REPORT

Opuha Water

Proposed Opuha Dam Downstream Weir Enhancement - LHS Option

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Opuha Water

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1 Introduction

Further to recent discussions this report overviews recent work about revisiting an Opuha Dam Downstream Weir (ODDW) enhancement left hand side (LHS) scheme. LHS options involve demolition of the crest of the existing ungated ogee weir and installation of flap gates on the crest of a new ogee weir at a lower level. Possible arrangements were described at a high level in February 2011[1]. It is important that this report is read in conjunction with the 2011 work as the earlier report provides a more comprehensive description of the proposal and outlines as-built details.

The assessment focusses on possible diversion arrangements because management of construction stage floods was a key consideration when Opuha Water Limited (OWL) elected to consider right hand side (RHS) scheme options. Appendix A includes some preliminary design sketches from February 2011 together with other recent sketches illustrating the diversion concept.

Also reported is an updated cost estimate for the LHS scheme to include provision for the described arrangement as well as a preliminary programme.

2 Construction diversion – LHS options

2.1 Background

Demolition of the existing ogee weir crest and training walls in the vicinity of the crest impacts on the ability of the ODDW structure to pass floods during the construction period. Because the overflow embankment earth fill is exposed at a low level, the overflow embankment is also at a risk of damage if a significant flood was to occur during critical construction activities. A simple coffer dam around the existing ogee weir is complicated by the very close proximity of the existing radial gate and ogee weir.

Consequently, the LHS arrangement described in February 2011 was based on advice from Contact Energy that a coffer dam was impractical and that the scheme could be operated for key periods with the operating range of the ODDW pond limited to 2.0 m above the top of the gate opening[2]. A 2.0 m operating range corresponds to a maximum pond level during construction of 337.75 m RL, 3 m lower than the existing maximum operating level (and existing weir crest) at 340.75 mRL. The capacity of the gate in the fully open position with the pond at 337.75 m RL is approximately 26 m^3/s which compares to an estimated Gooseberry Stream mean annual flood in the order of 17-18 m^3/s. A diversion capacity only a little greater than the mean annual flood is much less than the diversion capacity typically associated with dam construction. Also, while accepting that the pond can be kept artificially low outside of flood conditions, the level duration curve included in Appendix B indicates that about ninety percent of the time the pond level is greater than 337.75 mRL.

OPWL subsequently determined in 2011 that the risk of the pond level exceeding 337.75 m RL during critical construction activities as well as the operational inconvenience of limiting the pond to 337.75 mRL was too high. Risk associated with the diversion was a key factor influencing consideration of right hand side (RHS) scheme options as the RHS opportunities allowed a coffer dam crest level coincident with the existing enclosure embankment at 342.25 mRL. Thus for RHS options previously considered, there would not have been an impact on ability of the ODDW to pass floods during construction.

[1] Tonkin & Taylor; Opuha Dam, Downstream Weir Enhancement: Rough cost estimate; February 2011; T&T reference 51137.006

[2] Ibid

2.2 LHS diversion option

Following recent discussions with OWL, set out below is consideration of a diversion arrangement to facilitate construction of a LHS scheme intended to:

i. Preserve the existing routine pond operating regime to 340.75 mRL during normal operating conditions (i.e. not during times of flood). The proposal will enable the pond to operate to 340.75 mRL during construction and will provide significantly more flexibility than limiting the pond level to 337.75 mRL as initially proposed by Contact Energy.

ii. Provide an increased ability to pass floods during construction (relative to the 2011 LHS scheme) to a level acceptable to OWL and ECan (Environment Canterbury as relates to the Building Consent Authority function as well as potential resource consent implications), albeit that the risk of a construction stage exceedance is greater than the RHS options previously considered.

2.2.1 Overview

The diversion arrangement now proposed to facilitate construction of a LHS scheme features a coffer dam to 340.75 mRL (now as agreed with OWL) consisting of a reinforced concrete wall and earth bund. The wall is necessary to allow the diversion bund to connect to the existing reinforced concrete weir structure given the limited space between the existing ogee weir and the existing radial gate. It is noted that other crest level options may also be available to provide different levels of flood protection. The level duration curve included in Appendix B indicates that over the relatively short period from 7 November 2011 to 15 May 2014 (when the overflow embankment did not operate) about ninety nine percent of the time the pond level is less than 340.75 mRL.

The proposed wall would be founded at about 336.55 m RL adjacent to the existing concrete structure dropping slightly as the wall extends away from the existing concrete (TBC by survey). The average height would be approximately 4.2 m with a crest at 340.75 m RL. The wall would be designed as a cantilever with coffer dam fill placed over the footing with a shear connection to rock as is required. Photographs 1-3 below illustrate where the wall would be located and provide a perspective on the foundation conditions. The wall thickness may vary from about 250 mm at the top to around 450 – 500 mm at the base. Depending upon requirements for working room adjacent to the existing weir the wall could be approximately 16.5 m long at the base coincident with a crest at 340.75 m RL. The dimensions will vary for other wall crest levels.

While specific details of the temporary bund are best left to the constructor (for example the degree of initial construction relative to maintenance requirements during construction), the arrangements may comprise the following if an earth bund is selected:

- 2 m wide crest.
- Upstream and downstream side slopes approximately 2H:1V.
- Height up to about 4.75 m adjacent to the diversion wall assuming that the base of the wall is locally at 336.0 m RL at this interface, reducing to 0.75 m high where existing rock level is at 340.0 m RL (topography to be confirmed by survey).

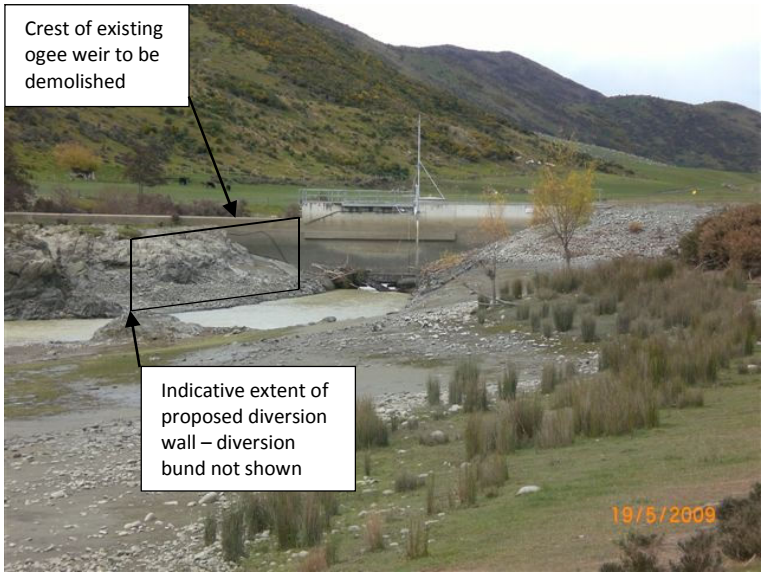
Appendix A includes some preliminary design sketches from February 2011 together with other recent sketches illustrating the diversion concept.

Estimated construction costs exclusive of GST for the diversion arrangement described are described in Section 8 and set out in Appendix E.

Other arrangements may be possible in lieu of an earth bund, for example arrangements such as proprietary systems, sand bags, mass blocks with membranes. Such arrangements would be at

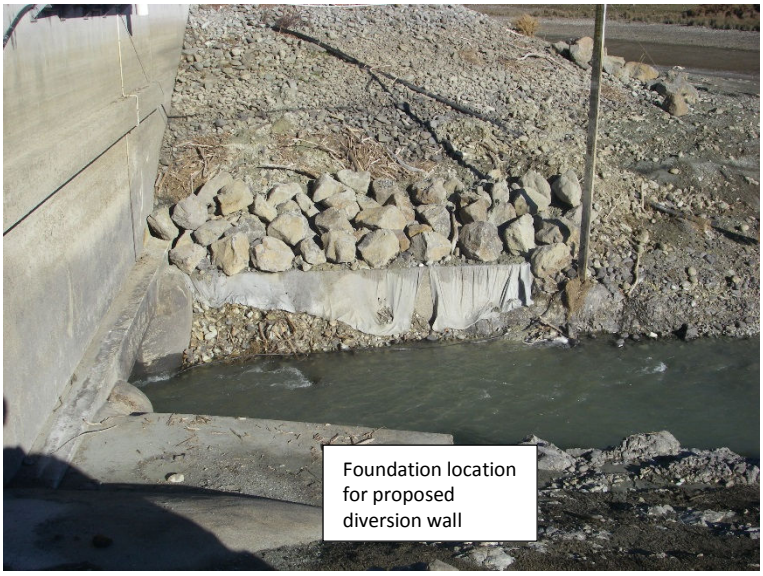
the discretion of the constructor to meet some form of performance specification. Specification requirements would need to address stability, flooding levels and increased flow velocities in the vicinity of the intake.

No specific consideration has been given as to potential implications on the efficiency of the gate flow during normal operation as a consequence of the proposed wall.



Photograph 1: Streamflow through existing radial gate, existing ogee weir and proposed diversion wall

Photograph 2: Streamflow through existing radial gate and foundation area for proposed diversion wall



Photograph 3: Streamflow through existing radial gate and foundation area for proposed diversion wall

2.2.2 Construction sequencing

Construction of a LHS scheme featuring the described diversion arrangement is anticipated to be much as follows:

i. **Prior to construction lower the Opuha lake level**. It will be necessary to plan the works for a time of the year that enables the lake to be drawn down prior to construction commencing. A low lake level during construction will enable floods to be retained in the lake and as far as is achievable, limit releases from the reservoir during coincident floods in Gooseberry Stream. Ensuring an appropriate lake level prior to construction is a very important component of the proposal (refer to Table 2 following). Owl have recently indicated that 385 m RL is a suitable level/target lake level prior to construction that can be accommodated by OWL. No routing has been undertaken to confirm the

ii. **Lower the pond level and construct diversion wall**. It will be necessary to lower the pond below 336.55 m RL to enable construction of the diversion wall. The pond will more or less limited to stream flow through the existing radial gate when during this period i.e. there will be only be very limited ability to attenuate power station flows and power station releases will more or less be the flow released from the ODDW. While the constructors working area will be at risk from flood rise, in principle the ability of the ODDW to release flood flow will be unchanged during this phase.

iii. **Form diversion bund.** A diversion bund is required to isolate the existing ogee weir from the pond. The bund will link the existing overflow embankment to the proposed diversion wall. In principle the pond level will be able to raise above 336.55 during the latter stages of coffer dam construction

iv. **Demolish crest of existing weir and both training walls in the vicinity of the new weir crest.** This is the critical construction activity insofar as risk of damage to the structure is concerned.

v. **Construct new weir block and training walls.** Once reinforced concrete construction is complete then the risk of flood flow damaging the existing overflow embankment will be less than the present situation.

vi. **Works to protect the toe of the existing chute and sill**. Note that with regard to flood protection, there is some flexibility associated with the scheduling of subsequent work as the ODDW will have capacity to pass greater flow at this point with /or without the new

gates. However, without the coffer dam the new gates will be required in order to provide the necessary degree of routine flow attenuation/operational flexibility for the remainder of the construction period (i.e. the pond won't be able to be raised to 340.75 m RL until the new gates are operational). There is merit in undertaking the toe protection work first.

vii. **Install new gates on reformed weir crest**.

viii. **Install foot bridge deck over the weir**.

ix. **Remove the coffer dam.** Subject to the final arrangements adopted, there may be little point in removing the diversion wall.

2.2.3 Design standards

At present, a five year or greater average recurrence interval (ARI) flood event may be expected to cause some damage to the overflow embankment. The overflow embankment has been designed for a five year ARI event. The probability of at least one five year ARI events occurring in a typical five year period is 67 %.

The NZSOLD Guidelines[3] state the following in regard to earth dams:

"If a site-specific risk-based approach which considers exposure times and the downstream consequences of failure is not completed, the Owner and Designer should give consideration to the following guidelines for diversion capacity:

- *If the incremental consequences of a dam failure during construction include no potential for the loss of life downstream of the dam, a return period of 50 years may be appropriate for the sizing of the diversion works.*
- *If the incremental consequences of a dam failure during construction include the likelihood of the loss of one or more lives downstream of the dam, a return period of 250 years or greater may be appropriate for the sizing of the diversion works."*

It is worth noting that the weir structure per se is not an earth dam. While the overflow embankment is (and is at risk for a short period when the LHS training wall is demolished) the unique nature of the works justify that a "site-specific risk-based approach which considers exposure times and the downstream consequences of failure" is undertaken to determine an appropriate standard.

Appendix D includes more information from the NZSOLD Guidelines and is included to provide some more background on the matter with regard to the NZSOLD perspective.

While the source document is now not operative, the following ANCOLD comments are of relevance[4]:

"Matters to consider, as appropriate for the limited construction period, site arrangements and consequences of the diversion capacity being exceeded, are:

- *For proposed dams, risk of failure during construction, as far as practicable, to be no greater than the risk of failure over the long-term life of the dam.*
- *For existing dams, as far as practicable, provisions so that existing risks from floods will not be increased during remedial works."*

The guidance referenced has been taken into account to provide a perspective on the arrangements considered.

[3] New Zealand Society on Large Dams, New Zealand Dam Safety Guidelines, May 2015
[4] ANCOLD; DSC11 Acceptable Flood capacity for Dams; August 1992

To assisting the unique nature of the project, the 50 year ARI event mentioned by NZSOLD is greater than the magnitude of the flood that will cause the overflow embankment to operate with the new gates in place.

2.2.4 Diversion capacity

The design report[5] refers to work by PB Power that states that in the wide open positon (1,500 mm wide opening) the existing radial gate can accommodate the flows listed in Table 1 below.

Table 1: Existing radial gate capacity - 1,500 mm gate opening

Pond level (m RL)	Gate discharge (m^3/s)
334.25	0
334.75	8.88
335.25	12.76
336.25	18.60
337.25	23.48
338.25	27.91
339.25	32.09
340.25	36.13

To provide some insight into the pond levels listed in Table 1, included in Appendix B is a level duration curve for the ODDW pond based on the data from 7 November 2011 to 15 May 2014. The period is dominated by normal every day operating conditions and does not include significant floods (e.g. an event of sufficient magnitude to cause the overflow embankment to operate). The level duration curve indicates that during this period the pond level exceeded 340.75 m RL less than 1 % of the time. The curve also shows that the pond exceeded 340.75 m RL for 10% of the time over the very short period from 1 January to 28 March 2013. The periods are short and it is understood that there were no floods during this time that were close to causing the overflow embankment to operate. This appears to indicate that from the perspective of routine operation (i.e. excluding floods) 340.75 m RL is an appropriate level to adopt for the diversion.

