipers and Curries Reservoirs – Pipers Dam Capacity 15 GL

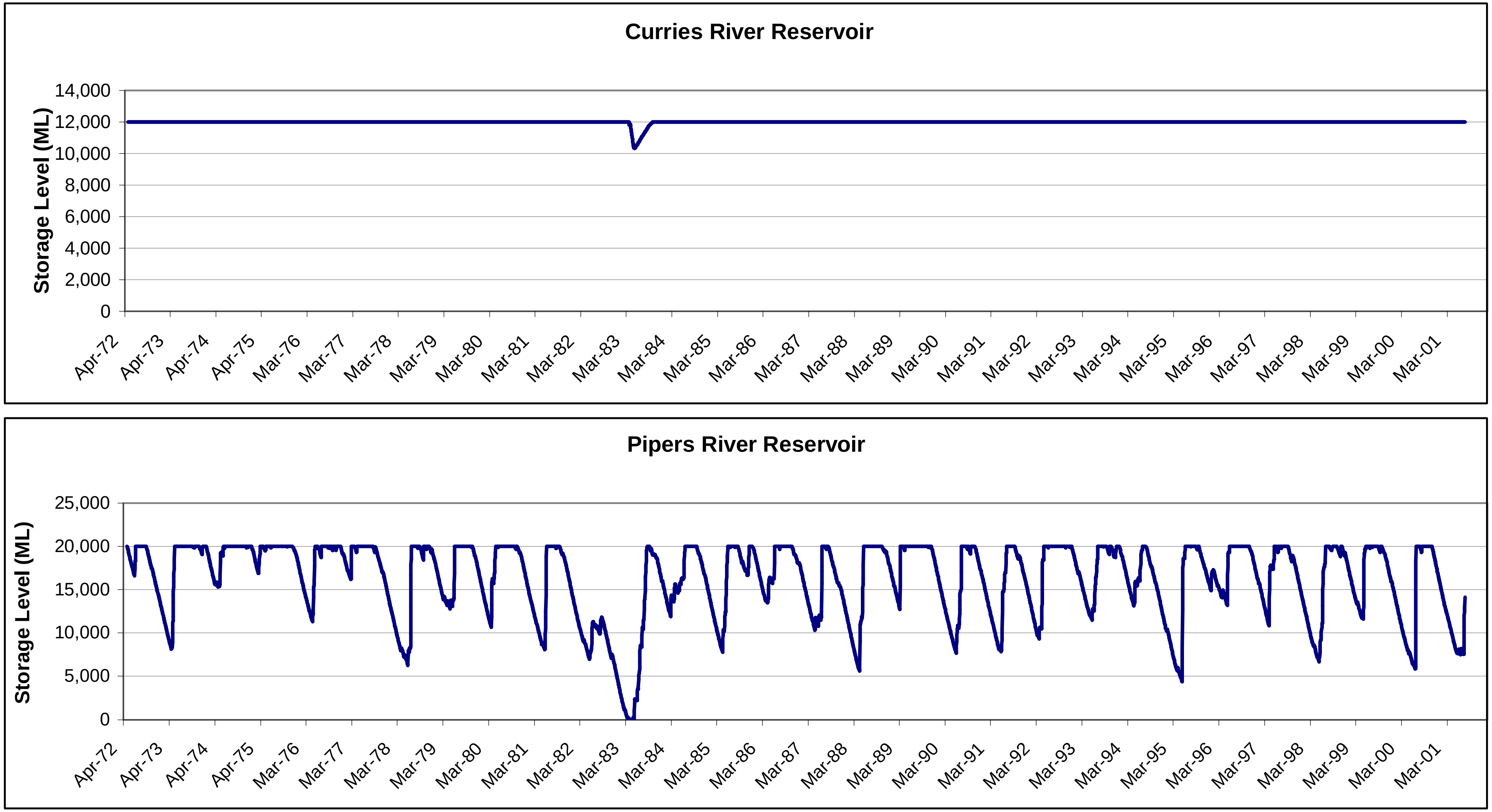


Figure 9 Tracking of Pipers and Curries Reservoirs – Pipers Dam Capacity 20 GL

7.2 Domestic Sewage Reuse

An alternative to the Pipers River option would be to utilise outflow from the wastewater treatment plants in the Launceston area. This water would be transferred to the proposed storage site at Bell Bay above the pulp mill site. A larger storage would be required to balance peak and minimum daily flows.

