Appendix G

GHD 2012 Derby Tidal Power Preliminary Design Report

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TEA Investments (No.1)

Report for Derby Tidal Power Project

Preliminary Design Report

May 2012

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

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Executive Summary

TEA Investment No.1 has requested GHD to prepare preliminary design documentation including a preliminary bill of quantities for the civil works, turbines and appurtenant works for pricing by a contractor for the Tidal Power Plant in King Sound in Western Australia. The Derby Tidal Project is located at the mouth of Doctor's Creek, 12 km north of Derby.

The documentation presented in this report was prepared by developing a layout proposed by the TEA Investment No. 1 and is based on previous design work undertaken by GHD.

The proposed tidal power scheme will comprise 5 turbines of 8 MW (total 40 MW) with an additional 1 turbine of 8 MW for future expansion, 14 inlet gates and 8 outlet gates.

1. Introduction

1.1 Project Background

The Derby Tidal Project is located at the mouth of Doctor's Creek, 12 km north of Derby

In 1999 GHD give specific reference documents for a tender by Leighton Contractors Pty Ltd for the Derby Tidal Project where the power plant was located on the Doctor's Creek peninsula. In the middle of 2002 the documentation was re-visited. Different tidal power schemes were considered with varying configuration of the main structures (number of gates, number and sizes of turbines) as well as the location of the power plant. In this design the main civil engineering structures and power house were located about 2.2 km further north of the previous design at a more exposed offshore location.

It was common to all options that the scheme comprised high and low basins and energy was generated by the turbines mainly discharging water from the high basin to the low basin. In some cases, the direct tidal flow was used to generate power. The main differences were in the extent of the trapped basins and in the location of the power house. The size of the basins and number of inlets and outlet gates are the energy potential and they also control capital costs.

GHD was carrying out the design work for the Tidal Power Consortium at that time and developed a number of designs. At that time, a number of different model runs were undertaken in order to optimise the scheme. The construction risks were examined and the exposed offshore location of the main civil engineering structures was assessed as having demanding construction challenges.

In order to provide further optimisation in the construction cost and to reduce the construction risks compared to the previously analysed schemes, TEA Investment No.1 has proposed a revised design layout which would reduce the size of the high basin and move the main structures to the peninsula between the two tidal basins which would reduce construction risks. The arrangement of this design layout is approximately the same location as that designed by GHD in 1999.

Figure 1 Doctors Creek

Reference: GHD photograph (15th May 2012)

1.2 Project Summary

The documentation presented in this report is based on developing a layout proposed by TEA Investment No. 1 to a preliminary design level including a preliminary bill of quantities for the civil works, turbines and appurtenant works for the pricing by a contractor. The proposed tidal power scheme will comprise 5 turbines of 8 MW (total 40 MW) with the layout capable of receiving an additional 1 turbine of 8 MW for future expansion as requested by TEA Investment No. 1. The scheme includes a total of 14 inlet gates with invert level set at RL -7.0 m AHD and 8 outlet gates with invert levels set at RL -10.0 m AHD. All gates openings are 10 m wide by 6.5 m high.

The documents prepared for this report are based on a review of available documentation and drawings related to the previous design work carried out by GHD. A copy of the drawings has been included in Appendix A.

The numerical model developed previously could not be used as the model software is now out dated. A new numerical model was developed by GHD based upon the original model so as to estimate energy production per annum.

A bill of quantities was prepared and is based on the preliminary drawings with ± 20% accuracy. A copy is included in Appendix B.

2. Numerical Modelling

2.1 Introduction

This section describes the development and use of a Microsoft Excel based computer model which simulates the hydraulic operation and power delivery of the proposed Derby tidal power plant. The current model is derived from previous work and uses tidal data to predict power output in 2013.

2.2 Background

The model was originally developed in 1999 as a quality assurance (QA) check to another model coded in Visual Basic. The Visual Basic model was the primary model in that investigation, and was used to analyse 30 years of tidal data. At the time, Microsoft Excel was not powerful enough to handle the large arrays of data required for meaningful tidal calculations over such a long period. The model was therefore only used to evaluate data over small snapshots of time (one or two days) to ensure the visual basic model was operating correctly.

In 2012, GHD was commissioned to revisit the project and provide design services for a new configuration. As part of the scope, GHD was requested to perform some numerical modelling to confirm the annual output of the new configuration. The original visual basic model was consulted and found to contain out-dated code that no longer served its purpose. The QA Excel model on the other hand was found to be functional. GHD therefore chose to develop this model, taking advantage of improved computational power to extend the model to evaluate a full year's worth of data.

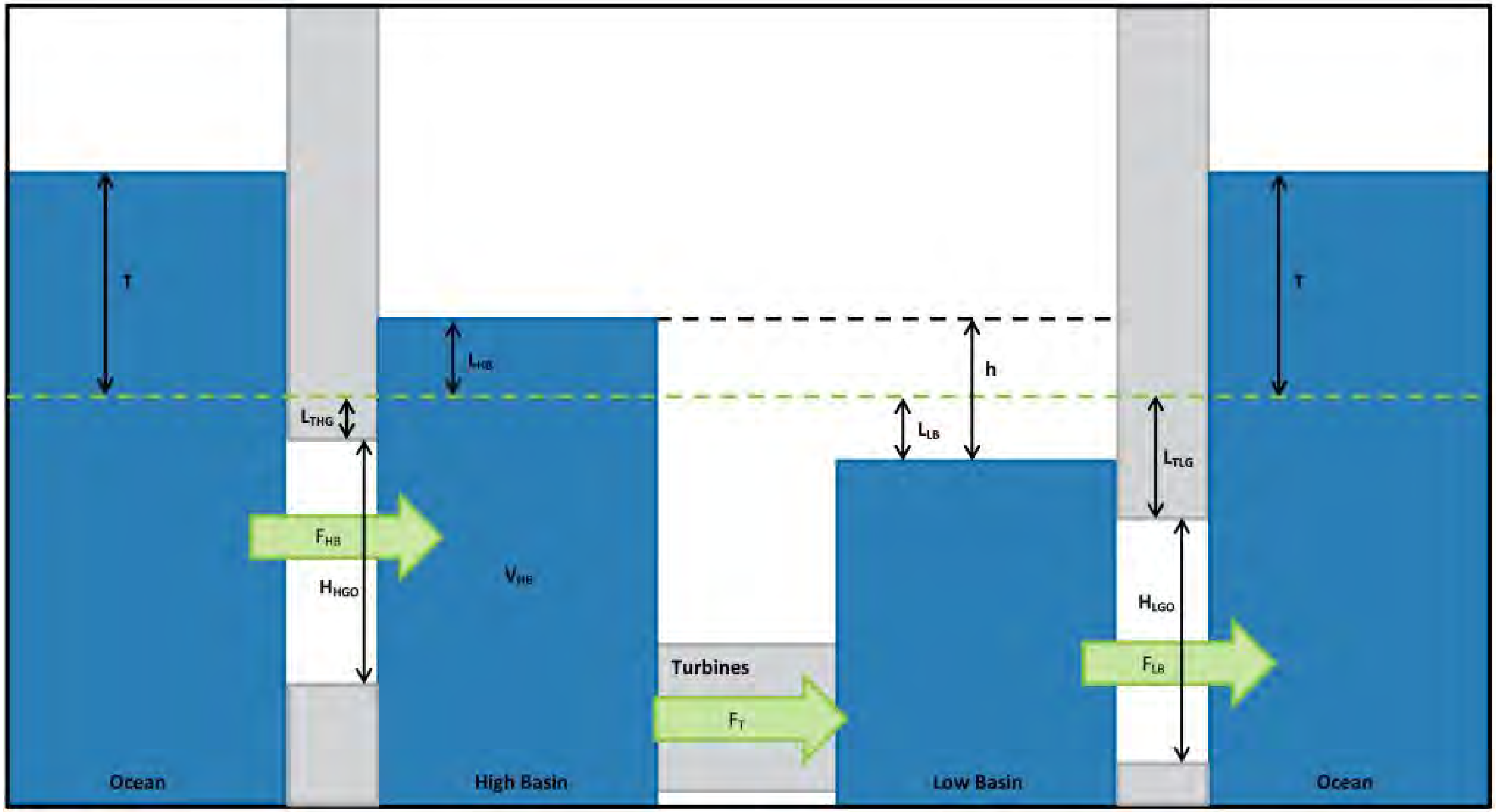
The model as it stood before the current commission consisted of a main calculation spreadsheet and a number of input spreadsheets created for different infrastructure configurations and operation methodologies. Details and assumptions surrounding the model development and modification are discussed in Section 2.6.

2.3 Configuration

The current version of the model considers only one 'fixed' infrastructure configuration consisting of:

- Two basins (high and low);
- Two large embankments separating the basins from the Indian Ocean;
- Fourteen high basin gates;
- Eight low basin gates; and
- Five 8 MW hydro turbines.

Water flows from the ocean into the high basin through the inlet gates, from the high basin to the low basin through the turbines and from the low basin to the ocean via the outlet gates. The drawings have been drafted illustrating the detailed arrangement of the above listed equipment and have been provided as part of the civil component of the commission. A simplified schematic has been provided in Figure 2.



T	Tide (m)	L_{HB}	High Basin Level (m)	F_T	Total Flow (through turbines) (m^3/s)
H_{HGO}	High Gate Opening Height (m)	L_{LB}	Low Basin Level (m)	**h**	Head (m)
H_{LGO}	Low Gate Opening Height (m)	F_{LB}	Flow out of Low Basin (m^3/s)	V_{HB}	Volume High Basin (m^3)
L_{THG}	Top of High Gate Level (m)	F_{HB}	Flow into High Basin (m^3/s)	V_{LB}	Volume Low Basin (m^3)
L_{TLG}	Top of Low Gate Level (m)	– –	Relative level Above Sea Level (m)		

Figure 2 Basin Arrangement Schematic

2.4 Methodology

GHD has completed the numerical modelling exercise under the following methodology:

- Review numerical model developed for previous Derby tidal modelling;
- Identify model basis from which the current model has been developed;
- Simplify model to one spreadsheet for one configuration;
- Extend model to reflect one year's worth of tidal data;
- Update basin level / volume data;
- Investigate available turbine models and suppliers;
- Update turbine efficiency data;
- Run the tidal model for maximum flow;
- Summarise output results; and
- Recommend further optimisation.

2.5 Model Description

The current model essentially uses 2013 tidal data at 15 minute intervals to evaluate water flow in and out of the low and high basins via a step-wise iterative process. The methodology behind the water flow is simplistically described in Table 1.

Table 1 Flow Methodology

Tide Level	High Basin	Low Basin
High Tide	High Basin Gates Open (allowing flow into the high basin)	Low Basin Gates Closed (preventing flow into the low basin)
Low Tide	High Basin Gates Closed (preventing flow into the high basin)	Low Basin Gates Open (allowing flow out of the low basin)

Barrage gates are opened and closed when levels are equal on both sides.

After each time interval the model evaluates the volume of water in each basin, calculates the resulting head across the turbines and uses a turbine efficiency diagram to estimate the power produced during the next 15 minute time interval. In an optimised system water will continuously flow from the high basin to the low basin, generating power.

At the same time the model checks the difference between water levels in the basins and the tide level to determine whether to open the inlet or outlet gates so as to either fill or empty the basins. Once the water level inside the basin matches that of the tide then the appropriate gates will open or shut.

2.6 Model Assumptions and Limitations

2.6.1 Input Data

Tidal data was provided by the Department of Marine and Harbours based on tidal information at the Derby Wharf but adjusted according to tide observations at a gauge mounted at the mouth of Doctors Creek over a period from 2000 to 2001. The current model relies on data generated in 15 minute intervals for the year 2013.

The relationships between basin water levels and basin volumes have been derived from topographical surveys using 12 D software. Basin volumes have been evaluated for discrete water levels in increments of 0.5 metres. Data has been included in Appendix C.

External factors were ignored as their impact on each tidal cycle would be negligible, i.e. rain and flood inflow, leakage, seepage and evaporation.

A hill diagram is an array of numbers describing a hydro turbine's efficiency under a range of discrete head differentials and flow rates. The current model utilises a hill diagram for an 8 MW turbine that was sourced as part of the previous study. GHD suggest that suppliers are engaged to obtain updated turbine efficiency data. Some suppliers have been contacted, however at the time of this report issue no data had been provided. The currently used hill diagram has been included in Appendix C.

The discrete nature of data in the lookup arrays and tables requires the model to calculate values between table data points. Linear interpolation has been used for this purpose.

2.6.2 Operational Design Basis

The current model has been designed for maximum power over a given time interval. For each iteration, the head differential across the turbines is calculated and the flow adjusted such that the maximum power is produced over that time interval. This is not the most efficient mode of operation as is discussed in Section 2.9.

No consideration has been given to load matching or water conservation in the current model.

2.6.3 Hydraulic Coefficients

There are a range of hydraulic coefficients that can be used for determining flow through gate openings.

In previous studies by GHD it was found that there is no definitive formula which is agreed upon for calculating these flows however it was also observed that varying the coefficients used within the typical range found in various texts influenced the power output by less than a few percent. As such, the coefficients used in previous versions of the model have not been altered.

2.6.4 Parameter Assumptions

The following assumptions have been made in the development of the current model.

Table 2 Tidal Power Modelling Parameters

Parameter	Units	Value	Comments
Iteration Time Period	sec	900	Tidal data time increments
Number of Turbines Installed	#	5	From civil design
Generator Capacity	MW	8.00	
Turbine Gearbox Efficiency	%	98.7	
Generator Efficiency	%	97.5	
Generator Step-up Transformer Efficiency	%	99.0	
Equivalent Forced Outage Rate	%	1.0	
Turbine Capacity Limit	MW	8.48	
Minimum Head for Turbine Operation	m	1.5	
Head Loss Across the Turbine Structure	%	4.5	% of head differential
Auxiliary Loads and Transmission Losses	MW	0	Not considered
Minimum Head Differential to Open Gates	m	0	
Initial High Basin Level	m	4.5	Based on tide range
Initial Low Basin Level	m	-4.5	Based on tide range
Number of High Basin Gates	#	14	From civil design
Level of the Top of the High Basin Gates	m	-0.5	From civil design
Gate Height	m	6.5	From civil design
Gate Width	m	10	From civil design
Number of Low Basin Gates	#	8	From civil design
Level of the Top of the Low Basin Gates	m	-3.5	From civil design
Gate Height	m	6.5	From civil design
Gate Width	m	10	From civil design
Cd – fully submerged orifice flow		0.8	
Cd – partially submerged weir flow (high driving head)		1.7	
Cd – partially submerged weir flow (low driving head)		0.8	
Leakage through Gates and Turbines when Closed	m^3/s	0	Assumed negligible

2.7 Gate Flow Formulae

Flow through a gate is calculated based on the head difference between the tide and basin levels and using hydraulic coefficients relevant to the flow conditions.

There are three flow conditions:

- Orifice Flow- Occurs when the water levels upstream and downstream of the gate are both above the soffit level.
- Weir Flow – Low driving head - Occurs when downstream levels are below the soffit level of the gate but there is relatively little additional upstream head. A fixed flow co-efficient is used.
- Weir Flow – High driving head - Occurs when the upstream flow is above the soffit level and the downstream level is below the soffit level of the gate. The flow equation includes a term which modifies the coefficient according to the submergence ratio (i.e. ratio of downstream level above sill to upstream level above sill).

Figure 3 illustrates orifice and weir flow, H_1 is the driving head.

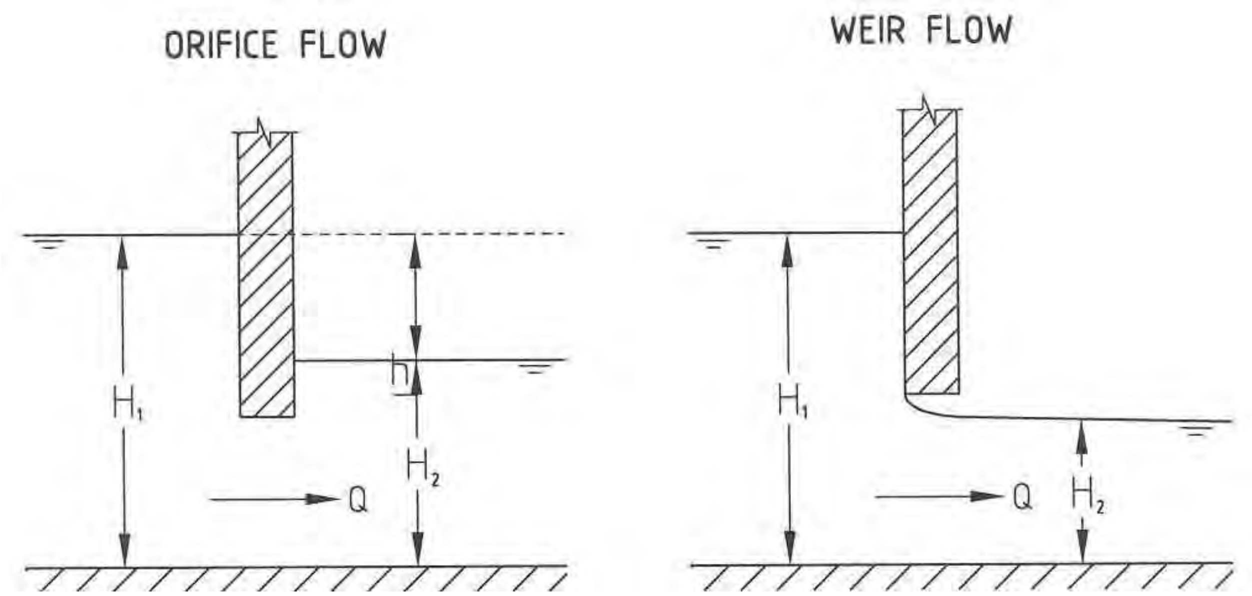


Figure 3 Flow Definition Diagram

The equations used to model gate flows were:

Orifice Flow:

$$Q = n_g.Cd.A\sqrt{2gh} \quad \text{where } h = H_1 - H_2 \text{ and } Cd = 0.8$$

Weir Flow – Low driving head:

$$Q = n_g.Cd.H_1.W\sqrt{2g(H1-H2)}\text{, when } \frac{H2}{H1} > 0.85,$$

Where Cd = 0.8

Weir Flow – High driving head:

$$Q = n_g.Cd.W.H_1^{1.5}.(TERM), \text{ when } \frac{H2}{H1} \leq 0.85$$

$$\text{Where } Cd = 1.7 \sqrt{m}/\sec$$

$$\text{And TERM} = -228.83 \left(\frac{H2}{H1}\right)^6 + 823.7 \left(\frac{H2}{H1}\right)^5 - 1211.8 \left(\frac{H2}{H1}\right)^4$$

$$+ 927.3 \left(\frac{H2}{H1}\right)^3 - 387.7 \left(\frac{H2}{H1}\right)^2 + 83.6 \left(\frac{H2}{H1}\right) - 6.248$$

Units: Q = flow (m^3/sec) A = gate area (m^2) W = gate width (single gate) (m),

n_g = number of gates h, H_1, H_2 = head (m)

2.8 Results

The current model has been developed in accordance with the methodology described in this report and run using the parameters described in Section 2.6. Monthly simulations have been modelled and the results are presented in Table 3 below. Under the assumptions described in Section 2.6, the simulation indicates that the current configuration should produce approximately 154 GWh in 2013.

Table 3 Monthly Power Generation Model Results

Month	Number of Days	Total Energy Produced (GWh)	Average Daily Energy (GWh)
January	31	13.5	0.44
February	28	12.0	0.43
March	31	14.2	0.46
April	30	13.0	0.43
May	31	12.9	0.42
June	30	12.2	0.41
July	31	12.6	0.41
August	31	12.5	0.40
September	30	12.6	0.42
October	31	12.8	0.41
November	30	12.6	0.42
December	31	12.9	0.42
Annual	**365**	**153.8**	**0.42**

Figure 4 shows the daily water level variation for the 1 of March 2013 being a typical spring tide. The graph helps to illustrate the fluctuations in power produced by the system over the course of typical day and the flow between the high and low basins.

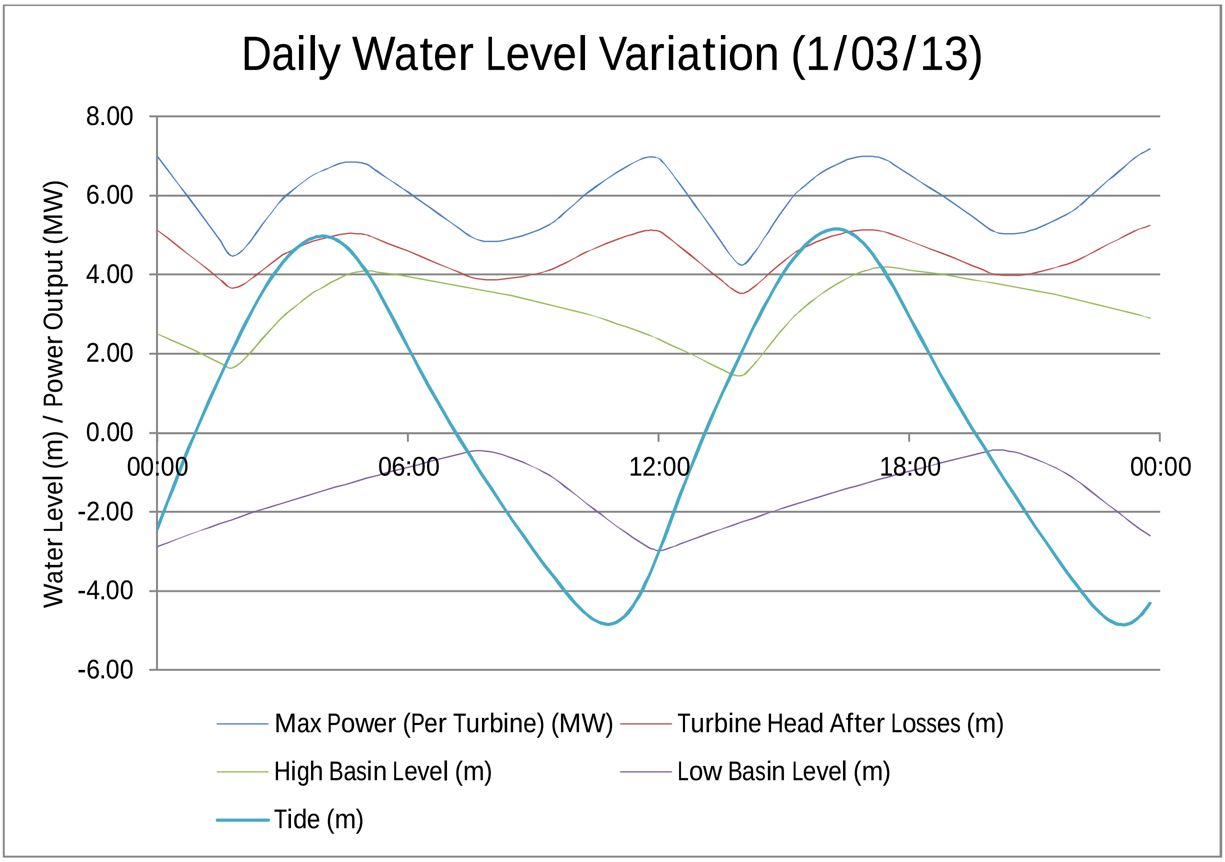


Figure 4 Daily Water Level Variation and Power Output with desirable turbine operation

The snapshot shown above illustrates a day in which all turbines are running continuously. The power generated per turbine is shown to fluctuate between approximately 4.5 MW and 7 MW. The turbines in this instance are being operated with reasonable efficiency at a relatively high capacity factor.

However, under neap tides the head differential across the turbines fluctuates around the minimum head for turbine operation.

Consequently, the model shows that turbines are turned on and off several times a day, which will in itself have a detrimental effect on turbine maintenance. A snapshot of such a condition is included in Figure 5. For the majority of this day, the turbines are only generating between 0 and 1 MW. Operating the turbines at such a low load is inefficient and forgoes water that could be conserved and more efficiently used when a higher turbine head differential is available.