Gooseberry Stream enters the ODDW pond below the main dam and has a catchment of some 1,500 ha. Table 2 below relates the magnitude of different average recurrence interval floods in Gooseberry Stream to pond levels on the basis that the radial gate is acting as a hydraulic control. Probabilities that a particular event is exceeded in typical one month and two week periods are also included. The adopted one month period relates to an assumed critical construction window and requires confirmation and as requested, a two week period is also reported to provide further perspective on the matter.

It is important to note that the scenarios outlined in Table 2 do not explicitly consider discharge from the Opuha Dam service spillway (aside from noting that a diversion arrangement set at 340.75 mRL may accommodate a combined flow from Gooseberry Stream and the dam of 38.6 m^3/s). The information presented in Table 2 has been revised from the earlier issue to include approximate long term average probability of exceedance during typical one month and two week long periods.

[5] Tonkin & Taylor; Opuha Dam Project Design Report For Civil Works Contract Undertaken By Doug Hood Ltd; May 1999; T&T reference 13909

Table 2: Probability of pond level exceedance based on estimated Gooseberry Stream flood flow with and without power station discharge

Approximate pond level[1] (m RL)	Estimated Gooseberry Stream flow (m^3/s)	Power station discharge (m^3/s)	Pond outflow (m^3/s)	Approximate frequency of Gooseberry stream event ARI (years)	Approximate long term average probability of exceedance during typical periods (%)	
					During one month	During two weeks
339.90	18.6	16.25	34.9	2.2	5.1%	2.4%
340.00	19.0	16.25	35.3	2.2	4.9%	2.3%
340.25	20.1	16.25	36.1	2.3	4.5%	2.1%
340.50	21.2	16.25	37.5	2.5	4.2%	2.0%
340.75	**22.3**	**16.25**	**38.6**	**2.6**	**3.9%**	**1.8%**
336.25	18.6	0	18.6	2.2	5.1%	2.4%
337.25	23.5	0	23.5	2.8	3.6%	1.7%
338.25	27.9	0	27.9	3.6	2.7%	1.2%
339.25	32.1	0	32.1	4.5	2.1%	1.0%
339.70	34.0	0	34.0	5.0	1.8%	0.9%
340.25	36.1	0	36.1	5.6	1.6%	0.7%
340.50	37. 5	0	37.5	6.1	1.5%	0.7%
340.75	**38.6**	**0**	**38.6**	**6.4**	**1.4%**	**0.6%**

Note 1: Approximate pond level based on gate in the fully open position acting as hydraulic control

By way of comparison and to provide a general perspective on the probabilities outlined above the following comments are provided:

i. The overflow embankment has been designed for a five year ARI event. The probability of at least one five year ARI event occurring in a typical five year period is 67 % with or without the proposed works. More than one event may occur during the period.

ii. Gooseberry Stream flood flows in the order of 22.3 and 38.6 m^3/s are estimated to correspond to 2.6 and 6.4 ARI events respectively. The 2.6 ARI event would also equate to a pond level of 340.75 m RL if the dam is discharging 16.25 m^3/s (16.25 m^3/s being the maximum power station discharge). The 2.6 ARI flood level would be much less than 340.75 m RL if the dam is not discharging.

iii. The probability that a pond level of 340.75 mRL may be exceeded by inflow from Gooseberry Stream during a typical one month period is 1.4% without any discharge from the dam, increasing to 3.9 % if the dam/power station has a coincident discharge of 16.25 m^3/s.

iv. If dam discharges can be avoided during the critical construction window (by way of drawing the reservoir down prior to construction) then the 1.4 % probability that the pond level will exceed 340.75 mRL is low and less than the 1.84 % probability of a five year ARI discharge from the dam during a typical month without reservoir drawdown prior to construction.

v. The NZSOLD Guidelines make reference to a 50 year ARI event as the basis for the design of the diversion for an earth embankment without consideration of a specific risk assessment. The probability of at least one fifty year ARI event occurring in a typical two year period is 4.0 % (2 years corresponding to an assumed construction period for a significant project). So long as the Opuha Dam reservoir is drawn down prior to construction then the risk of

overtopping during construction, as far as practicable, is no greater than the risk of overtopping over the long-term life of the ODDW structure.

vi. Based on the iv. above, so long as the reservoir is drawn down to an appropriate level prior to construction, the older ANCOLD criteria ("existing risks from floods will not be increased during remedial works") is met.

The comments outlined above form a risk assessment as suggested by the NZSOLD Guidelines. It is apparent from the above that the lake level at the start of construction is a key parameter that determining the suitability of a diversion set at 340.75 mRL. OWL have suggested a target lake level at the start of construction of 385 m RL, 6.2 m below the crest of the service spillway weir at 394.2 mRL. It is recommended that detailed design include routing (based on existing models) to assess risks associated with this initial lake level.

3 Gate options and M&E requirements

The 2011 assessment assumed that the proprietary Obermeyer flap gate system would be adopted. A primary consideration at that time was that the existing Obermeyer gates on the crest of the service spillway were also provided by Obermeyer. It is noted that other proprietary systems exist (e.g. AWMA and Yooil) and a bespoke design is also an option.

Set out below is a brief description of option some options and detailed design includes work to confirm the preferred system and establish how the gates will be procured.

3.1 Obermeyer

Included in Appendix C is updated information recently received from Obermeyer. The following points are understood to be relevant at this time:

i Obermeyer have indicated that they may require 12 weeks to design and manufacture their gates following receipt of an instruction to proceed. This appears problematic – refer to the subsequent section on programme for further discussion.

ii It is noted that OWL have reported some ongoing issues with the control system associated with the present gates. Work will be needed to ensure that similar issues to not arise at the ODDW installation if Obermeyer gates are selected.

iii The proposed ODDW gates will most likely be raised most of the time. Some thought is needed to ensure that potential risks associated with the sudden loss of air pressure in the supporting air bags can be accommodated by OWL.

iv It is noted that the information included in Appendix C excludes certain necessary work. For example power supply, gate installation and reticulation of the air supply. Arrangements will be necessary to resolve these matters e.g. including provision for a sub-contractor than can design and install the air supply pipework.

v Present arrangements including weir crest level is based on weir coefficient information advised by Obermeyer and it is necessary that this parameter is confirmed.

vi Obermeyer advise that their gates can sustain a 300 mm overtopping flow. Whilst flushing has not been assessed quantitatively at this time, this may be of benefit for flushing releases insofar as maximising the volume of the flush is concerned.

3.2 AWMA

Whilst AWMA have expressed a strong desire to be involved, at the time of writing details about the AWMA proposal are yet to be received. The following points are understood to be relevant at this time:

i It is noted that AWMA have not yet been able to confirm the capacity of their system to pass the design flow in the lowered position.

ii AWMA have indicated that their system will require a reinforced crest shape more complicated than that indicated by Obermeyer.

iii It is noted that, based on the recent information from Obermeyer, there will most likely be programme issues with the time necessary to supply the Obermeyer system. Equivalent/comparable information about the AWMA system is not yet available.

iv It is understood that AWMA are presently providing flap gates of a similar size to those anticipated for a project in Auckland.

v It is understood that AWMA may prefer to supply and install the gates although this is to be confirmed.

vi AWMA have indicated that their gates are designed to operate in either closed or open positons only and that the gates will lock in the raised position. AWMA advise that this is of benefit in the unlikely event of a sudden loss of air pressure necessary to keep the gates raised.

A relatively high level email is included in Appendix C outlining the AWMA advice as at 21 July 2015.

3.3 Other options and miscellaneous mechanical and electrical requirements

Proprietary systems other than Obermeyer and AWMA also exist. For example Yooil who have also been approached albeit that no response has been received from this organisation. It is not proposed to follow this any further. Indications are that that it is desirable that the gate supplier has specific New Zealand experience and both Obermeyer and AWMA have this track record.

It is recognised that a bespoke flap gate design may also be adopted albeit that it is understood that the recently completed CPWL Stage 1 project identified that propriety design and build gate systems were cost effective. Consideration of a bespoke design is not considered at this point further albeit that this may be revisited if required by OWL.

A range of miscellaneous mechanical and electrical (M&E) will be necessary if a proprietary system is adopted. For example confirmation of the power supply (and potential backup) to suit the adopted system is also required.

4 Energy dissipation

A LHS option will increase the flow in the existing chute by a significant amount. The flow will be much greater than was originally contemplated when the structure was designed. Present measures to dissipate energy include mass concrete at the base of the existing chute as well as an end sill.

Recent review of construction stage photographs indicates that the extent of the mass concrete relative to rock level, as well as rock mass integrity under the mass concrete, is a little uncertain. Resolution of this matter is important as inadequate protection of the toe of the chute during increased design flows could result in undermining and instability of the structure.

Subject to assessment, additional mass concrete and/or reinforcement may be required to increase stability of the toe. Prior to or during the initial stages of detailed design it will be necessary to remove some of the existing mass concrete and confirm the location of the rock head and the quality of the rock mass at this location.

A very nominal sum of $75,000 (base estimate excluding contingency) is included to allow for this work. The investigation is needed to confirm the scope.

5 Hydroelectric generation

It is not simple to include the proposed hydroelectric scheme within the LHS scheme now contemplated. However, it may be possible to consider this as a separate project that would utilise the existing closure embankment as the coffer dam (i.e. the new structures would be built below the existing closure bund).

6 Resource consent matters

It will be necessary to review the resource consent conditions against the proposed LHS scheme. Based on prior discussions we understand that OWL are presently completing this assessment. One matter that this work will need to address is the different diversion arrangement now proposed.

7 Programme

A programme for the new LHS option is included in Appendix F. As of 22 July the programme is draft. As discussed, the purpose of developing a programme at this point is to provide a perspective as to how the proposed LHS scheme may relate to a construction period commencing about April 2016 when OWL anticipate having the lake at least at 385.0 m RL. The following comments are made in regard to the draft programme:

i The programme assumes that the detailed design process starts on 10 August 2015, approximately two and a half weeks from 22 July (date of first issue of draft programme). A later start date will impact on programme. The programme highlights the importance of a timely start. The programme has very little float and whilst achievable is considered tight.

ii The draft programme assumes that Obermeyer gates will be used. It is recognised that other proprietary systems (e.g. AWMA) as well as a bespoke design could be selected. At the time of writing programme information from AWMA is not available. The programme relies on a decision in early September regarding gate supply. This is necessary so that civil design can suit the selected gate system. The programme is also reliant on conformation of information from the gate supplier in early September necessary to progress the civil design.

iii Obermeyer advise that a 12 week period is required from the time that the order is placed to the point that the gates are ready to dispatch from Obermeyer (TBC). Shipping is understood to be in excess of this period and could take around six to seven weeks (to be confirmed). At this stage is seems unlikely that OWL will be in a position to place a confirmed order for the gates until tenders for civil works have been reviewed. This indicates that there will be a delay (either before, during or after civil works) unless the time to supply the gates can be reduced.

iv The draft programme allows a two week period for Christmas 2015-16.

v Provision is included for OWL to approve tenders in mid-February 2016.

vi A number of updates will be required to the draft programme including, for example to consider the likes of the selected gate system (including the method of procurement) as well as the approach to the building consent (provided draft programme does not provided for a staged approach – a staged approach may be necessary depending upon ECan requirements regarding the level of detail needed by ECan to issue building consent for the gates).

vii The programme does not include provision for amendments to resource consents and assumes that if needed this work may occur in parallel with design (i.e. if required that this is not a critical path activity).

viii The programme does not include provision for development of hydroelectric generation.

8 Cost estimate information

The February 2011 rough order cost estimate of the capital cost for construction of the ODDW LHS enhancement has been updated and is set out below. The estimate is based on the outline proportions and arrangements described in the February 2011 report together with updates to rates from recent work and inclusion of the diversion scheme to 340.75 m RL described in Section 2. Aside from most key levels, arrangements are typically based on assumed sizes. A notable exception is the work associated with energy dissipation as describe above (very nominal base estimate sum of $75,000 included at this point). The outline bill of quantities included has been prepared on this basis (Appendix E). It should be appreciated that the arrangements and cost estimates may be revised during detailed design.

The methodology adopted for cost estimation is appropriate for this very preliminary stage given the nature of the assessment and available base data. Consequently, the anticipated margin of error around the cost estimate is ±40 % (as reported in 2011).

Obermeyer has provided a cost estimate to design, fabricate and supply gate components on a CIF basis to a major New Zealand port. Details of the OHI cost estimate are provided in Appendix C and USD prices advised by OHI are converted to NZD on an assumed rate of $1 NZD equals $0.65 USD (0.70 used in 2011). OHI were requested to price 1.55 m high gates. Lump sum costs for services (predominantly power and air supply) associated with the gates were assumed and are more uncertain than costs for civil works.

Other than prices provided by OHI, suitable 2014 construction rates for civil works were selected for items, based on previous tender and construction experience, and a base cost estimate built up. Rates were bench marked against recent rate information from Breen and Downer relating to RRHS schemes. Costs for rock excavation assume that rock is highly jointed and easily ripped and that the work face is not congested. Estimates assume concrete demolition material may be locally stockpiled for future use as rip rap material. Most rates have been reviewed and endorsed by Tim Anderson.

Percentages were allowed for contingency (civil 25 % & gate supply 15 %), contractor's preliminary and general (15 %), and constructors margin (12 %).

The estimate was arrived at with the following procedure:

i. The 'base estimate' (BE) is estimated from estimated quantities and rates. This is the estimated amount that would be on the bill of quantities for physical construction items based on the preliminary level assessments described.

ii. A 25 % contingency is added to the base civil estimate. A 15 % contingency is added to the base Obermeyer gate supply cost. This allows for unknowns that may be encountered during construction and uncertainties in preliminary level assessments. Application of this brings the cost to 1.25 x BE (civil) + 1.15 x BE (M & E).

iii. The contractor for the works needs to allow for preliminary and general items covering management and overhead related costs (both on-site and off-site) and these are estimated at 15 % of the base cost and contingency, i.e. P&G = (1.25 x BE (civil) + 1.15 x BE (M & E)) x 0.15.

iv. Contractors margin is advised to be 10 – 15 % of the base cost and contingency, i.e. (1.25 x BE (civil) + 1.15 x BE (M & E) + P&G) x 0.12. – included as advised by Tim Anderson but

recognising that Breen have advised that the rate information they provided included provision for all their margins whereas Downer advise that their information did not include this provision i.e. it could well be conservative to include this allowance based on the rates adopted.

The reported estimate is therefore made up from:

Base estimate	BE
Contingency	1.25 x BE (civil) + 1.15 x BE (M&E)
P&G	0.15 x (1.25 x BE (civil) + 1.15 x BE (M&E))
Margin	0.12 x (P&G + (1.25 x BE (civil) + 1.15 x BE (M&E))

The cost estimate for the works as of July 2015 is as summarised in Table 3.