A water balance analysis using a spreadsheet was prepared to determine the required storage size at Longreach in order to provide a reliable water supply.

The information obtained from the Launceston City Council indicates that the total average outflow from their four main plants (Ti Tree, Newnham, Norwood and Hoblers Bridge) is around 50 ML/d. Allowing for losses of 10%, the total available outflow is around 45 ML/d. While there is the likelihood of this figure increasing in the future, it is unclear at what stage this will occur.

Under its licence condition, the Launceston City Council is required to regularly monitor the outflow performance of their WWTPs.

Typical treated effluent quality from these plants is as follows:

Table 17 Treated Effluent Performance from Launceston WWTPs

Parameter	Average	Median	Maximum	90%ile
BOD	14.2 mg/L	6.0 mg/L	880 mg/L	18 mg/L
TSS	19.4 mg/L	11.0 mg/L	620 mg/L	34 mg/L
TDS	22.0 mg/L	26.0 mg/L	890 mg/L	533 mg/L

The water requirements for the pulp mill have been determined at 75 ML/d and, accordingly, there would need to be some form of supplement supply from other sources to meet this demand. Given the limited water available from Curries River dam (there is the scope to provide a further 3.4 ML/d from this storage), it is envisaged that an additional water source will also be required. This could be in the form of an intake from the Esk River System or a smaller scale supply from Pipers River.

Assuming a reduced water usage of 42 ML/d at the mill, it would be necessary to construct 1.0 GL storage at Bell Bay to buffer the variation in output from the domestic wastewater treatment plants. It is also expected that some form of advanced treatment of the effluent would also be required most likely in the form of membrane microfiltration (with coagulation up front and disinfection at the end). It is estimated that a membrane plant with capacity of 42 ML/d would cost around $35 Million.

A membrane plant with capacity of 75 ML/d would cost around $55 Million.

In light of the uncertainties in security of supply, this option was not assessed further.

7.3 Desalination

A detailed review of desalination has not been undertaken but such a system may be feasible if it drew water from the Tamar Estuary and made use of cogeneration with the boiler to optimise energy usage. The brine waste solution would be discharged out the process water ocean outfall. Such a system may require a review of the emission guidelines to achieve this.

It is estimated that a desalination plant with capacity of the order of 65 ML/day would cost around $150 Million, and consume around 90,000 kWhr per year in energy. The plant will also need to discharge approximately 70 ML/day of brine waste, which would be discharged through the process water outfall. This would mean that the outfall pipe would need to be increased from around 750 mm diameter to 1,200 mm diameter, at an approximate cost increase of $12 Million.

Appendix A

Water Hammer Analysis

Hydraulic Design

The longitudinal section of the main includes a high point at approximately Ch 1.8 km. At this point the main is sufficiently high to allow gravity flow from here to the end of the main. In effect, then, the main will be part pumped main and part gravity main, with the majority being gravity.

The design of the main has therefore been considered in three sections based on the locations of significant high points along the route. The first section runs from the pump station at Aquatic Point to the top of the hill on which the Trevallyn Treatment Plant is located (Ch 1.8 km); this is a pump main. The second section runs from Trevallyn to a high point of RL 155 m between Dilston and Mt Direction on the East Tamar Highway; this is the first section of gravity flow. The third section runs as a gravity main from this high point to the storage dam located at Longreach (see figure).

It is particularly important that the Hydraulic Grade Line (HGL) be above the top of the pipe at all points along the pipeline. The highest points along the line then become control points.

The diameter of pipe used for the first section has been sized taking into account the balance between pipe cost and power cost (keeping in mind static lift constitutes around 85% of the required pump head).