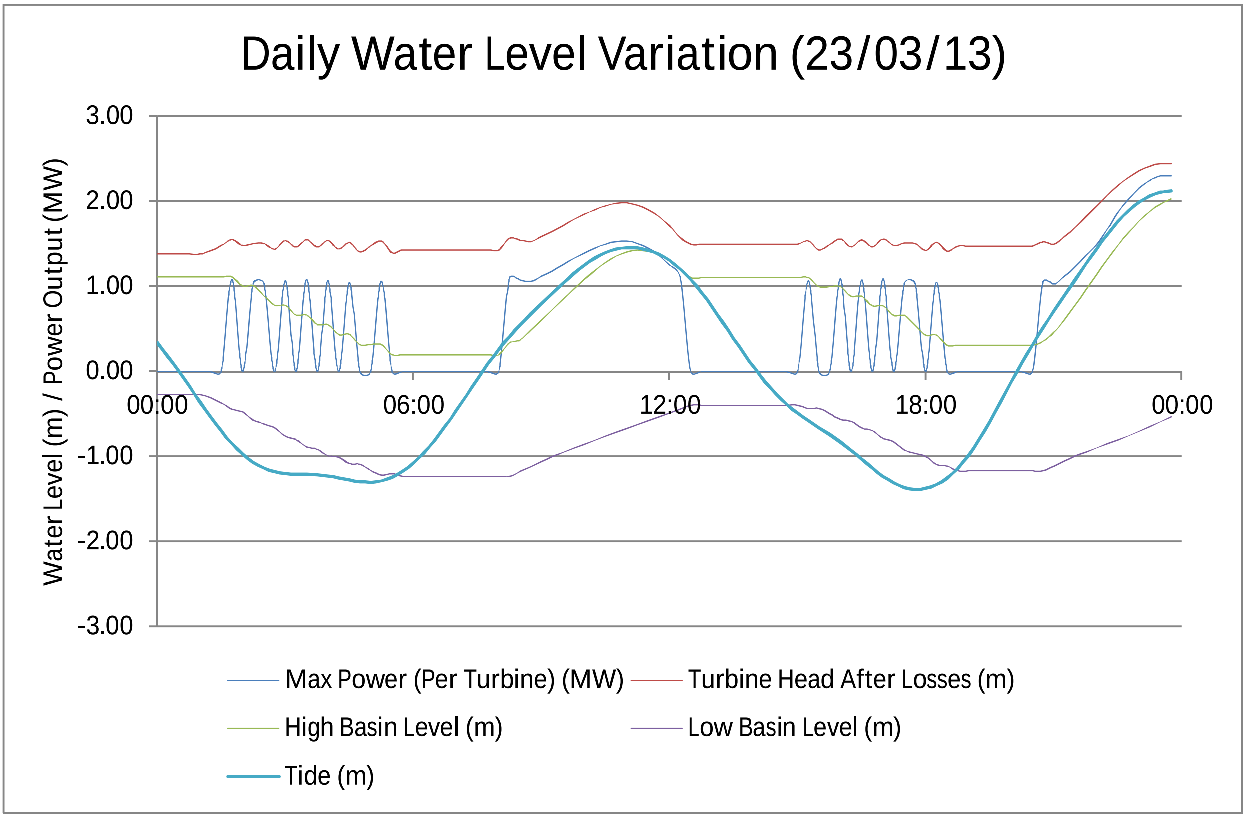


Figure 5 Daily Water Level Variation with undesirable turbine operation

Based on the modelling results presented above, the current tidal configuration will produce in excess of 150 GWh per annum. It is also expected that the current model and operating methodology can be optimised to improve this figure by in excess of 10%. GHD has identified a number of areas that could be further optimised in Section 2.9 below.

2.9 Recommended Optimisation

During each interval the current model calculates the maximum power available based on the level in each basin. There is no provision in the current model for altering the power output based on other factors such as the load demand for the interval or the tide conditions. Table 4 shows the percentage of time the power station is operating.

Table 4 Power Station Availability

Month	Number of Days	% of Time Turbine Running
January	31	94.66%
February	28	91.78%
March	31	92.67%
April	30	93.78%
May	31	96.44%

Month	Number of Days	% of Time Turbine Running
June	30	98.13%
July	31	96.88%
August	31	91.60%
September	30	89.83%
October	31	89.82%
November	30	95.49%
December	31	97.38%

In an optimised system it should be possible for water to continuously flow from the high basin to the low basin, generating power. Suggested methods of optimisation that should be investigated in the future are:

- Load matching – when there is a low demand the system is able to produce only what power is required during the 15 minute interval rather than the maximum possible. The level in the high basin therefore does not fall as quickly and the system will be able to maintain power production for longer periods. This would be achieved with turbine speed control.
- Selective operation of turbines – the model in its current form cannot choose to use less than 5 turbines when operating. Depending on the hill diagram for the selected turbine model and the available head during the 15 minute interval, running fewer turbines may be optimal. For the current configuration, and operating methodology, running 4 turbines generates an additional 5 GWh. It is expected that higher annual outputs are achievable by varying the number of turbines running over the tidal period.
- Basin volume modelling – The annual power generated is also dependant on the basin volumes. The current model utilises a high basin that has a significantly lower volume than was used in previous studies. The current model was run with the previous basin levels to assess the sensitivity of basin volumes on output. The previous levels were found to produce an additional 8 GWh per year. Consequently, there is an opportunity to improve the annual output of the plant via further optimisation of the basin locations or by dredging.

GHD can provide a proposal for the above listed optimisation works for the project if required.

3. Earth and Civil Works

3.1 Objectives and General Concepts

The overall development of the Derby Tidal Power Station consists of two main barrages across the west and east channels of Doctors Creek situated to the north of the Derby Town site. Associated with the barrages two levees will be constructed across the higher flood plain mud flats.

The Western Levee extends between the West Barrage and the high ground to the west of the channel. The West Levee prevents potential short-circuiting of high tide inflow into the High Storage Basin and also prevents the loss of water from the basin at high tide.

The East Barrage runs along the peninsula in a northerly direction and then crosses the east channel in an easterly direction.

The East Levee extends from the East Barrage in an easterly direction across the higher flood plain mud flats forming a permanent barrier which restricts any inflow of water from King Sound into the Low Basin at high tide.

An access road will be constructed from the Derby town site generally along the highest elevation in approximately the centre of the peninsula which separates Doctors Creek. The access road will be built to an elevation that will permanently separate the High (west) and the Low (east) Basins. The access road will also provide a stable platform for services to the site and for the transmission lines to Derby and other towns.

Inlet and outlet structures with a connecting channel to the Ocean and the Turbine Tidal Power Station structure in close proximity to the gates will be constructed on the peninsula. Connecting channels upstream and downstream of the turbine structure cut across the peninsula effectively will link the High Basin with the Low Basin.

3.2 Barrages

3.2.1 General

The crest levels of the east and west barrages have been designed to minimise overtopping under the 1 in 1000 year coincident wave and water level conditions given in the Wave and Water Level Report (**Ref: DCK-G-001 Doctors Creek Meteorological and Oceanographic Risk Analysis**).

A crest level of RL +9.0 m AHD has been adopted for the upstream, seaward slope of the barrages, with a crest width of approximately 3 metres or 3 armour stones wide, whichever is the greater. An adjacent road way platform will be formed at approximately RL +7.5 m AHD to provide access across the barrages under normal operating conditions.

The general arrangement of both the East and West Barrages will be similar, with the base width determined by adjacent water depths. Transition sections will be required between the barrage section and the inlet and outlet gate structures.

The proposed barrages will maximise the use of sand material obtained at the site. A rock bund will be constructed across the creeks as low as practicable and dredged sand built up on the downstream side. The rock bund will be constructed using quarry run or excavation spoils and side slopes will be formed at the natural angle of repose, typically in the order of 1:1.25 to 1:1.5. Sufficient crest width will be provided on the Stage 1 rock bund to enable construction access.

A graded rip rap filter layer will be constructed on the upstream slope of the rock bund and dredged sands will be built up to the full height of the barrage. The outer slope of the rock bund will be raised to match the level of sand fill as the barrage construction proceed to full height. Formation of flat sand slopes, in the order of 1:5, will be used to overcome piping in a reverse head situation. The downstream slope will be protected by rip rap to prevent erosion from small, locally generated waves and ambient current flows.

The upstream, or seaward barrage slopes will be armoured to withstand cyclonic wave conditions. Preliminary designs indicate armour slopes of 1:2.5, with armour rock varying in size from 0.7 tonnes to 2 tonnes. Rock grading limits will be in accordance with the *Manual on the Use of Rock in Coastal and Shoreline Engineering (CIRIA/CUR, London, 1991)*. Armour rock material will be selected to meet recommended criteria for rock durability, however the design wave condition is a cyclonic event and therefore abrasion is not critical to armour material.

A layer of filter cloth and secondary armour will be constructed on the upstream slope of the rock and sand bund to provide a hydraulically stable bedding for the primary armour rock. Top up material to form the base slope for armour layers will be graded to meet filter rules for the secondary armour if necessary.

3.2.2 West Barrage

The West Barrage has been located in a position such that the naturally high area on west bank of the High Basin channel is fully utilised. The West Barrage embankment will be accessed from the permanent Access Road from the Derby Town. A rock protected embankment profile will be used immediately after the inlet gate structures transition walls.

The barrage embankment comprises a rockfill and sand dredge material protection consisting of a thick primary rock armour on a secondary armour layer on a 1V:2.5H slope on the Ocean side and rip rap rock protection on the High Basin side.

A starter embankment of Stage 1 rock material will be formed prior to the placement of the dredged sand. Once the profile reaches the top of the starter wall, set nominally at RL 0.0 m AHD, a graded filter will be placed above the starter wall in layers. Each filter layer will be followed by an equal thickness of dredged sand forming a 1V:5H slope into the basin.

The dredged sand on the High Basin face will be protected by a layer of selected hard rock rip rap from the quarry to the lower areas and general rip rap sourced from the peninsula excavation, if available and suitable, to the upper reaches of the slope.

The embankment will be protected from wave action on the ocean face by three classes of rock armouring. The rock armour has been sized to suit the tide elevations and conditions. A graded filter system will form a control barrier between the rock armouring and the embankment material to prevent the loss of any material through the migration of water through the embankment. From the end of the barrage wall at the west bank to the start of the West Levee, a 150 m long transition embankment will be formed.

3.2.3 North-East Barrage

The North-East Barrage has been positioned so that it is constructed on the sand bars to the north of the end of the peninsula where it crosses the east channel along the edge of the higher ground.

A rock protected embankment profile will be used immediately after the inlet gate structures transition walls similar to the West Barrage.

The North-East Barrage embankment will be protected by rock armouring to the Ocean side and a rip rap to the Low Basin side similar to that described for the West Barrage.

A 150 m long transition will be formed from the bank to the east of the flood plain to connect with the East Levee

3.3 Levees

3.3.1 West Levees

From the western end of the West Barrage a 100 m long transition has been provided between the levee and the barrage (refer to Drg 61-27947-C02 and C05). The transition allows for an even and regular change to the profile and material type from the barrage to the levee. The starter bunds of compacted local material will contain the dredged sand foundation material under the gravel road. A drainage system with outlets at regular intervals discharging into the high basin has been provided to control the phreatic water levels that may be generated within the sand core material.

The outer faces of the levee will be protected by a layer of suitable rip rap to protect the levee against wave action from both the Ocean and High Basin. Due to the West Barrage length being only 500 m no laybys have been provided. However a turning circle has been provided at the end of the levee has been provided

3.3.2 East Levees

The East Levee will be constructed on a similar basis as the West Levee with a transition to the East Buttress. However due to the lower tide levels which will be maintained within the low basin the basin embankment slopes have been flattened to allow for a thinner and cost effective layer of slope protection to be installed. The rip rap to the Ocean face would remain to the same standard used on the West Levee.

The East Levee extends a distance of approximately 4,450 m from the North-East Barrage to the final end turning circle where the East Levee meets the temporary Haul Road. The East Levee is to be used as the primary access Haul Road for the barrage embankment material. Due to the initial high volume of traffic on this road, for safety and speed of construction, laybys have been provided at 250 m intervals along the Low Basin embankment face

3.4 Access Road

A permanent unsealed all weather access road has been provided from the Derby Town site to the tidal power station. The access road has been designed to comply with the Derby Shire requirements and regulations which require that the construction conforms to Main Roads Western Australia (MRWA) Rural Road Class - 4 design standards. All necessary road markings, signage and guide posts will be provided.

From chainage 0.0 m the centre line of the Derby Highway, east along Dampier Drive to chainage 1100 m, the new access road will match into the existing roads. The new road will be aligned and drained to MRWA standards.

The access road curves in a north easterly direction, from chainage 1100 m, across the southern most extremes of the Doctors Creek west channel where culverts have been provided in the two branches to maintain the natural flow of water to the area south of the road. From the culverts to the power station the road follows a close route to the highest elevation of natural ground.

Along the route, turning bays have been provided at 250 m intervals to either side of the road staggered by 125 m. These laybys will be used for the installation of the high tension transmission pylons. Additional width has been provided to the eastern side of the road for the installation of services.

Slope protection and drainage has been provided to the access road similar to that which is provided in the East Levee.

3.5 Hardstand Area

A hardstand area has been provided to the south west of the turbine structures for the erection of the maintenance and control structures. The outer edge of the hard stand area has been set at RL+7.5 m AHD with gradients toward a higher elevated section running along the central third of the hard stand. All the stormwater will drain evenly off the perimeter edges. Rip rap protection has been provided to the embankment slopes. The south western embankments will be protected by the placement of the spoil material from the turbine transfer channel to form a flat platform which will blend in with the natural topography of the peninsula.

The hard stand area is split into two separate areas by the main access road. An area to the west of the road has been provided as a tourist facility. Included on this area is a sheltered assembly area which includes toilet facilities for both male and female. Parking facilities for tourist buses and cars are provided. The area is fenced off from the main workshop and control room area to the west of the hard stand.

3.6 Design Verification

3.6.1 Barrages and Levees Embankment Materials

The design of the barrages is based on the information given in the Tender Documents, in particular Ref: DCK-G-001 Doctors Creek Meteorological and Oceanographic Risk Analysis. This Preliminary Design Report is preliminary in nature and further studies of coincident wave and water level conditions under ambient and cyclonic conditions will be necessary during detailed design. Near shore wave propagation studies should be undertaken when wave heights and wave periods have been confirmed. This will in turn allow design wave conditions to be more accurately defined. Barrage design sections will need to be verified by physical modelling to optimise crest heights and widths and armour rock sizes on the barrages.

3.6.2 Barrages and Levees Slope Stability Analysis

Preliminary stability analyses of the barrages and levees under static and seismic conditions were carried out as part of this preliminary design.

Conventional limit equilibrium methods were used to analyse static stability of the barrages and levees using the computer program SLOPE/W. The same program was used to analyse the influence of an earthquake on dam stability (pseudo static method) by applying a horizontal seismic acceleration coefficient. For each design condition the minimum factor of safety was determined by selecting a range of potential failure surfaces and searching for the minimum within an area. Providing the minimum occurs within the selected region, it can be assumed that the critical failure circle has been identified.

Following AUSTRALIAN NATIONAL COMMITTEE ON LARGE DAMS (ANCOLD) recommendation, the seismic analysis was carried out for Maximum Design Earthquake (MDE) which is for a return period of approximately 500 years. According to the Report on Seismic Evaluation of the Derby Tidal Power Station Site prepared by Gordon Geological consultants dated 3 March 1998, an acceleration of a=0.1g is adopted for MDE. This coefficient has not been verified by GHD.

The preliminary results show that the barrages and levees have satisfactory factors of safety for all analysed cases under static and seismic loads

3.6.3 Seepage Analysis

The adopted barrage section consists mainly of:

a) Heavy armour on the Ocean side of the barrage to control wave action

b) Stage 1 material (rockfill material from peninsula) to form a starter bund for the dredged sand;

c) Dredged sand creating the main barrage body to achieve the stability of the barrage and seepage control; and

d) Slope protection on the flat basin slope of the barrage.

A downstream slope of 1V:5H (repose angle of sand below water level) will be created using a dredging operation to place sand. The resulting wide bases of the barrages provide long seepage paths through the foundation which minimises the risk of seepage failure in the sand foundation.

A preliminary seepage analysis was carried out using the computer program SEEP/W to assess the hydraulic gradient in the foundation and seepage flow through the barrages. A steady state analysis was carried out which estimates higher results than are expected due to regular changes of water level. The estimated hydraulic gradient in the foundation was around 0.1 which leads to a factor of safety against seepage failure of sand foundation to be in the range Fs=6 to Fs=8 which is the recommended range for fine sand.

Based on the preliminary seepage analysis, the flow through the barrage was estimated to be 4×10^{-5} m^3/sec per metre length of the barrage. Total flow through the entire length of the barrages may be expected in the order of 4000 m^3/day which is 0.01% of the average flow through the gates.

4. Structures and Buildings

4.1 Objectives and General Concepts

To control the inflow and outflow of water from the two basins a series of gates have been provided in the west and east channels. The main objectives of these structures outlined below are as follows:

- To provide an efficient design that is appropriate for both construction and operation;
- To attain the specified design life, specifically 120 years for all fixed structures, and 45 years for inlet and outlet gates, stoplogs, etc; and
- To withstand the required design loads incorporating earthquake loads, wave and storm loads, extreme operating levels and unusual events.

Wherever possible, it has been the intent of the designers to incorporate aspects of the temporary works into the final design. This will contribute to a reduction in the magnitude of temporary works necessary and provide for a more efficient design.

4.2 Turbine House

4.2.1 Turbine House Structure

The turbine house has been designed to accommodate six turbines, generators, switchyard and associated equipment. In addition, an internal maintenance access area has been included to allow for easy removal and service of turbine and generator components. Other than concrete walls and slabs, no exposed structures exist. This eliminates cyclone or corrosion problems.

The entire structure with consist of concrete walls and roof, allowing for the turbine entry and draft tube profiles to be incorporated into the structure. As the global mass of the structure is important, sand fill will be utilized to reduce costs as compared to mass concrete. The structure allows for an access road to be placed over the top surface of the structure. This, in turn allows access for cranes adjacent to gates, generators and other equipment pits.

The turbine house will be constructed by the excavation of a pit through a raised mount into the existing peninsular clay soils with local dewatering, if required. The structure will be founded and keyed into the ground at approximately RL -16.0 m AHD.

The turbine house has been designed using a marine grade S50 concrete mix in accordance with the specification for aggressive areas including areas exposed to air or sea water. This mix is a low heat blended cement incorporating Granulated Blast Furnace Slag and Silica Fume.

All reinforcement embedded in the concrete will be welded together to provide electrical conductivity throughout for cathodic protection purposes. This applies to all structures exposed to marine conditions.

Consideration was given to various dead, live and earthquake load cases using a limit state approach, to ensure both global and local stability at all times. The worst case design load consisted of an emergency shutdown of all six turbines simultaneously combined with a maximum differential head across the structure. This is essentially a maximum water head plus the effects of water hammer from emergency shutdown.

4.2.2 Stoplogs and Screens

The stoplogs used in the turbine house have been designed to accommodate two specific sizes for both the inlet and outlet openings. Sufficient stoplogs have been provided to isolate one turbine unit (two inlets and one outlet). The gates will consist of a series of universal column sections placed on top of each other. The column sections will be welded together to ensure a smooth watertight surface is attained. This method ensures corrosion protection and maintenance can be easily and efficiently executed. In addition, large air voids will be contained within the stoplogs, using buoyancy to reduce the effective weight, allowing for more efficient lifting.

The guides accommodating the stoplogs are to be made of Grade 316 Stainless Steel. These will eliminate concrete wear, and provide a smooth surface for improved sealing. The use of Grade 316 Stainless Steel will ensure the required design life is achieved. As universal column sections are used for the stoplogs, the resulting width of the gate is minimized. This reduces the amount of stainless steel plate required for the guides.

The stoplogs will be efficiently sealed using a graflon coated neoprene sealing system. This system minimizes wear, and allows for an effective seal between the stoplog and the stainless steel guides. Adjacent stoplog structures will have horizontal rubber seals, which will minimise water leakage allowing for better maintenance access.

The trash rack and screens for the turbines will be to the specification of the turbines supplier.

4.2.3 Inlet Structure

The inlet structure is designed to accommodate 14 inlet gates and operating mechanisms. A flexible pavement access road will run over the top of the structure at RL +7.50 m AHD. The invert level of the inlet structure has been set at RL -7.00 m AHD. The structure will be founded on a raft slab which is connected integrally to sheet piling which forms part of the temporary works. Whilst the below ground segments of the sheet piling will become part of the permanent structure, the above ground segments will be cut away once construction is completed. This will allow stability of the structure to be maintained, without additional works being required.

Vertical concrete walls will separate each gate and support the concrete box girder carrying earth fill, providing the weight necessary for maintaining stability.

The inlet structure has been designed using a marine grade S50 concrete, similar to the turbine structure for all areas. This will ensure a superior design life.

Corrosion protection will be afforded to permanent sheetpiling by a composite system which includes protective painting and cathodic protection.

The structure was designed using various dead, live and earthquake load cases utilizing a limit state approach, to ensure both global and local stability at all times.

4.2.4 Gates and Stoplogs

The stoplogs used in the inlet structure have been designed to provide a smooth, flat and easy to maintain surface. All steel structures will be appropriately coated to withstand the harsh marine environment. Sufficient stoplogs have been allowed to isolate one gate unit (one inlet and one outlet stoplog). These stoplogs are interchangeable with those in the outlet structure. The stoplogs used in the inlet structure are identical in concept to those used in the turbine house.

Again, grade 316 Stainless Steel guides are provided for all stoplog guides. These will eliminate concrete wear, and provide a smooth surface for the seals to be placed.

The gates are also identical in concept to the stoplogs. The main advantage in using this system for the gates is the smooth watertight surface provided. This allows for ease of maintenance and application of corrosion protection systems. Additionally, the air voids trapped within the structure allow for the buoyant weight of the gate to be reduced, minimizing lifting requirements in water.

The gates will operate in stainless steel guides, similar to those used for the stoplogs. The guide plates cast into the concrete will be of sufficient thickness to provide long term wear to ensure design life is achieved. Apart from providing a smooth surface for the seals to act, the guides will also provide a consistent surface for the gate rollers mechanism at each corner of the gate.

Gate seals will be provided along both sides of the gate and along the bottom of the gate. Gate seals are self-cleaning and no grooves will be cut into the base of the concrete. Gate seals will be elastomeric rubber with graflon coating to ensure enhanced resistance against abrasive wear. In addition, these seals will provide low friction loads allowing for a reduction in required hoist capacity

Polystone 7000 will be provided along both sides of the gate to ensure reduced frictional resistance against abrasive wear with the guides.

4.2.5 Outlet Structure

In order to streamline maintenance requirements, and economies of scale, the design used in the outlet structure, including stoplogs, gates and sheet piling is identical to that outlined for the Inlet Structure.

The invert level of the outlet gates are set at RL -10.0 m AHD. The top of the structure is RL +7.50m AHD.

4.3 Transition Walls

Transition walls will be constructed to provide side connections of the Inlet and Outlet Structures and the Turbine Structure with the barrages or levees.

These walls will consist of diaphragm concrete walls, cast in-situ walls with precast concrete props that tie the two walls together. The thicknesses of the walls will depend on their retaining heights and range between 600 mm and 1000 mm in thickness.

4.4 Barrages

4.4.1 General

The main section of the North-East Barrage will be approximately 5,500 m long and the West Barrage will be approximately 550 m long.

4.4.2 West Barrage

The West Barrage will extend across the west channel of Doctor's Creek from the western bank of the High Basin channel up to the start of the inlet gates. For the barrage embankment details refer to Section 3.2.2. Transition walls will connect the inlet structure with the barrage on the west side and to the manmade island on the east side. In order to ensure adequate erosion protection around the inlet gates slopes of 1V:3H are maintained around the transition walls.

4.4.3 North-East Barrage

The North-East barrage is similar to the West Barrage. For a description of the barrage embankment refer to Section 3.2.3.

4.5 Levees

4.5.1 West and East Levees

The crest level of the levees is RL +6.40 m AHD. For a description of the levee bank refer to Section 3.3.

4.5.2 Temporary Works

In order to provide a clear working area for the construction of both the inlet and outlet structures and the turbine structure one large earth fill coffer dam will be constructed around the structures so that construction can proceed unhindered. The earth fill material will be sourced from the material excavated for the construction of the gates and turbine structures.

4.6 Corrosion Protection

4.6.1 Coatings to steel gates

All steel gates will be coated in accordance with the following:

- 1st coat - epoxy zinc phosphate primer – 75 um
- 2nd coat - ultra high build epoxy – 1000 um
- 3rd coat – re-coatable acrylic – 60 um

This protection system is designed in conjunction with the gate design, which provides a smooth plate surface for ease of recoating. In addition, the gates are designed for ease of removal at major maintenance intervals.

4.6.2 Steel reinforcing in concrete structures

Steel reinforcing in concrete structures will be welded to ensure the system is electrically continuous throughout. Reinforcing will be further welded to adjacent sheet piles in accordance with drawing notes to provide an electrically continuous structure. Although designed concrete structures do not initially require cathodic protection, welding throughout will allow a cathodic protection system to be installed at any time in the future in order to protect the reinforcement.

4.6.3 Cathodic Protection

Sheet pile structures directly exposed to salt water will be provided with Impressed Current Cathodic Protection in accordance with the requirements of Australian Standard AS2832. Sacrificial anodes shall be sized for a design life of 15 years.

CP units will be designed to maintain the voltage on the structure between -800 mV and -1050 mV under all operating and tidal conditions. CP units shall be sized to supply adequate polarising current at initial operation and subsequently following any interruption to the operation of the system.