Table 3 Summary of cost estimate as at July 2015

Description	Cost (NZD)
Excavation and earthworks	$140,000
Demolition	$25,000
Reinforced Concrete	$95,000
Diversion	$65,000
Foot access bridge	$35,000
Mechanical and Electrical Services and Plant	$480,000
Miscellaneous non-scheduled Items	$20,000
Base case sub-total	**$860,000**
Contingency - 25%	$103,000
Gate supply contingency - 15%	$67,000
Preliminary and general - 12%	$124,000
Profit margin - 12%	$139,000
Engineering - TBC%	TBC
Total	**$1,293,000**

It should be noted that the rough cost estimate does not include any of the following costs which are extra to the reported cost:

- Engineering fees - to be updated by a revised proposal to supersede earlier advice for a different scope.
- Exchange rate fluctuations, primarily of significance in relation to gate components supplied from offshore. It is noted that the New Zealand dollar has recently dropped in value relative to the US dollar.
- Cost associated with resource consenting and consultation relating do amendments to consents if required but aside from usual allowances for consent compliance included within the P&G provision.
- Costs associated with miscellaneous M&E work extra over items included in the Obermeyer estimate (e.g. power supply from the existing plant shed). Miscellaneous M&E work e.g. compressed air reticulation, gate installation and the like, whilst included, are based on very high level lump sum estimates and contain more uncertainty than other items.

- Hydroelectric generation is excluded from the July 2015 estimate.
- Environmental mitigation during construction aside from a nominal inclusion within the contractors P&G allowance.
- Costs related to damage from a construction stage flood or other event resulting in a pond level in excess of 340.75 m RL.
- Lost production (e.g. from managing lake level prior to and during construction).
- Financing.
- Taxes including GST.
- Insurance.
- Developer related costs.
- Commissioning and operation and maintenance.
- Construction cost variations due to high demand including as a consequence of the Canterbury earthquake and related aftershocks.
- Increases in costs of steel, fuel, or any other construction related material.
- Other and/or revised items not specifically described within the cost estimate.

9 Recommendations and further work

For OWL to progress the LHS option described the following further work is proposed (refer also to the attached programme):

i. Based on information provided, OWL to confirm what level of flood protection during construction is acceptable to OWL e.g. 340.75 mRL (and thus the height of the diversion wall that is appropriate). As of 22 July 2015 understood that in principle this level is approved.

ii. OWL consider what Opuha Dam target lake level may be accommodated during construction in order to assist with management of floods during construction including:

   – The time of year that the proposed lake levels may be accommodated.

   – Contingency/course of action in the event that the proposed levels may not be achieved when construction is planned to commence.

   As of 22 July 2015 understood that OWL have suggested a target lake level of 385 mRL and it is recommended that the performance of this initial level be confirmed as an early stage detailed design activity. This work may identify a requirement to review this target.

iii. An as-built topographical survey is necessary to confirm the ground and rock head profile in the vicinity of the proposed works. The survey will need to include the proposed diversion wall area foundation and this will require the pond to be lowered to below 336.55 mRL.

iv. Review rock mass integrity, in particular the areas in the vicinity of the diversion wall foundation and at the toe of the chute.

v. It is necessary to confirm if there are any implications arising from the resource consent conditions.

vi. Confirm approach to address gate supply and miscellaneous M&E work e.g. power supply.

Detailed design may then proceed as programmed.

10 Applicability

This report has been prepared for the benefit of Opuha Water with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Report prepared by:

.....

Tim Morris

Senior Civil Engineer

Authorised for Tonkin & Taylor Ltd by:

.....

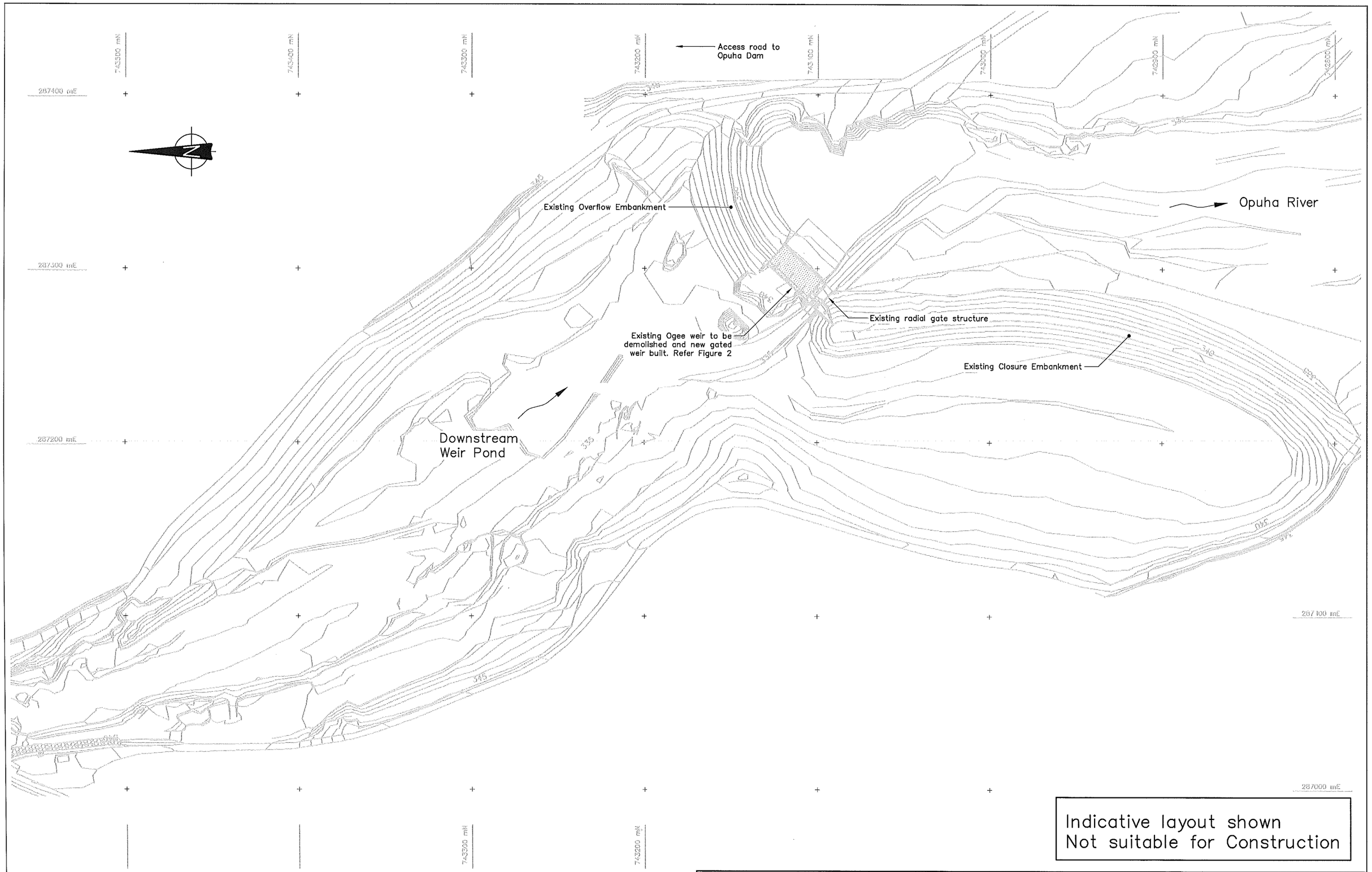
Grant Lovell

Project Director

TGM
p:\51137\51137.0180\workingmaterial\2015-07-09.tgm.rpt.opuha dam – proposed downstream weir enhancement lhs option rev 00.docx

Appendix A: Preliminary design sketches

- **Figure 1: Site Layout Plan (2011**
- **Figure 2: General Arrangement Plan (2011)**
- **Figure 3: Typical Section (2011)**
- **Figure 4: RHS/Southern Training Wall (2011)**
- **Figure 5: Plan of proposed diversion arrangement (2015)**
- **Figure 6: Elevation on proposed diversion wall (SW) (2015)**
- **Figure 7: Elevation on proposed diversion wall (NW) (2015)**



Indicative layout shown
Not suitable for Construction

SCALE 1: 2000
0 20 40 60 80 100 (m)

NOTES:

1. Existing works shown in light grey. Details obtained from as-built drawing 13897-7-C01. Details have not been verified on site for this study.

Tonkin & Taylor
Environmental and Engineering Consultants
Level 6, 151 Kilmore St, Christchurch
www.tonkin.co.nz

DRAWN	TGM	Jan. 11
DRAFTING CHECKED		
APPROVED		
CADFILE : \\51137.006-F1.dwg		
SCALES (AT A3 SIZE) 1: 2000		
PROJECT No. 51137.006		

Opuha Water Limited
Opuha Dam
Downstream Weir Enhancement
Site Layout Plan

FIG. No. Figure 1
REV. 0

P:\51137\51137.006\WorkingMaterial\CAD\51137.006-F1.dwg, F01, 27/01/2011 8:56:33 p.m.

Existing reinforced concrete and gabion basket Overflow Embankment training wall upstream of existing weir to be replaced to suit new foundation level

Overflow Embankment

Interface of new and existing concrete

Gabion protection to embankment toe

Extend excavation to meet river bed at approx. RL 334

Wing wall – Refer Dwg. 7-S12 for details

Finished contour

Existing rock contours

Upstream face of existing weir

Construction joint (Type A1 joint)

Upstream face of proposed weir

Indicative extent of rock excavation beyond existing weir. Lower existing rock level to maximum 338.20mRL

Four number openings 7125mm wide for new Obermeyer flap gates. New weir crest 339.20mRL for flow over lowered Obermeyer gates.

Three intermediate piers. 2.8m long x 0.5m wide (optional)

338.2mRL

CREST LEVEL = RL 340.75 MAX

7125

500

2400

400

1400

1V : 13.3H

4m – Type B Armouring

8m – Type A Armouring

8m – Type B Armouring

Refer Dwg. S17 for as built

Drainage slots below slab

RL 335.75

Cut off wall

SETOUT POINT 2

Wing wall – Refer Dwg. 7-S02 for details

New foot access around gates to suit existing radial gate walkway access from weir

Stabilised backfill to RL 337.75

75mm Reinforced concrete lining – HDG mesh reinforced

Radial gate structure

Compressed air supply from new plant room to Obermeyer gates.

SETOUT POINT 15

RL 334.25

Gabions

RL 333.05

Elver water supply intake

SETOUT POINT 16

Top of sill RL 333.85

Irrigation Release Channel

Type B Armouring

Type A concreted rock armouring

SEE DWG. S16 FOR ELVER BYPASS

Power supply from existing radial gate. Plant room assumed.

Foundation and 2.7m precast concrete plant room to house compressor and Obermeyer gate controls (location to be confirmed)

Electrical controls hut (1m clearance all round)

2m x 1m x 1m Gabions

Stabilised backfill to RL 339.75

Batter slope 2.5 : 1

Limit of cutoff wall

Extent of

Indicative layout shown
Not suitable for Construction

Notes:

1. Existing works shown in light grey. Details obtained from as-built drawing 13897-7-S01. Details have not been verified on site for this study.

SCALE 1:200

0 2 4 6 8 10 (m)

P:\51137\51137.006\WorkingMaterial\CAD\51137.006-F2.dwg, F02, 27/01/2011 8:49:14 p.m.

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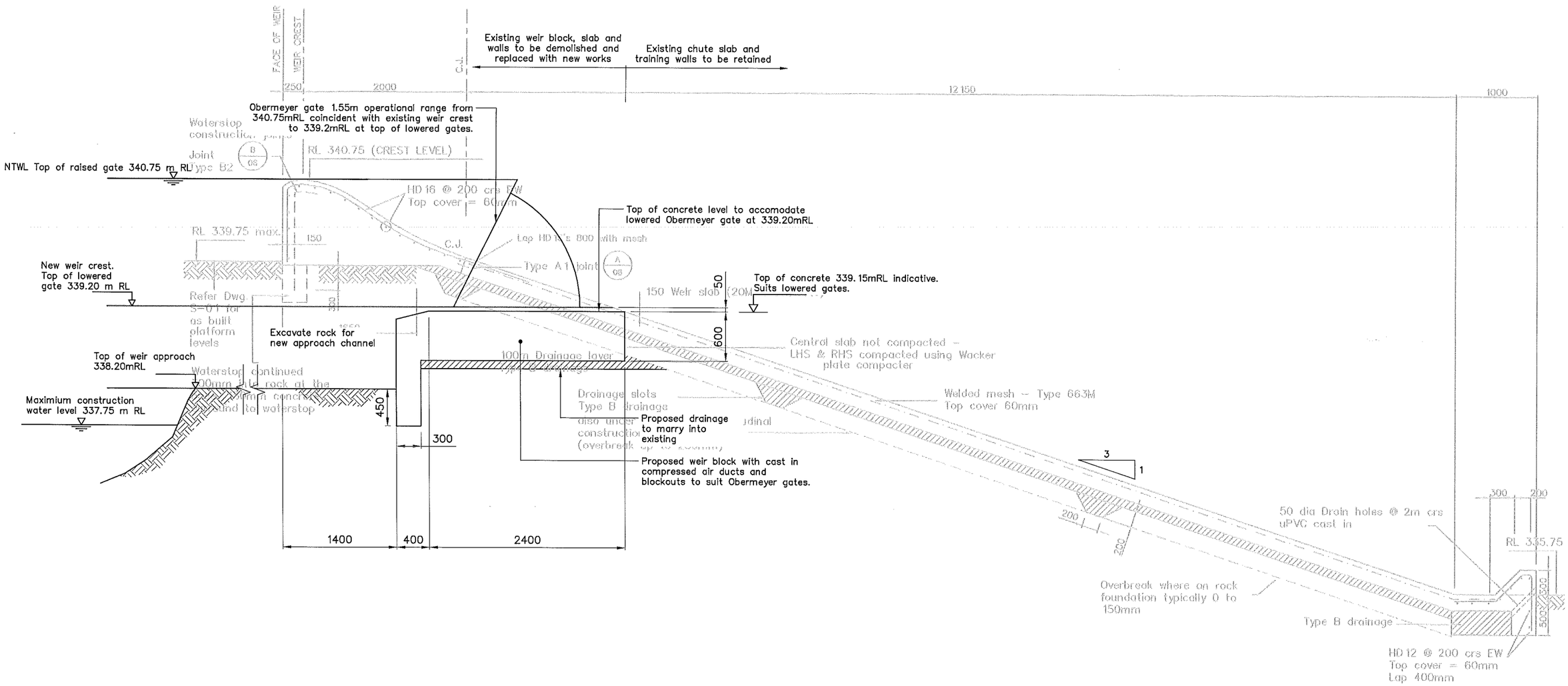
DRAWN	TGM	Jan. 11
DRAFTING CHECKED		
APPROVED		
CADFILE : \\51137.006-F2.dwg		
SCALES (AT A3 SIZE) 1:200		
PROJECT No. 51137.006		

Opuha Water Limited
Opuha Dam
Downstream Weir Enhancement
General Arrangement Plan

FIG. No. Figure 2

REV. 0

Indicative layout shown
Not suitable for construction



SCALE 1:50

0 500 1000 1500 2000 2500(mm)

NOTES:

1. Existing works shown in light grey and details obtained from as-built drawing 13897-7-S02. Details have not been verified on-site for this study.