The pipe diameters for the second and third sections are sized to keep the hydraulic grade line above the top of the pipe at all times for the design flow of 1325 L/s.

A Hazen-Williams Friction Coefficient of 130 has been used in this analysis to represent the pipe in its expected long-term operational state. The table below is a summary of the sizes chosen and the frictional losses expected at a flow of 1,325 L/s – the flow required to deliver 40 G/L per year to the pulp mill site:

Table 18 Pipeline Section Details

	Section 1	Section 2	Section 3
Length (km)	1.8	21.8	16.0
Diameter (mm)	800	920	920
Head Loss due to friction and fittings (m)	11.7	71.6	52.5

Water Hammer

As discussed earlier, this report looks at two different water hammer scenarios:

1. A continuous pipeline from Lake Trevallyn to the Longreach storage dam, with air valves installed at each of the two high points described above.
2. A storage tank at the end of Section 2 holding at least 15 mins storage at 1325 l/s, and a valve situated at the Longreach storage dam controlled by the water level in the storage tank. These would be linked by telemetry to ensure that the pipeline remains full of water in the event of pump failure to avoid air problems on restarting of the pumps.

Scenario 1

A sudden power failure causing the pumps at the Aquatic Point Pump Station to cut out would generate water hammer waves in the pipeline that could create significant damage. Sudden pump stop produces a negative surge initially, and, depending on the pipeline profile, this can lead to separation of the water column. This in turn could lead to collapse of a pipe due to excessive negative pressures, or it could lead to excessive positive pressures due to the shock created by rejoin of the water column. The pipeline must be designed to withstand the negative pressures created by this process, and the positive pressures generated by the rejoin.

The water hammer analysis for this scenario has been carried out using the computer analysis package *Watham.* The figures below give a graphical representation of what happens to pressure and velocity in the pipe before and after the pumps stop: the green profile represents the natural surface, the grey line represents the hydraulic grade line, and the red lines represent the envelope of pressures and velocities experienced over the duration of the analysis undertaken (200 secs).