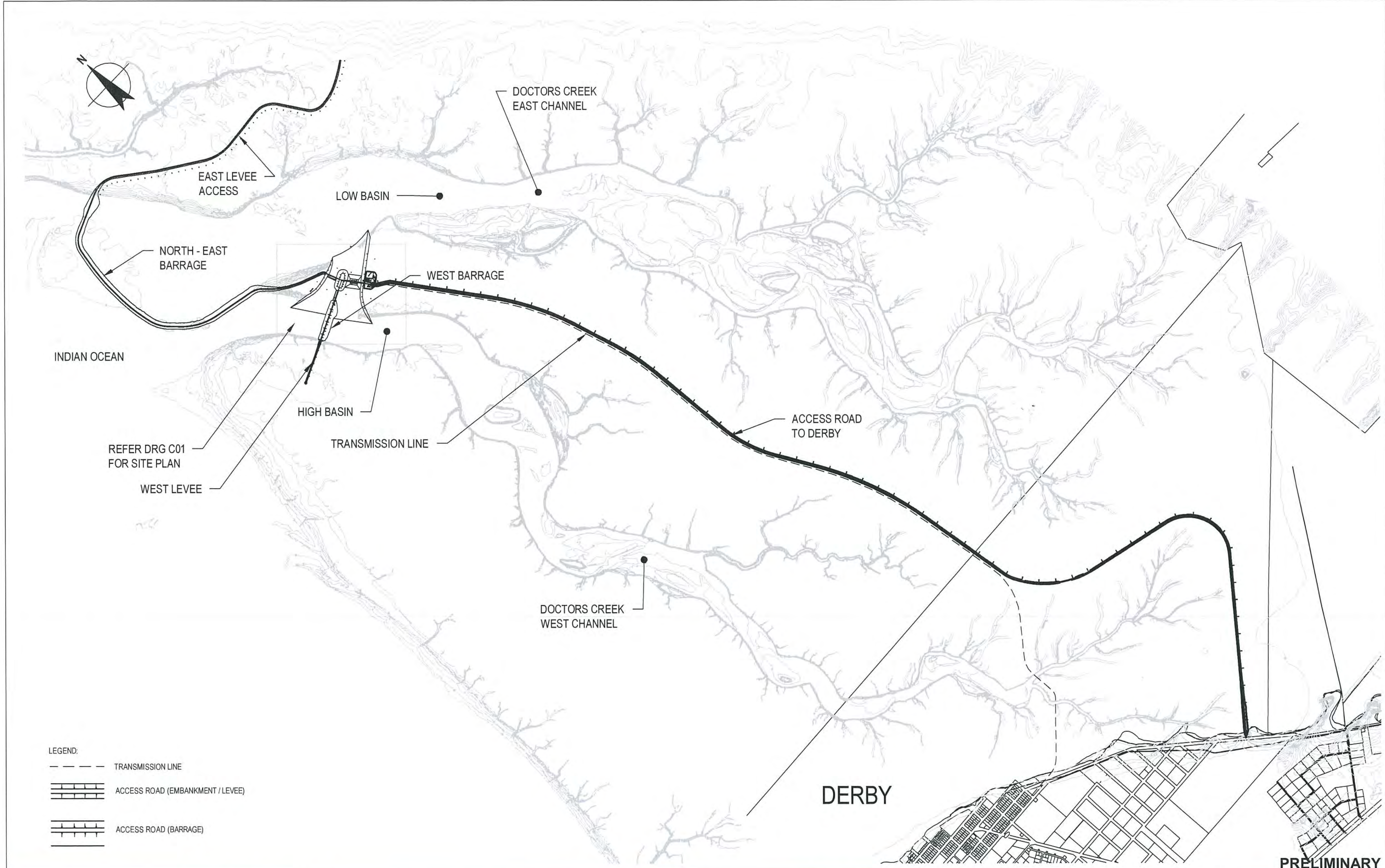
The system will include computerised monitoring and database facilities to provide ongoing corrosion management, including logging of operating/condition data.

All concrete structures exposed to salt water shall be designed for the future application of Galvanic Cathodic Protection in accordance with the requirements of AS2832.

4.7 Optimisation

Further considerations will be given in determining the final alignment of the north-east barrage and east levee to establish a more cost effective structure asit appears likely that cost savings can be achieved. However, reducing the length of the barrage by constructing it along the shortest route across the east channel would also reduce the capacity of the Low Basin. Further modelling should be carried out to evaluate what impact the change would have on the power production of the scheme.

Appendix A
Drawings



PRELIMINARY

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Note: * indicates signatures on original issue of drawing or last revision of drawing

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SCALE 1:50,000 AT ORIGINAL SIZE

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Drafting Check		Design Check	
Approved (Project Director) Date	21/06/2012		
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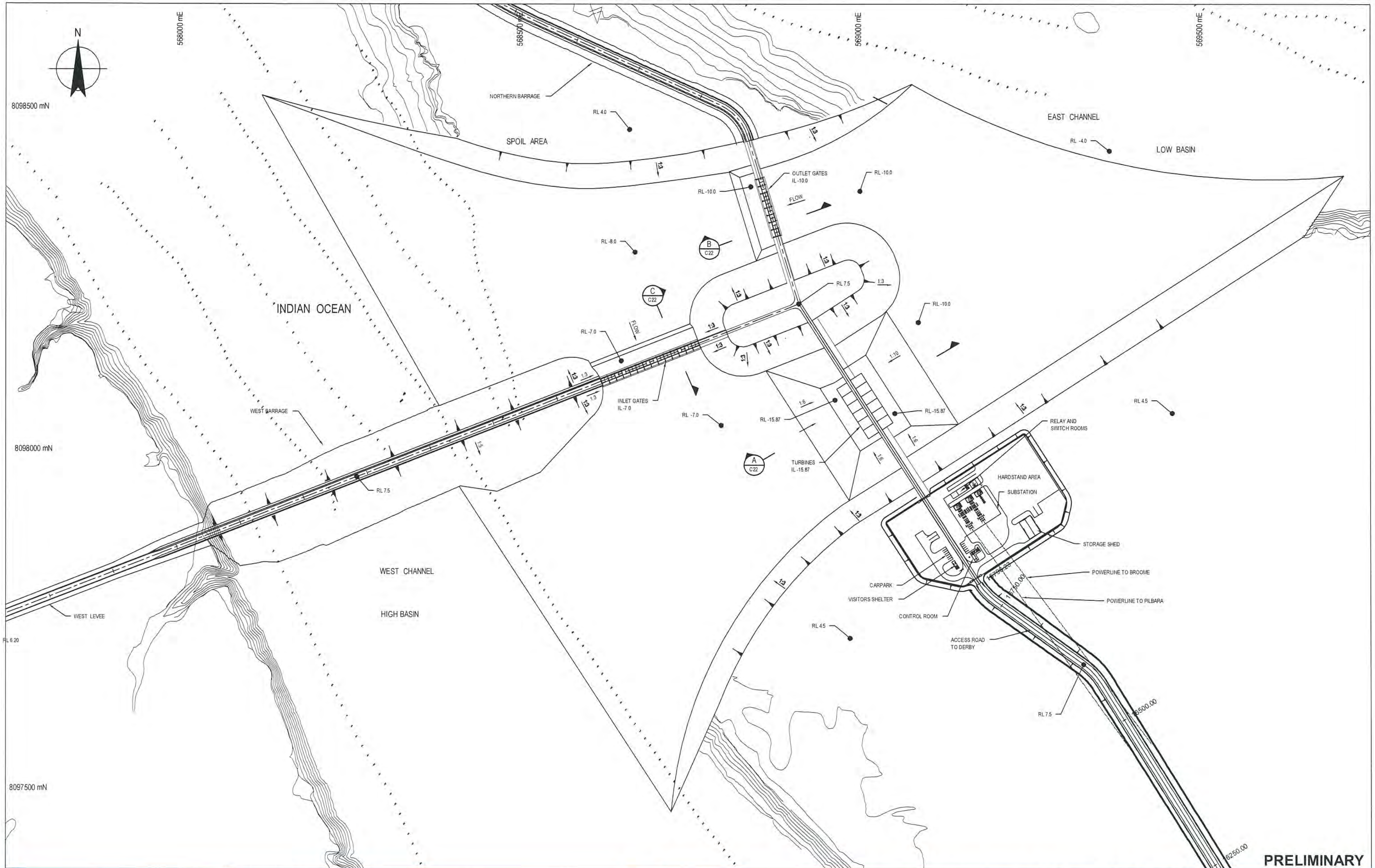
Client **TEA INVESTMENT No.1**

Project **DERBY HYDO POWER PROJECT**

Title **LOCALITY PLAN GENERAL ARRANGEMENT**

Original Size A1 **Drawing No: 61-27947-G01** **Rev: B**

Plot Date: 20 June 2012 - 12:57 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-G01_REV B.dwg



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Design Check	
Approved (Project Director)	
Date	21/06/2012
Scale	1:2500

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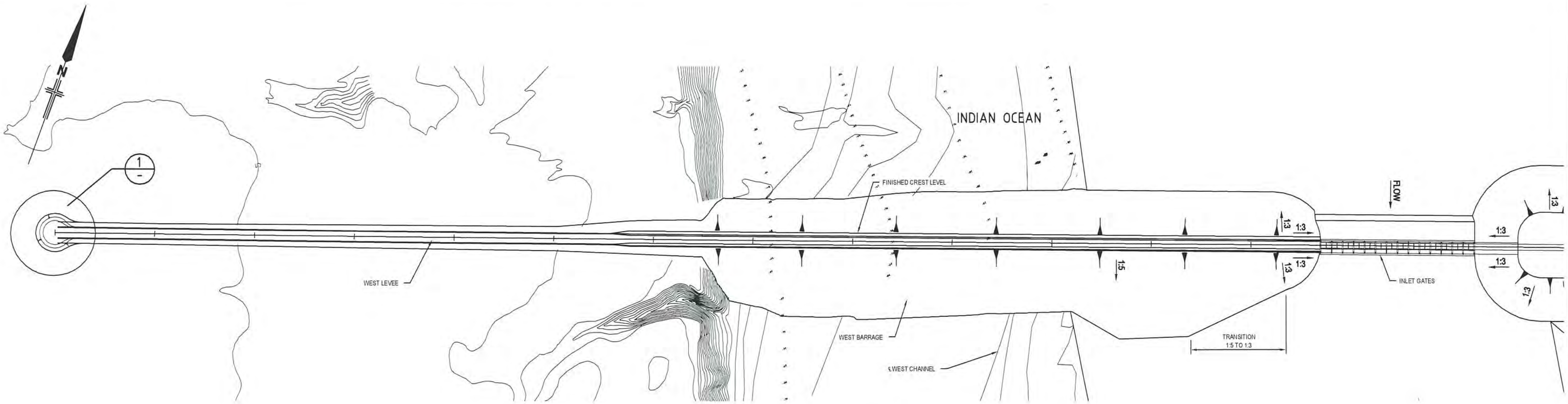
Client: **TEA INVESTMENT NO.1**
Project: **DERBY TIDAL POWER PROJECT**
Title: **SITE LAYOUT GENERAL ARRANGEMENT**

Original Size: A1 **Drawing No: 61-27947-C01** **Rev: A**

Plot Date: 20 June 2012 - 12:33 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C01.dwg



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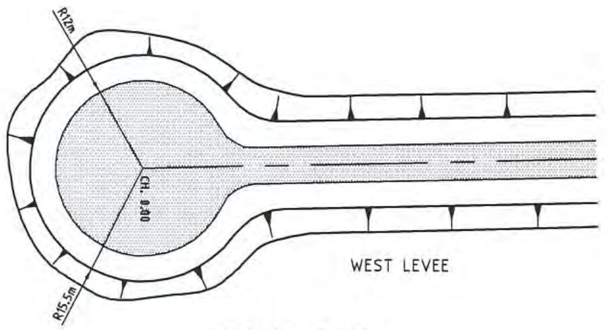

TURNING CIRCLE
DETAIL 1 / –
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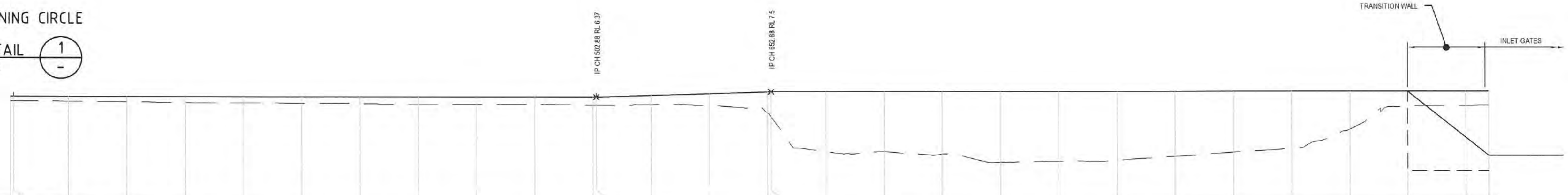

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CHAINAGE (m)	0.00	2.88	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00	502.88
GRADE							0						
HORIZ. CURVE DATA													

MIN. FINISHED CREST LEVEL (AHD)	6.722	7.100	7.478	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500
NATURAL SURFACE LEVEL (AHD)	4.74	4.53	2.99	2.10	-5.37	-5.40	-5.92	-7.68	-7.43	-7.31	-6.41	-5.59	-4.78	-0.62	4.29	4.48	
CHAINAGE (m)	550.00	600.00	650.00	652.88	700.00	750.00	800.00	850.00	900.00	950.00	1000.00	1050.00	1100.00	1150.00	1200.00	1250.00	1269.49
GRADE	0.76									0							
HORIZ. CURVE DATA																	

LONGITUDINAL SECTION
HORZ 1:2000 VERT 1:500

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date

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Drafting Check EDM | Design Check
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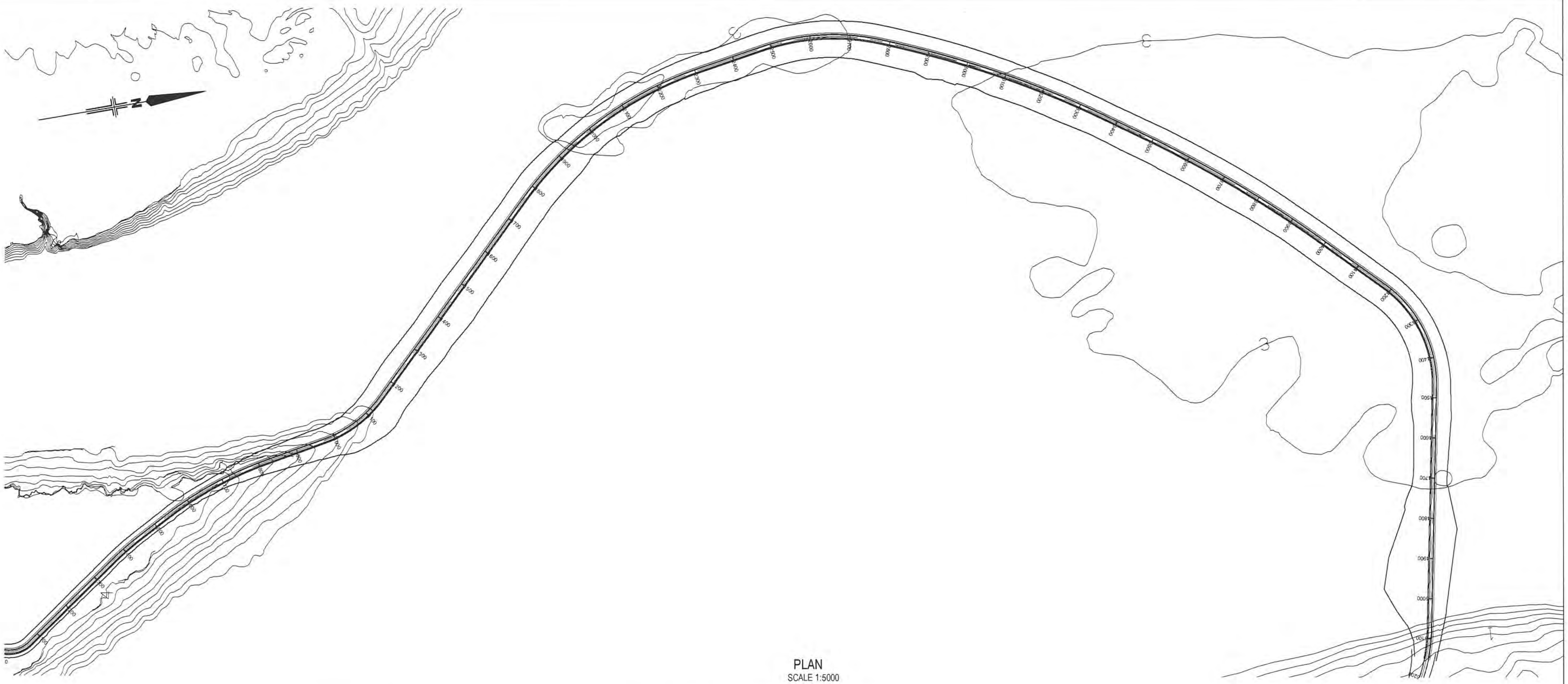
Client TEA INVESTMENT NO.1
Project DERBY TIDAL POWER PROJECT
Title WEST BARRAGE EMBANKMENT AND LEVEE PLAN AND LONGITUDINAL SECTION

Original Size A1 | Drawing No: 61-27947-C02 | Rev: A

Plot Date: 20 June 2012 - 12:34 PM | Plotted by: Mark Bozikovic | Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C02.dwg



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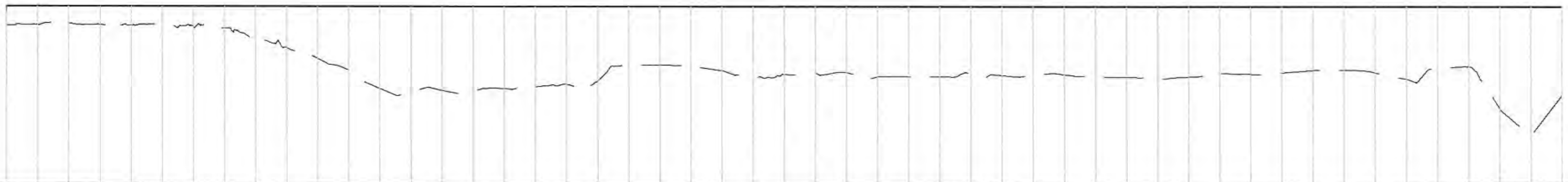

DATUM RL. -21.00

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400.00	7.500	4.54
500.00	7.500	4.52
600.00	7.500	4.23
700.00	7.500	4.00
800.00	7.500	2.29
900.00	7.500	0.80
1000.00	7.500	-0.85
1100.00	7.500	-2.68
1200.00	7.500	-5.62
1300.00	7.500	-6.16
1400.00	7.500	-5.93
1500.00	7.500	-6.02
1600.00	7.500	-5.60
1700.00	7.500	-5.33
1800.00	7.500	-4.94
1900.00	7.500	-4.36
2000.00	7.500	-1.93
2100.00	7.500	-1.84
2200.00	7.500	-1.99
2300.00	7.500	-2.72
2400.00	7.500	-3.62
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2700.00	7.500	-3.06
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4000.00	7.500	-3.30
4100.00	7.500	-3.06
4200.00	7.500	-2.68
4300.00	7.500	-2.61
4400.00	7.500	-3.06
4500.00	7.500	-4.07
4600.00	7.500	-2.34
4700.00	7.500	-2.10
4800.00	7.500	-8.80
4900.00	7.500	-13.09
5000.00	7.500	-6.70

GRADE: 0

HORIZ. CURVE DATA: -75.00m; 750.00m; 900.00m; -300.00m; 900.00m; 550.00m; 2500.00m; 3000.00m; 300.00m

LONGITUDINAL SECTION
HORZ 1:10000 VERT 1:500

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date

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Approved (Project Director)		Date	21/06/2012
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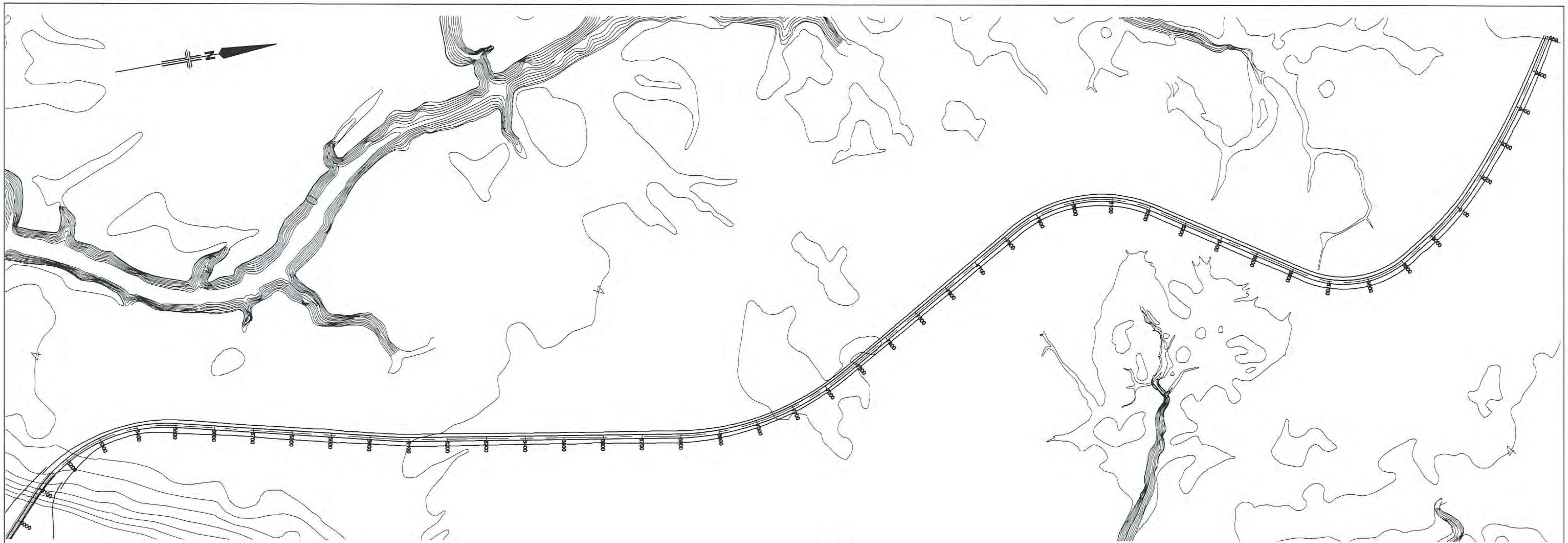
Client **TEA INVESTMENT No.1**
Project **DERBY TIDAL POWER PROJECT**
Title **NORTH & EAST BARRAGE EMBANKMENT & LEVEE PLAN & LONGITUDINAL SECTION SHEET 1 OF 2**

Original Size **A1** **Drawing No: 61-27947-C03** **Rev: A**

Plot Date: 20 June 2012 - 12:35 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C03.dwg



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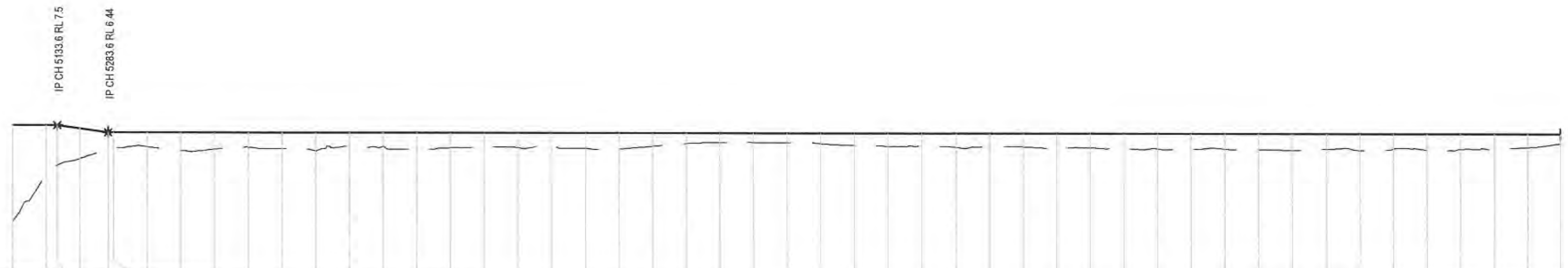

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MIN. FINISHED CREST LEVEL (AHD)	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440
NATURAL SURFACE LEVEL (AHD)	4.43	4.40	4.00	4.19	4.31	4.29	4.40	4.16	4.06	4.47	4.89	5.02
CHAINAGE (m)	6000.00	6100.00	6200.00	6300.00	6400.00	6500.00	6600.00	6700.00	6800.00	6900.00	7000.00	7100.00

MIN. FINISHED CREST LEVEL (AHD)	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440
NATURAL SURFACE LEVEL (AHD)	5.06	5.00	4.90	4.72	4.53	4.61	4.38	4.57	4.47	4.27	4.36	4.24
CHAINAGE (m)	7200.00	7300.00	7400.00	7500.00	7600.00	7700.00	7800.00	7900.00	8000.00	8100.00	8200.00	8300.00

MIN. FINISHED CREST LEVEL (AHD)	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440	6.440
NATURAL SURFACE LEVEL (AHD)	4.19	4.12	4.17	4.05	4.01	4.16	4.01	4.23	4.06	4.16	4.17	4.46	5.08
CHAINAGE (m)	8400.00	8500.00	8600.00	8700.00	8800.00	8900.00	9000.00	9100.00	9200.00	9300.00	9400.00	9500.00	9595.70

GRADE: 0 | -0.71 | 0

HORIZ. CURVE DATA: 400.00m | -700.00m | 350.00m | -250.00m | -680.00m | -1800.00m

LONGITUDINAL SECTION - DAM
HORZ 1:10000 VERT 1:500

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

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Date 21/06/2012
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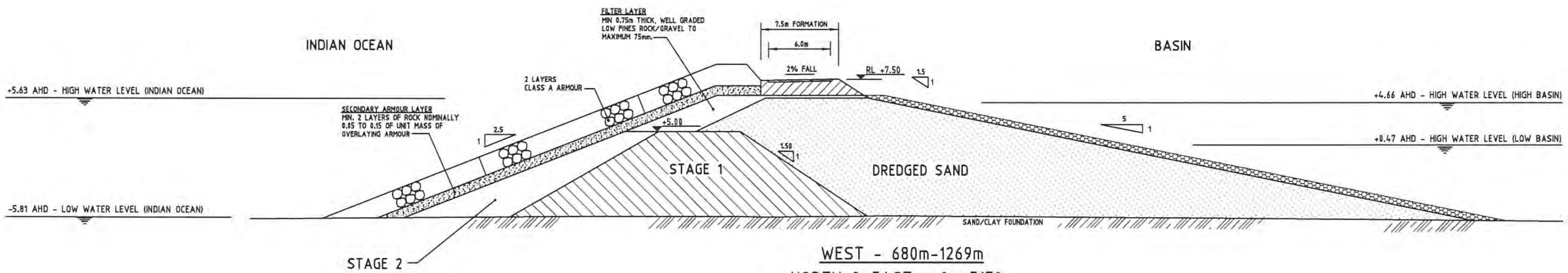
Client **TEA INVESTMENT No.1**
Project **DERBY TIDAL POWER PROJECT**
Title **NORTH & EAST BARRAGE EMBANKMENT & LEVEE PLAN & LONGITUDINAL SECTION SHEET 2 OF 2**

Original Size A1
Drawing No: **61-27947-C04**
Rev: A

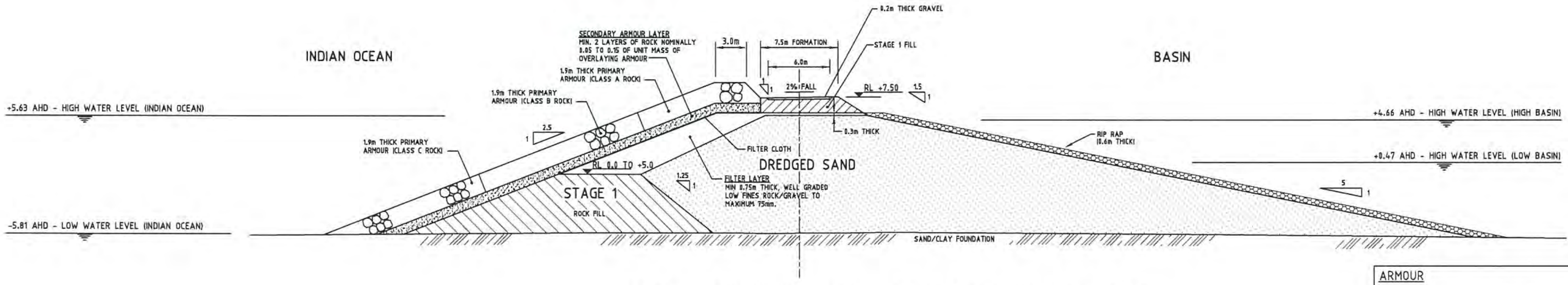
Plot Date: 20 June 2012 - 12:35 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C04.dwg



WEST - 680m-1269m

NORTH & EAST - 0m-5150m

SECTION B (C03&04)



GENERAL SECTION OVER CLAY WITH GRAVEL/SAND ON SURFACE

WEST - 580m-680m

SECTION C (C03&04)

NOTE:
FILTER CLOTH TO BE LAID FROM 0.5m BELOW MINIMUM WATER LEVEL OF RL -5.81 AHD.