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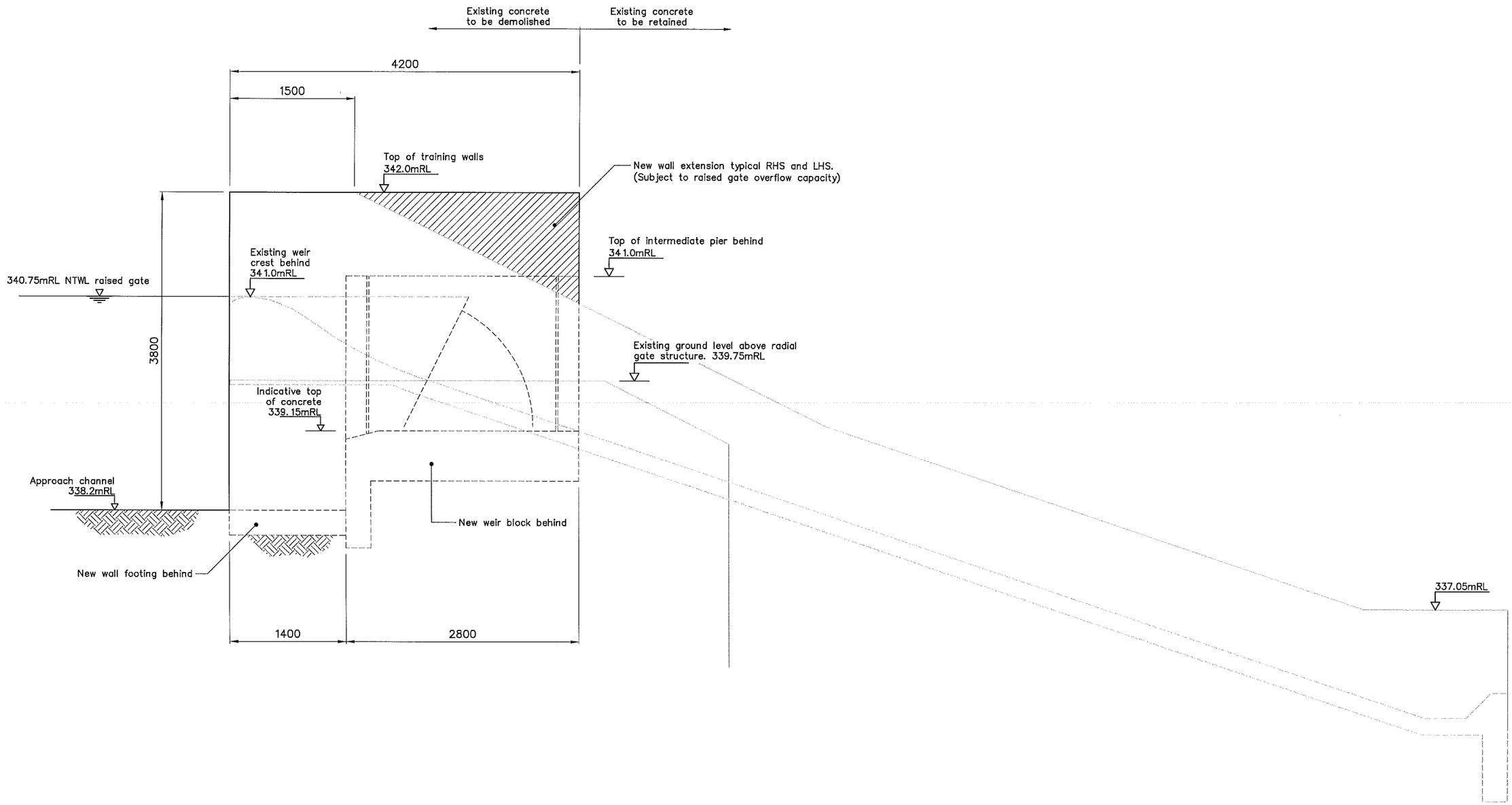
DRAWN	TGM	Jan. 11
DRAFTING CHECKED		
APPROVED		
CADFILE : \\51137.006-F3_F4a.dwg		
SCALES (AT A3 SIZE) 1 : 50		
PROJECT No. 51137.006		

Opuha Water Limited
Opuha Dam
Downstream Weir Enhancement
Typical Section

FIG. No. Figure 3

REV. 0

P:\51137\51137.006\WorkingMaterial\CAD\51137.006-F3_F4a.dwg, F03, 27/01/2011 9:06:39 p.m.



Indicative layout shown
Not suitable for construction

SCALE 1:50

0 500 1000 1500 2000 2500(mm)

NOTES:

1. Existing works shown in light grey and details obtained from as-built drawing 13897-7-S04. Details have not been verified on-site for this study.

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DRAWN	TGM	Jan. 11
DRAFTING CHECKED		
APPROVED		
CADFILE : \\51137.006-F3_F4.dwg		
SCALES (AT A3 SIZE) 1 : 50		
PROJECT No. 51137.006		

Opuha Water Limited
Opuha Dam
Downstream Weir Enhancement
B45/Southern Training Wall

FIG. No. Figure 4

REV. 0

P:\51137\51137.006\WorkingMaterial\CAD\51137.006-F3_F4.dwg, F04, 27/01/2011 8:57:43 p.m.

Existing reinforced concrete and gabion basket Overflow Embankment training wall upstream of existing weir to be replaced to suit new foundation level

Overflow Embankment

Construction access not shown

Finished contours

Existing rock contours

Upstream face of existing weir

Upstream face of proposed weir

Indicative extent of rock excavation beyond existing weir. Lower existing rock level to maximum 338.20mRL

Three intermediate piers. 2.8m long x 0.5m wide (optional)

Bund location adjacent to overflow embankment to suit construction access.

Interface of new and existing concrete

Gabion protection to embankment toe

Wing wall – Refer Dwg. 7-S12 for details

Extend excavation to meet river bed at approx. RL 334

Construction joint (Type A1 joint)

Contraction joints @ 10m spacing (Type B1 joint)

Four number openings 7125mm wide for new Obermeyer flap gates. New weir crest 339.20mRL for flow over lowered Obermeyer gates.

338.2mRL

CREST LEVEL = RL 340.75 MAX

1V : 13.3H

4m – Type B Armouring

8m – Type A Armouring

8m – Type B Armouring

Refer Dwg. S17 for as built

Drainage slots below slab

RL 335.75

Wing wall – Refer Dwg. 7-S02 for details

Extend excavation to meet river bed at approx. RL 334

Earth bund

height varies

7.5m

2m

5m

Stabilised backfill to RL 339.75

New foot access around gates to suit existing radial gate walkway access from weir

75mm Reinforced concrete lining – HDG mesh reinforced

Extent of proposed wall

Radial gate structure

Compressed air supply from new plant room to Obermeyer gates.

SETOUT POINT 15

RL 334.25

Gabions

RL 333.05

Elver water supply intake

SETOUT POINT 16

Top of sill RL 333.85

Irrigation Release Channel

Type B Armouring

Type A concreted rock armouring

SEE DWG. S16 FOR ELVER BYPASS

Power supply from existing radial gate. Plant room assumed.

Stabilised backfill to RL 339.75

Foundation and 2.7m precast concrete plant room to house compressor and Obermeyer gate controls (location to be confirmed)

Electrical controls hut (1m clearance all round)

2mx1mx1m Gabions

Limit of cutoff wall

Indicative layout shown
Not suitable for Construction

Notes:

1. Existing works shown in light grey. Details obtained from as-built drawing 13897-7-S01. Details have not been verified on site for this study.

SCALE 1:200

0 2 4 6 8 10 (m)

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Environmental and Engineering Consultants
Level 6, 151 Kilmore St, Christchurch
www.tonkin.co.nz

DRAWN	TGM	Jan. 11
DRAFTING CHECKED		
APPROVED		
CADFILE : \\51137.006-F2.dwg		
SCALES (AT A3 SIZE) 1:200		
PROJECT No. 51137.006		

Opuha Water Limited
Opuha Dam
Downstream Weir Enhancement
Plan of proposed diversion arrangement

FIG. No. Figure 5

REV. 0

Tonkin & Taylor

Project:

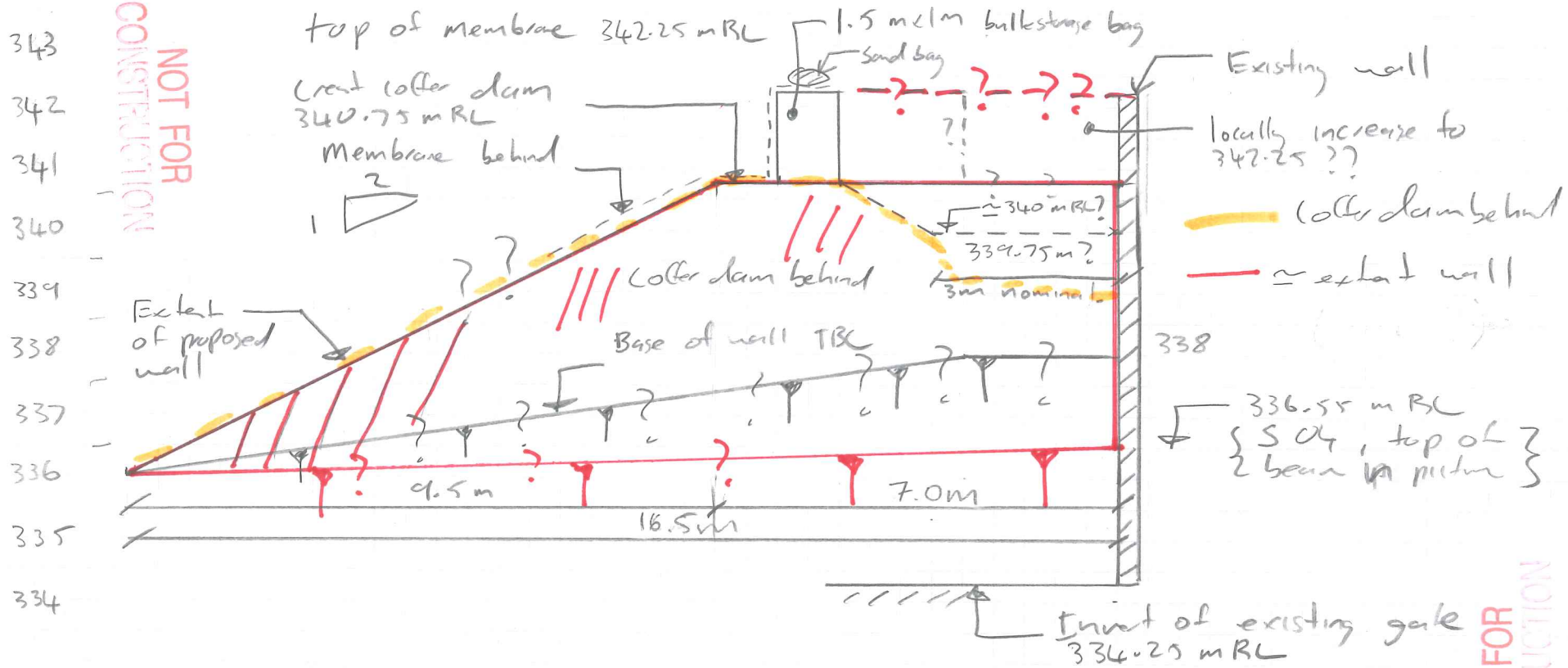
Description: Figure 6 - Elevation on proposed diversion wall (Sk)

Computed: 20 Office:

Checked: 20 Job No:

Revised: 20 File:

Checked: 20 Sheet No.



Options

(1) Max pond level during construction 337.75 m RL
Construction risk if flood occurs, may include damage to overflow embankment. Poor operating range.

(2a) Coffer dam & wall to 340.75 m RL — operating range maintained
Risk of construction damage if pond exceeds 340.75 m RL during construction — may include existing overflow embankment

(2b) Coffer dam to 340.75 m RL with crest wall to 342.25 m RL (1.5m high)
less risk of damage due to overtopping but spillway capacity much less greater risk of overflow embankment failing whilst construction occurs.