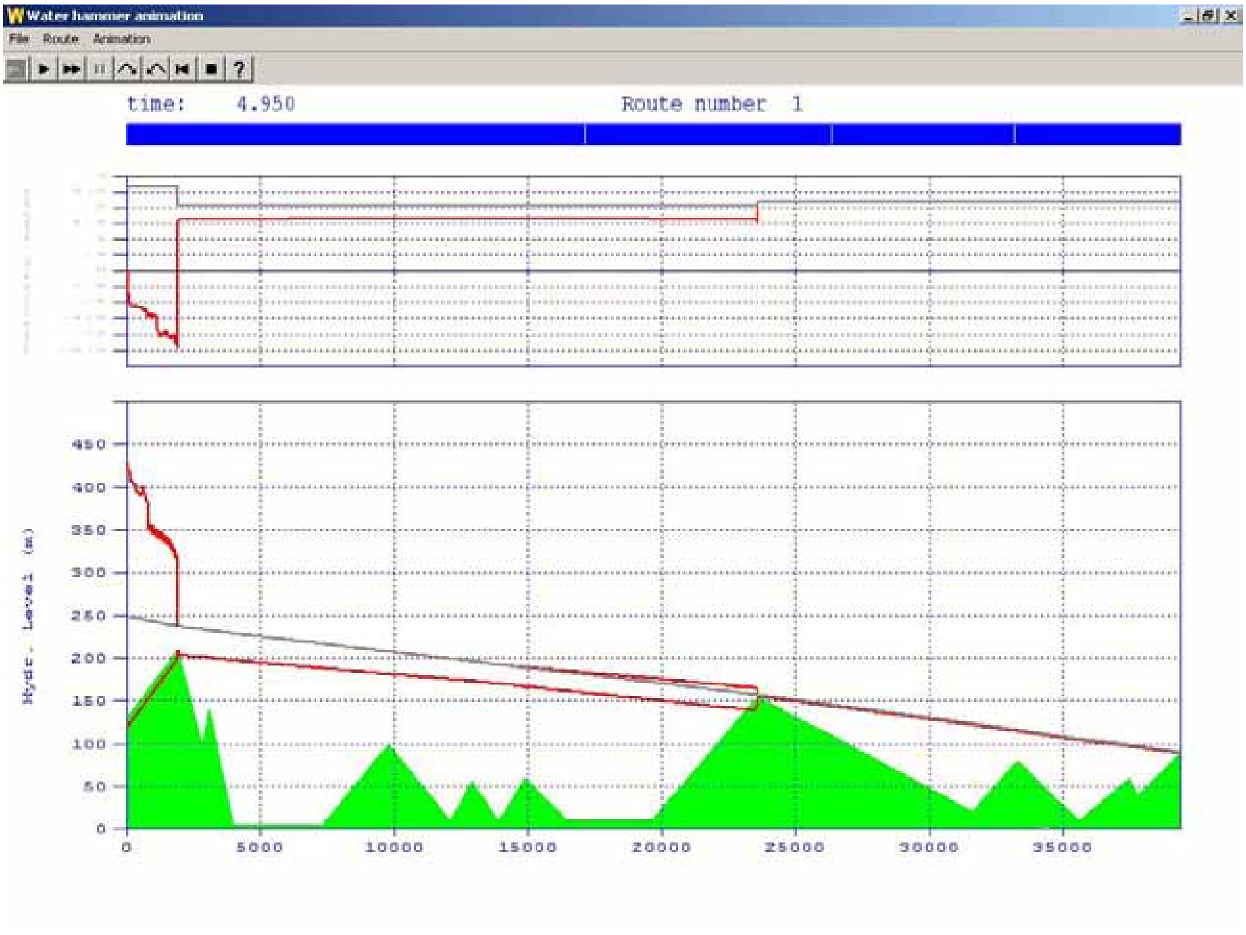


Figure 10 Pressure and Velocity with Pumps Running

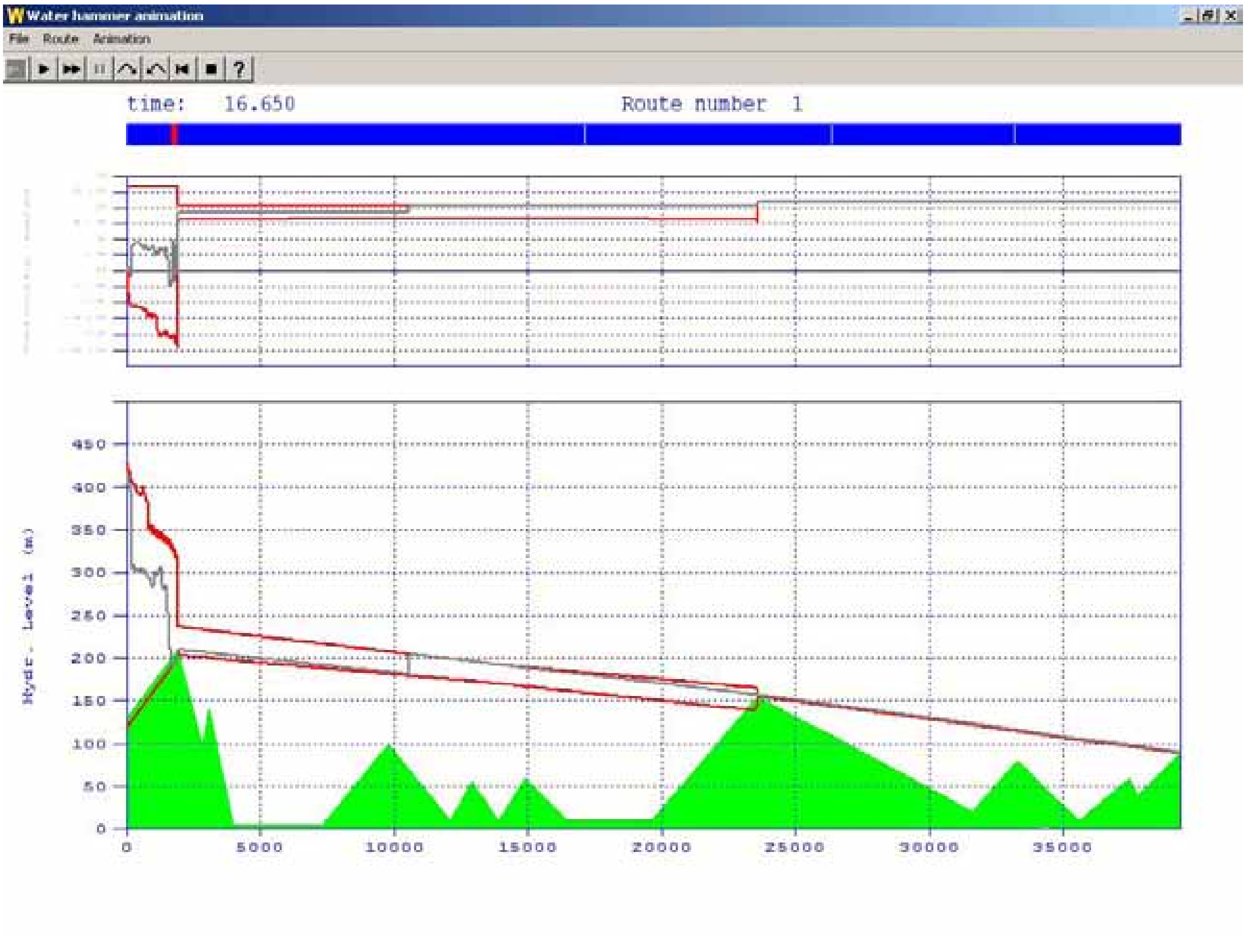


Figure 11 Pressure and Velocity a short time after Power Failure

In Figure 1-1, the system is flowing with 1,325 l/s, and small steps in the velocity are evident at the changes in pipe diameter.

A short time after the power failure, in Figure 1-2 we can see that significant negative pressures have developed in Section 1 of the pipe leading to column separation. In Section 2 of the pipe it can be seen that a water hammer wave is propagating along the pipe. This wave gets reflected when it reaches the high point at chainage 23 km and continues to move back and forward in section 2 with dissipating energy.

While the maximum pressures are within the capability of steel pipe, the most critical aspect of the pipeline design with respect to water hammer is selecting a pipe that has a critical buckling pressure able to withstand any negative pressures generated in the pipe. The negative pressure trying to collapse the pipeline consists of approximately 100 kPa of column separation and a 40 kPa contribution from the backfill around the pipe. (Assuming our backfill has a unit weight of around 20 kN/m^3 and the pipe is buried 2 m under natural surface). For Section 1 a steel pipe with a 6 mm wall thickness and cement lining has a critical buckling pressure of 151 kPa and would provide a Factor of Safety of 2.5 against buckling. The remaining sections are not subject to negative pressures.

Scenario 2

Water Hammer problems in the second scenario could be experienced as a result of 'instantaneous' closure of the valve situated at the Longreach storage Dam. Since this valve would need to be such a large sized bore, it is unlikely that it could be shut-off in a short enough period of time to constitute instantaneous closure. The analysis that we have carried out can therefore be deemed fairly conservative for this situation. See below for Watham graphics:

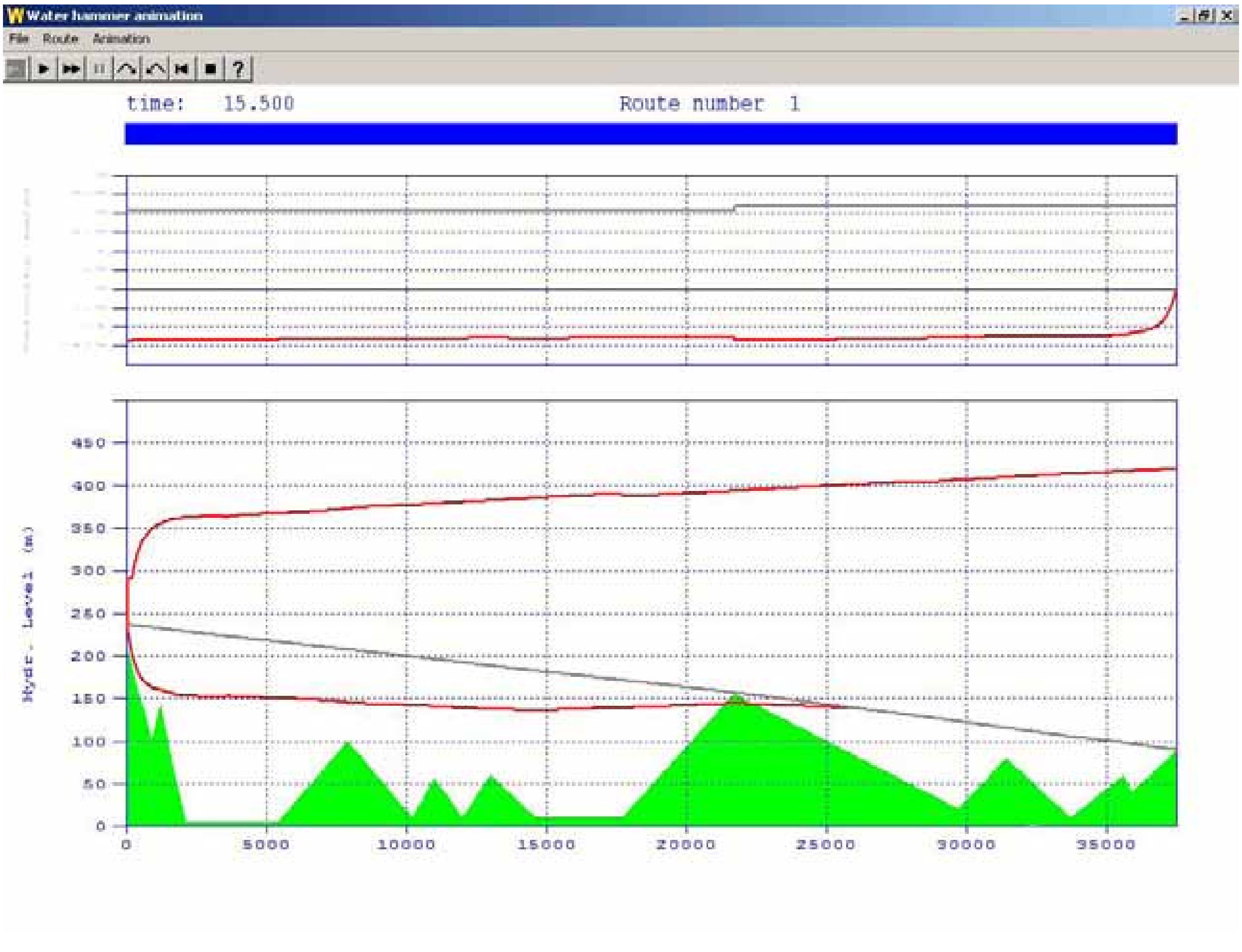


Figure 12 Pressure and Velocity with flow running at 1325 l/s

Figure 13 Pressure and Velocity a short time after Valve Closure

In Figure 2-1, the system is flowing with 1325 l/s, and a small step in the velocity can be seen at the change in pipe diameter at Ch 23 km.

A short time after the valve closure, in Figure 2-2 we can see that a water hammer wave has developed and is propagating along the pipe. This wave gets reflected when it reaches the storage tank at Trevallyn and continues to move back and forward between Trevallyn and Longreach with dissipating energy.

With the exception of "localised" high points, the main needs to be designed for a maximum positive pressure of 320 m. There is no evidence from the modelling that column separation will occur under this scenario.

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0	R Casimaty	D Kinniburgh	D Kinniburgh	D Kinniburgh	D Kinniburgh	21/10/05
1	R Dodson	L McVey	L McVey	D Kinniburgh	D Kinniburgh	2/03/06
2	R Dodson	D Kinniburgh	D Kinniburgh	D Kinniburgh	D Kinniburgh	06/07/06