ARMOUR	
CLASS A	1.5 - 2.5 TONNE ROCK
CLASS B	1.0 - 2.0 TONNE ROCK
CLASS C	0.25 - 1.0 TONNE ROCK
STAGE 1	300mm ALL IN ROCK FILL
STAGE 2	75mm MAXIMUM WELL GRADED GRAVEL

(ASSUMING ARMOUR ROCK SG2.25)
(SEAWATER SATURATED)

RIP RAP

HIGH BASIN

RL -1.0 TO RL +5.5 = HARD ROCK RIP RAP FROM QUARRY (?kg TO ?kg)
ABOVE RL +5.5 = CORE ROCK FROM PENINSULA (?kg TO ?kg)

LOW BASIN

RL -6.0 TO RL +1.0 = HARD ROCK RIP RAP FROM QUARRY (?kg TO ?kg)
ABOVE RL +1.0 = CORE ROCK FROM PENINSULA (?kg TO ?kg)

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Date
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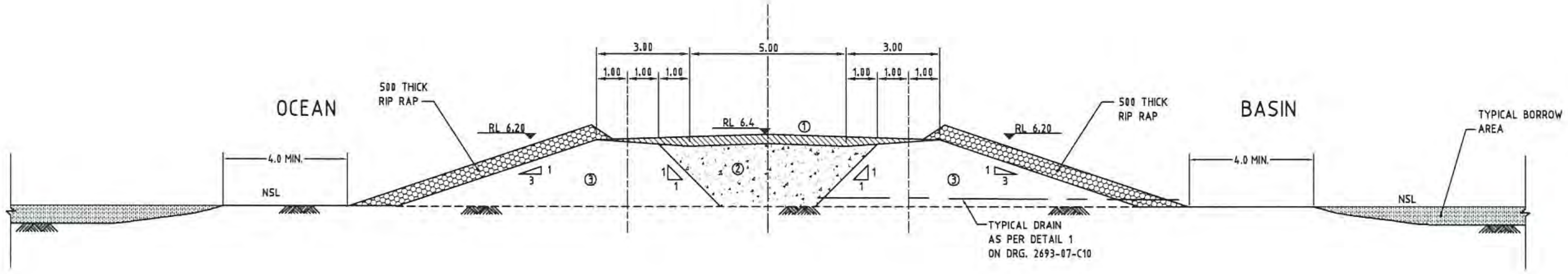
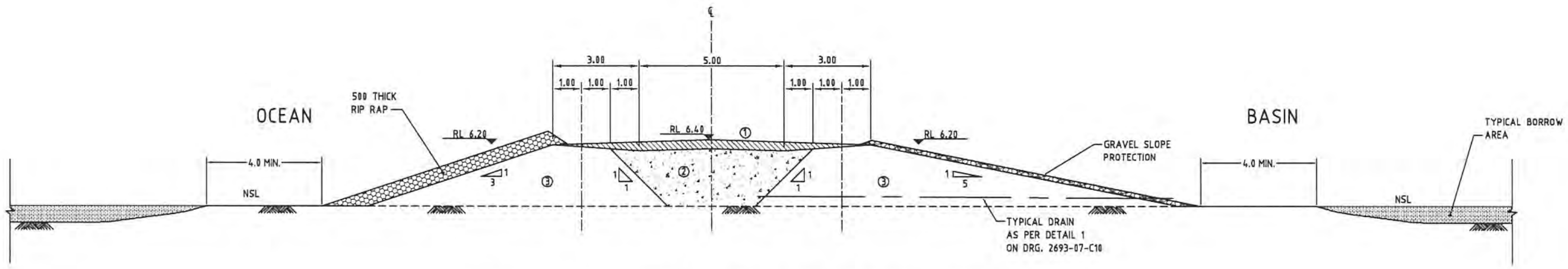
Client **TEA INVESTMENT NO.1**
Project **DERBY TIDAL POWER PROJECT**
Title **BARRAGE EMBANKMENT EARTHWORKS TYPICAL SECTIONS AND DETAILS**

Original Size A1 | **Drawing No: 61-27947-C05** | **Rev: A**

Plot Date: 20 June 2012 - 12:36 PM | Plotted by: Mark Bozikovic | Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C05.dwg



TYPICAL SECTION - 0m-580.0m WEST LEVEE



TYPICAL SECTION - NORTH & EAST LEVEE 5150.0m-9595.7m

1 OPTION 1 - 2 AS DREDEGED SAND WITH 150 THICK COMPACTED GRAVEL

1 OPTION 2 - 2 AS SHIRE PIT SAND WITH 200 THICK COMPACTED GRAVEL

1 OPTION 3- 2 AS PINDAN SAND WITH 400 THICK COMPACTED GRAVEL

3 COMPACTED SILTY/CLAY BORROWED FROM BASIN OR APPROVED BORROW PIT

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
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0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

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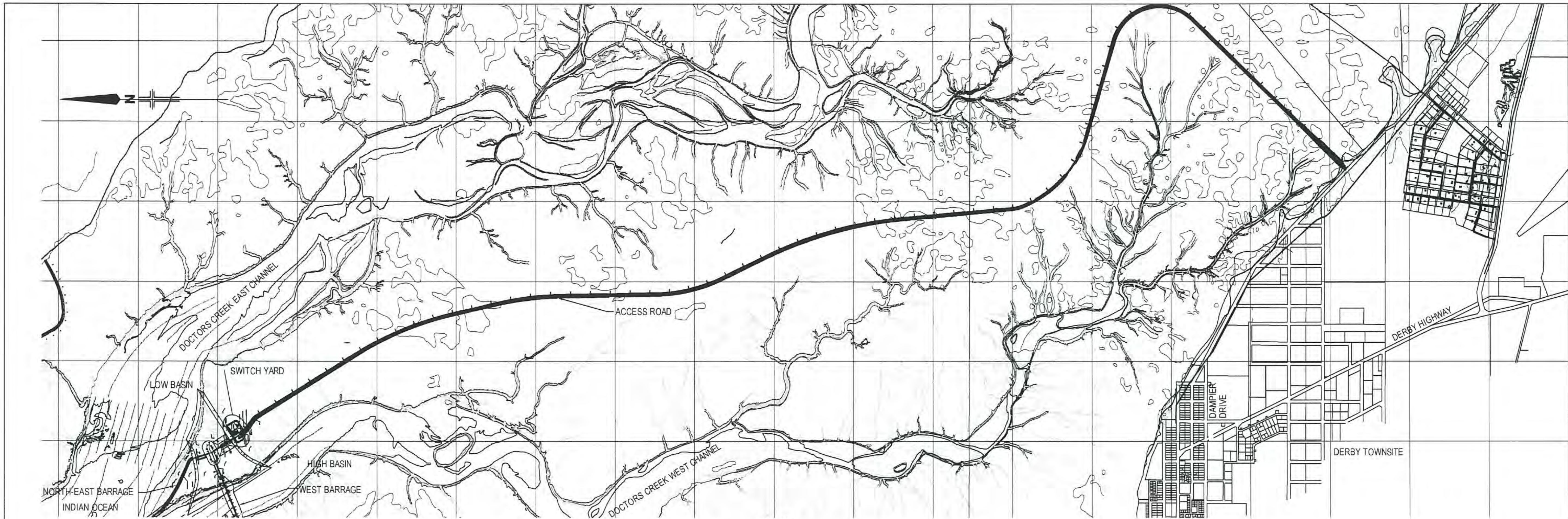
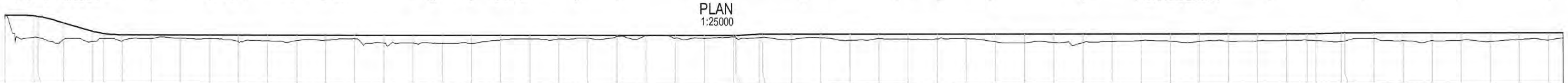
Client **TEA INVESTMENT No 1**
Project **DERBY TIDAL POWER PROJECT**
Title **LEVEE EARTHWORKS TYPICAL SECTIONS AND DETAILS**

Original Size A1 | **Drawing No: 61-27947-C06** | **Rev: A**

Plot Date 20 June 2012 - 12:36 PM Plotted by Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C06.dwg



PLAN
1:25000



DATUM RL. -5.00

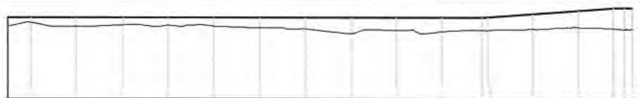
VERTICAL CURVE: VC 300, 1501.17 K; VC 300, 1501.17 K

CHAINAGE (m)	MIN. FINISHED CREST LEVEL (AHD)	NATURAL SURFACE LEVEL (AHD)
0.00	10.00	10.00
250.00	9.84	5.21
285.32	9.72	5.15
500.00	8.39	4.78
750.00	6.55	4.31
845.61	6.08	5.00
1000.00	5.80	4.42
1250.00	5.80	4.99
1500.00	5.80	5.07
1750.00	5.80	5.00
2000.00	5.80	4.31
2250.00	5.80	4.53
2500.00	5.80	4.62
2750.00	5.80	4.70
3000.00	5.80	5.03
3250.00	5.80	4.08
3500.00	5.80	4.08
3750.00	5.80	4.00
4000.00	5.80	4.00
4250.00	5.80	4.80
4500.00	5.80	5.00
4750.00	5.80	5.00
5000.00	5.80	5.19
5250.00	5.80	5.50
5500.00	5.80	5.68
5750.00	5.80	5.17
6000.00	5.80	5.12
6250.00	5.80	5.44
6269.52	5.80	5.36
6469.52	6.00	5.28
6500.00	6.00	5.36
6750.00	6.00	4.90
7000.00	6.00	5.26
7250.00	6.00	4.70
7500.00	6.00	5.08
7750.00	6.00	4.99
8000.00	6.00	5.00
8250.00	6.00	5.00
8500.00	6.00	4.37
8750.00	6.00	4.11
9000.00	6.00	4.22
9250.00	6.00	4.19
9500.00	6.00	4.40
9750.00	6.00	4.63
10000.00	6.00	4.48
10250.00	6.00	4.40
10500.00	6.00	4.45
10750.00	6.00	4.52
11000.00	6.00	4.60
11178.12	6.00	4.67
11250.00	6.05	4.58
11469.52	6.20	4.37
11500.00	6.20	4.50
11750.00	6.20	5.00
12000.00	6.20	4.54
12250.00	6.20	4.55
12500.00	6.20	4.61
12750.00	6.20	4.34
13000.00	6.20	4.76
13250.00	6.20	4.67

JOINS LINE A

GRADE: 0% | -0.75% | 0% | 0.1% | 0% | 0.07%

HORIZ. CURVE DATA: -600.00m | 1350.00m | 500.00m | -5000.00m | 2000.00m | -4000.00m



DATUM RL. -5.00

JOINS LINE A

VERTICAL CURVE

CHAINAGE (m)	MIN. FINISHED CREST LEVEL (AHD)	NATURAL SURFACE LEVEL (AHD)
13500.00	6.20	5.57
13750.00	6.20	5.00
14000.00	6.20	5.22
14250.00	6.20	5.17
14500.00	6.20	5.00
14750.00	6.20	4.80
15000.00	6.20	4.68
15250.00	6.20	4.02
15500.00	6.20	4.50
15750.00	6.20	4.32
15969.52	6.20	4.49
16000.00	6.26	4.46
16250.00	6.70	4.66
16500.00	7.15	4.87
16693.10	7.50	4.70
16750.00	7.50	4.58
16796.23	7.50	4.62

GRADE: 0% | 0.18% | 0

HORIZ. CURVE DATA: -4000.00m | -100.00m | 100.00m

LOGITUDINAL SECTION
1:20000 H 1:500 V

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
B	MAIN ACCESS ROAD ROUTE CHANGED	MB	NP		6/2012

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 200 400 600 800 1000m SCALE 1:20,000 AT ORIGINAL SIZE

0 5 10 15 20 25m SCALE 1:500 AT ORIGINAL SIZE

0 250 500 750 1000 1250m SCALE 1:25,000 AT ORIGINAL SIZE

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0 0.05 0.1 0.15 0.2 0.25m SCALE 1:5 AT ORIGINAL SIZE

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Client **TEA INVESTMENT No1**
Project **DERBY TIDAL POWER PROJECT**
Title **MAIN ACCESS ROAD PLAN AND LONGITUDINAL SECTION**

Original Size A1 **Drawing No: 61-27947-C07** **Rev: B**

Plot Date: 20 June 2012 - 12:37 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C07_REV B.dwg

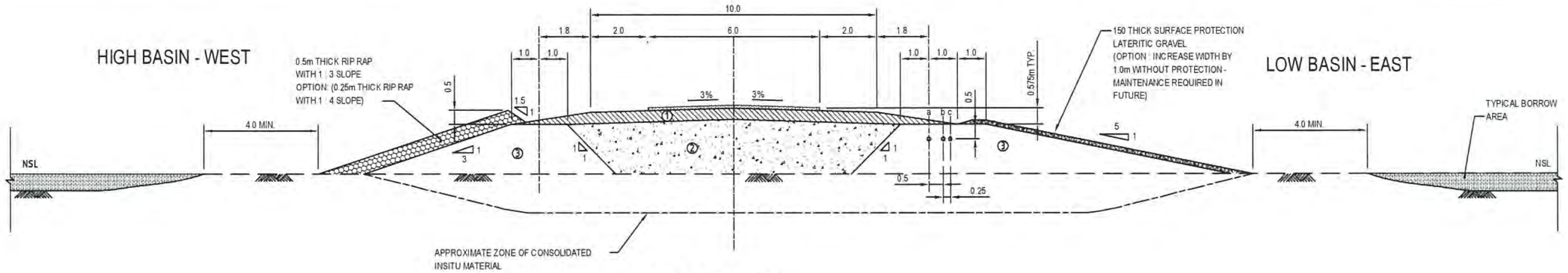
① OPTION 1 - ② AS DREDEGED SAND WITH 150 THICK COMPACTED GRAVEL

① OPTION 2 - ② AS SHIRE PIT SAND WITH 200 THICK COMPACTED GRAVEL

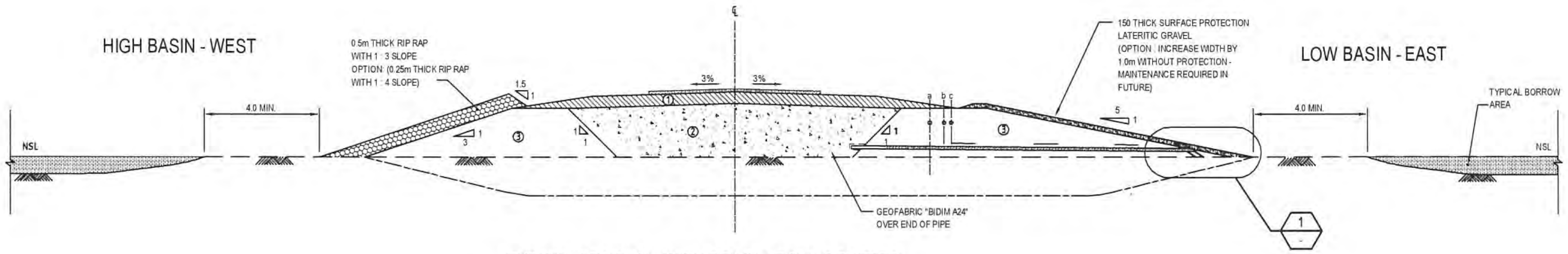
① OPTION 3- ② AS PINDAN SAND WITH 400 THICK COMPACTED GRAVEL

③ COMPACTED SILTY/CLAY BORROWED FROM BASIN OR APPROVED BORROW PIT

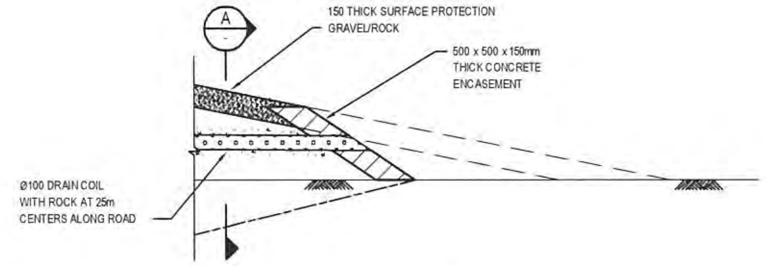
a WATER SUPPLY PIPE
b TELSTRA TELEPHONE CABLE
c CONTROL COMMUNICATION CABLE



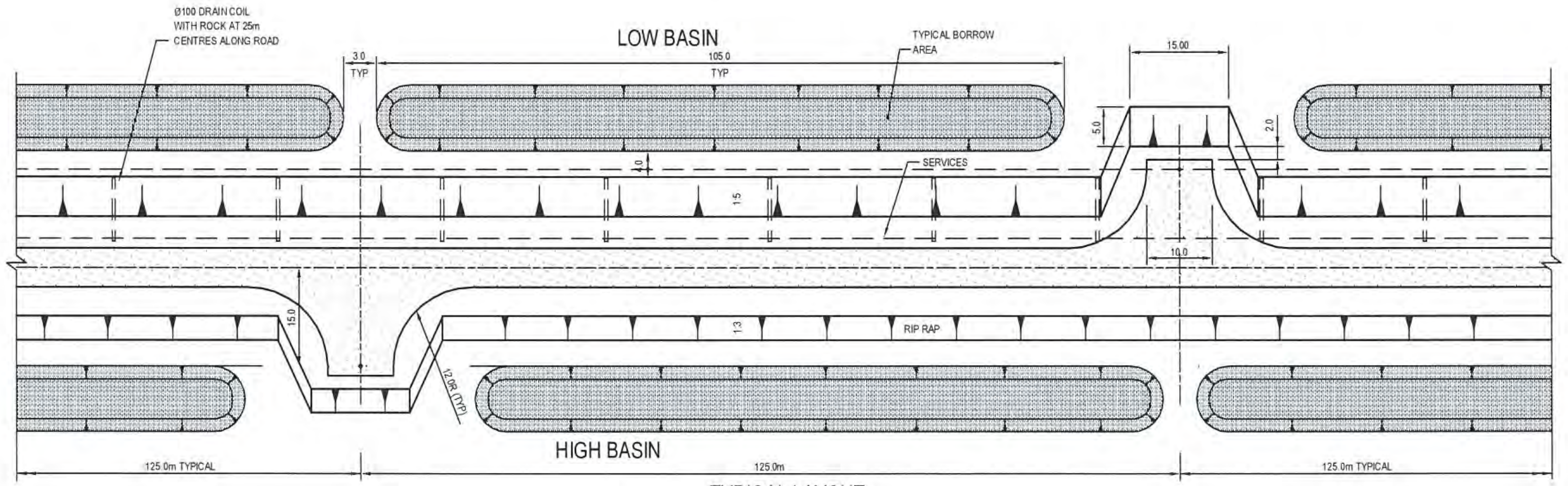
TYPICAL SECTION
SCALE 1:100



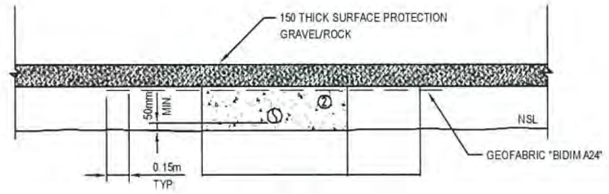
TYPICAL SECTION - WITH DRAIN AT 25m CENTRES
SCALE 1:100



1 DETAIL
SCALE 1 : 25



TYPICAL LAYOUT
SCALE 1:500



A SECTION
SCALE 1 : 25

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
B	ROAD CULVERT DELETED	MB	NP		6/2012

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 1 2 3 4 5m — SCALE 1:100 AT ORIGINAL SIZE