11000 (dependent on rock level)
6000
℄ GATE
21750
6000
2250
Existing weir crest
(CREST LEVEL) RL 340.75
Proposed Diversion Wall
pass pipe
RL 342.0
300x300 Blockout for Elver
950
Limit of high level cutoff wall
Turning circle (6m Radius)
RL 339.75
Proposed land not shown.
400 RC buttress walls on D/S side
Expansion joint (Type A4 joint)
Expansion joint (Type A4 joint)
RL 339.75
7500
RL 339.75
U/S of Weir block
Construction joint (Type A6 joint)
500X500 RC Beam
2.25 max.
Stabilised backfill on D/S side
Minimum of 4m width of silty gravels/colluvium against U/S face of wall
300 min.
Expansion joint (Type A4 joint)
Gabions - set base mesh of gabions into wet concrete
Embankment fill on D/S side
Line of cut off wall foundation
Inferred line of rock
336.55
1500
1500
RL 337.0
1m
Embankment fill
Limit of foundation cutoff wall
1m
Profile of stabilised backfill on D/S side
336m RL
800X750W RC Beam
RL 335.75
Gate opening
RL 334.25
1500
150mm Concrete slab 663M mesh reinforcement centrally placed
2500
2500

NOTE : ADEQUATE WALL PROPPING PRIOR TO BACKFILLING - BACKFILL TO BE AT UNIFORM LEVEL EACH FACE OF WALL AT ALL TIMES EXCEPT FOR STABILISED FILL ABOVE U/S EMBANKMENT LEVEL

SECTION 1/03
Scale 1:50

(ELEVATION OF GATE STRUCTURE ENTRY & CUTOFF WALLS)

200
RL 342.0
Normal top water level
D/S Wall face
300
1850
300
RL 339.85
Joint Type A6
200
RC Cutoff wall - found on rock
1400
Rock Level Varies
Embankment fill
300
Stabilised backfill (free draining)

SECTION 2/–
Scale 1:50

Joint Type A6
200
RC Cutoff wall - found on rock
Rock Level Varies
300
Excavate to rock & backfill with stabilised backfill. 100 drainage layer over

SECTION 3/–
Scale 1:50

300
RL 342.0
RL 339.75
300
500
200
1100
Stabilised backfill behind buttress walls

SECTION 4/–
Scale 1:50

S	AS BUILT		
F	Ladder deleted	JOG	2/12/97
E	General revisions	JOG	27/3/96
D	Minor revisions	JOG	21/12/95
C	General revisions	GAP	29/11/95
B	General revisions	JOG	25/11/95
A	Construction Issue	JOG	23/11/95
REVISION		CHECKED Initial	Date

Drawing Checked

APPROVED / /

This drawing is not to be used for construction purposes unless signed as approved

REFERENCE

TONKIN & TAYLOR
CONSULTING ENGINEERS
AUCKLAND 19 MORGAN ST NEWMARKET
WELLINGTON 109 FEATHERSTON ST
CHRISTCHURCH 155 KILMORE ST
WHANGAREI 17 RUST AVE

Inferred line of rock
3/–
Excavate to rock & backfill with stabilised backfill. 100 drainage layer over
3/–
℄ GATE
Fill line
RL 336.0
RL 336.0
Inferred line of rock
5000
Gabions
RL 333.85
RL 333.05
100 Drainage layer

SECTION 2/03
Scale 1:50

NOTE : FOR POST BREACH AS BUILT DETAILS REFER TO DWGS. 7 - S20 TO 7 - S23

Cut rock face
300 penetration
300
U/S Wall face
75
HDG Mesh 663M centrally placed in concrete lining (Typical)

SECTION 1/–
Scale 1:50

TITLE

NOT FOR CONSTRUCTION

OPUHA DAM PROJECT

Figure 7
Elevation on proposed diversion wall (NW)

ORIGINAL SCALES (A1)
1 : 50

DRAWING No. 13897-7-S09
DATE NOV. 1995

Revision A B C D E F S

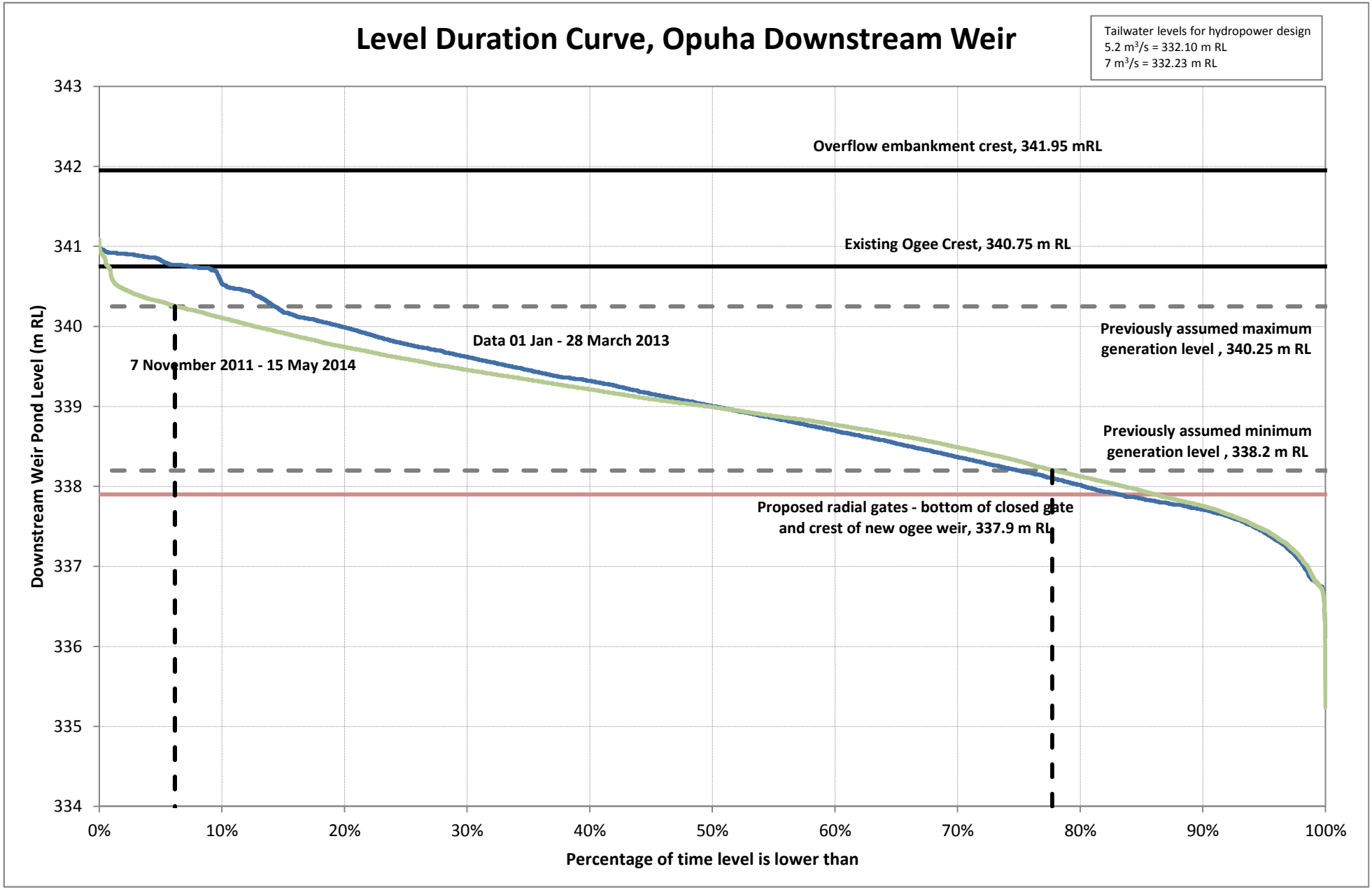
Drawn/Traced MPP

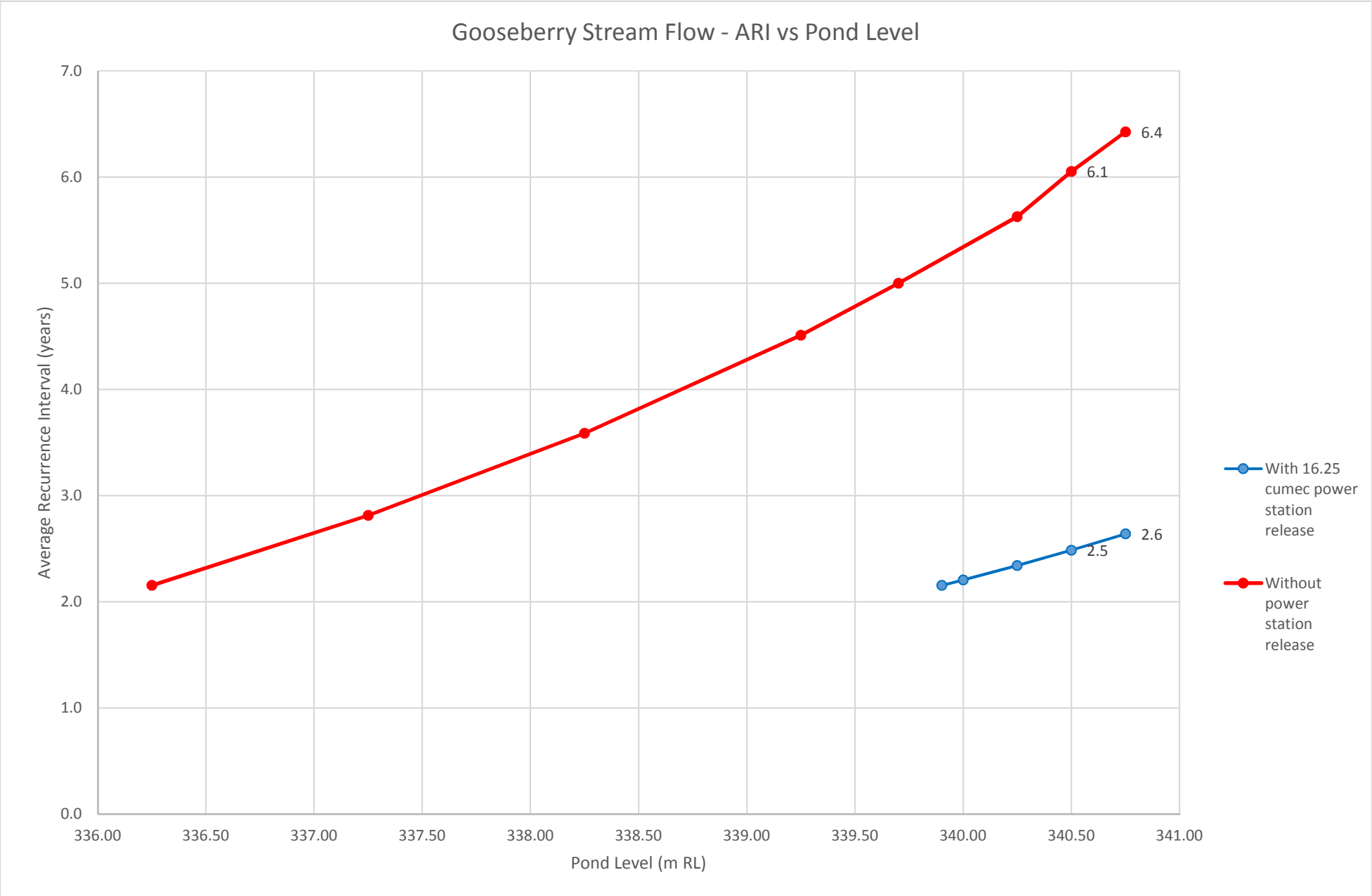
T:\Auckland\Archive\CADArchive\13897\7-s09.dwg, Model, 27/01/2011 10:09:45 a.m.

Appendix B: Selected graphs

- **ODDW level duration curve for the period 7 November 2011 to 15 May 2014**
- **Gooseberry Stream Flow – ARI versus pond level**

Tonkin & Taylor




Gooseberry Stream Flow - ARI vs Pond Level
Average Recurrence Interval (years)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
336.00
336.50
337.00
337.50
338.00
338.50
339.00
339.50
340.00
340.50
341.00
Pond Level (m RL)
6.4
6.1
2.6
2.5
With 16.25 cumec power station release
Without power station release

Appendix C: Proprietary gate information

- **Obermeyer Hydro**
- **AWMA**
- **Yooil**

Tim Morris

From: Rob Eckman <rob.eckman@obermeyerhydro.com>
Sent: Wednesday, 1 July 2015 8:05 a.m.
To: Tim Morris
Subject: RE: Opuha Dam - proposed gates
Attachments: opuhadam06302015.pdf

Tim,

Again thanks for your patience. I have been travelling the last couple of weeks and am behind on my correspondence. In any event please find attached updated price for 4 x 1.55-meter high x 7.125-meter wide Obermeyer Gates. Price includes control system and air supply equipment and includes freight CIF to major port in New Zealand.

Net shipping weight is about 16,000 kg. One standard CONEX is sufficient for shipping.

Current lead time is approximately 12-weeks ex works after receipt of purchase order. This assumes 3-weeks for final engineering and design and 1-week review of submitted shop drawings.

I hope this is sufficient information. Please let me know any specific questions.

Thanks
Obermeyer Hydro, Inc.
Robert Eckman
Vice President

From: Tim Morris [mailto:TMorris@tonkin.co.nz]
Sent: Monday, June 29, 2015 8:52 PM
To: OHI RDE
Cc: gjb@obermeyerhydro.com; mcs@obermeyerhydro.com
Subject: RE: Opuha Dam - proposed gates
Importance: High

Hi, would appreciate if someone can please respond to the request of 12 June below. Look forward to hearing from you.

Many thanks

Tim Morris.

Tim Morris, tmorris@tonkin.co.nz
Tonkin & Taylor Ltd
33 Parkhouse Road, Wigram
P.O. Box 13-055
Christchurch
New Zealand

Phone 64 3 363 2443, Fax 64 3 363 2441, Mobile 021 343 338

You can send large files to my filedrop page:
https://transfer.tonkinandtaylorgroup.com/filedrop/tmorris@tonkin.co.nz

==========
Tonkin and Taylor Ltd. www.tonkin.co.nz

From: Tim Morris
Sent: Friday, 12 June 2015 6:00 p.m.
To: 'OHI RDE'
Subject: RE: Opuha Dam - proposed gates

Hi Robert,

Just following up on a project we asked you about several years ago. The project went on hold for a while and the necessary environmental approvals have now almost been obtained for this project. Can you please advise if you are still interested in supplying gates as below and if so can you please advise any amendments to the estimate below dated 10/5/12.

Look forward to hearing from you.

Best regards

Tim.

Tim Morris, tmorris@tonkin.co.nz
Tonkin & Taylor Ltd
33 Parkhouse Road, Wigram
P.O. Box 13-055
Christchurch
New Zealand

Phone 64 3 363 2443, Fax 64 3 363 2441, Mobile 021 343 338

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https://transfer.tonkinandtaylorgroup.com/filedrop/tmorris@tonkin.co.nz
==========
Tonkin and Taylor Ltd. www.tonkin.co.nz

From: OHI RDE [mailto:rde@obermeyerhydro.com]
Sent: Thursday, 10 May 2012 11:34 a.m.
To: Pieter Vanderpoel
Cc: gjb@obermeyerhydro.com; mcs@obermeyerhydro.com
Subject: Re: Opuha Dam - proposed gates

Pieter,

Updated price for supply of a 1.55-meter high x 7.125-meter wide x 4gate bay Obermeyer Gate System is USD 276,400.00 CIF NZ port. The price includes the same scope as discussed with Tim Morris last year. I did go ahead and update the scope to include a redundant air compressor system (two air compressors and dryers). Most of our clients prefer to have two sources of air in case one machine is down for what ever reason.

I am out of the office this week but wanted to make sure you had this number per your requested schedule. I will follow up when I get back with a more formal proposal.

Thanks
Obermeyer Hydro, Inc.
Robert Eckman
Vice President

| ----- Original Message -----

From: Pieter Vanderpoel
To: rde@obermeyerhydro.com
Cc: gjb@obermeyerhydro.com ; mcs@obermeyerhydro.com
Sent: Thursday, May 03, 2012 4:01 PM
Subject: FW: Opuha Dam - proposed gates

.....
Pieter Vanderpoel
pvanderpoel@tonkin.co.nz
Civil Engineer

Tonkin & Taylor Ltd.
33 Parkhouse Road, Wigram, Christchurch
DDI: +64 (3) 363 2462
Mobile: +64 (27) 519 1914
Office: +64 (3) 363 2440

Project:
T&T Ref:

From: Pieter Vanderpoel
Sent: Friday, 4 May 2012 10:01 a.m.
To: 'rde@obermeyerhydro.com'
Cc: Tim Morris; 'gjb@obermeyerhydro.com'; 'mcs@obermeyerhydro.com'
Subject: Opuha Dam - proposed gates

Hi Rob

Following on from communication from Tim Morris last year, we are progressing assessments of an upgrade to the downstream weir structure at Opuha Dam to provide four 7.125m wide gates over a 1.55m operating range. Please see the attached drawings for details.

As per Tim's emails in November 2011, the gates will require a semblance of independent operation.

We would like you to update the previous cost estimates completed in October 2010 to allow for the altered height and width of the gates, as well as any changes in material/procurement/shipping costs etc. We would like this information by the end of next week (Thursday 10 May your time) if possible.

If there is any further information that you require to put together a revised package of cost information, please feel free to contact either Tim or myself.

We look forward to hearing from you next week.

Kind regards

Pieter

.....
Pieter Vanderpoel
pvanderpoel@tonkin.co.nz
Civil Engineer

Tonkin & Taylor Ltd.
33 Parkhouse Road, Wigram, Christchurch
DDI: +64 (3) 363 2462
Mobile: +64 (27) 519 1914
Office: +64 (3) 363 2440

OBERMEYER HYDRO, INC.

P.O. BOX 668 FT. COLLINS, COLORADO 80522 USA TEL 970-568-9844 FAX 970-568-9845
E-mail: hydro@obermeyerhydro.com WWW: http://www.obermeyerhydro.com

Project Quotation Sheet
Project: Opuha Dam
Client: Tonkin and Taylor, Tim Morris
Gate Size: 1.55-meters high (300-mm overtopping) x 7.125-meters long x 4-gate bays
Date: June 30, 2015

Obermeyer Hydro, Inc. is pleased to issue this proposal for the supply of an Obermeyer Water Control Gate for your upcoming Opuha Dam Project located in South Canterbury, New Zealand. This quote is based on four, 1.55-meter high by 7.125-meter wide Obermeyer Gates. Obermeyer Hydro will supply the following components for this project:

Steel Package: (8) nominal 3.56-meter wide steel gate panels along with clamp bars, hinge retainers, web retainers, splitters, restraining strap clamps, and stainless steel abutment plates. All structural steel components to be manufactured from ASTM A572 grade 50 steel or engineering equivalent. Gate panels to be sand blasted in accordance with SSPC-SP10 and coated with two coats of black epoxy paint. Clamp bars and other carbon steel components shall be hot dip galvanized in accordance with ASTM A123 and ASTM A153.

Bladder Package: (8) nominal 3.56-meter wide polyester reinforced inflatable air bladders complete with air bladder connection assembly for connecting into owner supplied air piping.

Air Supply: Package to include dual 5.6-kilowatt Ingersoll Rand (or equal) rotary screw air compressors with Ingersoll Rand (or equal) refrigerated air dryer and filters. Each compressor/air dryer to be skid mounted on a 280-liter tank with pressure relief valve and purge valve. Equipment to inflate gate system to maximum operating pressure in less than 60- minutes.

Control System: One OHI model 10-3 PLC based upstream water level

control system. System to utilize a Square D M340 (other brands available upon request) series PLC to monitor upstream water elevation using a Druck or KPSI submersible depth transmitter. Control system to automatically maintain constant upstream water elevation. Control system to incorporate touch pad for easy operator interface and shall be packaged in a NEMA 12 rated electrical enclosure. Control system to be complete with inflate and deflate solenoid valves, manual bypass valves, pressure regulator, and pressure relief valves. All internal components shall be 24 VDC. System to operate four independent gate zones.

Misc. Package: Stainless steel main anchor bolts (factory assembled for new concrete), stainless steel fasteners, stainless steel abutment and restraining strap anchor bolts, interpanel seals, abutment seals, restraining straps, three copies of engineering drawings and calculations, and three copies of operation and maintenance manuals.

Obermeyer Hydro is pleased to offer the above equipment for the sum total of USD 289,700.00 CIF Christchurch, New Zealand. The above price is valid until August 15, 2015 and is for shipment from USA in accordance with mutually agreed upon project schedule.

The above prices do not include the following items:

1. Interconnecting conduit, wiring, or piping.
2. Stilling well for water level transmitter.
3. Installation except for any purchased supervision and training.
4. Bid, supply, or performance bond.
5. Customs, tariffs, duties or any federal, state, or local taxes.
6. Freight or freight insurance.
7. Control building for housing compressor and controls.

On-site installation supervision and consultation is available for USD 1,500.00 per day plus actual cost of air ticket between Denver, Colorado and closest international airport to the project site.

Terms shall be 25% due upon placement of an order, 65% paid to OHI upon submission of ocean bound bill of laiding, and 10% paid to OHI within 15-days of system startup or 180-days after shipment from USA whichever occurs

first. All payments except for the initial deposit shall be by an assignable confirmed, irrevocable letter of credit per instructions furnished by Obermeyer Hydro, Inc.. The 25% deposit shall be by wire transfer.

All parts manufactured by Obermeyer Hydro are offered and guaranteed as outlined in attached OHI sales agreement. Items that are supplied, but not manufactured by Obermeyer Hydro, are covered by the original manufacturer's warranty.

Sincerely,
Obermeyer Hydro, Inc.
Robert Eckman
Vice President

OBERMEYER HYDRO, INC.

SALES AGREEMENT

NOTICES - All notices required by the contract will be sent to:

PURCHASER	COMPANY
.	Obermeyer Hydro, Inc P.O. Box 668 Fort Collins, CO 80522 TEL: 970-568-9844 FAX: 970-568-9845

WARRANTY - Company warrants title to the product (s) and also warrants the product (s) on date of delivery to purchaser to be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THOSE EXPRESSLY STATED IN THIS CONTRACT.

If within five years from the date of initial operation, but not more than five years and six months from the date of shipment by Company of any item of the product (s), Purchaser discovers that such item was not as warranted and promptly notified Company in writing thereof, Company shall remedy such non-conformance by, at Company's option, adjustment or repair or replacement of the item of any affected part of the product (s). Purchaser shall assume all responsibility and expense for removal and reinstallation of any part requiring adjustment, repair, or replacement. Company shall assume responsibility for supervising the adjustment, repair, or installation of any replaced component and for any freight CIF Guayaquil, Ecuador related to said remedy. The same obligations and conditions shall extend to replacement parts furnished by Company thereunder. Company shall have the right of disposal of parts replaced by it. The Company shall not be liable for any repairs, replacements, or adjustments to the Product (s) or any costs of labor performed by the Purchaser or others without the Company's prior written approval.

The purchaser shall not operate the Product (s) which is considered to be defective, without first notifying the Company in writing of its intention to do so. Any such use of the Product (s) will be at the Purchaser's sole risk and liability unless Company gives Purchaser approval to operate the Product (s). Such approval will not be unreasonably withheld.

The effects of corrosion, erosion and normal wear and tear are specifically excluded from the Company's warranty.

Company's liability to Purchaser relating to the product (s) whether in contract or in tort arising out of warranties, representations, instructions, installations, or defects from any cause, shall be limited exclusively to correcting the product (s) and under the conditions as aforesaid.

Any separately listed item of the product (s) which is not manufactured by the Company shall be covered only by the express warranty of the manufacturer thereof.

PATENTS - Company shall pay costs and damages finally awarded in any suit against Purchaser or its vendees to the extent based on a finding that the design or construction of the product (s) as furnished infringes a United States patent (except infringement occurring as a result of incorporating a design or modification at Purchaser's request) provided that Purchaser promptly notifies Company of any charge of

such infringement, and Company is given the right at its expense to settle such charge and to defend or control the defense of any suit based upon such charge. This paragraph sets forth Company's exclusive liability with respect to patents.

DELAYS - If company suffers delay in performance due to any cause beyond its control, such as Acts of God, war, act of government, act or omission of Purchaser, fire, flood, strike or labor trouble, sabotage, delay in obtaining from others suitable services, materials, components, equipment, or transportation, the time of performance shall be extended a period of time equal to the period of the delay and its consequences. Company will give Purchaser notice in writing within a reasonable time after Company becomes aware of any such delay.

DELIVERY - Timely delivery at the designated point is contingent upon Purchaser's supplying to Company, when needed, all required technical information, including drawing approval, and all required commercial documentation. Company may make partial shipments. Company shall select method of transportation and route, unless terms are FOB point of shipment without freight allowed and Purchaser specifies the method and route. When delivery terms are FOB destination or freight allowed to destination, "destination" means common carrier delivery point (within the continental United States, excluding Alaska and Hawaii), nearest the final destination. For shipments outside the United States Company shall arrange for inland shipment to port of exit and shall cooperate with Purchaser's agents in making necessary arrangements for overseas shipment and preparing necessary shipping documents.

LIQUIDATED DAMAGES - The Purchasers sole remedy for the Company's failure to deliver in a timely manner shall be Liquidated Damages in the amount of 0.1% of the contract price per day.

STORAGE - Any item of the product (s) on which manufacture or delivery is delayed by causes within the Purchaser's control or causes which affect Purchaser's ability to receive, the product (s) may be placed in storage by Company for Purchaser's account and risk.

TITLE AND INSURANCE - Title to the product (s) and risk of loss or damage shall pass to Purchaser upon tender of delivery, except that a security interest in the product (s) or any replacement shall remain in Company, regardless of mode of attachment to realty or other property, until the full price has been paid in cash. Purchaser agrees to do all acts necessary to perfect and maintain said security interest, and to protect the Company's interest by adequately insuring the product (s) against loss or damage from any external cause with Company named as insured or co-insured.

TAXES AND LICENSES - The price does not include any Federal, State or local property, license, privilege, sales, use, excise, gross receipts or other like taxes which may be nor or hereafter applicable to, measured by, or imposed upon this transaction, the Product (s) its sale, its value or its sue, or any services performed in connection therewith. Such taxes will be itemized separately to Purchaser, who shall make payment to the Company. The company will accept a valid exemption certificate from the Purchaser if applicable. If such exemption certificate is not recognized by the governmental taxing authority, Purchaser agrees to assume responsibility for payment of any taxes covered by such exemption certificate.

The Purchaser shall obtain all construction and other permits, licenses, inspections as may be required for the erection, construction and operation of the Purchaser's facilities.

SPECIAL SHIPPING DEVICES - The value of each special shipping device (oil barrel, reel, tarpaulin, cradle, crib and the like) used by Company to contain or protect the product (s) in shipment will be invoiced to the Purchaser as a separately stated addition to the contract price. If the Company's Proposal or

quotation or other contract documents stipulate the return of any such device, it shall be returned by the Purchaser in good condition for credit, FOB Purchaser's plant, freight collect, within thirty (30) days after receipt by Purchaser.

Return of any such device as to which there is no stipulation but which has been separately invoiced is at the option of the Purchaser. If returned promptly in useable condition, FOB destination, freight prepaid, Company will grant purchaser a credit with the invoiced amount (except oil barrels, as to which arrangements for return and refund mush be made by the Purchaser with the refiner).

The foregoing provisions as to special shipping devices shall not apply to any such device shipped outside the continental United States and Canada.

GENERAL - Company will comply with all laws applicable to Company. Installation, erection or servicing of the product (s) by Company, if specified or requested by Purchaser, shall be governed by the terms and conditions of Company(s) service agreement.

This document and the other documents specifically referred to as being a part hereof, constitute the entire contract on the subject matter, and shall not be modified except in writing signed by both parties. Assignment may be made only with written consent of the other party.

TERMINATION - The Company may terminate this agreement upon thirty (30) days prior written notice to Purchaser for any material breach of this contract by Purchaser. In the event of such termination, Purchaser shall pay out reasonable and proper termination charges as set out in a) and b) below.

a) Purchaser has it full remedies at law for a material breach of contract by the Company and damages, if any, will be recoverable as states in the contract. All payments due will be suspended until Purchaser has had a reasonable opportunity to complete the project. For all other stipulations Purchaser may terminate this contract upon thirty (30) days prior written notice to the Company and payment of reasonable and proper termination charges. Such charges will include a portion of the Purchase Order Price, adjusted as necessary reflecting the amount of work completed, man hours expended and materials acquired at the time of termination plus the expenses associated with the termination, including, but not limited to, any additional expenses incurred by reason of termination or cancellation of the Company's agreement with its suppliers and any applicable costs plus pro rata profits calculated on the full contract price.

b) All termination charges shall be due and payable within thirty (30) days after the date of the Company's invoice.

SUSPENSION - Purchaser may, by written notice to the Company, suspend the Company's performance, in whole or in part, or extend the work for reason of force majeure, inability to obtain local state or federal government licensing or approvals, or for any other reason, except that such right of suspension or extension with respect to any portion of the Product (s) which has been released by the Company for procurement or manufacture shall require the mutual agreement of the parties.

In the event of any suspension or extension, other provisions of this contract, such as the price of the Product (s) and Services, shall be equitably adjusted to reflect the time of suspension, and any additional cost or expenses which may be occasioned to the Company hereby. At any time after suspension (s) ordered by the Purchaser has extended for a cumulative period of ninety (90) days, except to the extent that the Company may have previously consented to a suspension in excess of ninety (90) days, the Company may, upon giving Purchaser at least thirty (30) days prior written notice, terminate the contract and Purchaser shall pay reasonable and proper termination charges as set out in the Termination section a) and b).

TERMS - Terms shall be 25% due upon placement of an order, 65% upon presentation of clean commercial invoice for supplied materials, and 10% due within 15-days of project start-up or 180-days days after shipment from United States Port whichever comes first. All payments except for the initial deposit shall be by confirmed, irrevocable letter of credit per instructions furnished by Obermeyer Hydro, Inc. The 25% deposit shall be by wire transfer.

SCOPE OF SUPPLY - The Company's Scope of Supply is listed on the attached Price Proposal that is hereby incorporated by reference.

PRICE - The price for this equipment package CIF Christchurch, New Zealand is USD _____.

GOVERNING LAW - The interpretation of this contract shall be governed by the laws of Colorado, USA.

OBERMEYER HYDRO, INC
P.O. BOX 668, FORT COLLINS, CO 80522

By _____

ROBERT ECKMAN
VICE PRESIDENT

PURCHASER'S ACCEPTANCE

The foregoing Proposal is hereby accepted

By _____

Title _____

Date _____

Tim Morris

From: Mike Anthony <Mike@awmawatercontrol.com.au>
Sent: Monday, 20 July 2015 6:59 p.m.
To: Tim Morris; Hugh Watson
Subject: RE: Opuha - flap gates

Hi Tim,
Apologies for the delay. Budget pricing for the LayFlat gates are given below. We still need to come up with freight, install and controls pricing which will be completed tomorrow.