0 5 10 15 20 25m — SCALE 1:500 AT ORIGINAL SIZE

0 250 500 750 1000 1250mm — SCALE 1:25 AT ORIGINAL SIZE

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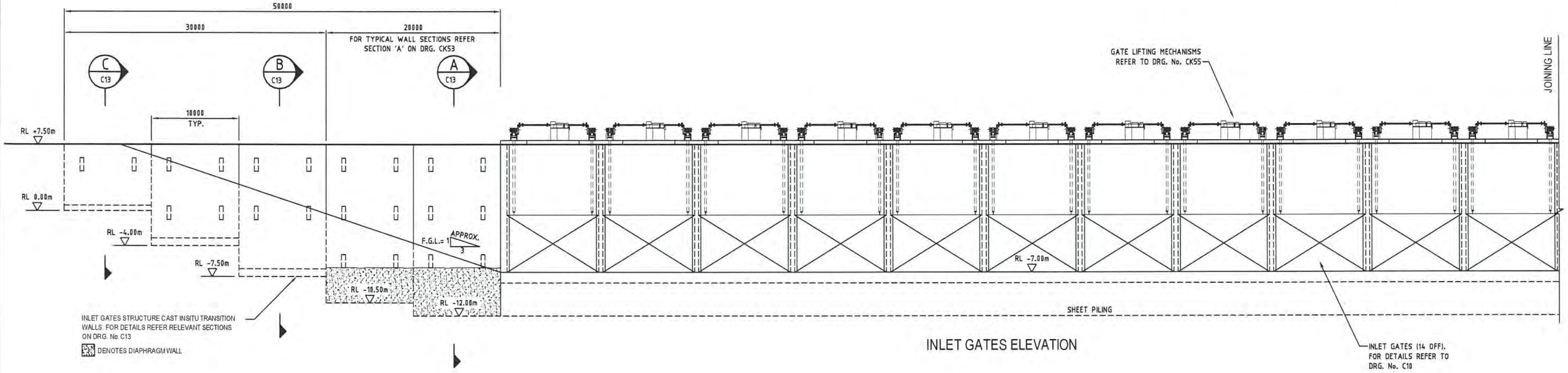
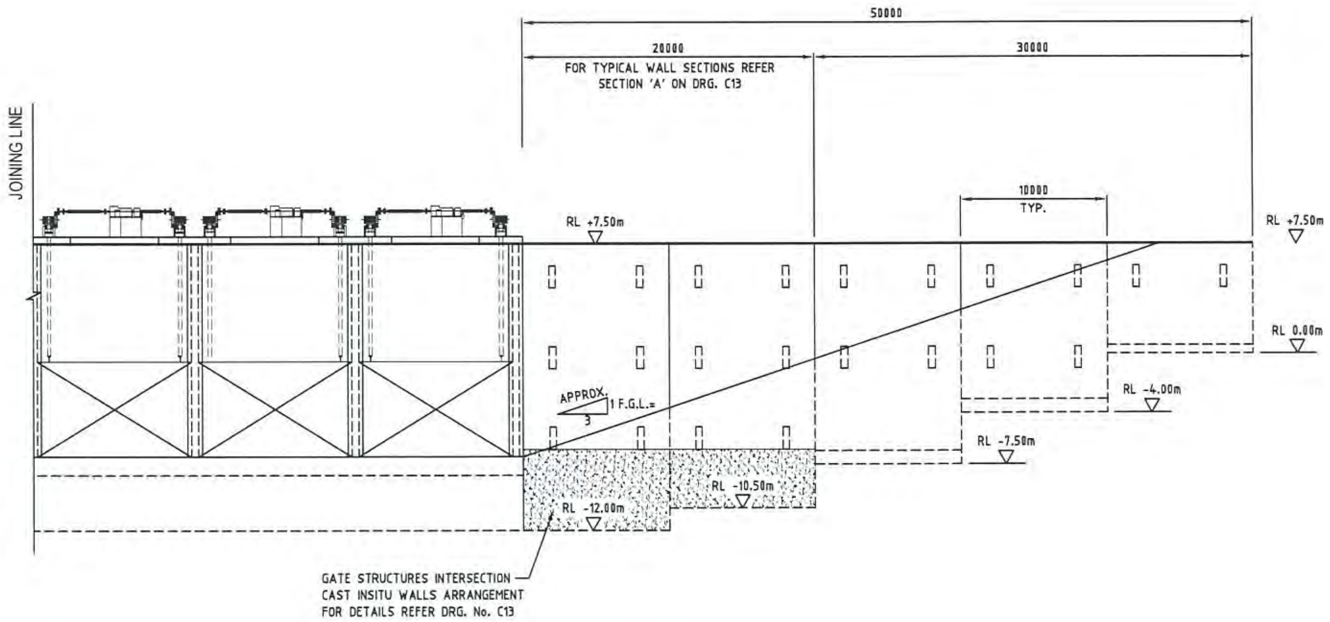
Client **TEA INVESTMENT No 1**
Project **DERBY TIDAL POWER PROJECT**
Title **MAIN ACCESS ROAD TYPICAL SECTIONS AND DETAILS**

Original Size A1 — Drawing No: **61-27947-C08** — Rev: **B**

Plot Date: 20 June 2012 - 12:38 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C08_REV B.dwg



INLET GATES ELEVATION



PRELIMINARY

No	Revision Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 2500 5000 7500 10000 12500mm
SCALE 1:250 AT ORIGINAL SIZE

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Approved (Project Director)			
Date	21/06/2012		
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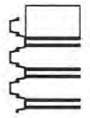
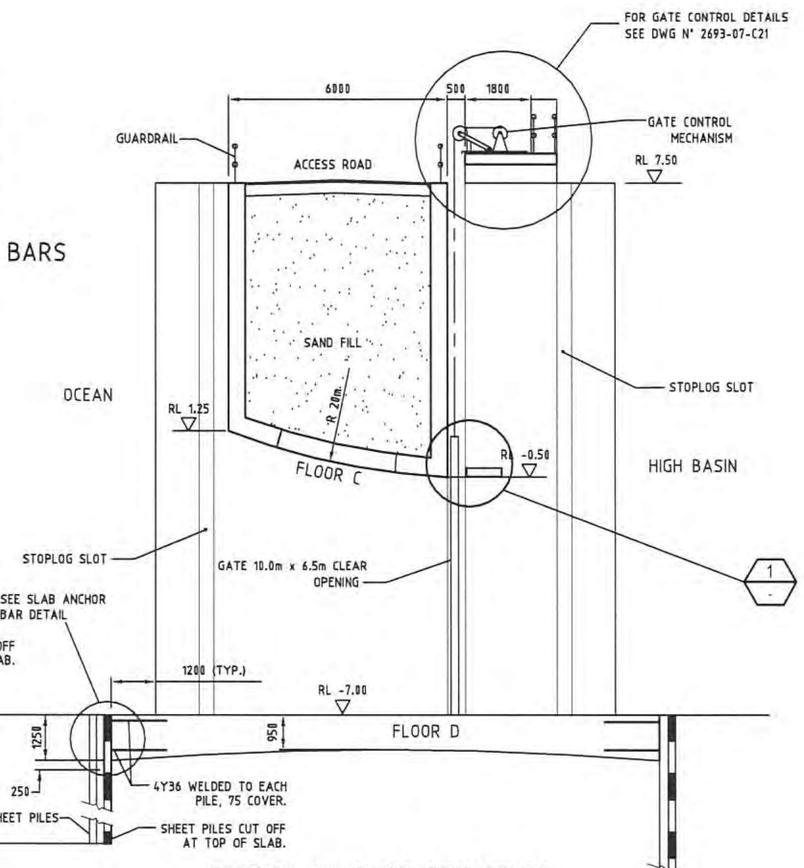
Client **TEA INVESTMENT No 1**
Project **DERBY TIDAL POWER PROJECT**
Title **INLET GATES STRUCTURES ELEVATIONS**

Original Size **A1** **Drawing No: 61-27947-C09** **Rev: A**

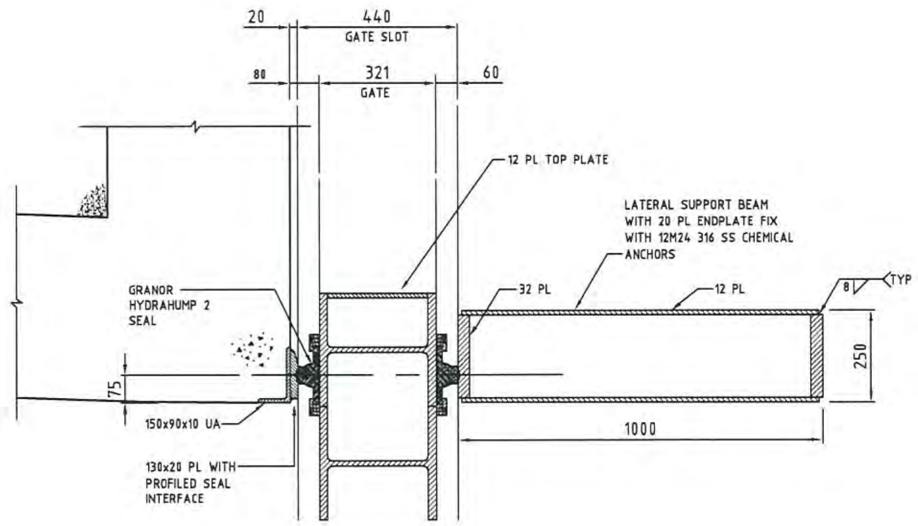
Plot Date: 20 June 2012 - 12:38 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C09.dwg



PLAN
SLAB ANCHOR BARS



SECTION ON INLET STRUCTURE
1:100



DETAIL 1 GATE TOP SEAL DETAIL
1:10

REINFORCEMENT TABLE

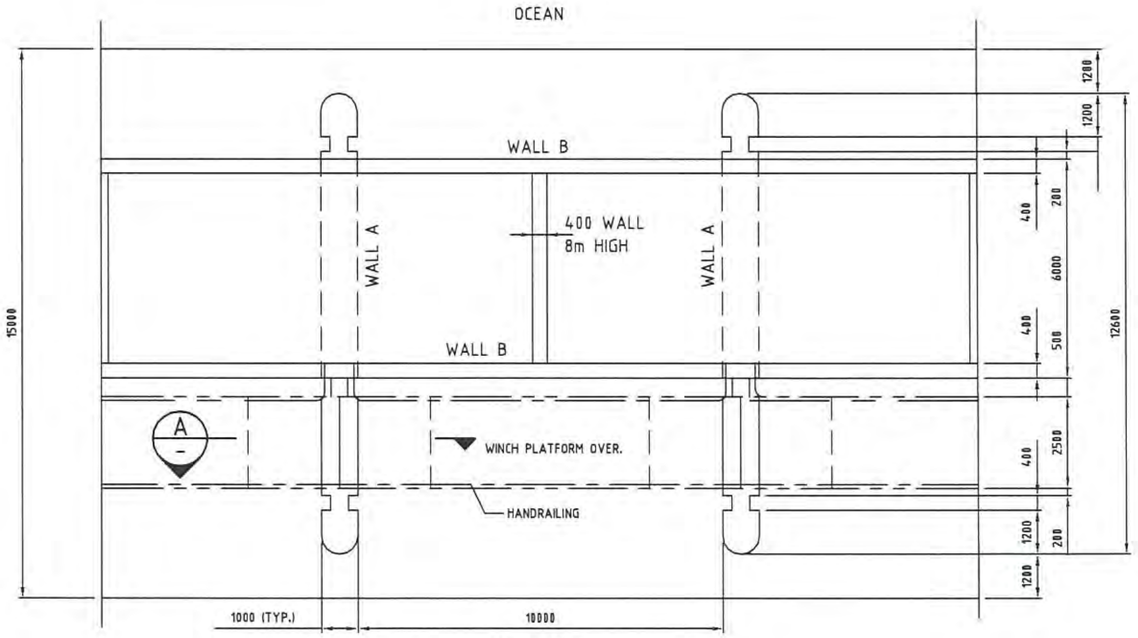
LOCATION	REINFORCEMENT
WALL A	M.O.S.: 175 kg/m³
WALL B	M.O.S.: 200 kg/m³
FLOOR C	M.O.S.: 200 kg/m³
FLOOR D	M.O.S.: 175 kg/m³
FLOOR E	M.O.S.: 200kg/m³
PRECAST WINCH PLATFORM SUPPORT SLAB	M.O.S.: 165kg/m³
PRECAST WINCH PLATFORM SLAB	M.O.S.: 110 kg/m³

KEY:

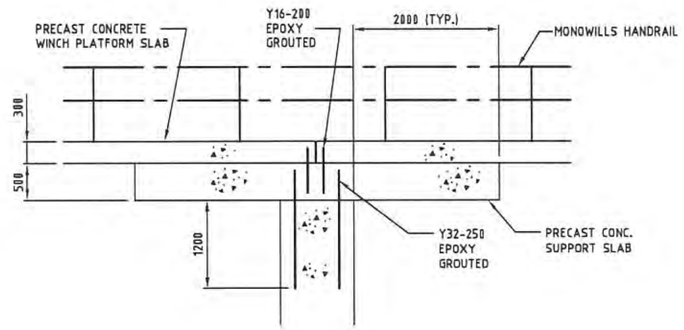
M.O.S. : MASS OF STEEL PER CUBIC METRE OF CONCRETE.

ROAD TRAFFIC CONDITIONS:

CRANE LOAD 25 TONNE OR 30 TONNE AXLE LOAD



TYPICAL PLAN VIEW
1:100



SECTION A
1:50

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

SCALE 1:10 AT ORIGINAL SIZE (0 100 200 300 400 500mm)

SCALE 1:20 AT ORIGINAL SIZE (0 200 400 600 800 1000mm)

SCALE 1:50 AT ORIGINAL SIZE (0 500 1000 1500 2000 2500mm)

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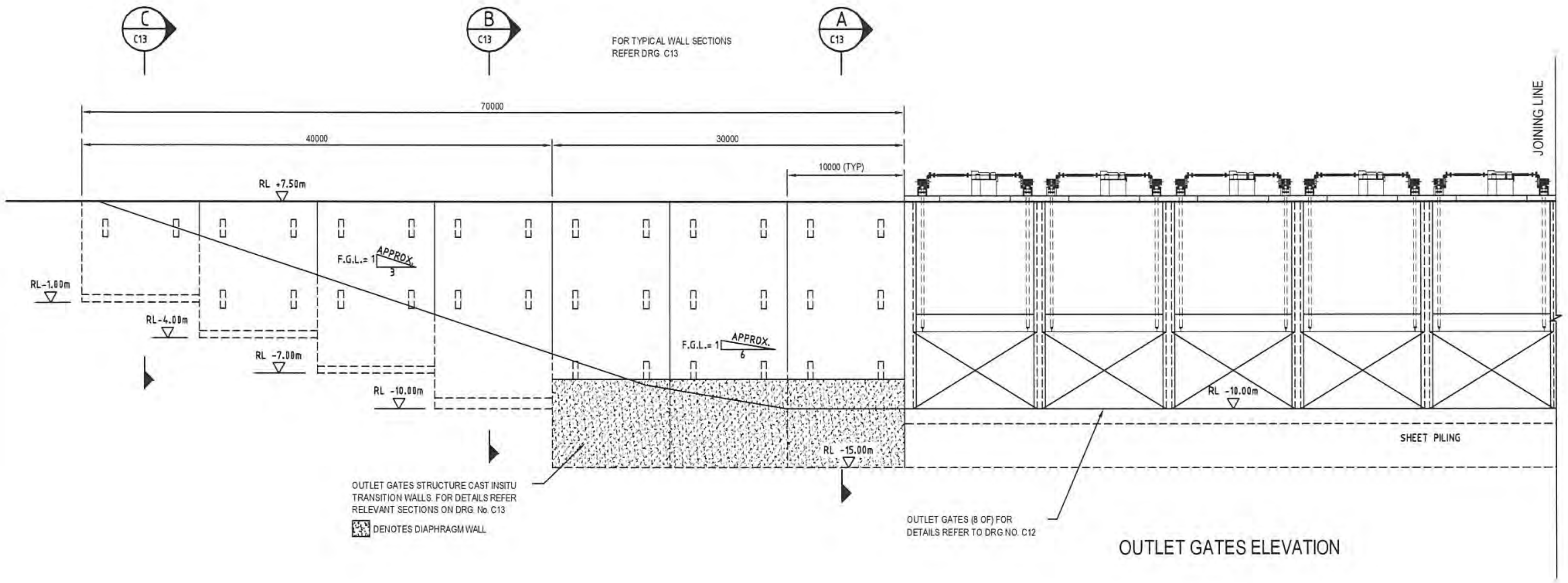
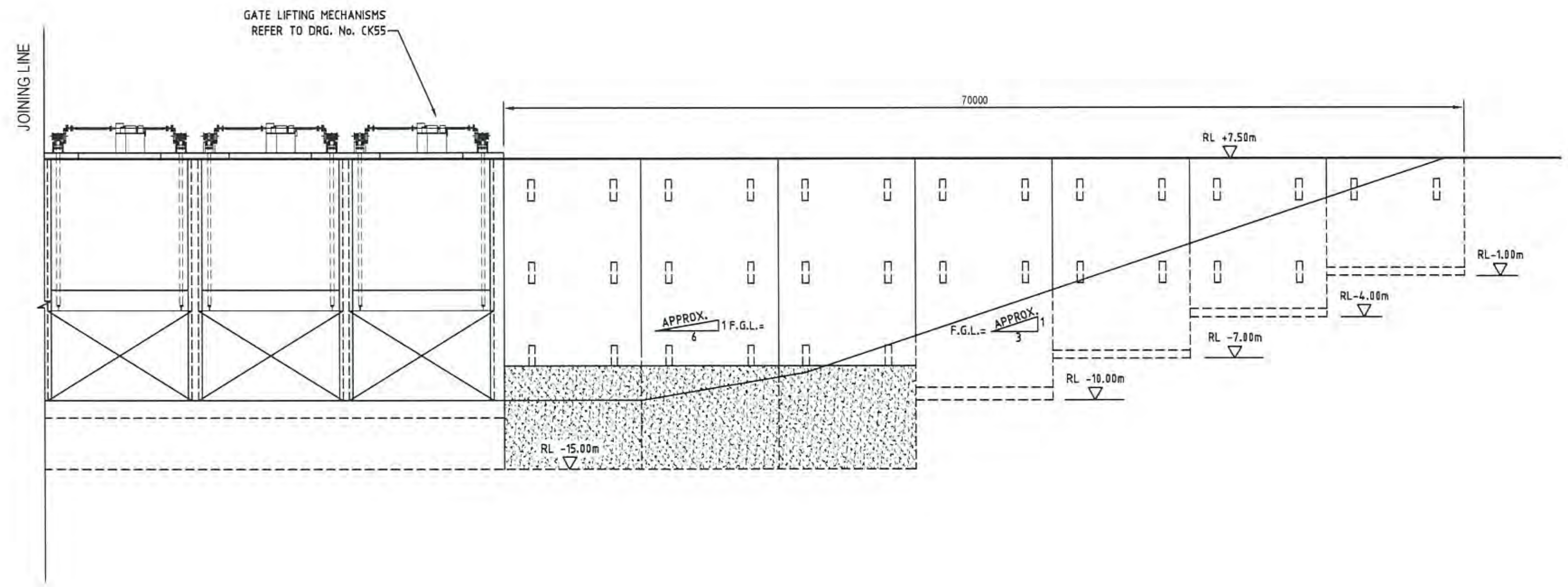
Client: TEA INVESTMENT No 1
Project: DERBY TIDAL POWER PROJECT
Title: INLET GATES STRUCTURE HIGH BASIN LAYOUT, SECTIONS & DETAILS

Original Size A1 | Drawing No: 61-27947-C10 | Rev: A

Plot Date: 20 June 2012 - 12:39 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C10.dwg



OUTLET GATES ELEVATION



PRELIMINARY

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0 2500 5000 7500 10000 12500mm

SCALE 1:250 AT ORIGINAL SIZE

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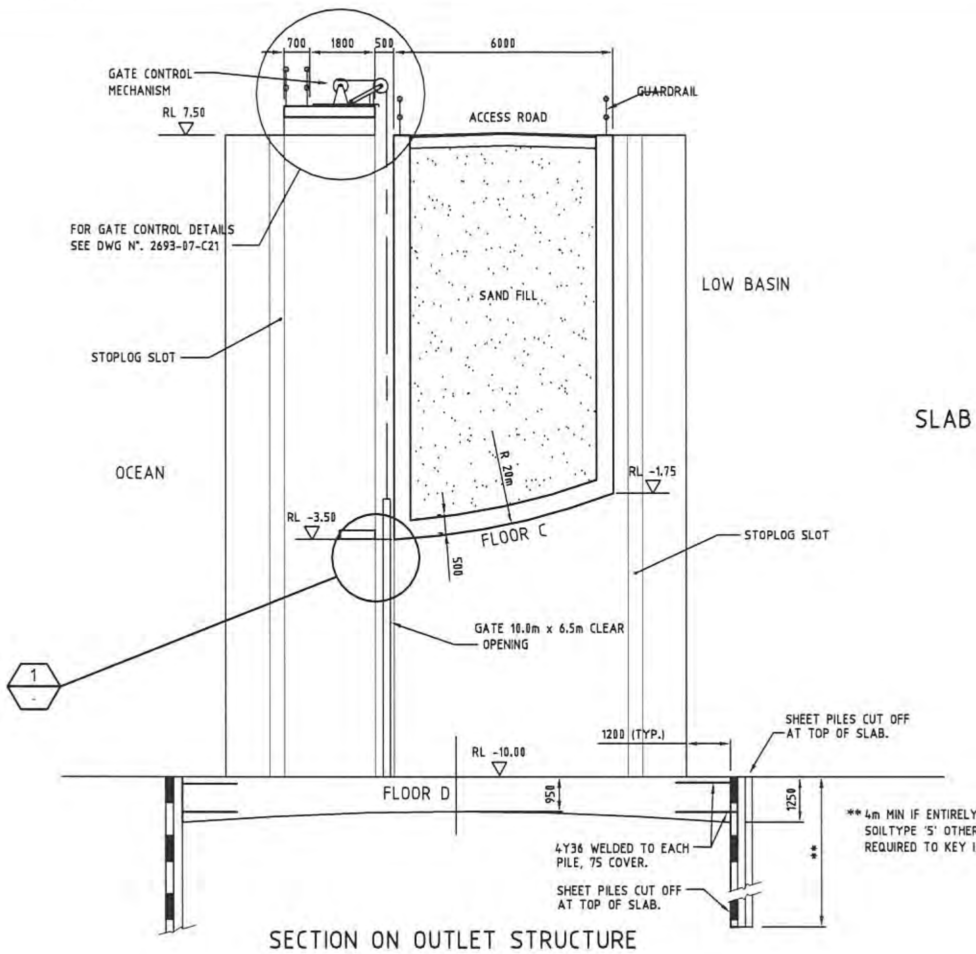
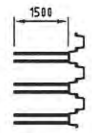
Drafting Check	Design Check	Project	**DERBY TIDAL POWER PROJECT**
Approved (Project Director) Date	21/06/2012	Title	**OUTLET GATES STRUCTURE ELEVATION**
Scale AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	Original Size A1	**Drawing No: 61-27947-C11** Rev: A

Plot Date: 20 June 2012 - 12:39 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C11.dwg



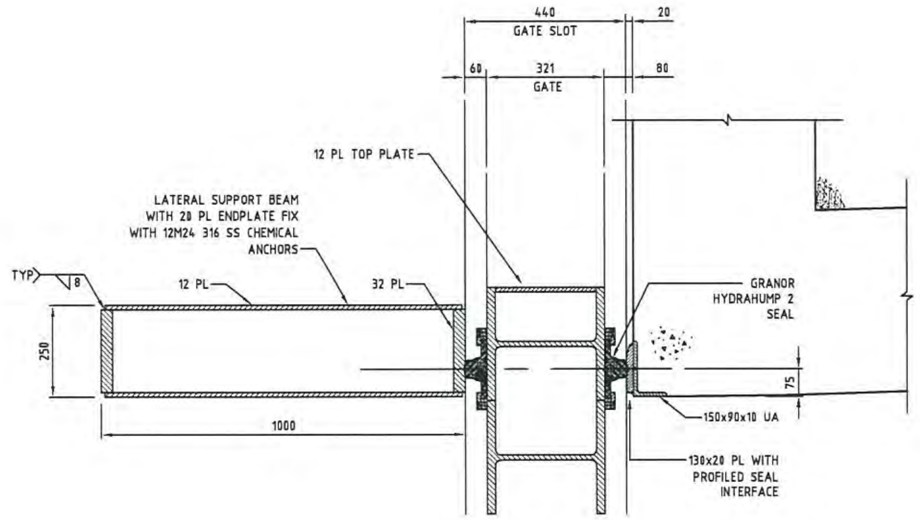
SECTION ON OUTLET STRUCTURE

1:100



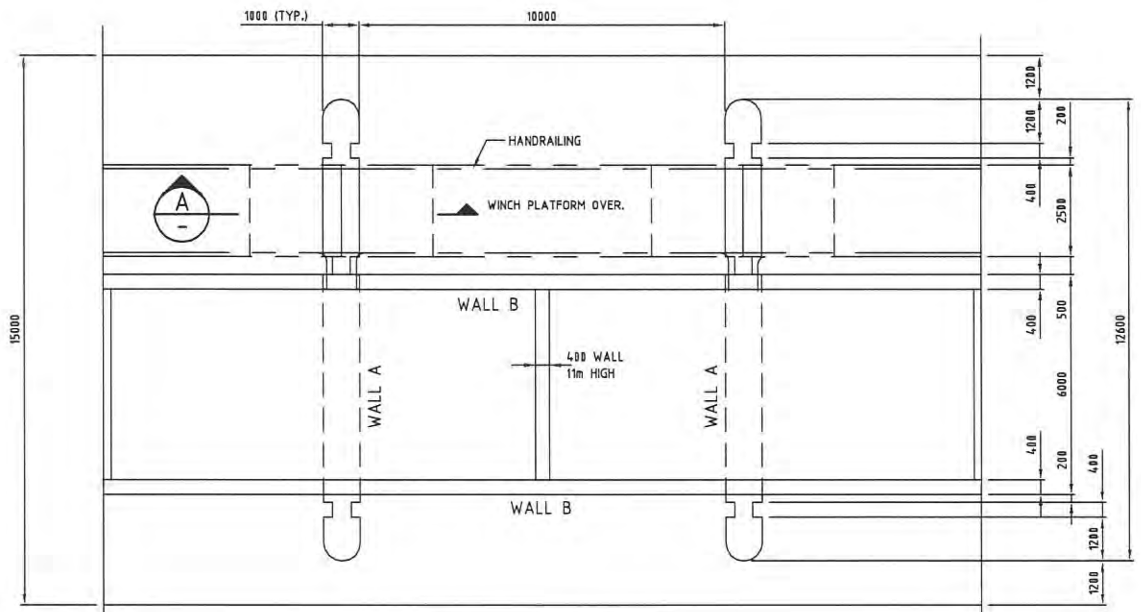
PLAN

SLAB ANCHOR BARS



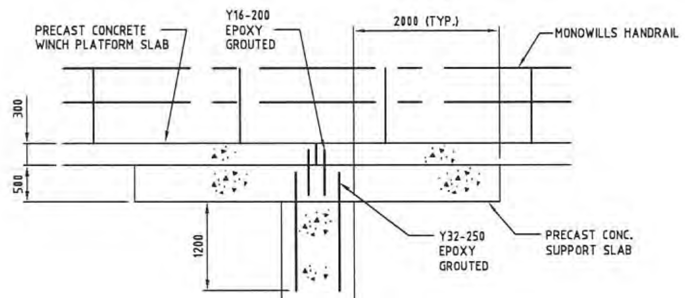
GATE TOP SEAL DETAIL 1 DETAIL

1:10



TYPICAL PLAN VIEW

1:100



SECTION A

1:50

REINFORCEMENT TABLE

LOCATION	REINFORCEMENT
WALL A	M.O.S.: 175 kg/m³
WALL B	M.O.S.: 200 kg/m³
FLOOR C	M.O.S.: 200 kg/m³
FLOOR D	M.O.S.: 175 kg/m³
FLOOR E	M.O.S.: 200 kg/m³
PRECAST WINCH PLATFORM SUPPORT SLAB	M.O.S.: 165kg/m³
PRECAST WINCH PLATFORM SLAB	M.O.S.: 110 kg/m³

KEY:

M.O.S. : MASS OF STEEL PER CUBIC METRE OF CONCRETE.

ROAD TRAFFIC CONDITIONS:

CRANE LOAD 25 TONNE OR 30 TONNE AXLE LOAD

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 250 500 750 1000 1250mm SCALE 1:25 AT ORIGINAL SIZE

0 500 1000 1500 2000 2500mm SCALE 1:50 AT ORIGINAL SIZE

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Design Check
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Date 21/06/2012
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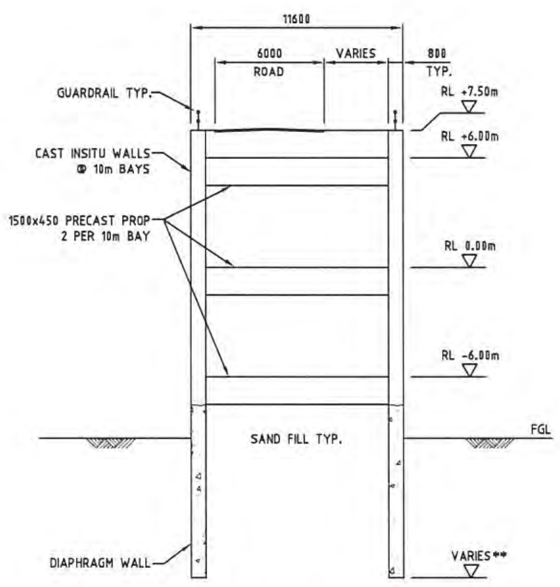
Client TEA INVESTMENT No 1
Project DERBY TIDAL POWER PROJECT
Title OUTLET GATES STRUCTURE LOW BASIN LAYOUT, SECTIONS & DETAILS

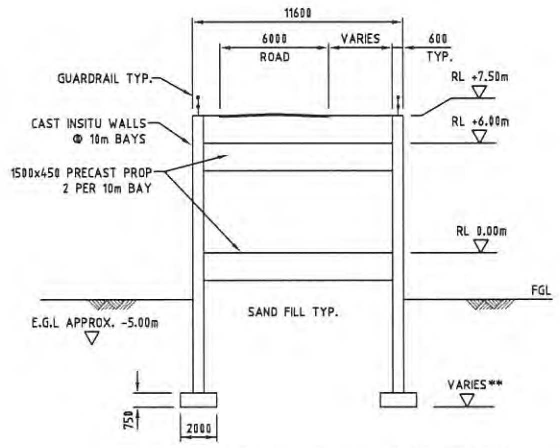
Original Size A1 Drawing No: 61-27947-C12 Rev: A

Plot Date: 20 June 2012 - 12:40 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C12.dwg



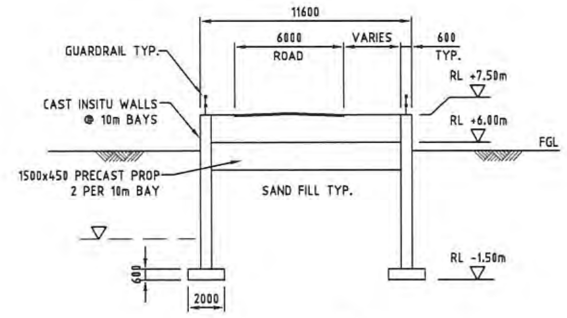
SECTION A (C09 & C11)

**FOR LEVELS REFER TO ELEVATIONS



SECTION B (C09 & C11)

**FOR LEVELS REFER TO ELEVATIONS



SECTION C (C09 & C11)

REINFORCEMENT TABLE	
LOCATION	REINFORCEMENT
ALL DIAPHRAGM WALLS	M.O.S.: 175 kg/m³
ALL CAST INSITU WALLS	M.O.S.: 140 kg/m³
ALL CAST INSITU BASES	M.O.S.: 125 kg/m³
ALL PROPS	M.O.S.: 140 kg/m³

KEY:
M.O.S. : MASS OF STEEL PER CUBIC METRE OF CONCRETE.

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Scale 1:200
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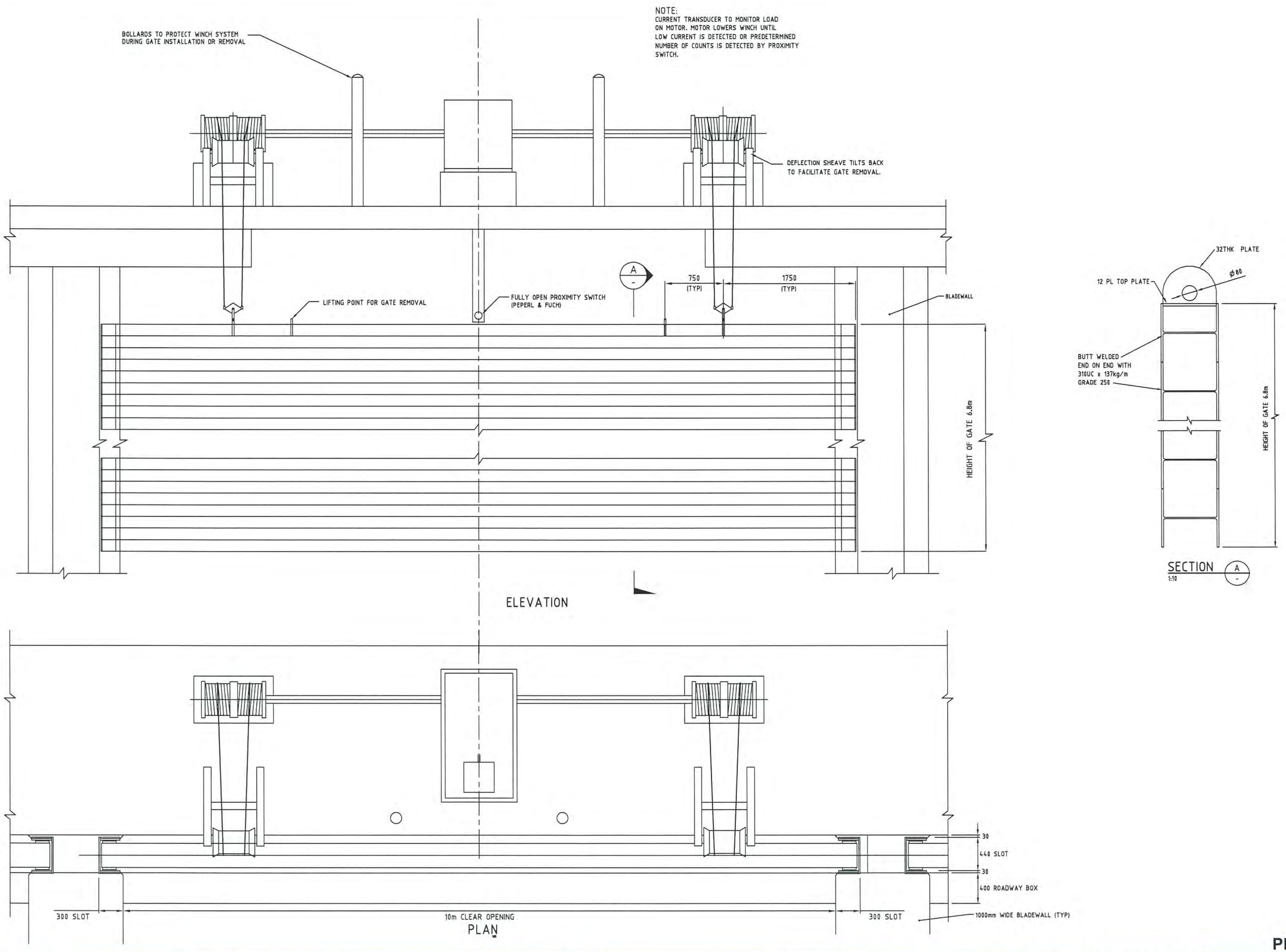
Client **TEA INVESTMENT No1**
Project **DERBY TIDAL POWER PROJECT**
Title **GATES STRUCTURES SIDE TRANSITION WALL TYPICAL SECTIONS & DETAILS**

Original Size A1 **Drawing No: 61-27947-C13** **Rev: A**

Plot Date: 20 June 2012 - 12:40 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C13.dwg



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No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

0 250 500 750 1000 1250mm
SCALE 1:25 AT ORIGINAL SIZE

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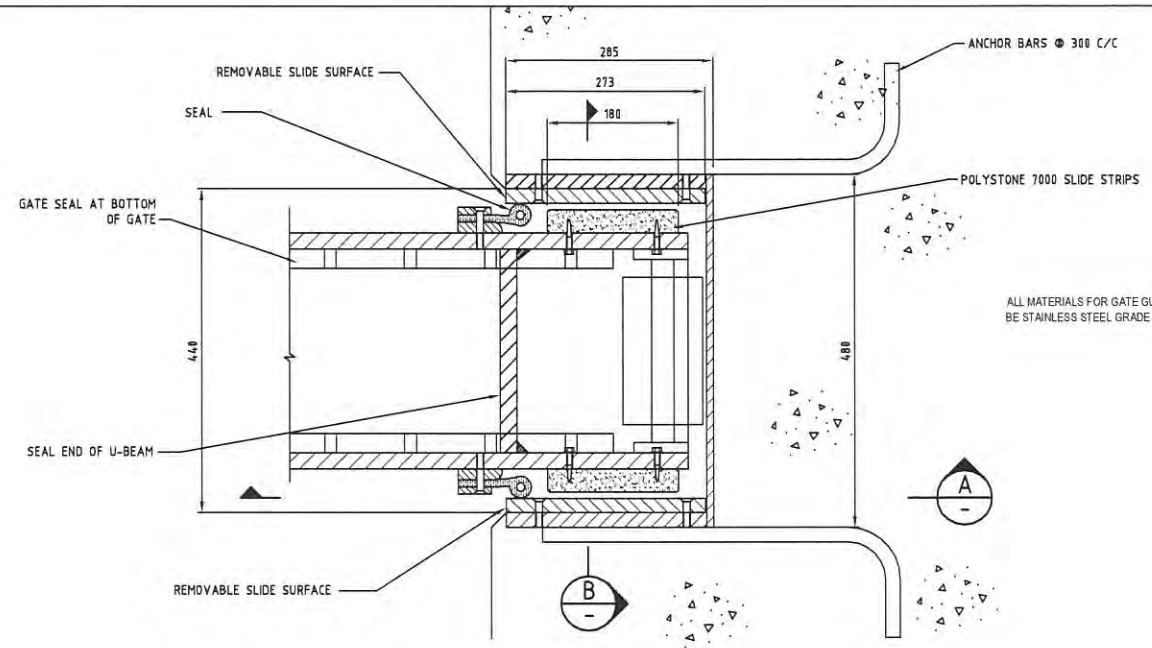
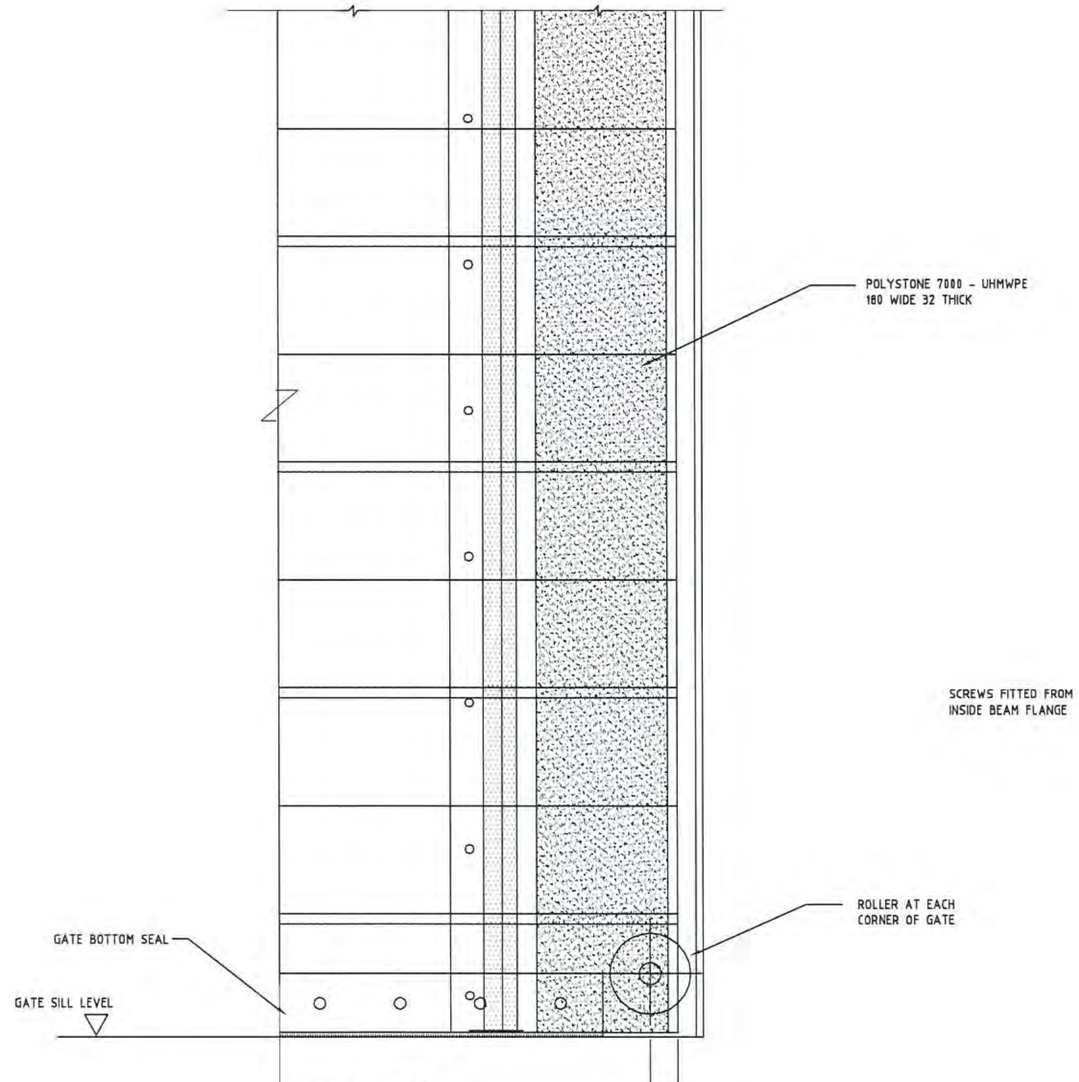
Client **TEA INVESTMENT No 1**
Project **DERBY TIDAL POWER PROJECT**
Title **GATES LIFTING MECHANISMS AND CONTROLS DETAILS SHEET 1 OF 2**

Original Size A1 **Drawing No: 61-27947-C14** **Rev: A**

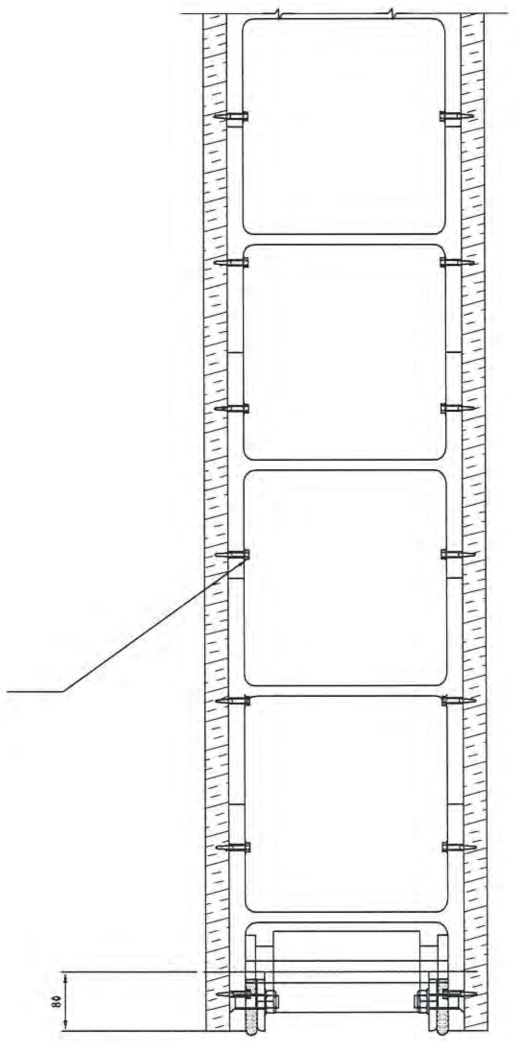
Plot Date: 20 June 2012 - 12:41 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C14.dwg



ALL MATERIALS FOR GATE GUIDE TO BE STAINLESS STEEL GRADE 316



SECTION A



SECTION B

NOTES:

1. STEEL PROTECTION BY 2 COAT EPOXY AND CATHODIC PROTECTION
2. ALL WELDED CONNECTIONS BETWEEN STRUCTURAL MEMBERS SHALL BE 5mm CONTINUOUS FILLET WELD U.N.O.
3. FILLET WELDS SHALL BE PREQUALIFIED CATEGORY SP U.N.O.
4. STEEL GRADE 250MPa

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No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 50 100 150 200 250mm
SCALE 1:5 AT ORIGINAL SIZE

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Date	21/06/2012		
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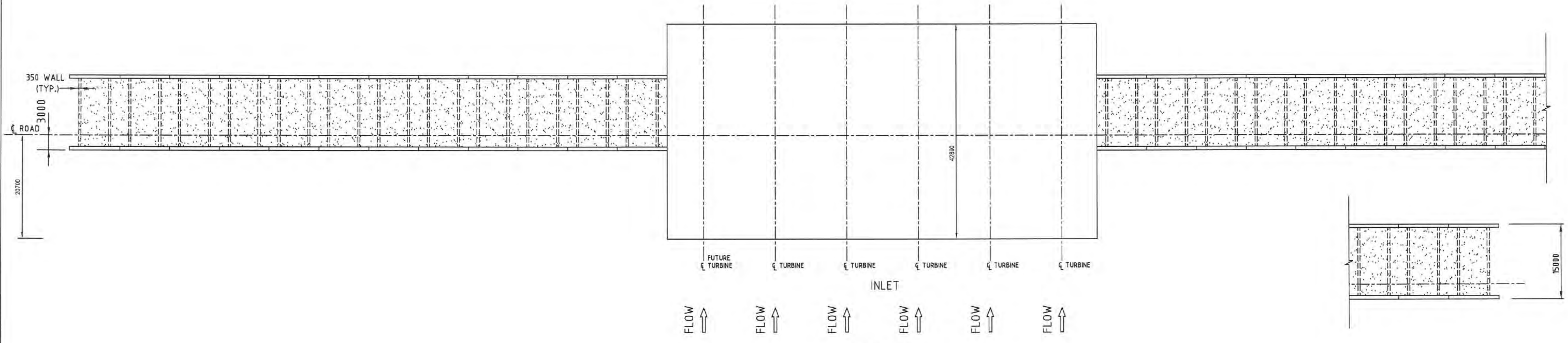
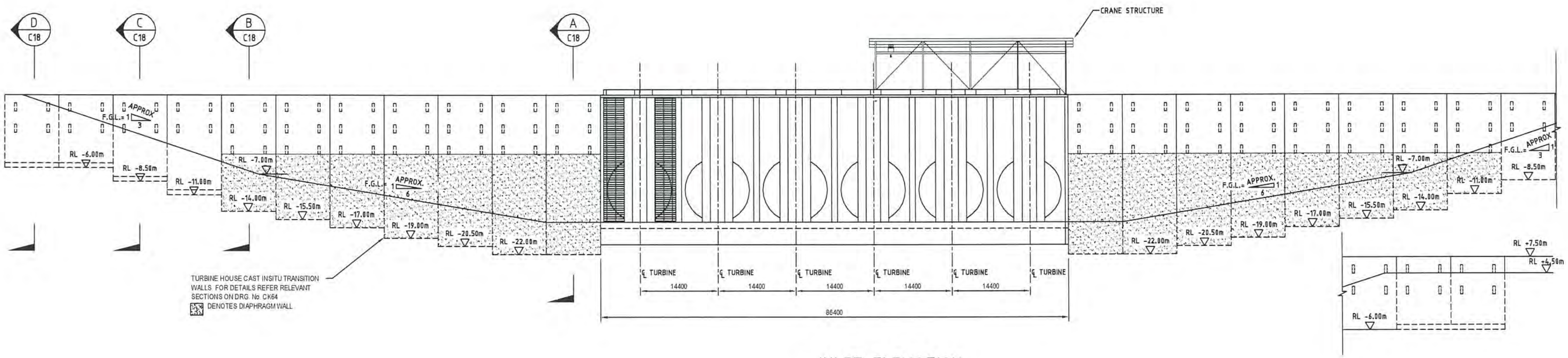
Client: **TEA INVESTMENT No 1**
Project: **DERBY TIDAL POWER PROJECT**
Title: **GATES, LIFTING MECHANISMS AND CONTROLS DETAILS SHEET 2 OF 2**

Original Size: A1 **Drawing No: 61-27947-C15** **Rev: A**

Plot Date: 20 June 2012 - 12:41 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C15.dwg



PLAN
1:400



INLET ELEVATION
1:400

NOTE:
- CATHODIC PROTECTION; THESE GATES STRUCTURES SHALL BE CATHODICALLY PROTECTED.
- ALL CONCRETE SHALL BE GRADE 50
  COVER TO BE - 70mm TO EXTERNAL FACES
  40mm TO INTERNAL FACES
- CEMENT 420kg/m MIN.
  WATER CEMENT RATIO 0.38 MAX (SUPER PLASTISIZER)
  CEMENT TYPE: 70% GCBFS LOW HEAT CEMENT (CHILLED)

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 4 8 12 16 20m
SCALE 1:400 AT ORIGINAL SIZE

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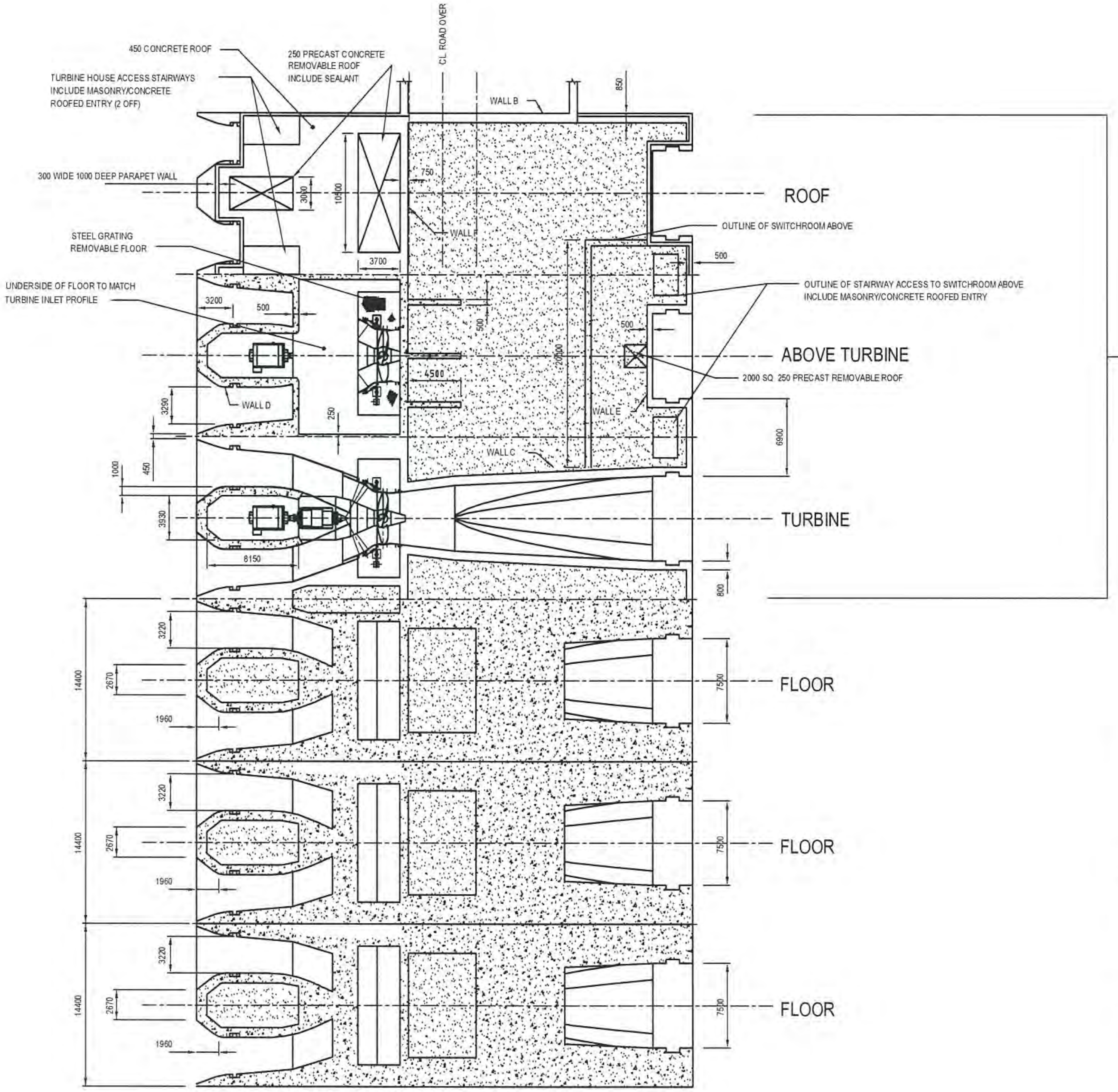
Drafting Check E.G.M.	Design Check	Project	DERBY TIDAL POWER PROJECT
Approved (Project Director)		Title	POWER HOUSE PLAN & ELEVATION
Date 21/06/2012			
Scale 1:400	This Drawing must not be used for Construction unless signed as Approved	Original Size A1	Drawing No: 61-27947-C16 Rev: A

Plot Date: 20 June 2012 - 12:42 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C16.dwg



TYPICAL SECTIONS THROUGH TURBINES

NOTES:

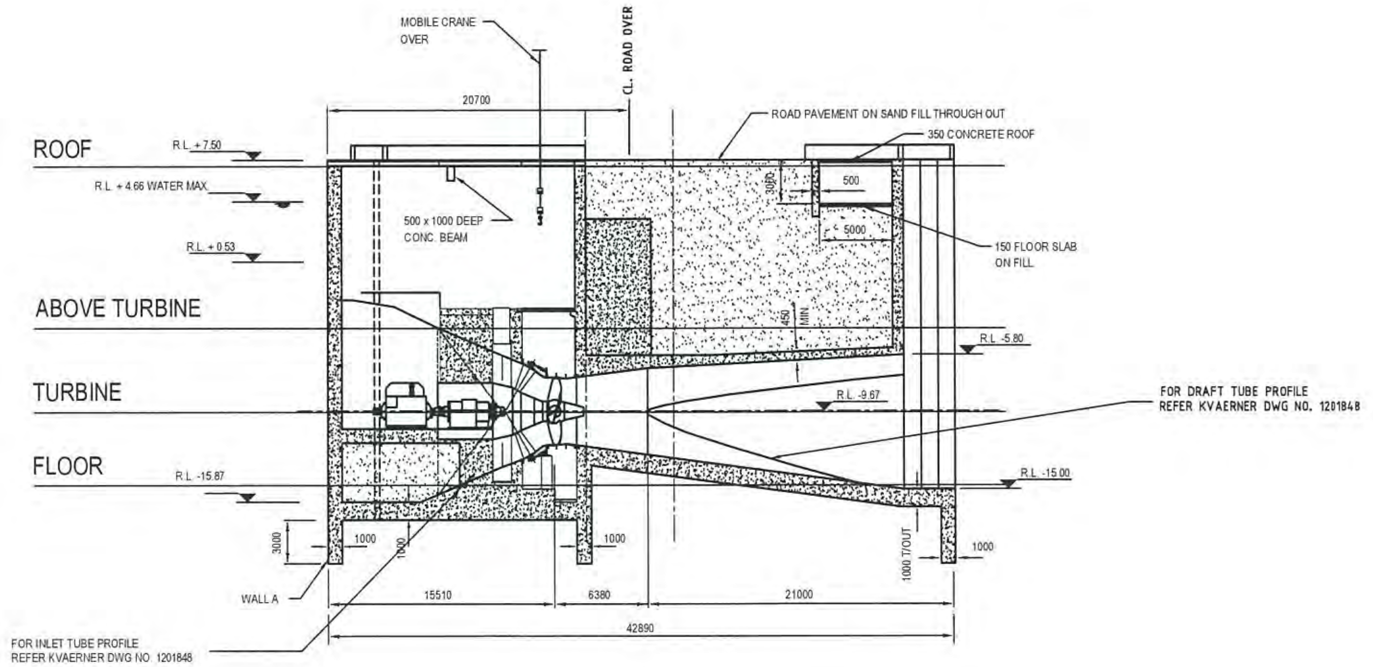
ALLOW FOR ANCILLIARIES SUCH AS:-
- HANDRAILS
- STAIRWAYS & ACCESSWAYS
- MONORAILS (2t S.W.L.)
- LIGHTING (EXTERNAL/INTERNAL)
- PARAPET WALLS
- DRAINAGE (ROAD/SLAB)
- VENTILATION
- REMOVABLE FLOORING
- LIFTING ANCHORS
- JOINT SEALANTS
- WATERSTOPS AT CONSTRUCTION JOINTS
- TRASH SCREENS

CONCRETE
S50 MPa EXTERNAL
S32 MPa INTERNAL (WHERE NOT IN CONTACT WITH SALTY WATER)

REINFORCEMENT SCHEDULE

LOCATION	REINFORCEMENT
WALL A	M.O.S. - 210kg/m ^{3}
WALL B	M.O.S. - 200kg/m ^{3}
WALL C	M.O.S. - 200kg/m ^{3}
WALL D	M.O.S. - 190kg/m ^{3}
WALL E	M.O.S. - 175kg/m ^{3}
WALL F	M.O.S. - 200kg/m ^{3}
OTHERS	M.O.S. - 175kg/m ^{3}

M.O.S. = MASS OF STEEL



SECTION THROUGH TURBINE CENTRELINE

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 2500 5000 7500 10000 12500mm
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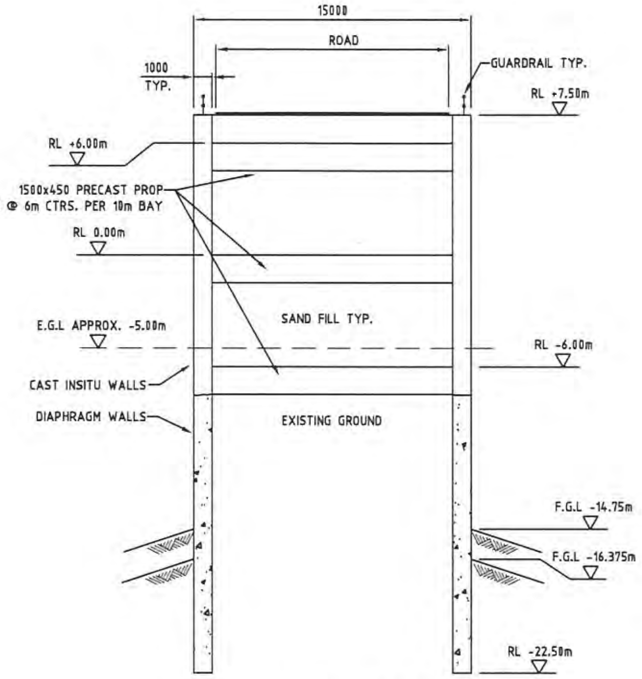
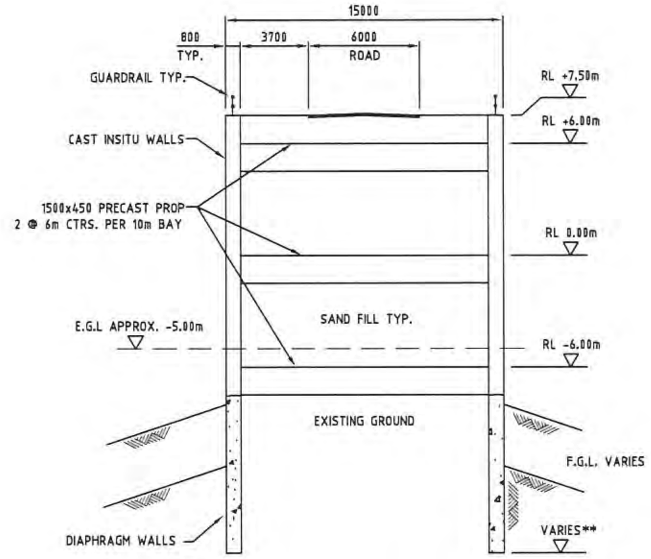
Client TEA INVESTMENT No 1
Project DERBY TIDAL POWER PROJECT
Title POWER HOUSE SECTIONS & DETAILS

Original Size A1 Drawing No: 61-27947-C17 Rev: A

Plot Date: 20 June 2012 - 12:42 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C17.dwg

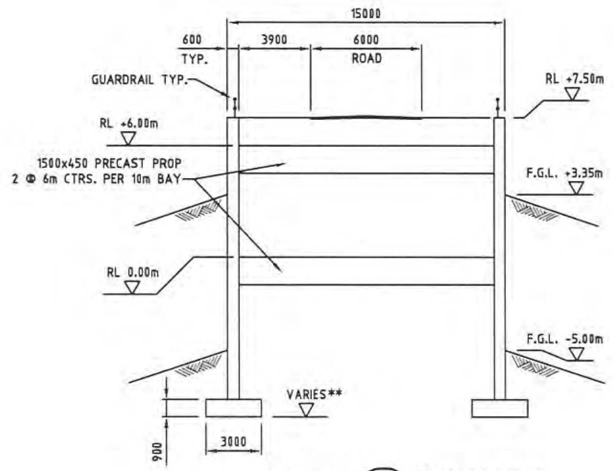


SECTION A CK16



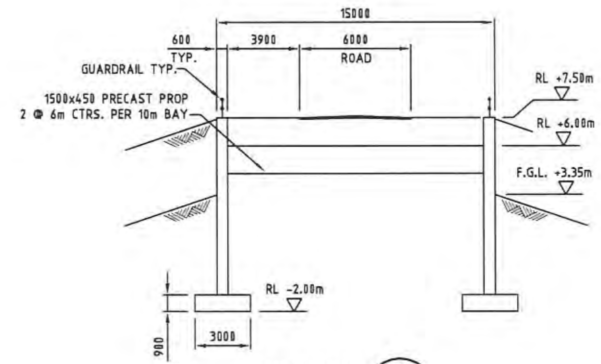
SECTION B C16

**FOR LEVELS REFER TO ELEVATIONS



SECTION C C16

**FOR LEVELS REFER TO ELEVATIONS



SECTION D C16

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Date	21/06/2012		
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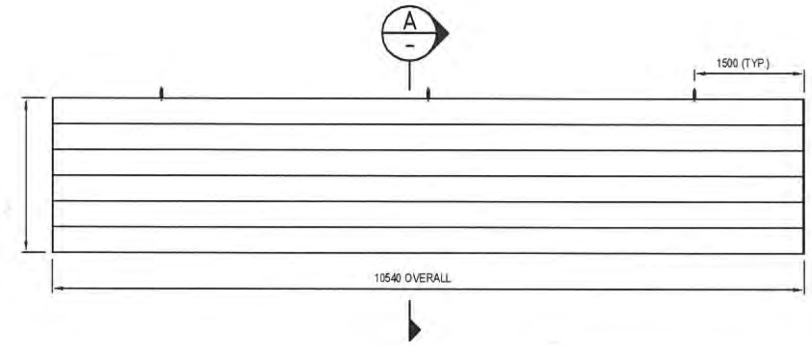
Client **TEA INVESTMENT No1**
Project **DERBY TIDAL POWER PROJECT**
Title **POWER HOUSE SIDE TRANSITION WALLS TYPICAL SECTIONS AND DETAILS**

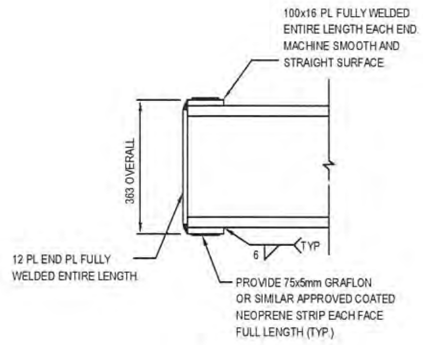
Original Size A1 **Drawing No: 61-27947-C18** **Rev: A**

Plot Date: 20 June 2012 - 12:42 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C18.dwg

NOTES:-
1. ALL WELDED CONNECTIONS BETWEEN MEMBERS SHALL 6mm PARTIAL PENETRATION WELDS U.N.O.
2. WELDS SHALL BE PREQUALIFIED CATEGORY SP U.N.O.
3. STEEL GRADE 250MPa

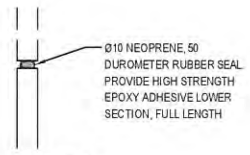


ELEVATION
1:50

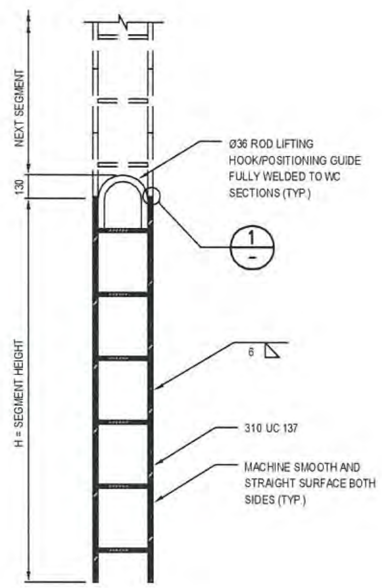


PLAN
GATE END DETAIL
1:10

HJKHGKG



DETAIL 1
1:5



SECTION A
1:20

No. 2 OF - H = 2163
No. 1 OF - H = 2472

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date

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SCALE 1:5 AT ORIGINAL SIZE (0 50 100 150 200 250mm)
SCALE 1:10 AT ORIGINAL SIZE (0 100 200 300 400 500mm)
SCALE 1:20 AT ORIGINAL SIZE (0 200 400 600 800 1000mm)

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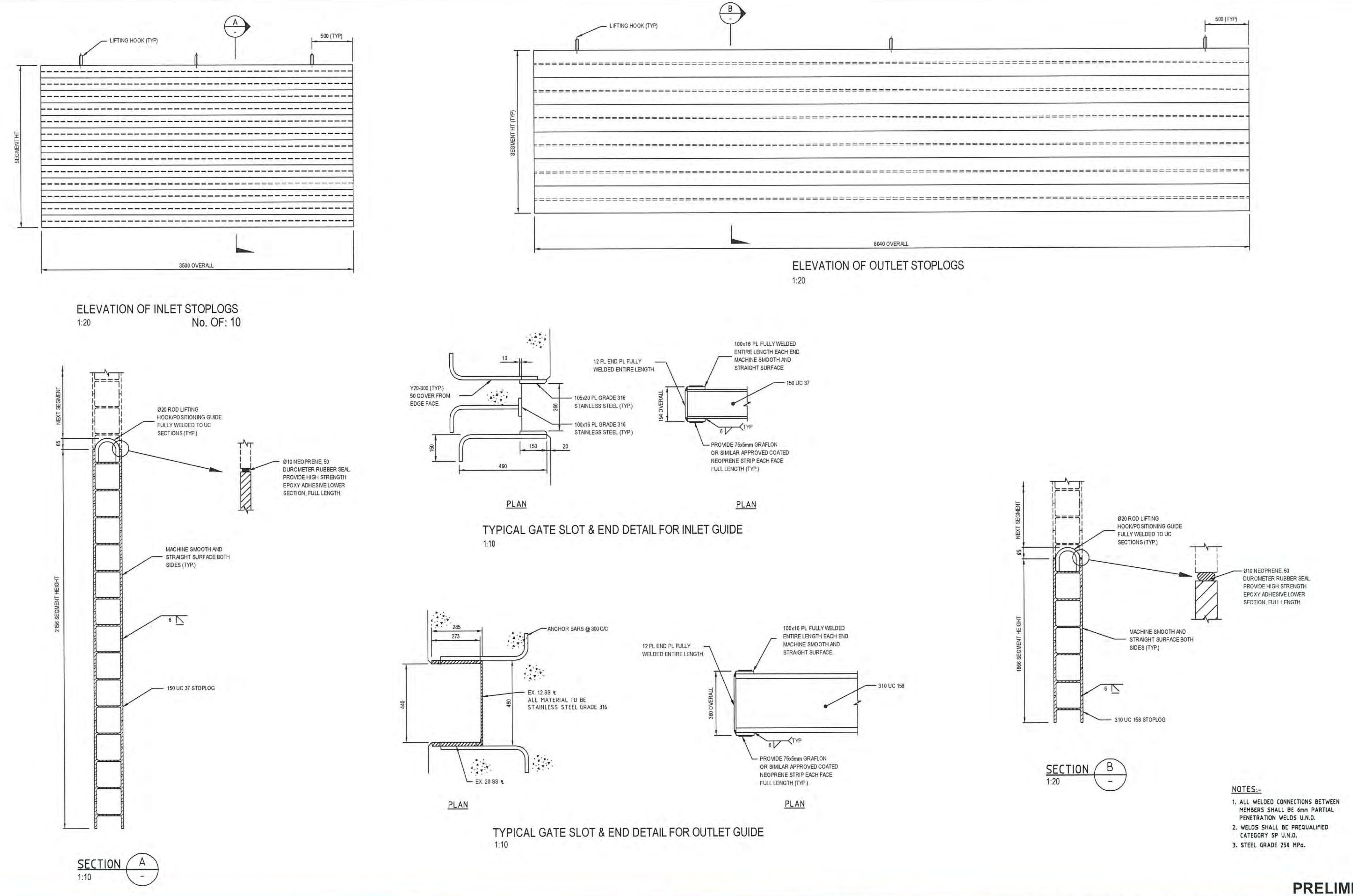
Client **TEA INVESTMENT No 1**
Project **DERBY TIDAL POWER PROJECT**
Title **INLET AND OUTLET GATES STOPLOG DETAILS**

Original Size A1 **Drawing No: 61-27947-C19** **Rev: A**

Plot Date: 20 June 2012 - 12:43 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C19.dwg



NOTES:-

1. ALL WELDED CONNECTIONS BETWEEN MEMBERS SHALL BE 6mm PARTIAL PENETRATION WELDS U.N.O.
2. WELDS SHALL BE PREQUALIFIED CATEGORY SP U.N.O.
3. STEEL GRADE 250 MPa.

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE
0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

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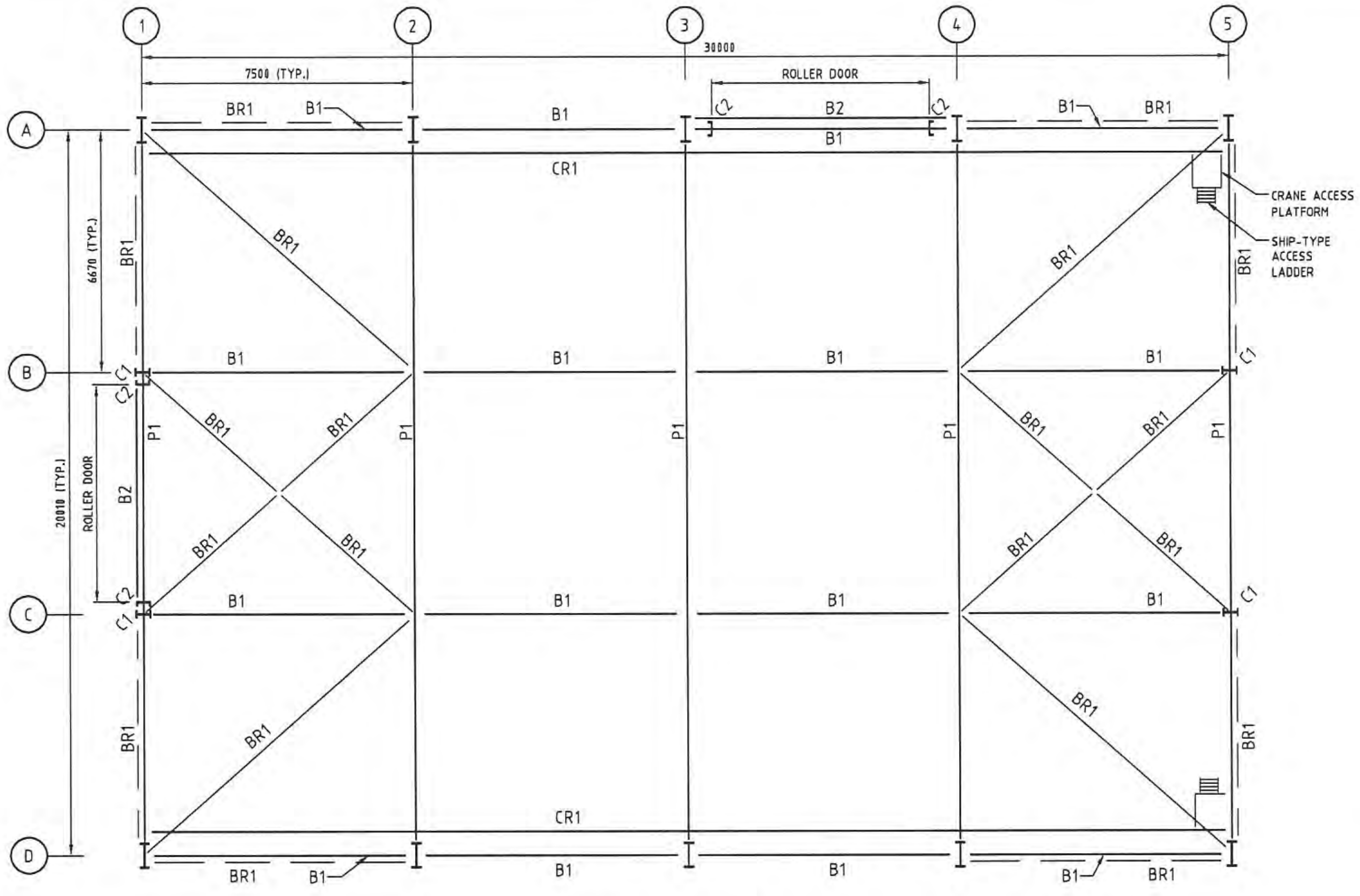
Drafting Check		Design Check	
Approved (Project Director) Date	21/06/2012		
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

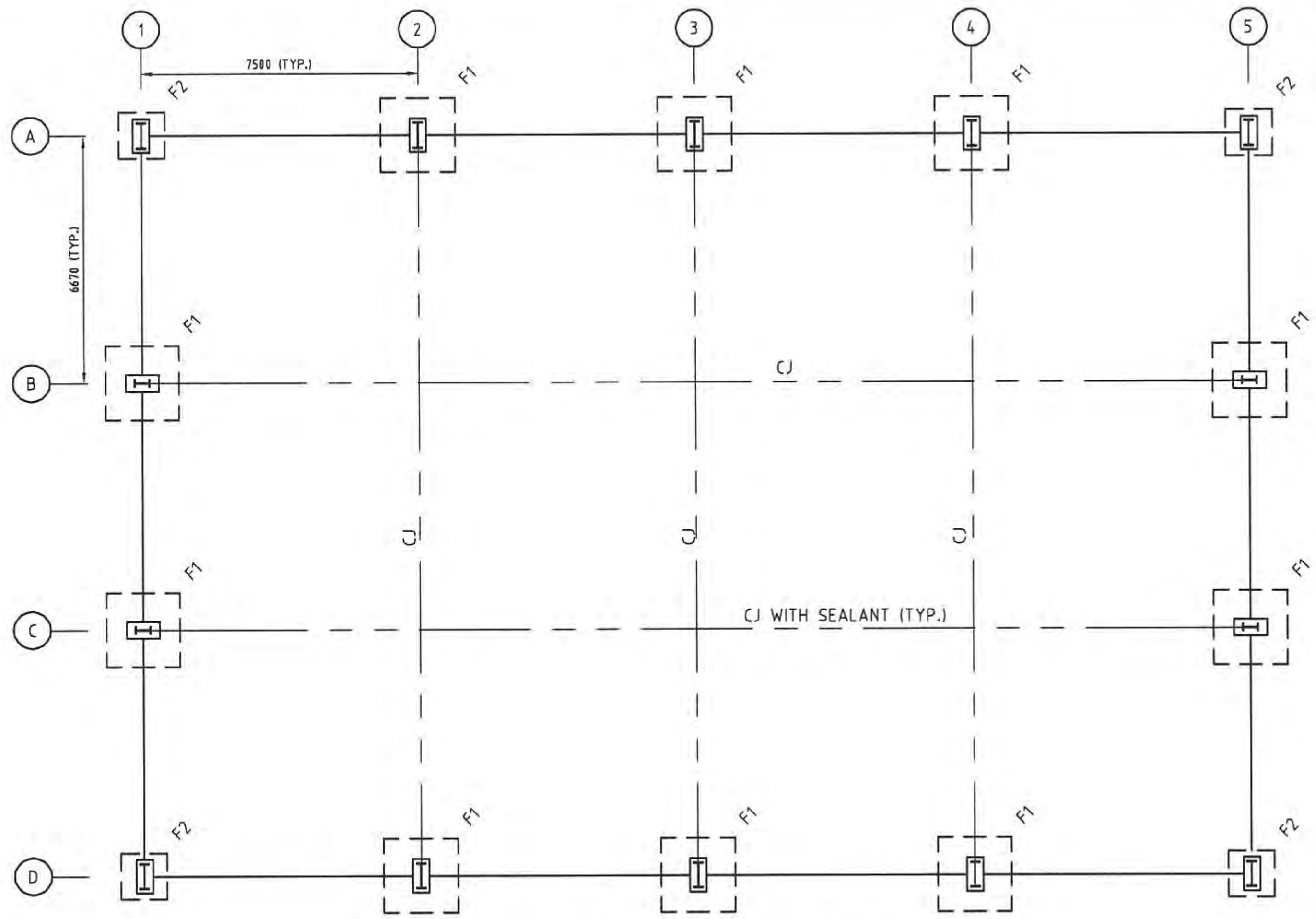
Client **TEA INVESTMENT No 1**
Project **DERBY TIDAL POWER PROJECT**
Title **POWER HOUSE STOPLOG DETAILS**

Original Size A1 **Drawing No: 61-27947-C20** **Rev: A**

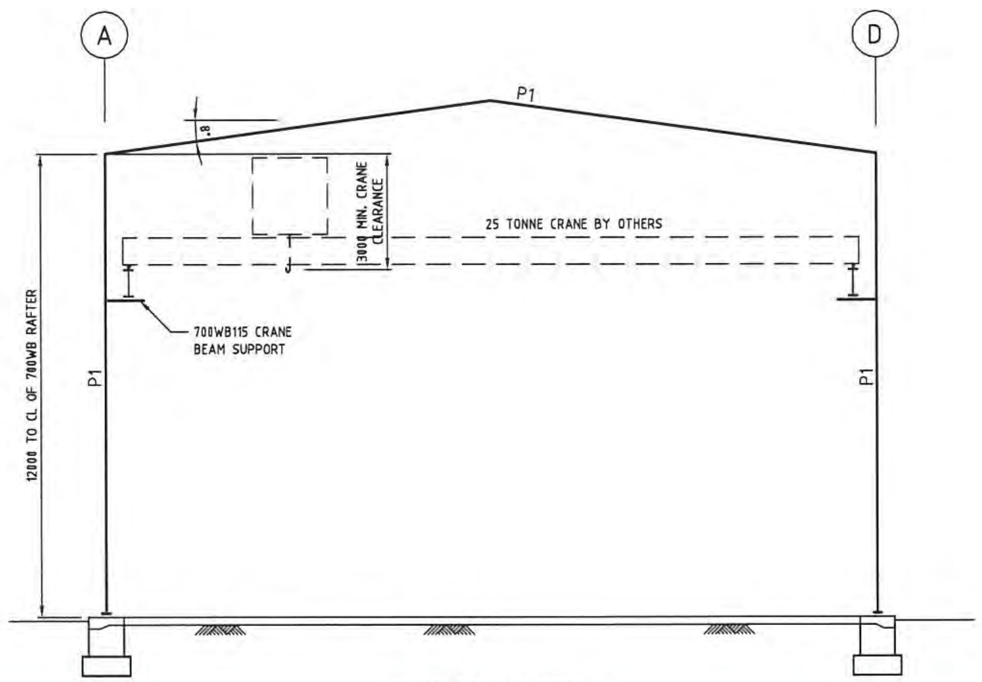
Plot Date: 20 June 2012 - 12:56 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C20.dwg



STEELWORK PLAN



FOOTING & GROUND SLAB PLAN



TYPICAL SECTION

LEGEND

P1 - PORTAL FRAME - 700WB115
8M20 SS BOLTS

B1 - 140x5.4 CHS

B2 - 410UB54 LINTEL

C1 - 410UB54 COLUMN

C2 - 380 PFC

BR1 - 100x100x6 EA

CR1 - 700WB115 + AS41 RAIL

PURLINS - 125 PFC AT 1250 CRS INTERMEDIATE, 900 ON EDGES

GIRTS - 125 PFC AT 1500 CRS INTERMEDIATE, 900 ON EDGES

NOTES

USE 10 PL CLEATS

USE M20 SS 316 BOLTS (TYP.)

CLADDING - SS CLADDING, SPANDEK PROFILE
ALLOW 5% OF ROOF AREA TO BE TRANSLUSCENT SHEETING

CONCRETE:

200 SLAB + 300 EDGE THICKENING

F1 - 2000x2000x500 (1000 SOIL COVER)
+900x450x1000 HIGH PEDESTAL

F2 - 1250x1250x400
+900x450x1000 PEDESTAL

ALL CONCRETE - S50

REINFORCEMENTS:

FOOTINGS - F1 & F2 : 90 kg/m3

SLAB - 65 kg/m3

GENERAL:

INCLUDE ALL FACILITIES AS PER APPENDIX 9

- APRON SLAB, SUGGEST 7m x 6m SLAB (2 OFF) AT ROLLER DOORS
- DRAINAGE
- RIDGE VENTILATION
- PROVIDE INSULATION AS PER APPENDIX 9

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Approved (Project Director) Date		21/06/2012	
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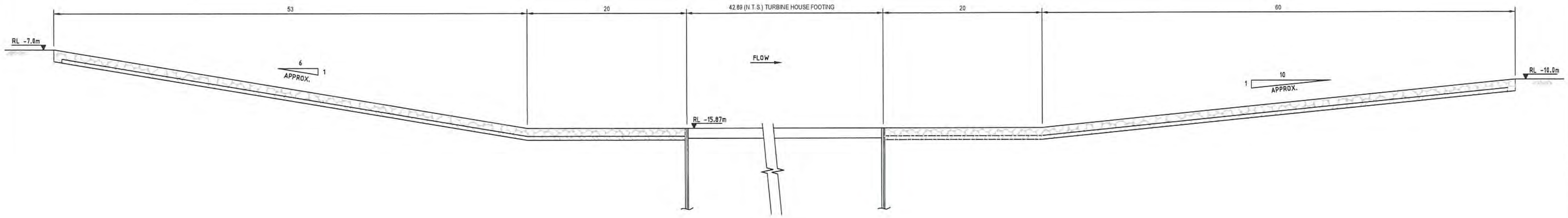
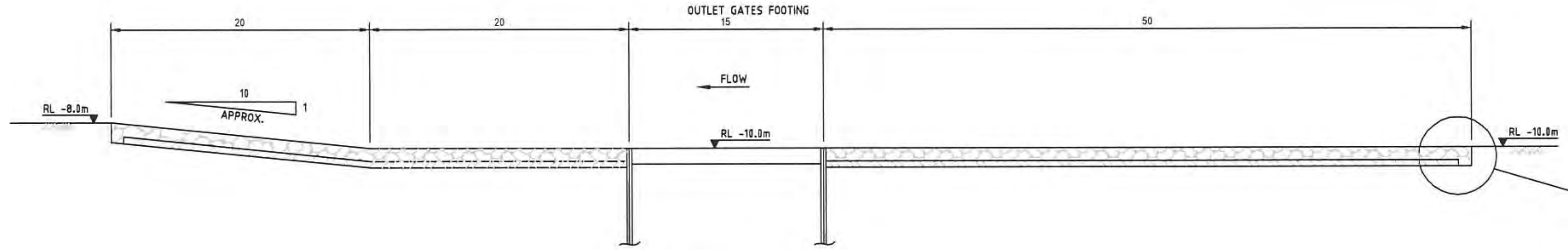
Client **TEA INVESTMENT No1**
Project **DERBY TIDAL POWER PROJECT**
Title **MAINTENANCE WORKSHOP GENERAL LAYOUT**

Original Size **A1** **Drawing No: 61-27947-C21** **Rev: A**

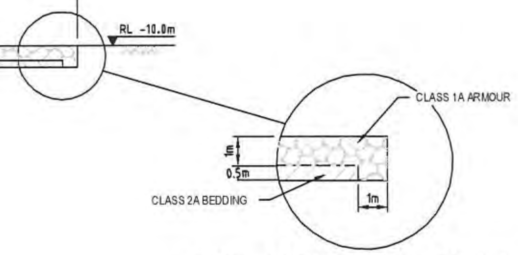
Plot Date: 20 June 2012 - 12:56 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C21.dwg



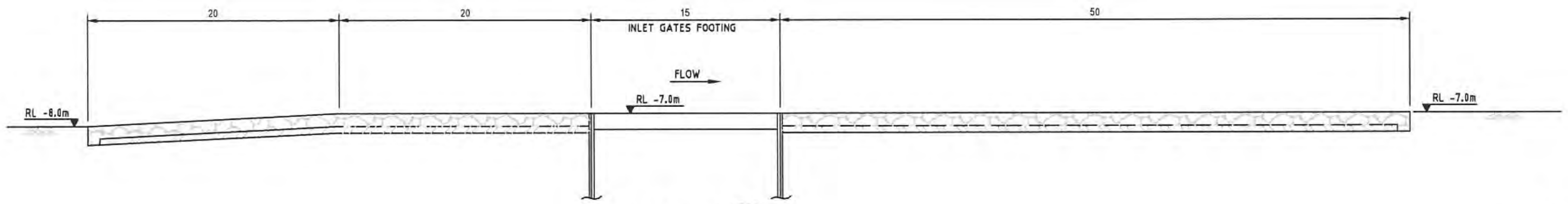
SECTION A C01



SECTION B C01



TYP. ROCK PROTECTION U.N.O.
1:125



SECTION C C01

NOTES:
1. FOR PLAN LAYOUT REFER SKETCH No 61-13003-50
2. REFER TO DRG. CK-16 FOR ARMOUR CLASS DESCRIPTIONS

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

0 250 500 750 1000 1250mm
SCALE 1:25 AT ORIGINAL SIZE

0 1250 2500 3750 5000 6250mm
SCALE 1:125 AT ORIGINAL SIZE

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DO NOT SCALE

Drawn FMM 9/5/12
Designer EDM 9/5/12
Drafting Check E.DM
Design Check
Approved (Project Director)
Date 21/06/2012
Scale AS SHOWN
This Drawing must not be used for Construction unless signed as Approved

Client TEA INVESTMENT No 1
Project DERBY TIDAL POWER PROJECT
Title GATE STRUCTURES & POWER HOUSE SILL ARMOURING - CROSS SECTIONS

Original Size A1
Drawing No: 61-27947-C22
Rev: A

Plot Date: 20 June 2012 - 12:56 PM Plotted by: Mark Bozikovic Cad File No: G:\61\27947\CADD\DRAWINGS FINAL ISSUE\61-27947-C22.dwg

Appendix B

Bill of Quantities

TEA INVESTMENT NO. 1
DERBY TIDAL POWER PROJECT
QUANTITIES
Revision 1- June 2012
G:\61\27947\Excel\[TEA Investment No.1 - Derby Tidal Power Quantities_Revision 1.xlsx]Quantities

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE $	AMOUNT	SUB-TOTAL AMOUNT $
1	**GENERAL**					
	Site Mobilisation and Demobilisation		LS			
	Levee construction around sitework (doughnut)		Item			
	Removal of doughnut and excavate site to finished levels		Item			
2	**MAIN ACCESS ROAD**					
	Clearing	98	ha			
	Strip topsoil (150 thick)	147,000	m^3			
	Volume Zone 2 to replace stripped topsoil (if stripping is done)	147,000	m^3			
	Zone 3 material - compacted silty/clay borrowed from basin or approved borrow pit	213,350	m^3			
	Zone 2 subgrade material - As dredged sand	216,740	m^3			
	150 thick basecourse compacted gravel	32,650	m^3			
	150 thick surface protection lateritic gravel	12,700	m^3			
	0.5 m thick rip-rap on 1:3 slope	25,050	m^3			
	100 Dia. Draincoil at 25m crs along road complete with rock surround, geofabric over the top and concrete ancasement at outlets	580	No.			
	Road surfacing - primer and two coat seal (If required)					
3	**WEST LEVEE AND BARRAGE**					
	0m to 680m					
	Clearing	2	ha			
	Strip topsoil (150 thick)	2,550	m^3			
	Volume Zone 2 to replace stripped topsoil (if stripping is done)	2,550	m^3			
	Zone 3 material - compacted silty/clay borrowed from basin or approved borrow pit	6,682	m^3			
	Zone 2 subgrade material - As dredged sand	3,700	m^3			
	150 thick basecourse compacted gravel	1,380	m^3			
	0.5 m thick rip-rap on 1:3 slope	16,955	m^3			
	100 Dia. Draincoil at 25m crs along road complete with rock surround, geofabric over the top and concrete ancasement at outlets	50	No.			
	680m to 1269m					
	Stage 1 rockfill	128,200	m^3			
	Stage 2 - 75 max. well graded gravel	47,100				
	Dredged sand fill	178,920	m^3			
	Filter layer	7,430	m^3			
	Secondary Armour layer - 2 layers of 0.05 to 0.15 rock	16,980	m^3			
	1.9m thick primary armour (Class A, B and C rock)	44,670	m^3			
	Rip-rap - 0.6thick protection on basin slope side	12,560	m^3			
	Stage 1 rockfill for subgrade	7,940	m^3			
	0.2 thick gravel surfacing	700	m^3			
	Geotextile	175,000	m^2			
4	**NORTH-EAST BARAGE AND EAST LEVEE**					
	0m to 5150m					
	Stage 1 rockfill	826,690	m^3			
	Dredged sand fill	299,520	m^3			
	Filter layer	790,700	m^3			
	Stage 2 - 75 max. well graded gravel	302,680	m^3			
	Secondary Armour layer - 2 layers of 0.05 to 0.15 rock	118,160	m^3			
	1.9m thick primary armour (Class A rock: 1.5-2.5t)	317,340	m^3			
	Rip-rap - 0.6thick proection on basin slope side	89,530	m^3			
	Stage 1 rockfill for subgrade	61,285	m^3			
	0.2 thick gravel surfacing	6,200	m^3			
	5150m to 9596m					
	Clearing	11	ha			
	Strip topsoil (150 thick)	16,700	m^3			
	Volume Zone 2 to replace stripped topsoil (if stripping is done)	16,700	m^3			
	Zone 3 material - compacted silty/clay borrowed from basin or approved borrow pit	128,885	m^3			
	Zone 2 subgrade material - As dredged sand	42,420	m^3			

TEA INVESTMENT NO. 1
DERBY TIDAL POWER PROJECT
QUANTITIES
Revision 1- June 2012
G:\61\27947\Excel\[TEA Investment No.1 - Derby Tidal Power Quantities_Revision 1.xlsx]Quantities

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE $	AMOUNT	SUB-TOTAL AMOUNT $
	150 thick basecourse compacted gravel	11,280	m^3			
	150 thick surface protection lateritic gravel	6,120	m^3			
	0.5 m thick rip-rap on 1:3 slope	14,590	m^3			
	100 Dia. Draincoil at 25m crs along road complete with rock surround, geofabric over the top and concrete ancasement at outlets	384	No.			
5	**INLET STRUCTURE**					
	Excavation and foundation preparation		Item			
	Dewatering		Item			
	Supply and install sheet piling (122kg/m,355MPa)	1,250	m^2			
	Supply and place blinding layer concrete (100mm)	470	m^3			
	Concrete - floor C	470	m^3			
	Concrete - floor D	3,100	m^3			
	Concrete - Wall A	3,020	m^3			
	Concrete - Wall B and mid-wall	1,210	m^3			
	Precast concrete winch platform support slab	100	m^3			
	Precast concrete winch platform slab	130	m^3			
	Gates stainless steel vertical guides	406	m			
	Stop logs stainless steel vertical guides	812	m			
	1000x250 Steel lateral support beam	14	No.			
	150x90x10 SS gate top seal angle	14	No.			
	Supply and place reinforcement for inlet gates	1,170	t			
	Sand fill for inlet gates	5,200	m^3			
	800 thick diaphragm wall	250	m^3			
	800 thick cast insitu walls	1,000	m^3			
	600 thick cast insitu walls	850	m^3			
	Cast insitu bases	350	m^3			
	1500x450 precast props	900	m^3			
	Supply and place reinforcement for walls and bases	340	t			
	Sand fill for inlet gate walls	16,600	m^3			
	Guardrail	200	m			
	Class 1A floor armouring	13,500	m^3			
	Class 2A bedding	6,750	m^3			
	Supply and install gate lifting mechanism	14	No.			
	Supply and install gates	14	No.			
	Supply stop logs for one gate	1	No.			
6	**OUTLET STRUCTURE**					
	Excavation and foundation preparation		Item			
	Dewatering		Item			
	Supply and install sheet piling (122kg/m,355MPa)	900	m^2			
	Supply and place blinding layer concrete (100mm)	270	m^3			
	Concrete - floor C	270	m^3			
	Concrete - floor D	1,750	m^3			
	Concrete - Wall A	2,200	m^3			
	Concrete - Wall B and mid-wall	910	m^3			
	Precast concrete winch platform support slab	60	m^3			
	Precast concrete winch platform slab	80	m^3			
	Gates stainless steel vertical guides	280	m			
	Stop logs stainless steel vertical guides	560	m			
	1000x250 Steel lateral support beam	8	No.			
	150x90x10 SS gate top seal angle	8	No.			
	Supply and place reinforcement for outlet gates	770	t			
	Sand fill outlet gates	4,250	m^3			
	800 thick diaphragm wall	700	m^3			
	800 thick cast insitu walls	1,950	m^3			
	600 thick cast insitu walls	800	m^3			
	Cast insitu bases	350	m^3			
	1500x450 precast props	1,400	m^3			
	Supply and place reinforcement for walls and bases	180	t			
	Sand fill for outlet gate walls	19,000	m^3			
	Guardrail	280	m			
	Class 1A floor armouring	11,700	m^3			
	Class 2A bedding	5,850	m^3			
	Supply and install gate lifting mechanism	14	No.			

TEA INVESTMENT NO. 1
DERBY TIDAL POWER PROJECT
QUANTITIES
Revision 1- June 2012
G:\61\27947\Excel\[TEA Investment No.1 - Derby Tidal Power Quantities_Revision 1.xlsx]Quantities

ITEM	DESCRIPTION	QUANTITY	UNIT	RATE $	AMOUNT	SUB-TOTAL AMOUNT $
	Supply and install gates	14	No.			
	Supply stop logs for one gate	1	No.			
7	**POWER HOUSE**					
	Excavation and foundation preparation		Item			
	Dewatering		Item			
	Supply and install sheet piling (122kg/m,355MPa)	580	m^2			
	Supply and place blinding layer concrete (100mm)	820	m^3			
	Concrete - Wall A	9,800	m^3			
	Concrete - Wall B	1,350	m^3			
	Concrete - Wall C	4,310	m^3			
	Concrete - Wall D	1,250	m^3			
	Concrete - Wall E	5,160	m^3			
	Concrete - Wall F	950	m^3			
	Concrete - Other	4,950	m^3			
	Concrete - 450 thick Roof	580	m^3			
	Concrete - 250 precast concrete removable roof	100	m^3			
	Concrete - 350 precast concrete removable roof	370	m^3			
	Concrete - 1000 high x 300 thick Parapet Wall	75	m^3			
	Stop logs stainless steel vertical guides	842.40	m			
	Supply and place reinforcement for turbine structure	5,560	t			
	Sand fill for turbine structure	3,800	m^3			
	1000 thick diaphragm wall	2,300	m^3			
	1000 thick cast insitu walls	2,400	m^3			
	800 thick diaphragm wall	1,000	m^3			
	800 thick cast insitu walls	2,000	m^3			
	600 thick cast insitu walls	1,000	m^3			
	Cast insitu bases	350	m^3			
	1500x450 precast props	2,350	m^3			
	Supply and place reinforcement for walls and bases	780	t			
	Sand fill for turbine structure	71,500	m^3			
	Guardrail	460	m			
	Class 1A floor armouring	30,600	m^3			
	Class 2A bedding	15,300	m^3			
	Removable steel grating in the turbine house	Item				
	Trash creens for turbines at inlet	12	No.			
	Supply and install stop logs for the inlet of one turbine	2	No.			
	Supply and install stop logs for the outlet of one turbine	1	No.			
	Supply and install lifting crane for turbines		Item			
	General Maintenance Workshop		Item			
8	**PROCURE AND INSTALL TURBINES**					
	Supply, 8 MW turbines, generators and trash racks	5	No.			
	Install and commisioning of 8 MW turbines and generators including mechanical, electrical, instrumentation, piping and other required services		Item			

Appendix C

Model Input Data

Basin Volumetric Data

Hill Diagram

Basin Volumetric Data

Project: Derby Tidal Power Project

Client: Tidal Energy Australia

High Basin Volumes	
Level	Volume
[m]	[Mcum]
-6	0.2
-5.5	0.4
-5	0.6
-4.5	0.9
-4	1.3
-3.5	2.1
-3	3.4
-2.5	5.0
-2	6.8
-1.5	8.8
-1	11.0
-0.5	13.5
0	16.0
0.5	18.6
1	21.4
1.5	24.3
2	27.4
2.5	30.8
3	35.2
3.5	41.5
4	50.1
4.5	61.4
5	75.5
5.5	91.1
6	107.0

Low Basin Volumes	
Level	Volume
[m]	[Mcum]
-6	2.31
-5.5	3.44
-5	4.92
-4.5	6.81
-4	9.33
-3.5	12.43
-3	16.05
-2.5	20.18
-2	24.63
-1.5	29.55
-1	34.91
-0.5	40.94
0	47.40
0.5	54.25
1	61.40
1.5	68.93
2	76.76
2.5	84.91
3	93.30
3.5	102.10
4	111.78

Hill Diagram	
Project: Derby Tidal Power Project	
Client: Tidal Energy Australia	GHD

Maximum Power and Flow Chart

Turbines		
Generator capacity	MW	8
Min Turbine head	m	1.5
Turbine limit (allowing for gen eff.)	MW	8.48
Power generation		
Turbine Gearbox Efficiency		0.987
Generator Efficiency		0.975
Generator Transformer Efficiency		0.99
Equivalent Forced Outage Rate		0.01
Total after all losses		0.943

	Data provided:																				
Head:	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11
Q max	0	140	120	160	180	180	180	180	180	180	180	162	148	138	130	123	116	110	104	100	96
Power max	0	1.03	1.55	2.39	3.28	4.19	5.06	5.92	6.78	7.60	8.39	8.48	8.48	8.48	8.48	8.48	8.48	8.48	8.48	8.48	8.48

Key
User Specified Parameter
Constant
Calculated Value
Used directly by model
Input in Parameters

MW HILL DIAGRAM FOR 8MW TURBINE

	Head (m)																					
Flow	**0**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**10.5**	**11**	**Flow**
0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0**
30	0	0.000	0.338	0.487	0.627	0.757	0.872	0.981	1.084	1.155	1.210	1.239	1.237	1.322	1.411	1.499	1.587	1.676	1.764	1.852	1.941	**30**
40	0	0.000	0.498	0.692	0.904	1.084	1.255	1.422	1.563	1.700	1.811	1.822	1.931	1.935	1.944	2.059	2.181	2.302	2.424	2.545	2.667	**40**
60	0	0.568	0.873	1.170	1.456	1.735	2.003	2.260	2.502	2.729	2.938	3.115	3.279	3.413	3.491	3.694	3.912	4.131	4.350	4.568	4.787	**60**
80	0	0.779	1.158	1.580	1.972	2.345	2.710	3.058	3.398	3.734	4.045	4.321	4.568	4.818	5.041	5.339	5.657	5.975	6.293	6.610	6.928	**80**
100	0	0.941	1.412	1.925	2.412	2.884	3.344	3.797	4.239	4.669	5.076	5.468	5.832	6.171	6.485	6.864	7.275	7.686	8.098	8.509	8.920	**100**
120	0	1.026	1.551	2.185	2.775	3.345	3.906	4.457	4.995	5.523	6.035	6.524	6.984	7.426	7.848	8.309	8.811	9.313	9.815	10.316	10.818	**120**
140	0	1.029	1.544	2.317	3.050	3.723	4.383	5.038	5.680	6.307	6.915	7.504	8.067	8.609	9.136	9.686	10.276	10.867	11.458	12.049	12.639	**140**
160	0	0.000	0.464	2.392	3.227	3.997	4.769	5.539	6.277	7.005	7.713	8.404	9.070	9.718	10.336	10.968	11.645	12.322	12.998	13.675	14.352	**160**
180	0	0.000	0.000	2.355	3.280	4.189	5.064	5.922	6.775	7.595	8.392	9.205	9.994	10.716	11.418	12.180	12.941	13.702	14.463	15.225	15.986	**180**

Pmax	1.029	1.551	2.392	3.280	4.189	5.064	5.922	6.775	7.595	8.392	8.482	8.482	8.482	8.482	8.482	8.482	8.482	8.482	8.482	8.482
Qmax	140	120	160	180	180	180	180	180	180	180	162	148	138	130	123	115.718	110	104	100	96

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Document Status

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