4 x 7000W x 1600H AWMA LayFlat gates @ NZD 116,000 each

Notes:

- Gates fabricated from epoxy coated mild steel
- Side panels to be fabricated from grade 304 stainless steel
- Scissor mechanisms to be fabricated from HDG mild steel
- Individual gates shall be fabricated in 3 sections and designed to operate as a single gate leaf
- Operation shall be via pneumatic air bags (6 per gate)
- Pneumatics shall include a locking cylinder to hold the gate in the raised position on loss of air
- Gate shall be designed to operate in the open and closed position only (no intermediate position)
- Pricing excludes GST (not applicable for export orders into NZ)
- No allowance has been made for delivery, installation or pneumatic controls

Best regards

Michael Anthony
Sales Manager
AWMA - Water Control Solutions

Phone +61 3 5456 3331
Mobile +61 419 669 006
Email mike@awmawatercontrol.com.au
Address 118 Roviras Rd, PO Box 433, Cohuna VIC 3568 Australia

"Specialists in the design, manufacture and installation of high quality water control infrastructure"

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Follow

From: Tim Morris [mailto:TMorris@tonkin.co.nz]
Sent: Monday, 20 July 2015 12:40 PM
To: Hugh Watson
Cc: Mike Anthony
Subject: RE: Opuha - flap gates

Hi Hugh, any update. Look forward to hearing from you.

Regards

Tim.

Tim Morris, tmorris@tonkin.co.nz
Tonkin & Taylor Ltd
33 Parkhouse Road, Wigram
P.O. Box 13-055
Christchurch

New Zealand

Phone 64 3 363 2443, Fax 64 3 363 2441, Mobile 021 343 338

You can send large files to my filedrop page:
https://transfer.tonkinandtaylorgroup.com/filedrop/tmorris@tonkin.co.nz
==========
Tonkin and Taylor Ltd. www.tonkin.co.nz

From: Hugh Watson [mailto:hugh@awmawatercontrol.com.au]
Sent: Thursday, 16 July 2015 10:51 a.m.
To: Tim Morris
Cc: Mike Anthony
Subject: RE: Opuha - flap gates

Hi Tim,

Sorry for the delay we have been waiting for a quote from one of our suppliers for the machining components, I have just chased them and they have promised me something today. Hopefully we can submit costings either late today or tomorrow.

With respect to the flow (based on the attached long winded email I sent you a few weeks ago) my approach would be to run with the broad crested weir equation, which gives a very similar coefficient to your original suggestion and I would question the higher coefficient suggested by others.

Ultimately one would run a CFD on the structure with the gate in place, if we had a commercial understanding around the projects direction I am sure we could engage this. (Would also need the weir civil geometry)

Any questions on the above in the meatime let me know,

Best regards

Hugh Watson
Engineering Manager
AWMA - Water Control Solutions

Phone +61 3 5456 3331
Mobile +61 4 2782 8939
Email **hugh@awmawatercontrol.com.au**
Address 118 Roviras Rd, PO Box 433, Cohuna VIC 3568 Australia

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Follow

From: Tim Morris [mailto:TMorris@tonkin.co.nz]
Sent: Thursday, 16 July 2015 8:14 AM
To: Hugh Watson
Subject: Opuha - flap gates
Importance: High

Hi Hugh, can you please let me know where you are at with this – look forward to hearing from you. Also, it is quite important ant that we have a clear understanding of the capacity of the weir to pass flood flow with the gate in the lowered position and would like this covered.

Look forward to hearing from you.

Best regards

Tim.

Tim Morris, tmorris@tonkin.co.nz
Tonkin & Taylor Ltd
33 Parkhouse Road, Wigram
P.O. Box 13-055
Christchurch
New Zealand

Phone 64 3 363 2443, Fax 64 3 363 2441, Mobile 021 343 338

You can send large files to my filedrop page:
https://transfer.tonkinandtaylorgroup.com/filedrop/tmorris@tonkin.co.nz
==========
Tonkin and Taylor Ltd. www.tonkin.co.nz

Appendix D: Diversion standards (from NZSOLD 2015)

Information on diversion flood frequencies adopted by various countries for the construction of embankment and concrete dams is included in ICOLD Bulletin 108A, and a discussion on the selection of an appropriate flood for the sizing of diversion works during construction is included in ICOLD Bulletin 144. There is no universally accepted method for selecting an appropriate flood for the sizing of diversion works during construction and the choice is generally based on the dam site, the dam type, the construction cost and the consequences if the diversion capacity is exceeded.

The performance criteria for diversion works during the construction of a dam, or the completion of rehabilitation works, should be as follows:

- For new dams the risk (likelihood x consequence) of loss of life during construction, as far as practicable, should be no greater than that over the life of the dam.
- For existing dams the consequences of dam failure should not be increased during the completion of any rehabilitation works.
- The design of any temporary works should include consideration of the PIC for any necessary cofferdams, and the design criteria for the cofferdams should be consistent with their PIC as recommended in section 6.3 of this module.

If there is insufficient upstream storage during construction to attenuate the peak diversion flood flow, the peak flow for the selected diversion flood dictates the required hydraulic capacity of the diversion works. However, if the diversion design relies partly on upstream storage to attenuate the peak flow, the total volume of the selected diversion flood should be estimated and the diversion design should include consideration of the possibility of the available storage volume being exceeded.

A risk-based approach provides an informed basis for selecting and sizing flood passage facilities during construction and risk reduction measures should be implemented where large reductions in risk are available for relatively low expenditure. In some cases it may be necessary to adopt risk reduction measures that are not justified on economic grounds; however, in all cases, the adverse effects of the risks should be made as low as reasonably practicable irrespective of any absolute criteria. By properly considering potential failure modes and applying 'as low as

reasonably practicable' criteria, based at least in part on risk assessment, useful inputs can be provided for developing a defensible business case for dam safety decisions and an assurance that all reasonably foreseeable failure modes have been identified and adequately addressed. The most obvious potential failure mode during construction is overtopping of the dam due to the inflow flood exceeding the capacity of the diversion facilities. Clearly the consequences of overtopping an embankment dam during construction would be far greater than those that would result from the overtopping of an equivalent concrete dam. The following subsections provide comment on the diversion works for concrete, embankment and concrete-faced rockfill dams.

Concrete Dams

For concrete dams, overtopping during construction would most likely lead to flooding of the work area and possibly some erosion of the dam toe. Provided the risk of toe erosion was not excessive, the main risks would be injuries or loss of life for construction personnel and damage to equipment. Because of the "block type" construction used for concrete dams, the level of potential damage and adverse effects can be managed and kept quite low. With an understanding of warning times and appropriate evacuation procedures the risks to personnel can be mitigated; however, damage to construction plant and the works and the tolerance for these costs are largely subject to the Owner's risk tolerance and/or an insurance matter. If personnel and dam safety risks are adequately managed, a return period of 10 years may be appropriate for the sizing of the diversion works.

Embankment Dams

Embankment dams are highly unlikely to withstand sustained overtopping; hence the sizing of the diversion works is critical to dam safety during construction. A risk-based approach should consider the likelihood of overtopping of the partially completed structure (e.g. early in dam construction the consequences of overtopping should be significantly less than those when the dam is nearing completion), the consequences of dam failure at various stages of construction, and the risks to the construction works, the construction programme and construction personnel. Diversion and spill facilities should not concentrate discharge flows onto the dam body.

The size of the diversion works is critical until such time as the dam crest exceeds the invert levels of the permanent flood discharge facilities and, in some cases, temporary spillway facilities may be required to reduce the risk to an acceptable level. Exposure times to flood risk can be considered as part of the risk assessment process and emergency action plans, with appropriate evacuation procedures, may reduce the risk to public safety during construction. Emergency action planning is addressed in Module 6.

If a site-specific risk-based approach which considers exposure times and the downstream consequences of failure is not completed, the Owner and Designer should give consideration to the following guidelines for diversion capacity:

- If the incremental consequences of a dam failure during construction include no potential for the loss of life downstream of the dam, a return period of 50 years may be appropriate for the sizing of the diversion works.
- If the incremental consequences of a dam failure during construction include the likelihood of the loss of one or more lives downstream of the dam, a return period of 250 years or greater may be appropriate for the sizing of the diversion works.

Concrete-faced Rockfill Dams

Concrete-faced rockfill dams, with well compacted free draining rockfill shoulders, usually have a greater resistance to overtopping than most embankment dams. The guidelines included above for embankment dams are also applicable to concrete-faced rockfill dams. However, added protection to the downstream face of a concrete-faced rockfill dam can reduce the likelihood of an overtopping failure (refer ANCOLD (1991)). If it can be demonstrated that proposed protection works on the downstream face will prevent dam failure, then it may be appropriate to include limited overtopping of the dam during the passage of the selected diversion flood event.

Appendix E: LHS construction cost estimate

Item	Description	Quantity	Unit	Rate	Amount (NZD)
1.0	Excavation and earthworks				
1.1	Excavate rock from approach to ogee weir from maximum to 338.2 m RL upstream of existing weir block.	850	cu.m	$60.00	$51,000
1.2	Excavate rock from underneath demolished concrete includes weir block, slab and side walls.	120	cu.m	$60.00	$7,200
1.3	Remove existing gabion training wall (to waste) at upstream extent of Overflow Embankment.	1	LS	$500.00	$500
1.4	Excavate Overflow Embankment in vicinity of LHS/northern chute training wall for subsequent wall demolition to stockpile for reinstatement)	1	LS	$500.00	$500
1.5	Reinstate gabion wall at lower foundation level	1	LS	$4,000.00	$4,000
1.6	Reinstate Overflow Embankment from stockpile	1	LS	$2,000.00	$2,000
1.7	Nominal allowance for potential upgrade of chute downstream toe and energy dissipation work	1	LS	$75,000.00	$75,000
	Sub-total				$40,200
2.0	Demolition				
2.1	Saw cut chute at interface with new slab	30	m	$35.00	$1,050
.2	Saw cut walls at interface with existing chute	3.5	m	$150.00	$530
2.3	Demolish central portion of existing weir associated chute area for	46	cu.m	$250.00	$11,500

Item	Description	Quantity	Unit	Rate	Amount (NZD)
	subsequent construction of new weir block.				
2.4	Demolish existing RHS/southern training wall and supporting chute slab where weir and slab is to be lowered.	4.7	cu.m	$250.00	$1,180
2.5	Demolish existing LHS/northern training wall and supporting chute slab where weir and slab is to be lowered (wall tied into slab)	4.7	cu.m	$250.00	$1,180
2.6	Demolish Overflow Embankment wing wall and footing upstream of existing weir block (wall not tied into weir block or chute)	2.5	cu.m	$250.00	$ 630
2.7	Demolish central portion of existing weir block.	26	cu.m	$250.00	$ 6,500
	Sub-total				$22,550
3.0	Reinforced Concrete				
3.1	Construct central portion of new weir block, including blockouts and fittings for Obermeyer gates				
3.1.1	Formwork	29	sq.m	$185.00	$5,370
3.1.2	Reinforcement	1750	kg	$ 4.10	$7,180
3.1.3	Place concrete	50	cu.m	$450.00	$22,500
3.1.4	Blockouts (recesses) for gate fixings	12	No.	$375.00	$4,500
3.2	Intermediate concrete piers (3 No.)				
3.2.1	Reinforcement	780	kg	$4.10	$3,200
3.2.2	Formwork	36.7	sq.m	$210.00	$7,710
3.2.3	Concrete	7.8	cu.m	$450.00	$3,510

Item	Description	Quantity	Unit	Rate	Amount (NZD)
3.3	Construct new RHS/Southern side wall and footing, including RHS end of new weir block with blockouts and fittings for far right gate				
3.3.1	Formwork (wall)	31	sq.m	$185.00	$5,740
3.3.2	Reinforcement (wall)	810	kg	$4.10	$3,320
3.3.3	Concrete (wall)	8.1	cu.m	$450.00	$3,650
3.3.4	Formwork (slab)	2	sq.m	$185.00	$370
3.3.5	Reinforcement (slab)	390	kg	$4.10	$1,600
3.3.6	Concrete (slab)	4	cu.m	$450.00	$1,800
3.3.7	Blockouts (recesses) for gate fixings (slab)	2	No.	$350.00	$700
3.4	Construct new LHS/Northern side wall and footing, including LHS end of new weir block with blockouts and fittings for far left gate				
3.4.1	Formwork (wall)	31	sq.m	$185.00	$5,740
3.4.2	Reinforcement (wall)	770	kg	$4.10	$3,160
3.4.3	Concrete (wall)	7.7	cu.m	$450.00	$3,470
3.4.4	Formwork (slab)	2	sq.m	$185.00	$370
3.4.5	Reinforcement (slab)	390	kg	$4.10	$1,600
3.4.6	Concrete (slab)	4	cu.m	$450.00	$1,800
3.4.7	Blockouts (recesses) for gate fixings (slab)	2	No.	$350.00	$700
3.5	Construct new Overflow Embankment wingwall and footing				
3.5.1	Formwork	17	sq.m	$185.00	$3,150
3.5.2	Reinforcement	380	kg	$4.10	$1,560

Item	Description	Quantity	Unit	Rate	Amount (NZD)
3.5.3	Concrete	3.8	cu.m	$450.00	$1,710
	Sub-total				$94,360
5.0	Diversion				
5.1	Clean and prepare surface	1	LS	$2,000.00	$2,000
5.2	Shear connection to rock - possible requirement to be quantified	TBC	TBC	TBC	TBC
5.3	Concrete - footing and wall	40	m3	$450.00	$18,000
5.4	Reinforcing	3600	kg	$4.10	$14,760
5.5	Formwork	114	m2	$185.00	$21,090
5.6	Form diversion bund - borrow to fill	370	m3	$14.00	$5,180
5.7	Remove coffer dam - cut to stockpile	300	m3	$10.00	$3,000
5.8	Manage/maintain coffer dam during construction	TBC	TBC	TBC	TBC
5.9	Allow to deal with floods up to nominated level - e.g. pumping and/or membrane	TBC	TBC	TBC	TBC
	Sub-total				$64,030
6.0	Foot access bridge over existing weir				
6.1	Structural Steel	2773	kg	$5.00	$13,870
6.2	Foot bridge decking	32	m2	$205.00	$6,560
6.3	Handrails	66	m	$185.00	$12,210
6.4	Nominal sum for freight and installation	1	LS	$4,000.00	$4,000

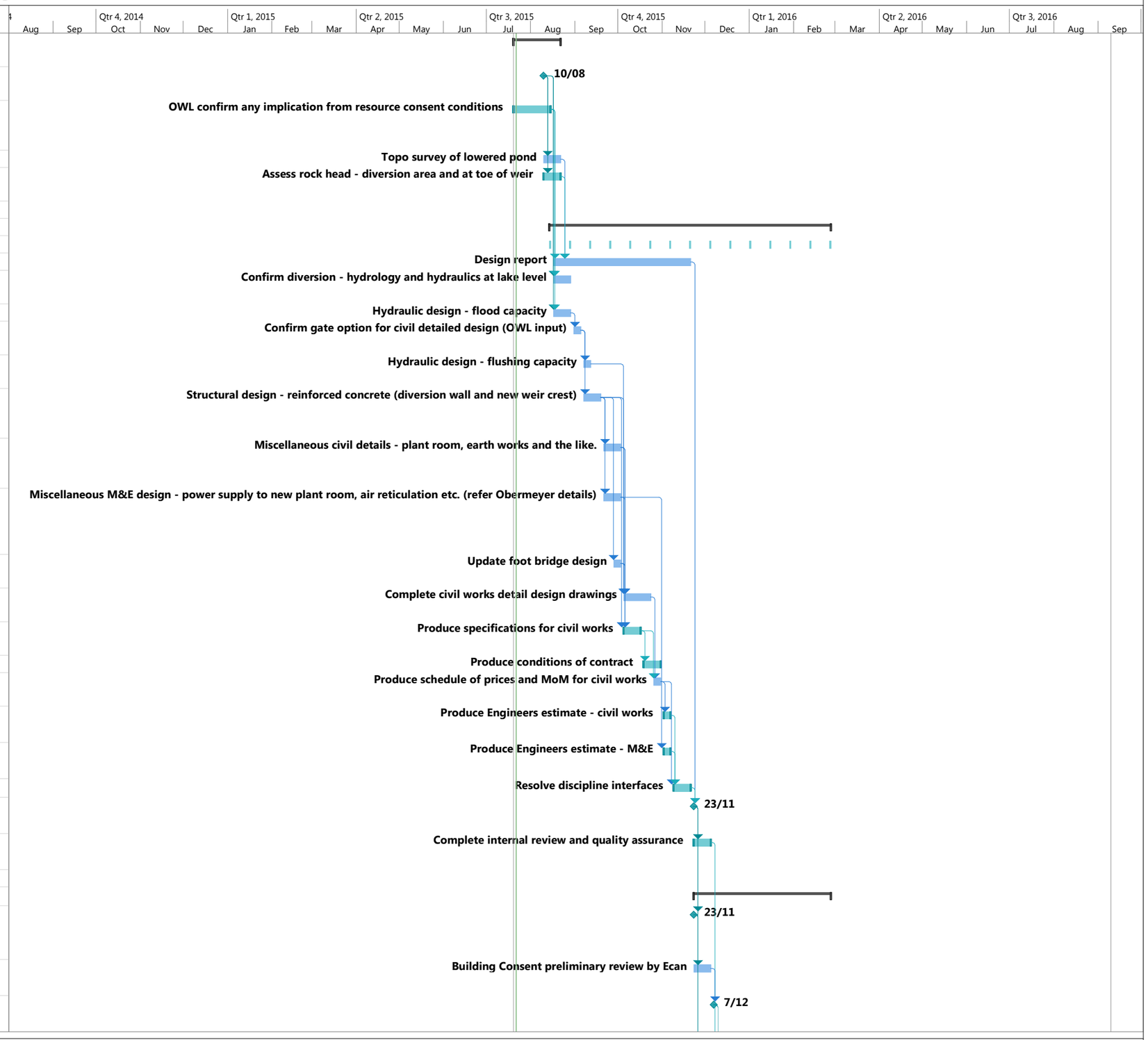
Item	Description	Quantity	Unit	Rate	Amount (NZD)
	Sub-total				$36,600
6.0	Mechanical and Electrical Services and Plant				
6.1	Plant room and foundation complete 2.67 m diameter precast reinforced concrete dangerous goods shed assumed location at the gate structure LHS (Hynds propriety structure assumed).	1	LS	$5,800.00	$5,800
6.2	Provide air supply from compressor to new radial gate including cast in pipework	1	LS	$10,000.00	$10,000
6.3	Design and supply 4 number Obermeyer flap gates 7.125 m wide with 1.55 m operational range (340.75 m RL to 339.2 m RL). Price provided by Obermeyer Hydro Inc. CIF to NZ port and converted to NZD on basis $1 NZD = $0.65 USD.	1	LS	$445,700.00	$445,700
6.4	Install and commission Obermeyer flap gates	1	LS	$20,000.00	$20,000
	Sub-total				$481,500
7.0	Miscellaneous Civil Items				
7.1	Nominal 5 % allowance on preceding for minor non-scheduled items.	$357,779	%	5%	$17,900

Appendix F: Indicative programme

Opuha Dam Downstream Weir - LHS scheme DRAFT Programme

Wed 22/07/15

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Preliminary activities & investigations**	**25 days?**	**Mon 20/07/15**	**Fri 21/08/15**
2		OWL confirm approval to proceed with detailed design	0 days	Mon 10/08/15	Mon 10/08/15
3		OWL confirm any implication from resource consent conditions	20 days	Mon 20/07/15	Fri 14/08/15
4		Topo survey of lowered pond	10 days	Mon 10/08/15	Fri 21/08/15
5		Assess rock head - diversion area and at toe of weir	10 days	Mon 10/08/15	Fri 21/08/15
6					
7		**Detailed design of civil works**	**131 days?**	**Fri 14/08/15**	**Fri 26/02/16**
8		Project design meeting	**131 days**	**Fri 14/08/15**	**Fri 26/02/16**
24		Design report	70 days	Mon 17/08/15	Fri 20/11/15
25		Confirm diversion - hydrology and hydraulics at lake level	10 days	Mon 17/08/15	Fri 28/08/15
26		Hydraulic design - flood capacity	10 days	Mon 17/08/15	Fri 28/08/15
27		Confirm gate option for civil detailed design (OWL input)	5 days	Mon 31/08/15	Fri 4/09/15
28		Hydraulic design - flushing capacity	5 days	Mon 7/09/15	Fri 11/09/15
29		Structural design - reinforced concrete (diversion wall and new weir crest)	10 days	Mon 7/09/15	Fri 18/09/15
30		Miscellaneous civil details - plant room, earth works and the like.	10 days	Mon 21/09/15	Fri 2/10/15
31		Miscellaneous M&E design - power supply to new plant room, air reticulation etc. (refer Obermeyer details)	10 days	Mon 21/09/15	Fri 2/10/15
32		Update foot bridge design	5 days	Mon 28/09/15	Fri 2/10/15
33		Complete civil works detail design drawings	15 days	Mon 5/10/15	Fri 23/10/15
34		Produce specifications for civil works	10 days	Mon 5/10/15	Fri 16/10/15
35		Produce conditions of contract	10 days	Mon 19/10/15	Fri 30/10/15
36		Produce schedule of prices and MoM for civil works	5 days	Mon 26/10/15	Fri 30/10/15
37		Produce Engineers estimate - civil works	5 days	Mon 2/11/15	Fri 6/11/15
38		Produce Engineers estimate - M&E	5 days	Mon 2/11/15	Fri 6/11/15
39		Resolve discipline interfaces	10 days	Mon 9/11/15	Fri 20/11/15
40		Complete detailed design (final draft)	0 days	Mon 23/11/15	Mon 23/11/15
41		Complete internal review and quality assurance	10 days	Mon 23/11/15	Fri 4/12/15
42					
43		**Tendering and Approvals**	**60 days**	**Mon 23/11/15**	**Fri 26/02/16**
44		Building Consent pre-application meeting with Ecan	0 days	Mon 23/11/15	Mon 23/11/15
45		Building Consent preliminary review by Ecan	10 days	Mon 23/11/15	Fri 4/12/15
46		Receive preliminary Building Consent comments from Ecan	0 days	Mon 7/12/15	Mon 7/12/15



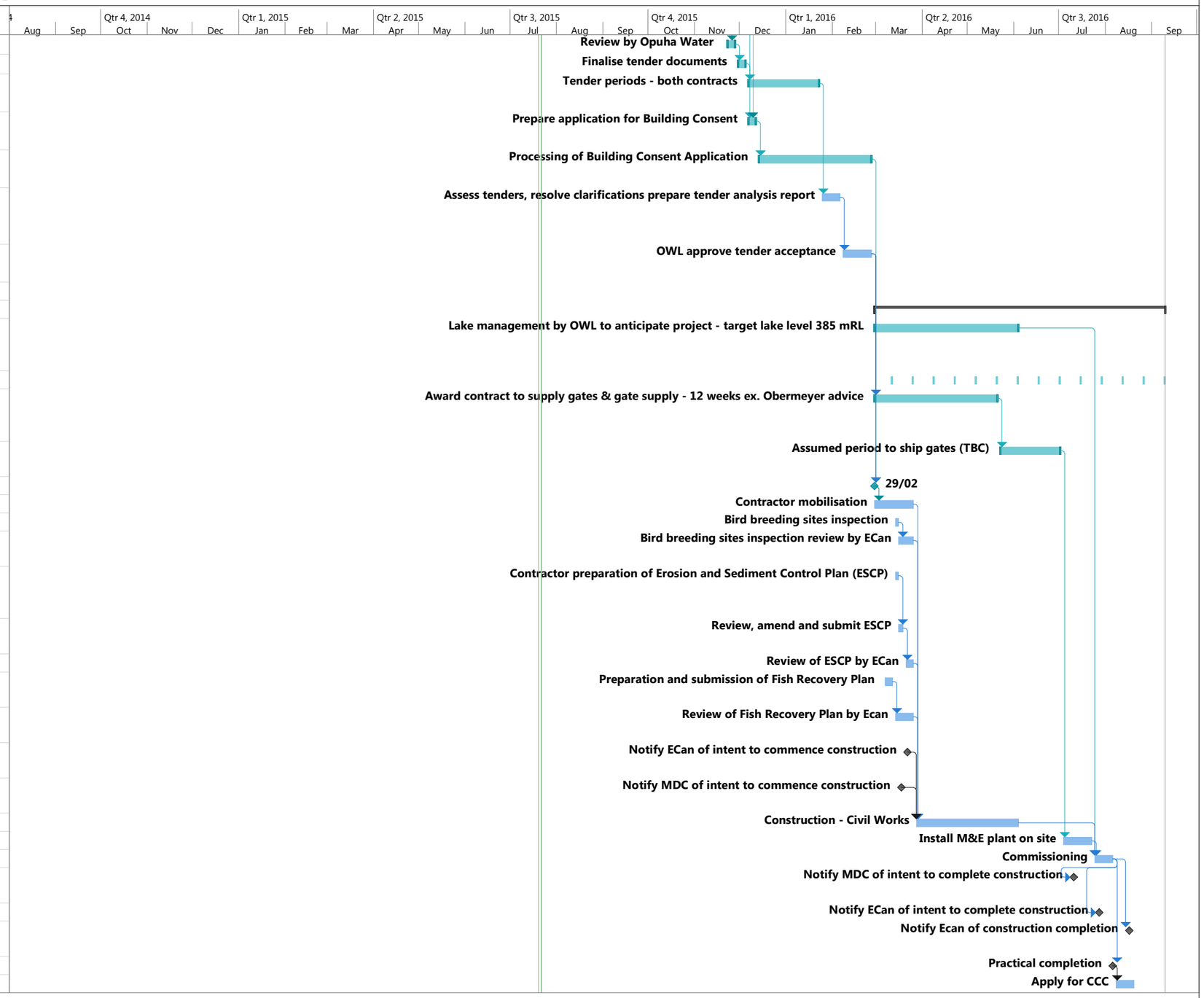
Project: 2015.07.21.tgm.LHS Pro
Date: Wed 22/07/15

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Opuha Dam Downstream Weir - LHS scheme DRAFT Programme

Wed 22/07/15

ID	Task Mode	Task Name	Duration	Start	Finish
47		Review by Opuha Water	5 days	Mon 23/11/15	Fri 27/11/15
48		Finalise tender documents	5 days	Mon 30/11/15	Fri 4/12/15
49		Tender periods - both contracts	25 days	Mon 7/12/15	Fri 22/01/16
50		Prepare application for Building Consent	5 days	Mon 7/12/15	Fri 11/12/15
51		Processing of Building Consent Application	45 days	Mon 14/12/15	Fri 26/02/16
52		Assess tenders, resolve clarifications prepare tender analysis report	10 days	Mon 25/01/16	Fri 5/02/16
53		OWL approve tender acceptance	15 days	Mon 8/02/16	Fri 26/02/16
54					
55		**Construction & Commissioning**	**140 days**	**Mon 29/02/16**	**Fri 9/09/16**
56		Lake management by OWL to anticipate project - target lake level 385 mRL	70 days	Mon 29/02/16	Fri 3/06/16
57		Construction stage meeting	**131 days**	**Fri 11/03/16**	**Fri 9/09/16**
72		Award contract to supply gates & gate supply - 12 weeks ex. Obermeyer advice	60 days	Mon 29/02/16	Fri 20/05/16
73		Assumed period to ship gates (TBC)	30 days	Mon 23/05/16	Fri 1/07/16
74		Award main contact	0 days	Mon 29/02/16	Mon 29/02/16
75		Contractor mobilisation	20 days	Mon 29/02/16	Fri 25/03/16
76		Bird breeding sites inspection	2 days	Mon 14/03/16	Tue 15/03/16
77		Bird breeding sites inspection review by ECan	8 days	Wed 16/03/16	Fri 25/03/16
78		Contractor preparation of Erosion and Sediment Control Plan (ESCP)	2 days	Mon 14/03/16	Tue 15/03/16
79		Review, amend and submit ESCP	3 days	Wed 16/03/16	Fri 18/03/16
80		Review of ESCP by ECan	5 days	Mon 21/03/16	Fri 25/03/16
81		Preparation and submission of Fish Recovery Plan	5 days	Mon 7/03/16	Fri 11/03/16
82		Review of Fish Recovery Plan by Ecan	10 days	Mon 14/03/16	Fri 25/03/16
83		Notify ECan of intent to commence construction	0 days	Tue 22/03/16	Tue 22/03/16
84		Notify MDC of intent to commence construction	0 days	Fri 18/03/16	Fri 18/03/16
85		Construction - Civil Works	50 days	Mon 28/03/16	Fri 3/06/16
86		Install M&E plant on site	15 days	Mon 4/07/16	Fri 22/07/16
87		Commissioning	10 days	Mon 25/07/16	Fri 5/08/16
88		Notify MDC of intent to complete construction	0 days	Mon 11/07/16	Mon 11/07/16
89		Notify ECan of intent to complete cc	0 days	Thu 28/07/16	Thu 28/07/16
90		Notify Ecan of construction completion	0 days	Tue 16/08/16	Tue 16/08/16
91		Practical completion	0 days	Fri 5/08/16	Fri 5/08/16
92		Apply for CCC	10 days	Mon 8/08/16	Fri 19/08/16



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Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress