

Huon Aquaculture Group Pty Ltd
Parramatta Creek Fish Processing Facility
APPENDIX G
DAM DESIGN





Huon Aquaculture Company

Winter Storage Dam Preliminary Report

July 2019

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1. Introduction

1.1 Purpose of this report

This Pre-Construction Report describes the design of a proposed new 75 ML Winter Storage Dam at Huon Aquaculture Company (Huon’s) Parramatta Creek Processing Facility.

The purpose of this report is to support Huon’s approvals associated with the development. Accordingly, the report has been prepared in accordance with the requirements described in the Department of Primary Industries, Parks, Water and Environment’s *Guidelines for Pre-Construction Reports*, (DPIPWE, 2015).

1.2 Background

Huon process fresh fish from Southern and Western Tasmania at Parramatta Creek. Fish are transported in specifically designed trucks. The fish are cooled during transport by ice and seawater. Once at the facility, the water and ice becomes wastewater. Presently, the wastewater is stored in one of four existing dams at the site. The water is shandied with fresh water and used for irrigation of adjoining farmland owned by Huon. Environmental monitoring of the site indicates that some land requires remediation prior to further irrigation. Huon plan to expand irrigation to a neighbouring property. In order to do so, the electrical conductivity of the irrigation water needs to be lowered. The design intent of the new winter storage dam is to provide additional wastewater storage and allow for additional shandying to reduce the electrical conductivity of the irrigation water.

1.3 General details

General details for the proposed dam are summarised in Table 1.

Table 1 General details

Parameter	Value	
Dam Coordinates	461835 E, 5423350 N	
Dam Type	Off stream	
ANCOLD Consequence Category	Significant	
Full Supply Level (FSL)	129.45	M AHD
Capacity at FSL	75	ML
Pond Area at FSL	1.94	Ha
Maximum Embankment Height	7.5	m
Upstream Batter Slope	3.0 (H) : 1 (V)	
Downstream Batter Slope	2.5 (H) : 1 (V)	
Crest Width	5	m
Crest Level	130.25	m AHD
Overflow Type	200 ND Outlet Pipe	
Spillway Type	3 m long Broad Crest Weir	

1.4 Scope and limitations

This report has been prepared by GHD for Huon Aquaculture Company and may only be used and relied on by Huon Aquaculture Company for the purpose agreed between GHD and the Huon Aquaculture Company as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Huon Aquaculture Company arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Huon Aquaculture Company and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Consequence Category

2.1 Scope of this section

Tasmanian legislation relating to dam safety includes the Water Management Act 1999 and the Water Management (Safety of Dams) Regulations 2015. On technical requirements, the regulations generally reference the relevant Australian National Committee on Large Dams (ANCOLD) Guidelines.

The guidelines, and to a certain extent the regulations, adopt a risk based approach with dam design and safety requirements dependent on the potential consequence of a dam failure. The consequence from a dam failure can vary and ANCOLD's Guidelines on the Consequence Categories for Dams (ANCOLD, 2012) defines a range of Consequence Categories according to the severity of impacts from a dam breach.

The Consequence Category is based on the assessed severity of damage, loss and hazard to human life posed by a failure of the structure.

GHD have undertaken an "Intermediate" level assessment of the Consequence Category of the proposed dam in accordance with ANCOLD, 2012.

2.2 Estimate of downstream impacts of a dam break

A failure of the dam would release wastewater into Parramatta Creek, a tributary of the Mersey River. 1.5 km downstream of the dam, a dam break flow would pass the Bass Highway. Twin culverts beneath the highway in this location would be quickly inundated with flow depths up to 0.7 m possible over the highway. The car park of the rest area downstream of the highway would also be inundated, with the shallow overland flows possible through the grounds of the adjacent café/conservatory. Downstream of this location the creek flows through agricultural land and forestry plantation until the confluence with the Mersey River. It crosses a number of minor roads and forestry tracks in this reach, however no Population at Risk (PAR) is anticipated downstream of the rest area. A dam break flood map has been produced and is included in Appendix B.

Macquarie Franklin undertook independent flood modelling of the dam break for Huon. The modelling generally provided consensus with the GHD modelling. The Macquarie Franklin modelling provided additional understanding of the flood timeframes. It was determined that the rest stop area would begin to flood approximately 21 minutes after the dam break commenced, and remained flooded for 23 minutes.

Methodology developed by Campbell et. al. in the paper titled "*Flooded cars: estimating the consequences to itinerants exposed to dam break floods on roads*" has been used to estimate the hazard posed to itinerants on the highway. A similar methodology has been used to estimate the hazard posed to itinerants at the rest stop. No Population at Risk is considered for the café/conservatory as it was determined that it is situated above the dam break flood level. Its grounds may, however, be subject to shallow, localised overland flooding.

The following assumptions underpin the analysis:

- The Bass Highway in this location has an Annual Average Daily Traffic (AADT) of 8184 (Department of State Growth data)
- 80% traffic occurs during daylight hours (12 hours a day) and 20% of traffic occurs after hours
- The average occupancy rate of 2 No. people per vehicle

- The speed limit on this section of road is 110 kph
- There is good line of sight on each approach to the inundation zone
- The estimated peak flood depth over the highway in a dam break event is 0.7 m, with a flow velocity of approximately 2.7 m/s
- The length of inundated road is around 125 m
- Flooding over the road/rest area could occur for up to approximately 23 minutes.
- On average 4 No. cars use the rest-stop per hour during daylight hours, 0 No. cars use the rest stop after hours.
- 10 min average stop at rest area.
- 1% probability of a rest stop user taking no action to avoid the flood waters.

The result of the analysis are summarised in Table 2.

Table 2 PAR and PLL assessment for dam break

Time of Day	Scenario	PT:S	PNE:T	PA:NE	Exposure	PARv	Weighted PARv	VD:A	Weighted PLL
Business Hours	Vehicle within inundation zone	0.68	0.01	0.90	0.07	2	0.01	0.04	0.01
	Vehicle driving into inundation zone during event	0.68	0.01	0.90	0.07	2	0.01	0.04	0.01
	Vehicle driving into inundation zone after event	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
	Rest Stop	0.67	0.01	0.90	0.072	2	0.144	0.90	0.13
After Hours	Vehicle within inundation zone	0.17	0.10	0.90	0.18	2	0.37	0.04	0.01
	Vehicle driving into inundation zone during event	0.17	0.10	0.90	0.18	2	0.37	0.04	0.01
	Vehicle driving into inundation zone after event	0.00	0.00	0.00	0.00	0	0.00	0	0.00
	Rest Stop	0.00	0.00	0.00	0.00	0	0.00	0	0.00
						PAR	1.175	PLL	0.17

The Severity of Damage and Loss from a dam break of the dam is assessed as “Medium” owing to the environmental, business and political implications and fallout from a dam break.

The Consequence Category Assessment is based on the severity of damage and loss in conjunction with the incremental risk to human life, expressed as either the Population at Risk (PAR) or Potential Loss of Life (PLL). The PAR is assessed as 1.175 and the PLL as 0.17. Consequence Category based on both PAR and PLL is reproduced from ANCOLD (2012) in Table 3.

Table 3 Consequence Category based on PAR (from Table 3 in ANCOLD 2012)

Population at Risk (PAR)	Severity of Damage and Loss			
	Minor	Medium	Major	Catastrophic
<1	Very Low	Low	Significant	High C
≥1 to <10	Significant (Note 2)	Significant (Note 2)	High C	High B
≥10 to <100	High C	High C	High B	High A
≥100 to <1000	(Note 1)	High B	High A	Extreme
≥1000		(Note 1)	Extreme	Extreme

Note 1 With a PAR in excess of 100, it is unlikely damage will be minor. Similarly, with a PAR in excess of 1,000 it is unlikely damage will be classified as medium.

Note 2 Change to ‘High C’ where there is the potential of one or more lives being lost.

Based on a PAR of 1.17 and ‘medium’ severity of damage and loss, ANCOLD suggests a Consequence Category of Significant. Based on PLL of 0.17 and ‘medium’ severity of damage and loss, ANCOLD suggests a Consequence Category of Significant.

The natural catchment upstream of the highway and rest area is not large and as such, the Wet Day Incremental PAR and PLL is considered unlikely to differ substantially from the sunny day assessment.

The Consequence Categories from each of the different scenarios and methodologies (PAR/PLL) are summarised in Table 4.

Table 4 Consequence Category Assessment

Scenario	Assessment	PAR/PLL	Severity of Damage and Loss	Consequence Category
Sunny Day	PAR	1.175	Medium	Significant
	PLL	0.17		Significant
Wet Day Incremental	PAR	1.175		Significant
	PLL	0.17		Significant

On balance, the Consequence Category of the Dam is assessed as Significant.

2.3 Implications of Consequence Category

2.3.1 Minimum competency requirements for design, construction and surveillance activities

The Water Management (Safety of Dams) Regulations 2015 (S.R. 2015, No. 98) outlines minimum competency requirements for individuals undertaking certain activities relating to the design, construction and surveillance of dams in Tasmania. Minimum competency requirements for activities are based on the consequence category and the height of the dam.

Regulatory requirements for the new dam i.e. a “Significant” consequence category less than 10 m in height is reproduced in Table 5.

Table 5 Minimum competency requirements according to Water Management (Safety of Dams) Regulations 2015 (S.R. 2015, No. 98, Section 13)

Activity	Competency Requirement
Design plans and specifications	Class 1
Pre-construction, investigation, design and report	Class 1 or Class 3
Supervision of construction and decommissioning	Class 1
Work as Executed Report	Class 1
Dam safety emergency management plans	Class 1
Intermediate surveillance inspections and reports	Class 2
Comprehensive surveillance inspections and reports	Class 2
Safety reviews (consequence category assessment)	Class 2
Dam incident investigation and report	Class 1 or Class 3

The GHD Design team whom have prepared this Pre-Construction report include a number of individuals whom meet the Class 1 competency requirements.

2.3.2 Design parameters

ANCOLD gives guidance on key design parameters based on the Consequence Category of the dam. This includes:

- Design Flood**– ANCOLD’s *Guidelines on Selection of Acceptable Flood Capacity for Dams* (ANCOLD 2000) recommends a fallback flood capacity of the 10⁻³ to 10⁻⁴ Annual Exceedance Probability (AEP) for Significant consequence category dams.

2.3.3 Inspection requirements

ANCOLD (2003) also gives guidance on inspection frequency for different Consequence Category dams. For a “Significant” Consequence Category the frequency of inspection should be as follows:

- Comprehensive Inspection** – On first filling then 5 yearly (Class 2)
- Intermediate Inspection** – Annual to 2-Yearly (Class 2)
- Routine Visual** – Twice Weekly to Weekly (by Operations Personnel)
- Special** – As required (Class 1)

**Dam owners may undertake a review to determine if a reduced or increased frequency of inspection is acceptable. The review should be carried out by a dams engineer.*

2.3.4 Reporting requirements

Operations, Maintenance and Surveillance Manual

ANCOLD (2003) guidance is that an Operation, Maintenance and Surveillance (OMS) Manual be produced prior to the commissioning of all but “Very Low” Consequence Category dams. The manual should cover design intent, daily operations and inspections, water management procedures, criteria for mechanical and electrical works (including pumps), surveillance, maintenance and reporting requirements. Operational Management Plans within the OMS Manual should specifically highlight all designer requirements for operation and response actions that must be met to ensure the ongoing safety of the dam.

Dam Safety Emergency Management Plan

ANCOLD (2003) suggests that a Dam Safety Emergency Management Plan (DSEMP) should be prepared where there is potential for a loss of life in the event of dam failure.

3. Geotechnical investigation

3.1 Geological setting

Mineral Resource Tasmania (MRT) 1:25,000 scale Geological Map “West Frankford,” covers the site and an extract is included in Figure 1. No other geotechnical records in the vicinity are available. Based on the mapping, the dam is situated in the vicinity of a number of geologies as follows (in order of oldest to youngest):

- **Dolerite (Jd)** – Dolerite and related rocks
- **Mudstone (Pib)** – Poorly sorted pebbly mudstone, sandstone and minor conglomerate; marine fossils present in places
- **Sandstone (Pfh)** – Quartz sandstone and shale, carbonaceous in some places and minor conglomerate
- **Paleogene (Ts)** – Undifferentiated Paleogene – Neogene sediments: dominantly non-marine sequences of gravel, sand, silt, clay and regolith
- **Alluvium (Qha)** – Stream alluvium, swamp and marsh deposits

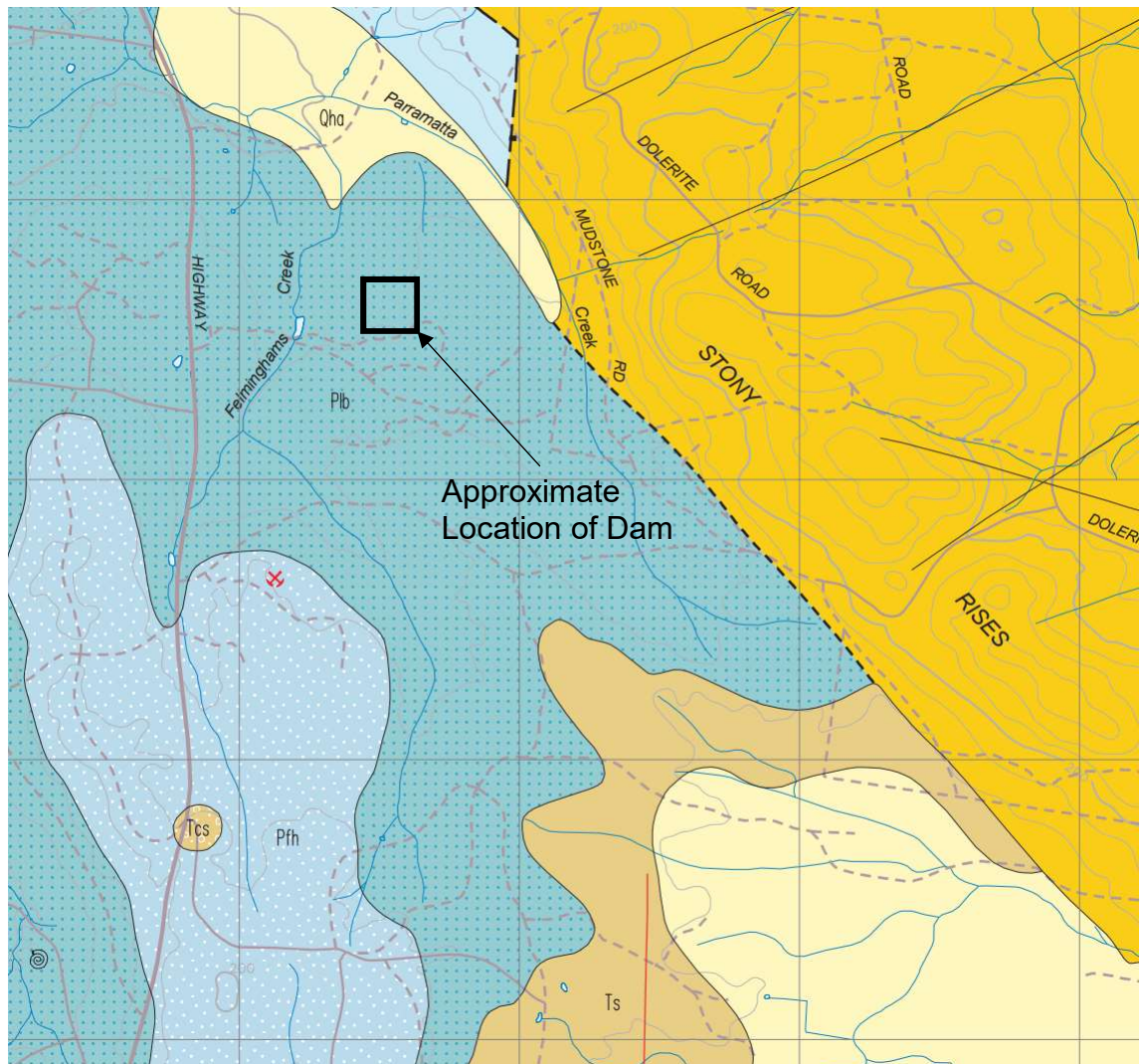


Figure 1 West Frankford geology map extract (Source: Mineral Resources Tasmania)

3.2 Geotechnical investigations

A geotechnical investigation was undertaken in the vicinity of the proposed dam site on the 27th April 2018. A total of nine test pits were excavated using a 13 t excavator.

Ground conditions were similar across all the test pits. A summary of typical sub-surface conditions is presented in Table 6. Detailed test pit logs and photographic records are presented in Appendix C and Appendix D respectively.

Table 6 Sub surface summary

Sub-Surface Summary
TOPSOIL; SILT with Sand, 0 – 0.5 m
Overlying
CLAY/SILT, low plasticity 0.2 – 1.8 m
Overlying
MUDSTONE, typically Highly Weathered, low strength, IR defects.

A number of bulk samples were collected and tested by ADG Laboratories, a NATA accredited laboratory located in Ulverstone. A summary of the classification testing is provided in Table 7, a summary of the grading results are presented in Table 8. Emerson Class results are presented in Table 9. Permeability test results are presented in Table 10. Laboratory certificates are contained in Appendix E.

It should be noted that post completion of the geotechnical investigation, the proposed dam site was moved further north downslope, to facilitate gravity drainage from the existing adjacent dams to the new dam. Ground conditions are expected to be similar for the new site, however further investigations are recommended to confirm this prior to construction.

Table 7 Testing summary

Test ID	Depth	Emerson Class	Moisture content (%)	Atterberg Limits (%)			L.S
				L.L	P.L	P.I	
TP2	0.7 - 0.8 m	4	33.3	54	26	13	13
TP4	0.7 - 0.8 m	4	15.4	21	15	6	4
TP4	2.3 - 2.4 m		18.4				
TP6	1.6 - 1.7 m		24.8				
TP7	0.7 - 0.8 m	5	23.1	33	19	15	8

Note: L.L. = Liquid Limit, P.L. = Plastic Limit, P.I. = Plasticity Index, L.S. = Linear Shrinkage

Table 8 Particle Size Distribution (PSD) Summary

Material Type	TP2@0.7 - 0.8 m	TP4@0.7 - 0.8 m	TP4@2.3 - 2.4 m	TP6@1.6 - 1.7 m	TP7@0.7 - 0.8 m
Cobbles		0			
Gravel	1%	2%	43%	40%	1%
Sand	11%	12%	23%	19%	18%
Fines	88%	86%	34%	41%	81%

Table 9 Emerson Class results

Test ID	Depth	Emerson Class	Emerson Class Description
TP2	0.7 - 0.8 m	4	Does not disperse – Carbonate and Gypsum Present
TP4	0.7 - 0.8 m	4	Does not disperse – Carbonate and Gypsum Present
TP4	2.3 - 2.4 m		
TP6	1.6 - 1.7 m		
TP7	0.7 - 0.8 m	5	Disperses (illite)

Table 10 Permeability Test Results

Test ID	Depth	Permeability, K _{sat} (m/s)
TP2	0.7 -0.8 m	2.24 x 10 ⁻¹⁰
TP4	0.7 – 0.8 m	3.78 x 10 ⁻⁹

3.3 Groundwater monitoring

Six groundwater monitoring wells are installed on the Parramatta Creek site. The wells are monitored for environmental water quality on a 3-monthly basis. In addition to collecting water samples for analysis, the groundwater level is also recorded.

Groundwater monitoring indicates that the groundwater level is usually shallow across the site, typically within 1 metre of the surface. However, groundwater was encountered deeper in the test pits. It is expected that the groundwater is slightly elevated due to the high volume of irrigation over the area. Due to shallow groundwater, conditions will need to be monitored during excavation of the storage to determine if additional measures are required to lower ground water levels, to prevent damage to the clay liner.

An underdrain has been included in the deisgn to allow construction of the CCL and prevent damage during operation, the final inclusion of the underdrain will depend on the results of the additional geotechnical investigations. If groundwater is more severe than initially thought a sand filter blanket may need to be placed on batters below the CCL.

4. Dam design

4.1 Design basis/assumptions

Key assumptions underpinning the concept design are as follows:

- Pond capacity is to be 75 ML at FSL (i.e. spillway crest). We have assumed that the capacity is sufficiently in excess of actual storage requirements such that the dam can be operated with sufficient dry freeboard to limit spill from the dam to an acceptable frequency.
- Wastewater will be piped to the dam via a gravity connection to the existing Dam 4. Available LiDAR survey indicates a pond level of approximately RL 132.0 m AHD for Dam 4. It is recommended that Huon confirm this level by survey prior to construction. To maintain a gravity supply from Dam 4 to the new pond, the Full Supply Level (FSL) of the dam has been set at 129.45 m, 2.55 m below the FSL of Dam 4.
- Accumulation of sediment is not considered to be an issue as the dam lies downstream of a series of other dams. In the event that sediments do accumulate in the dam over time and reduce the available storage, a vacuum truck could be used to de-sludge the lagoon.
- The dam is to be drained via a submerged outlet. An allowance has been made for a 200 mm ND outlet pipe.
- Geotechnical conditions for the dam site are consistent with those described in Section 3.

The battery limits for GHD’s design are as follows:

- Inlet pipe between Dam 4 & New Waste Water Dam - at the interface with embankment.
- Outlet pipe - at the point where the outlet pipe emerges from the downstream toe of the embankment.

4.2 Design details

The dam design proposes a hillside storage, with low (< 7.5 m high) engineered embankment to confine the pond to the north, east and west. Topsoil will be stripped and stockpiled for later spreading on external batter slopes to aid revegetation. Underlying clay will be stripped and stockpiled for later use as the select clay core and Compacted Clay Liner (CCL) within the storage to limit seepage risk.

Fill for construction of the embankment is to be won from the reservoir excavations. Should additional clay be required, geotechnical investigations found large area of consistent clay material directly south of the proposed dam site.

Table 11 General details

Parameter	Value	
Dam Type	Off stream	
ANCOLD Consequence Category	Significant	
Full Supply Level (FSL)	129.45	M AHD
Capacity at FSL	75	ML
Pond Area at FSL	1.94	Ha
Maximum Embankment Height	7.5	m
Upstream Batter Slope	3.0 (H) : 1 (V)	
Downstream Batter Slope	2.5 (H) : 1 (V)	
Crest Width	5	m
Crest Level	130.25	m AHD

An embankment design featuring a central clay core with should constructed from general fill. A typical section is presented in Figure 1. Stable downstream batter slopes of 2.5 (H):1(V) have been adopted. Upstream batter slopes of 3(H):1(V) have been adopted for ease of placement of the compacted clay liner (CCL) within the storage area and slope maintenance as required. Stability analysis has been undertaken and is presented in section 5.



The design features a 5 m wide embankment crest to facilitate construction, safety bunds have not been provided given Huon have confirmed the embankment is not for vehicular access. External batters shall be covered with grass

A 600 mm thick compacted clay liner is proposed within the dam storage area to minimise seepage. The CCL shall have a minimum permeability of 1×10^{-9} m/s. An estimate of seepage from the lagoon with the pond at full supply level has been performed, with 1 L/s being the estimated outflow. The CCL shall be covered with 300 mm of select weathered rock material at the base of the dam and batters shall be covered with 500 mm of select weathered rockfill.

Spillway

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A concrete crest block is proposed at the inlet of the spillway, the crest block shall be 500 mm wide and 500 mm deep. The crest block will act as a broad crested weir and prevent erosion of the crest.

Downstream of the crest the spillway chute will comprise a trapezoidal open channel, 3 m wide at the base and 0.5 m deep. The minimum grade shall be 1%. The channel will be reseeded with grass and lined with Grassroots or approved equivalent geotextile to prevent erosion during spillway flows.

External cut Off drains

The external drains have been sized for extreme flood events. The drains will be trapezoidal with a depth of 0.6 m and a base width of 0.5 m. Excavated spoil should be used to form a 0.5 m high earth fill bund on the storage side of the drain.

5. Stability analysis

5.1 Method of analysis

The Rocscience Slide 8.0 software package has been used to undertake 2D limit equilibrium slope stability analysis of the new dam. Bishop’s Simplified Method of Slices was adopted in calculating the Factor of Safety (FOS) against circular failures and the GLE/Morgenstern Price method for non-circular failures for static loading cases.

5.2 Section

A cross section has been taken through the highest section of the embankment as this will be the critical case for stability. The section is presented in Figure 3.

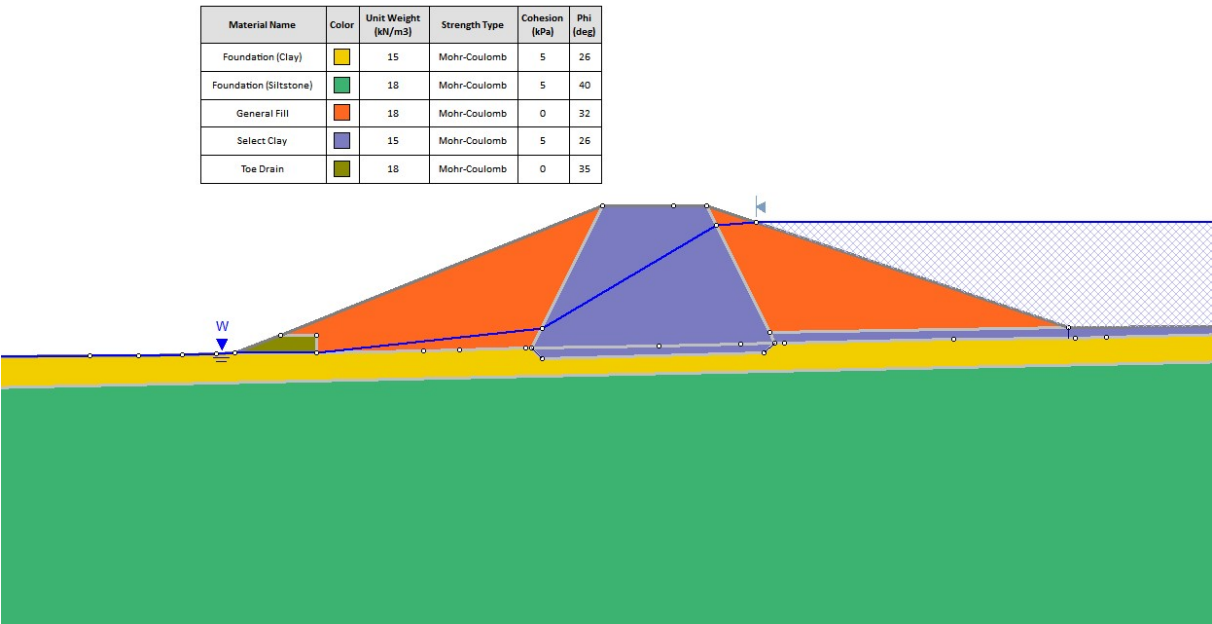


Figure 3 Stability section

5.3 Load cases

A number of load cases have been considered for the stability analysis, these are presented below.

Case		Drained or Undrained materials	Pond RL	Failure Direction	Target FoS
1	Short Term Construction	Undrained	129.450	US & DS	1.5
2	Normal Static Conditions	Drained	129.45	US & DS	1.5

5.4 Material parameters

Selection of material parameters has been guided by field observations and laboratory test results from the geotechnical investigation. The embankment fill material and foundation parameters adopted for the analysis are presented in Table 12. The undrained shear strength for the compacted clay is based on in situ testing during the field investigation.

Table 12 Material parameters

Material	Unit Weight (kN/m³)	Friction Angle (°)	Cohesion (kPa)	Undrained Shear Strength (kPa)	Saturated Permeability (m/s)
Foundation – Siltstone	18	40	5	-	1 x 10 ⁻⁶ m/s
Foundation – Clay	15	26	5	65	5 x 10 ⁻⁹ m/s
General Fill	18	32	0	-	1 x 10 ⁻⁶ m/s
Compacted Clay Liner	15	26	5	65	5 x 10 ⁻⁹ m/s
Toe Drain	18	35	0	-	1 x 10 ⁻³ m/s

5.5 Phreatic surface

Steady State FEA groundwater analysis has been used within Slide to determine the general phreatic surface. A water table has been applied to all cases based on this phreatic surface.

5.6 Static stability results

The results from the stability analysis show that the minimum factors of safety are achieved for all cases. The results are summarised in Table 13. Slide outputs are presented in Appendix G. It can be seen that factors of safety meet the minimums for case 1 and 2.

Table 13 Stability results

Case	Drained or Undrained materials	Failure Surface	Achieved FOS		Outcome
			US	DS	
1	Undrained	Non-Circular	1.8	1.6	PASS
		Circular	1.8	1.6	PASS
2	Drained	Non-Circular	1.8	1.6	PASS
		Circular	1.8	1.6	PASS

5.7 Seismic Risk

The dam will be founded on clay and siltstone which are not subject to liquefaction during a seismic event. The design uses conservative batter slopes, has a low embankment height and well compacted materials for construction. Based on this information it is unlikely that the embankment will suffer significant deformation in a seismic event.

5.8 Pond Drawdown

The embankment has been designed with upstream batter slopes of 3H:1V constructed with well compacted materials. It is not expected that rapid drawdown will occur under standard operating conditions. It is expected that the drawdown will occur over the full irrigation season.

Regular operational inspections should take note of any erosions or slumps which occur on the upstream batter.

In the event that the pond level is need to be drawn down rapidly it is expected that this would take approximately 6 days based on the outlet pipe dimensions. In this scenario there is a risk that shallow failures of the upstream toe may occur, which would require repair prior to refilling the dam.

6. Risk register

6.1 Scope of this section

This sections describes the risk assessment and Safety in Design process undertaken as part of the design.

6.2 Risk register

It is important that Huon Aquaculture has a clear understanding of the risks to be monitored, managed and budgeted for across the life of the lagoon. To facilitate this, GHD has developed a register to attempt to capture the key opportunities and risk associated with the safe design, construction, and operation and decommissioning of the lagoon.

The risk register comprises a 'likelihood and consequence' risk matrix to determine the risk rating for each risk identified, control measures that can be used to mitigate the risk and an assessment of the residual risk rating following implementation of the controls. The risk register assigns responsibility for the residual risks associated with the structure.

6.3 Safety in Design

The risk register includes Safety in Design risks. Safety in design is a strategy aimed at preventing injuries by considering hazards as early as possible in the planning and design process, enhancing safety through choices in the design process. A safety in design approach considers the safety of those who construct, operate, maintain, clean, repair and demolish an asset (includes building, structure, plant or equipment). Parties involved in the planning and design stage of a project are in a position to reduce the risks that arise during the life cycle of the asset. At each design stage "designers" can make a significant contribution by identifying and eliminating hazards, and reducing the likely risks from hazards where elimination is not possible. Often the most cost effective and practical approach is to avoid introducing a hazard to the workplace in the first place, by eliminating hazards at the design stage.

6.4 Risk workshop

To populate the risk register, a risk assessment workshop was attended by key GHD and Huon personnel on 24/09/2018. The workshop identified and developed mitigation measures for a number of potential key risks associated with the structure. The risk register does not attempt to capture all risks associated with the structure.

6.5 Residual risk

In accordance with our Safety in Design obligations under Tasmanian law, GHD has prepared the risk register in Appendix H.

GHD formally hands responsibility of the residual risks to Huon Aquaculture for further mitigation. The risk register should be provided to any other parties who may be identified as being able to influence design. The risk register should be continually updated to reflect the risks associated with all current activities associated with the asset.

7. Construction, operation and performance

7.1 Purpose of this section

This section outlines critical issues pertaining to the construction and performance of the new dam. The Technical Specification (refer Appendix I) details all construction requirements for the new dam.

7.2 Construction

7.2.1 Pre-construction geotechnical investigation

The location of the winter storage dam lies to the North of the existing Geotechnical Test Pits undertaken during the concept design phase. The dam location was changed in the detailed design phase. While the existing geotechnical information indicated that the sub-surface conditions were consistent across the site, it is recommended that additional test pits are undertaken in the footprint of the dam to reduce construction risk, and samples collected for triaxial testing to confirm material parameters adopted.

7.2.2 Pre-construction survey of existing Dam 4 pond & outlet

To ensure that wastewater can be conveyed via gravity to the winter storage dam proposed in the GHD design it is recommended that the pond level of the existing Dam 4 be surveyed. This will enable the transfer line to be designed (by others) accordingly.

7.2.3 Equipment required for construction

Construction will likely involve the use of excavators, trucks, water cart, pad-foot and smooth drum rollers. Construction should be awarded to a contractor with experience in dam construction, who has high level QA/QC including soil selection, placement and construction.

7.2.4 Construction supervision and Quality Assurance

The Water Management (Safety of Dams) Regulations 2015 requires that a person of Class 1 Competence (i.e. a Dams Engineer) supervise construction of the dam. A site presence by the GHD Designer is required during the critical stages of lagoon construction to verify design assumptions and to confirm the quality of the material and placement. Critical HOLD POINTS are outlined in the Technical Specification in Appendix I.

7.2.5 Embankment foundation inspection and in-situ testing

An inspection by the GHD Designer is required following stripping of the embankment footprint. The purpose of this inspection is to confirm the extent of strip requirement beneath the embankment footprint. This inspection will form a HOLD POINT for construction. During the inspection the GHD Designer will undertake in-situ shear vane testing of the foundation materials to validate design assumptions.

7.3 Operation

7.3.1 Desludging

It is unlikely that the new winter storage dam will require desludging, due to it being the final dam in a series of five dams which store wastewater. In the event that desludging is required, a vacuum truck could be used to desludge the dam.

7.3.2 Operations, Maintenance and Surveillance (OMS) Manual

Prior to commissioning of the new dam, Huon Aquaculture shall engage a dams engineer to develop an OMS manual detailing the safe operation of the dam in accordance with ANCOLD (2003).

7.3.3 Dam Safety Emergency Management Plan (DSEMP)

Given the potential for loss of life in a dam break event, the Water Management (Safety of Dams) Regulations 2015 requires that Huon engage a Person of Class 1 Competence (i.e. a Dams Engineer) to prepare a Dam Safety Emergency Management Plan (DSEMP) for the dam prior to commissioning.

7.3.4 Spillway and drains

Regular monitoring of the spillway channel and external cut-off drains shall be incorporated into routine inspections. If the spillway and/or drains become blocked they shall be cleaned out.

7.4 Performance

7.4.1 Monitoring

The design allows for monitoring of the pond level in this dam and sub-soil seepage flow for the purpose of dam safety monitoring (design of all instrumentation by others). The pond level and sub-soil seepage flows should be monitored daily as per the ANCOLD Guidelines. It is recommended that data loggers are utilised for monitoring.

7.4.2 Surveillance

Huon Aquaculture should engage a suitably qualified engineer to undertake the following inspections in line with ANCOLD Guidelines:

- Comprehensive inspection – At first filling, then 5 yearly
- Intermediate Inspection – Annual to 2-Yearly

In addition, Huon personnel trained in Dam Safety Surveillance should undertake Routine Visual Inspections of the structure.

- Routine Visual Inspections – Twice Weekly to Weekly.

8. References

ANCOLD (2000), Guidelines on Selection of Acceptable Flood Capacity for Dams, Australian National Committee on Large Dams, March 2000.

ANCOLD (2003), Guidelines on Dam Safety Management, Australian National Committee on Large Dams, August 2003.

ANCOLD (2012), Guidelines on the Consequence Category for Dams, Australian National Committee on Large Dams, October 2012.

DPIPWE (2015), Guidelines for Pre-Construction Reports, Department of Primary Industries, Parks, Water and Environment, December 2015.

REED, A.R. and CALVER, C.R. (compilers) 2004. Digital Geological Atlas 1:25 000 Sacel Series. Sheet 4642. West Frankford. Mineral Resources Tasmania.

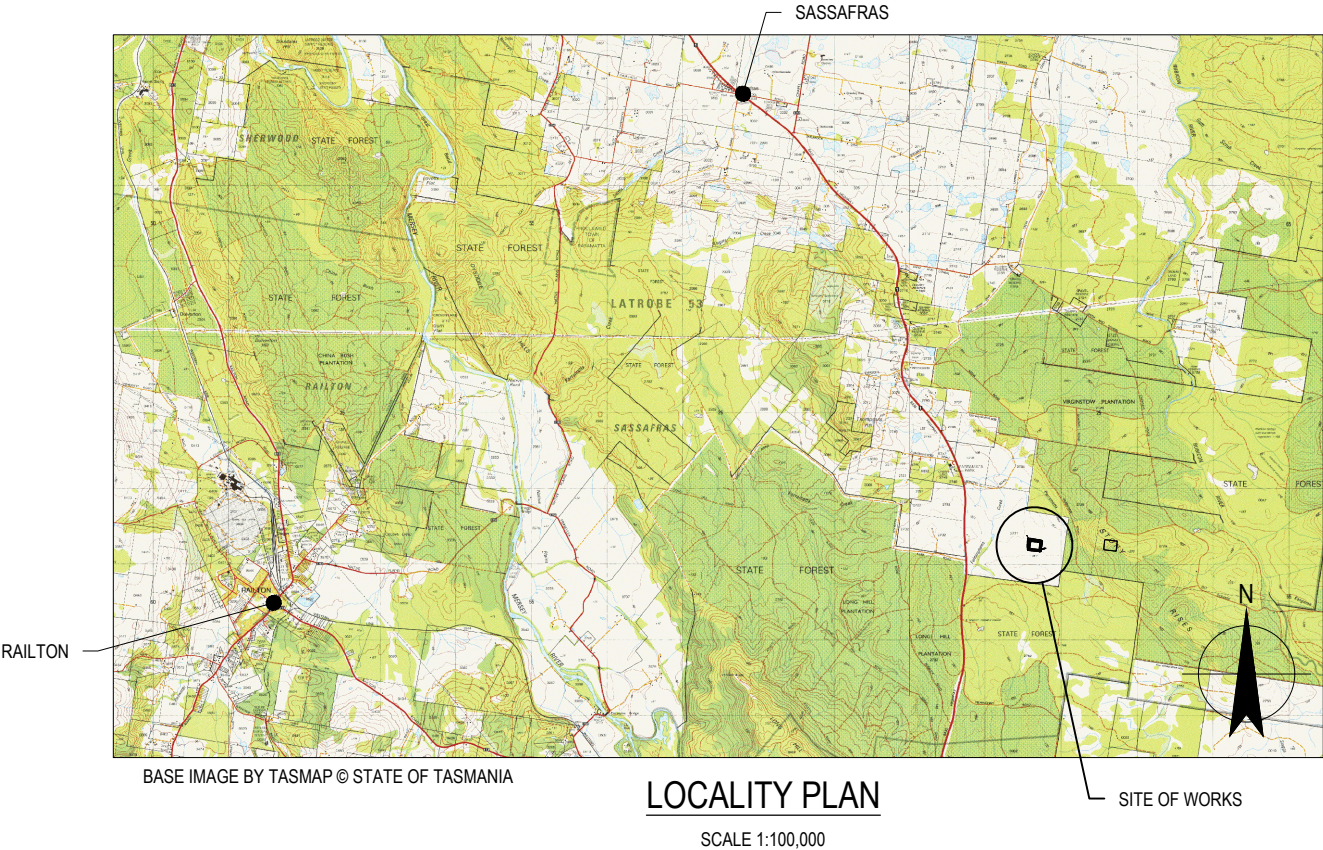
Appendices

Appendix A – Design drawings

HUON AQUACULTURE COMPANY

NEW WASTE WATER DAM

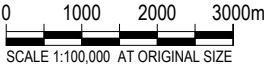
32-18804



DRAWING LIST	
DRAWING NUMBER	DRAWING TITLE
32-18804-C001	COVER PAGE, DRAWING LIST AND LOCALITY PLAN
32-18804-C002	SITE PLAN
32-18804-C003	GENERAL ARRANGEMENT - PLAN
32-18804-C004	TYPICAL LONGITUDINAL SECTION AND CROSS SECTION
32-18804-C005	SPILLWAY PLAN AND CROSS SECTION
32-18804-C006	OUTLET PIPE DETAILS

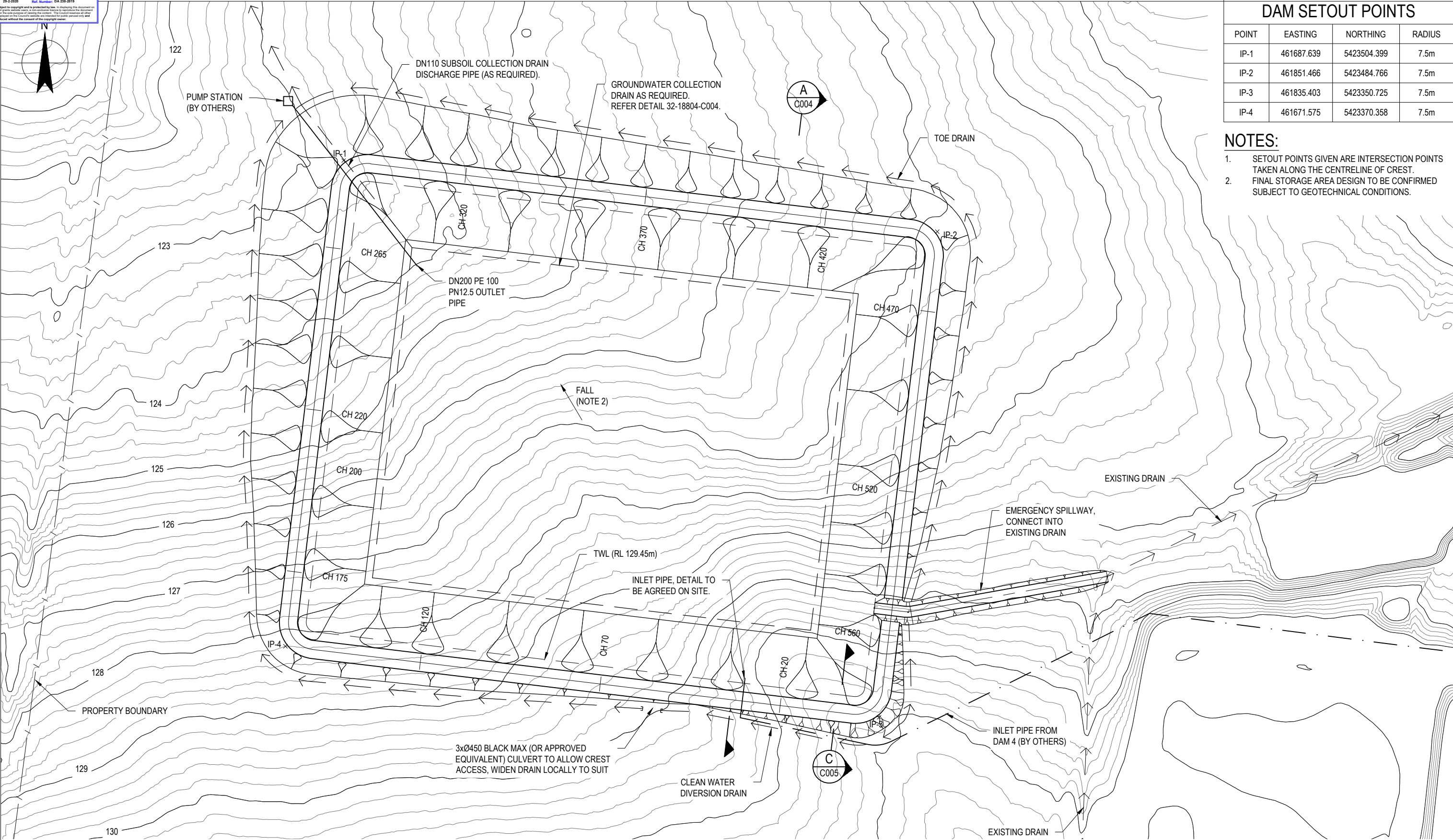
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A	ISSUED FOR CLIENT APPROVAL	DB	CC*	RL*	19.02.19
No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director



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PO Box 567 Burnie TAS 7320
T 61 3 6432 7900 F 61 3 6432 7901
E bwtmail@ghd.com W www.ghd.com

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		Approved (Project Director)				Title	COVER PAGE, DRAWING LIST AND LOCALITY PLAN	
		Date						
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved		Original Size	A3	Drawing No:	32-18804-C001	Rev: B



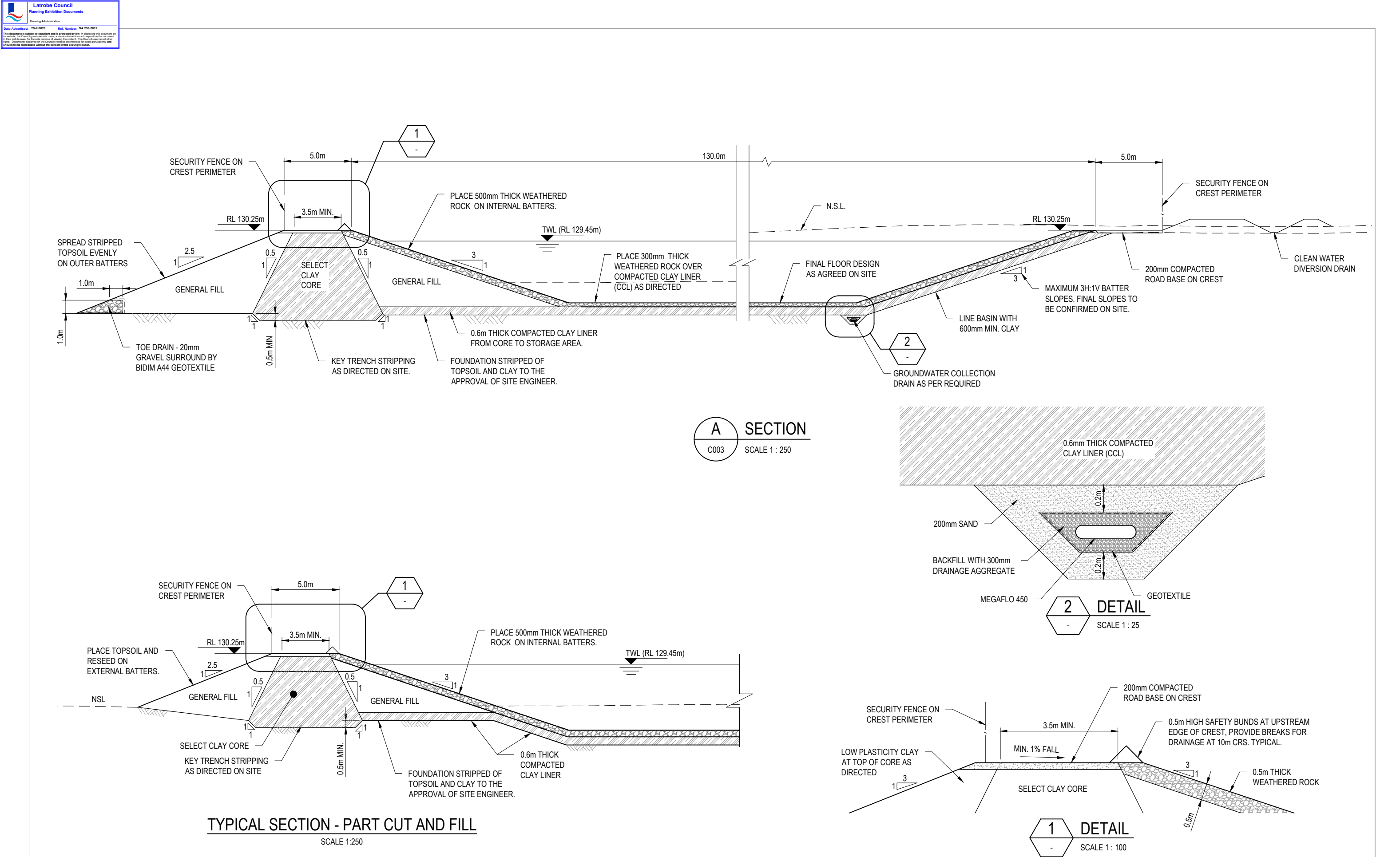
DAM SETOUT POINTS			
POINT	EASTING	NORTHING	RADIUS
IP-1	461687.639	5423504.399	7.5m
IP-2	461851.466	5423484.766	7.5m
IP-3	461835.403	5423350.725	7.5m
IP-4	461671.575	5423370.358	7.5m

- NOTES:**
- SETOUT POINTS GIVEN ARE INTERSECTION POINTS TAKEN ALONG THE CENTRELINE OF CREST.
 - FINAL STORAGE AREA DESIGN TO BE CONFIRMED SUBJECT TO GEOTECHNICAL CONDITIONS.

GENERAL ARRANGEMENT PLAN
SCALE 1:1000

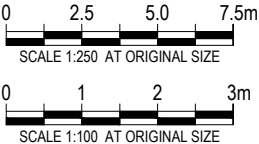
PRELIMINARY

				<div><div>0102030m</div><div>SCALE 1:1000 AT ORIGINAL SIZE</div></div>				<div><div><div><div></div><div>GHD</div></div><div>10 Columnar Court, Burnie TAS 7320 Australia PO Box 567 Burnie TAS 7320 T 61 3 6432 7900 F 61 3 6432 7901 E bwtmail@ghd.com W www.ghd.com</div></div></div>		<div><div>DO NOT SCALE</div><div>Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.</div></div>		<div><div>Drawn D.BOOKER</div><div>Designer C.CAHILL</div><div>Drafting Check</div><div>Design Check</div><div>Approved (Project Director)</div><div>Date</div></div>		<div><div>Client</div><div>Project</div><div>Title</div><div>Original Size</div></div>		<div><div>HUON AQUACULTURE COMPANY</div><div>NEW WASTE WATER DAM</div><div>GENERAL ARRANGEMENT PLAN</div><div>A3</div><div>Drawing No: 32-18804-C003</div><div>Rev: B</div></div>	
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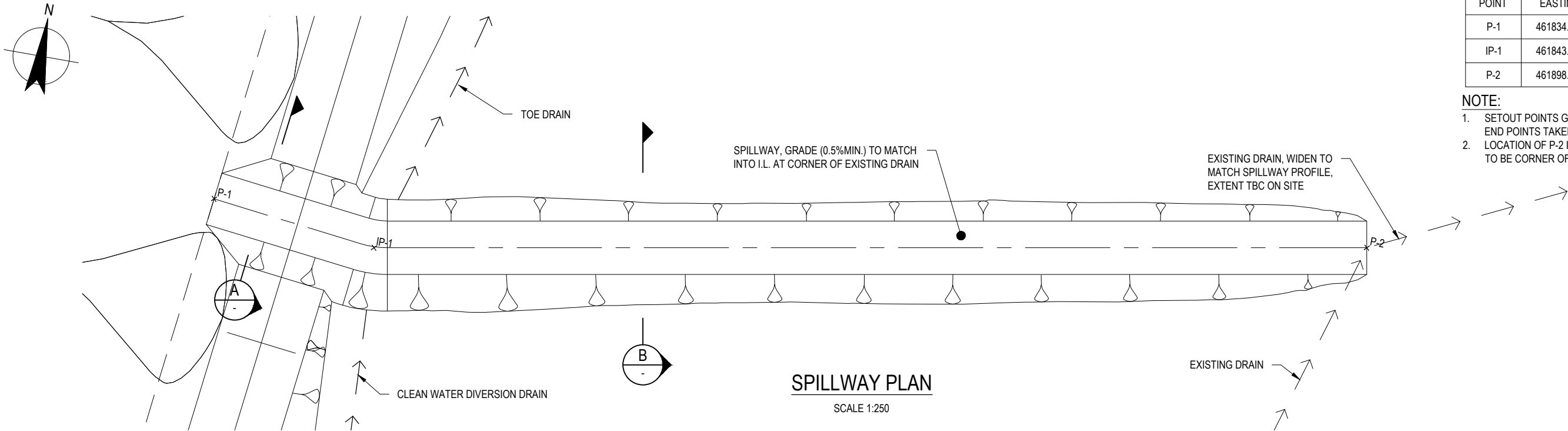




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T 61 3 6432 7900 F 61 3 6432 7901
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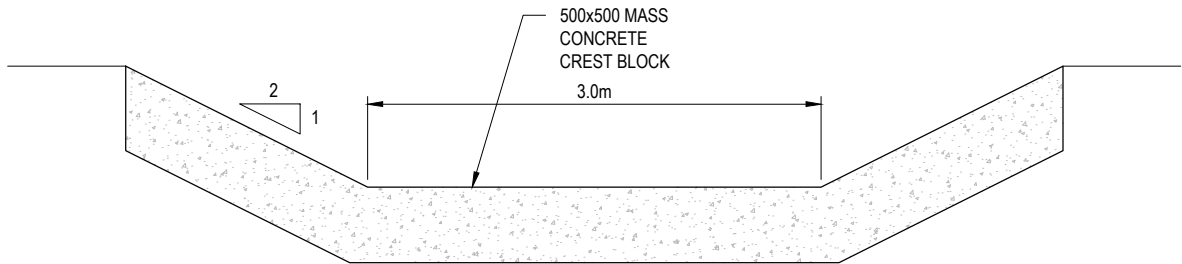
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Client	HUON AQUACULTURE COMPANY		
Project	NEW WASTE WATER DAM		
Title	TYPICAL LONGITUDINAL SECTION AND CROSS SECTION		
Original Size	A3	Drawing No:	32-18804-C004
		Rev:	B

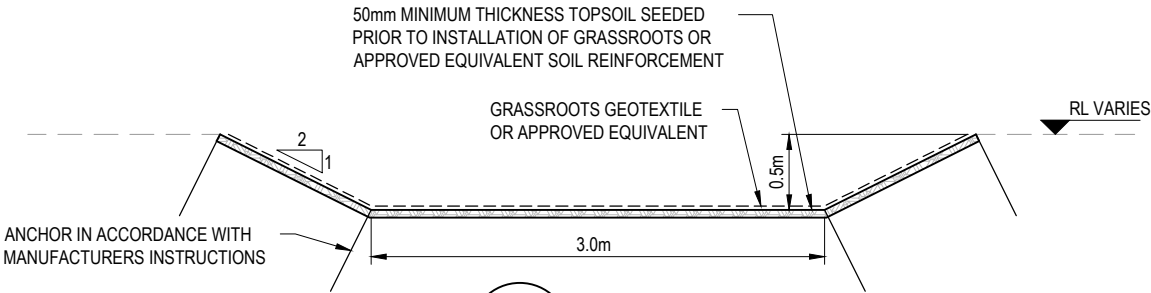


SPILLWAY SETOUT POINTS			
POINT	EASTING	NORTHING	COMMENTS
P-1	461834.083	5423380.890	-
IP-1	461843.416	5423379.772	5m RADIUS
P-2	461898.368	5423389.596	-

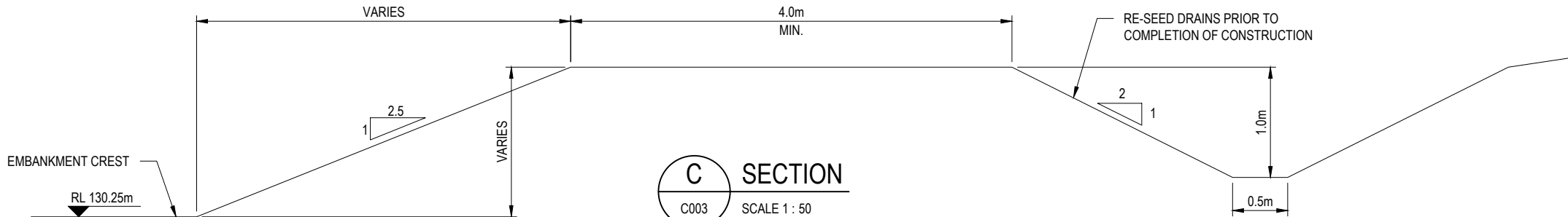
NOTE:
1. SETOUT POINTS GIVEN ARE START, INTERSECTION AND END POINTS TAKEN ALONG THE CENTRELINE OF SPILLWAY.
2. LOCATION OF P-2 IS INDICATIVE ONLY, ULTIMATE LOCATION TO BE CORNER OF EXISTING DRAIN.



A SECTION
SCALE 1 : 50
TYPICAL SECTION AT SPILLWAY CREST



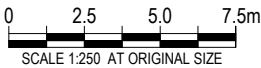
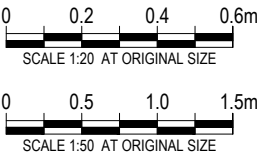
B SECTION
SCALE 1 : 50
TYPICAL SECTION AT SPILLWAY CHUTE



C SECTION
SCALE 1 : 50
TYPICAL SECTION AT TOE DRAIN
SCALE 1:50

PRELIMINARY

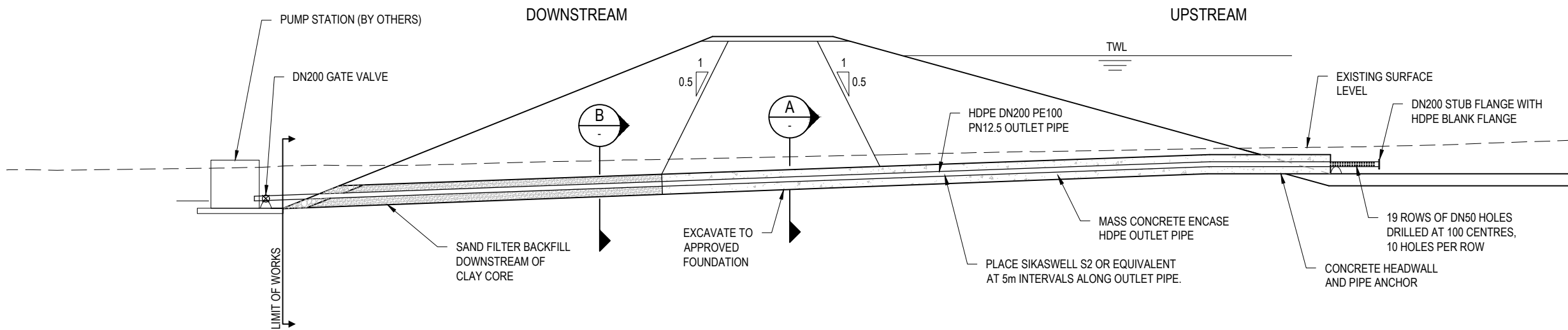
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No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director



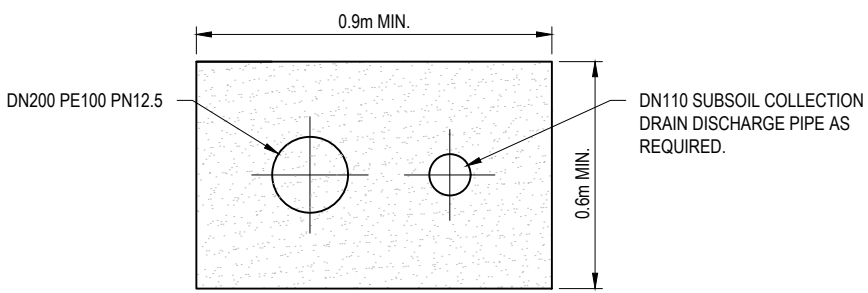
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10 Columar Court, Burnie TAS 7320 Australia
PO Box 567 Burnie TAS 7320
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	Approved	(Project Director)	Date	
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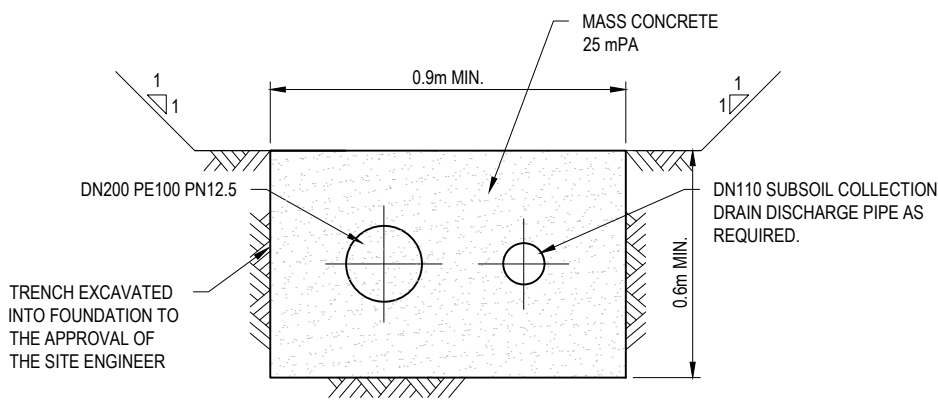
Client	HUON AQUACULTURE COMPANY		
Project	NEW WASTE WATER DAM		
Title	SPILLWAY PLAN AND CROSS SECTION		
Original Size	A3	Drawing No: 32-18804-C005	Rev: B



OUTLET PIPE
TYPICAL SECTION
SCALE 1:200



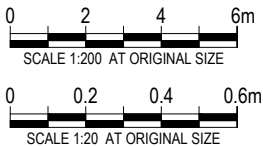
B SECTION
SCALE 1 : 20



A SECTION
SCALE 1 : 20

PRELIMINARY

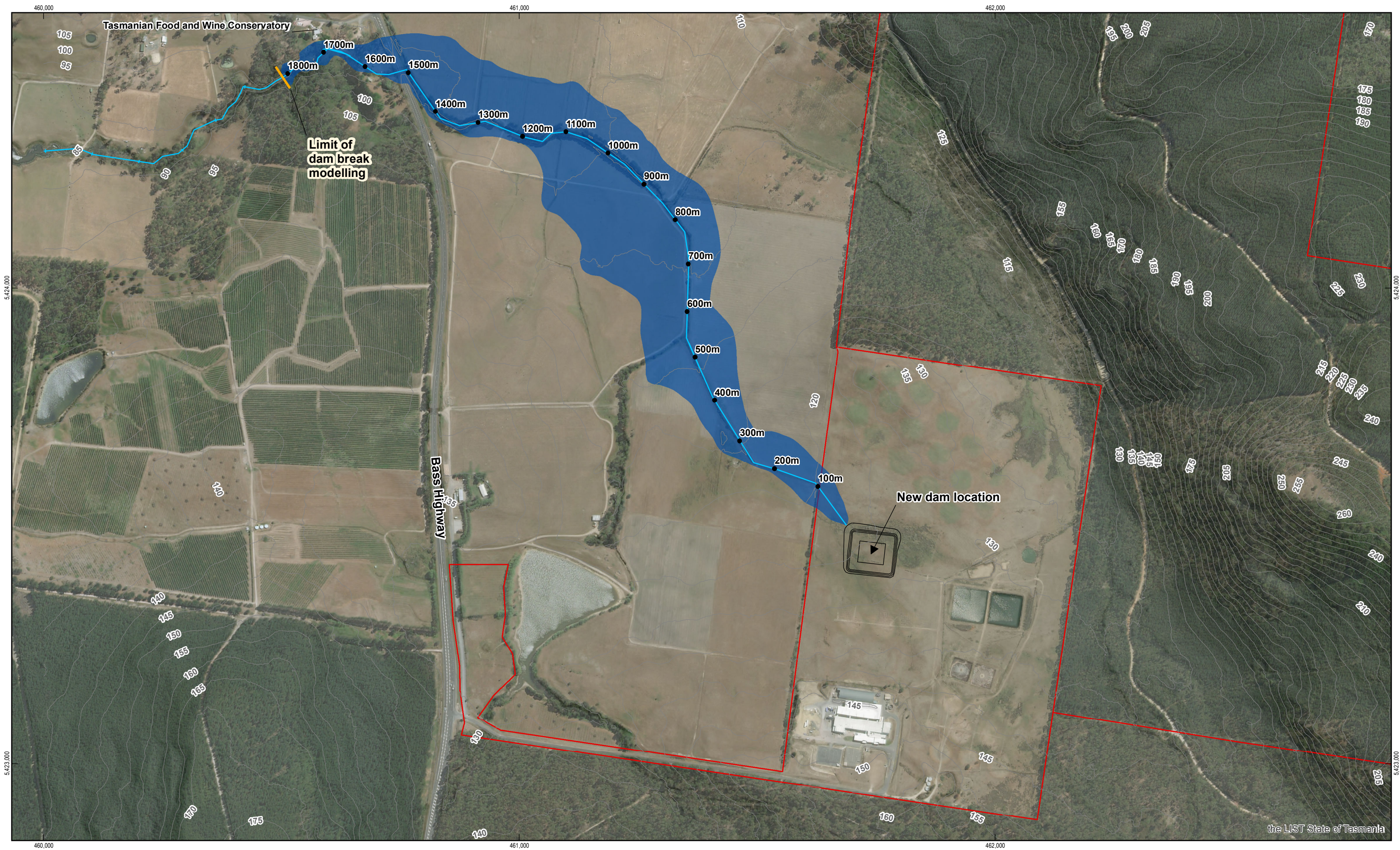
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	Approved (Project Director)			
	Date			
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Client	HUON AQUACULTURE COMPANY			
Project	NEW WASTE WATER DAM			
Title	OUTLET PIPE DETAILS - SHEET 1 OF 2			
Original Size	A3	Drawing No:	32-18804-C006	Rev: B

Appendix B – Dam break flood map



Appendix C – Test pit logs

SOIL LOG SHEET

Client : Huon Aquaculture	LOCATION No. TP01		
Project : New Wastewater Dam	SHEET 1 OF 1		
Location : Parramatta Creek	Position : 461818.0 E, 5423176.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \
Contractor : DIGGA	Rig Type : ZAXIS 135U	Processed : AO	Checked : CC
Date Started : 27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Date : 6 Feb 19

DRILLING				MATERIAL				ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run	Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests
					0.40		TOPSOIL, SILT with sand, brown, rootlets, sand is fine grained	ML	D	S-F	
					0.80		CLAY, mottled orange brown, some rootlets	CI - CH	SM	St	
1					1.60		Trace sand and gravel, mottled grey-orange-brown, no rootlets, friable, sand is fine grained, gravel is fine to medium grained, rounded				D
2					2.40		MUDSTONE, orange-grey, HW, low strength, rounded gravel observed in matrix, IR defects				
3							REFUSAL on MW Mudstone with 13t Excavator				
4											
5											



See standard sheets for details of abbreviations & basis of descriptions



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SOIL LOG SHEET

Client : Huon Aquaculture		LOCATION No. TP02	
Project : New Wastewater Dam		SHEET 1 OF 1	
Location : Parramatta Creek			
Position : 4671718.0 E, 5423224.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \	Processed : AO
Contractor : DIGGA		Rig Type : ZAXIS 135U	Checked : CC
Date Started : 27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Date : 6 Feb 19

DRILLING					MATERIAL					ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run	Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)
					0.40		TOPSOIL, SILT with sand, brown, rootlets, sand is fine grained	ML	D	F		DCP (blows/100mm) = 3/6/8/7/7/4/4/5/4/6/7/4/6/>10	
					0.70		CLAY, brown, rootlets, friable	CI - CH	SM	St			
1							Mottled orange, grey-brown, EW mudstone (?)				D	D (0.7 - 0.8m)	1
					1.70		MUDSTONE, orange-brown, some grey, HW, low strength, IR defects					2.0m: Becoming less weathered with depth	2
2													
					3.20								3
3							Limit of Test Pit - Refusal on MW Mudstone						
4													4
				</									

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Client :	Huon Aquaculture	LOCATION No. TP03		
Project :	New Wastewater Dam			
Location :	Parramatta Creek			
		SHEET 1 OF 1		
Position :	461657.0 E, 5423232.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \	Processed : AO
Contractor :	DIGGA	Rig Type : ZAXIS 135U		Checked : CC
Date Started :	27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Date : 6 Feb 19

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--------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------

SOIL LOG SHEET

Client : Huon Aquaculture	LOCATION No. TP04		
Project : New Wastewater Dam	SHEET 1 OF 1		
Location : Parramatta Creek	Position : 461678.0 E, 5423292.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \
Contractor : DIGGA	Rig Type : ZAXIS 135U	Processed : AO	Checked : CC
Date Started : 27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Date : 6 Feb 19

DRILLING					MATERIAL					ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run	Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)
1					0.20		TOPSOIL, SILT with sand, brown, rootlets, sand is fine grained	ML	D	F - ST	D	DCP (blows/100mm) = 3/7/10/10/10/10/9/10.10/8/6/4/10/>15 D (0.7 - 0.8m)	1
						Sandy SILT, brown, some orange grey, sand is fine grained, silt is low plasticity, with cobbles, up to ~300mm (MUDSTONE)	ML	SM	St - Vst				
					1.30		CLAY, mottled orange-brown, grey	Cl - CH	SM	St - Vst			
					1.60		MUDSTONE, orange-brown, HW, low strength, very-close to close defect spacing						
2					2.20		Orange-brown, grey				D	2.0m: Slight increase in strength with depth D (2.3 - 2.4m)	2
3													3
4					3.70		Limit of Test Pit - Refusal on MW MUDSTONE						4
5													5



See standard sheets for
details of abbreviations
& basis of descriptions



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SOIL LOG SHEET

Client : Huon Aquaculture	LOCATION No. TP05		
Project : New Wastewater Dam	SHEET 1 OF 1		
Location : Parramatta Creek	Position : 461767.0 E, 5423282.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \
Contractor : DIGGA	Rig Type : ZAXIS 135U	Processed : AO	
Date Started : 27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Date : 6 Feb 19

DRILLING					MATERIAL					ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run	Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)
1					0.20		TOPSOIL, SILT with sand, brown, rootlets, sand is fine grained	ML	D - SM	St	SV	DCP (blows/100mm) = 3/4/3/4/4/4/3/1/3/4/9/>15 0.5m: SV = 6S (vane no. 1) 0.8m: SV = 72 (vane no. 1)	1
				0.40		CLAY, brown, trace rootlets	CI - CH	SM	St				
						Mottled brown-orange							
				1.00		Sandy CLAY/SILT, grey-orange, some zones of HW Mudstone, sand is fine to medium grained	CI	Sm	St				
				1.40		MUDSTONE, orange, grey, HW, low strength, IR defects, some zones weathered EW, to sandy SILT/CLAY							
2													2
3											SV		3
4											SV		4
5											SV		5
					3.60		Limit of Test Pit - Refusal (near) on HW-MW Mudstone						



See standard sheets for details of abbreviations & basis of descriptions



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Job No.

3218804

Client : Huon Aquaculture		LOCATION No. TP06									
Project : New Wastewater Dam		SHEET 1 OF 1									
Location : Parramatta Creek											
Position : 461848.0 E, 5423334.0 N MGA94		Surface RL : N.R. Inclination\Bearing : \ Processed : AO									
Contractor : DIGGA		Rig Type : ZAXIS 135U Checked : CC									
Date Started : 27 Apr 18		Date Completed : 27 Apr 18 Logged by : CC Date : 6 Feb 19									
DRILLING		MATERIAL		ADDITIONAL DATA							
SCALE (m)		Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure		Group Symbol Moisture Condition Consistency / Relative Density Samples & Tests		Comments/Observations Insitu test results		SCALE (m)			
Method		Hole Support		Run		Water		Depth / (RL) metres		Graphic Log	
0.30		0.50		0.90		1.40		2.10		Limit of Test Pit - Refusal (near) on MW MUDSTONE	
TOPSOIL, SILT with sand, brown, rootlets, sand is fine grained		ML		D		F-St		DCP (blows/100mm) = 5/4/10/4/6/6/5/5/3/4/5/15/>10			
CLAY, mottled orange-brown, trace rootlets		CI - CH		SM		St		SV 0.6m: SV = 107 (vane no.1)			
Mottled yellow-orange-grey								SV 1.1m: SV = 120 (vane no. 1)			
MUDSTONE, grey, orange, HW, low to medium strength, IR defects								D D (1.6 - 1.7)			
See standard sheets for details of abbreviations & basis of descriptions		GHD Pty Ltd 2 Salamanca Square Hobart TAS 7001, Hobart T: 61 3 62100 600 F: 61 3 62100601 CLIENTS PEOPLE PERFORMANCE		Job No. 3218804							

Client : Huon Aquaculture						LOCATION No. TP07									
Project : New Wastewater Dam															
Location : Parramatta Creek						SHEET 1 OF 1									
Position : 461767.0 E, 5423345.0 N MGA94						Surface RL : N.R.		Inclination\Bearing : \				Processed : AO			
Contractor : DIGGA						Rig Type : ZAXIS 135U						Checked : CC			
Date Started : 27 Apr 18						Date Completed : 27 Apr 18				Logged by : CC				Date : 6 Feb 19	
DRILLING				MATERIAL								ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)			
1				0.25		TOPSOIL, SILT with sand, brown, rootlets, sand is fine grained	ML	D	F-St		DCP (blows/100mm) = 3/5/7/7/5/4/4/5/4/4/4/4/4/4/>>10	1			
						CLAY, mottled orange-brown, trace rootlets	Cl - CH	SM	St						
				0.70		No rootlets		SM - M	D				D (0.7 - 0.8m)		
2				1.70		MUDSTONE, grey, orange, brown, HW, low strength, IR defects						2			
				2.50		Limit of Test Pit - Refusal on MW MUDSTONE						3			
3												3			
4												4			
5												5			

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Planning Administration

Date Advertised: 29-2-2020 Ref. Number: DA 238-2019

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See standard sheets for details of abbreviations & basis of descriptions


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Job No.
3218804

SOIL LOG SHEET

Client : Huon Aquaculture	LOCATION No. TP08		
Project : New Wastewater Dam	SHEET 1 OF 1		
Location : Parramatta Creek	Position : 461651.0 E, 5423358.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \
Contractor : DIGGA	Rig Type : ZAXIS 135U	Processed : AO	Checked : CC
Date Started : 27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Date : 6 Feb 19

DRILLING					MATERIAL					ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run	Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)
					0.40		TOPSOIL, SILT with sand, brown, rootlets	ML	D	F -St		DCP (blows/100mm) = 5/8/6/5/3/3/5/5/5/4/5/5/5/5/7/12	
							CLAY, mottled orange-brown, trace rootlets	Cl - CH	Sm	St			
1					1.40		Trace sand, mottled grey-orange, sand is fine grained, (EW MUDSTONE)						
					1.80		MUDSTONE, grey-orange, HW, very low to low strength, IR defects						
2					2.00		Low strength						
					2.60		Limit of Test Pit - Refusal on MW MUDSTONE						
3													
4													
5													



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& basis of descriptions



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Job No.

3218804

SOIL LOG SHEET

Client :	Huon Aquaculture	LOCATION No. TP09	
Project :	New Wastewater Dam	SHEET 1 OF 1	
Location :	Parramatta Creek		
Position :	462044.0 E, 5423430.0 N MGA94	Surface RL : N.R.	Inclination\Bearing : \
Contractor :	DIGGA	Rig Type : ZAXIS 135U	Processed : AO
Date Started : 27 Apr 18	Date Completed : 27 Apr 18	Logged by : CC	Checked : CC
			Date : 6 Feb 19

DRILLING					MATERIAL					ADDITIONAL DATA			
SCALE (m)	Method	Hole Support	Run	Water	Depth / (RL) metres	Graphic Log	Description Soil Name (USC Symbol) Other Minor Components, Plasticity or Particle Characteristics, Colour, Moisture Condition, Consistency, Structure	Group Symbol	Moisture Condition	Consistency / Relative Density	Samples & Tests	Comments/Observations Insitu test results	SCALE (m)
					0.40		TOPSOIL; SILT with sand, brown, rootlets, sand is fine grained	ML	D	F-St		DCP (blows/100mm) = 4/5/3/3/4/9/>15	
					0.70		CLAY, mottled orange-brown, trace rootlets	CI-CH	SM	St			
					1.60		MUDSTONE, grey-orange, HW-EW, very low to low strength, IR defects						
					2.50		HW, low strength						
							Limit of Test Pit - Refusal on MW MUDSTONE						



See standard sheets for
details of abbreviations
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Appendix D – Geotech photographic logs





GHD Pty Ltd

10 Columar Court
Burnie Tasmania 7320

Client

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP01

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

This drawing should be read in conjunction with report number 32/18804

TP01

Photographic Log



GHD Pty Ltd

10 Columnar Court
Burnie Tasmania 7320

	Client
--	--------

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP02

Drawn CC	Date 6/02/2019	Job Number 32/18804	A4
Checked	Date		
Revision A	Date 43502	Cad Reference	

This drawing should be read in conjunction with report number 32/18804

TP02

Photographic Log





GHD Pty Ltd

10 Columar Court
Burnie Tasmania 7320

Client

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP03

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

This drawing should be read in conjunction with report number 32/18804

TP03

Photographic Log





GHD Pty Ltd

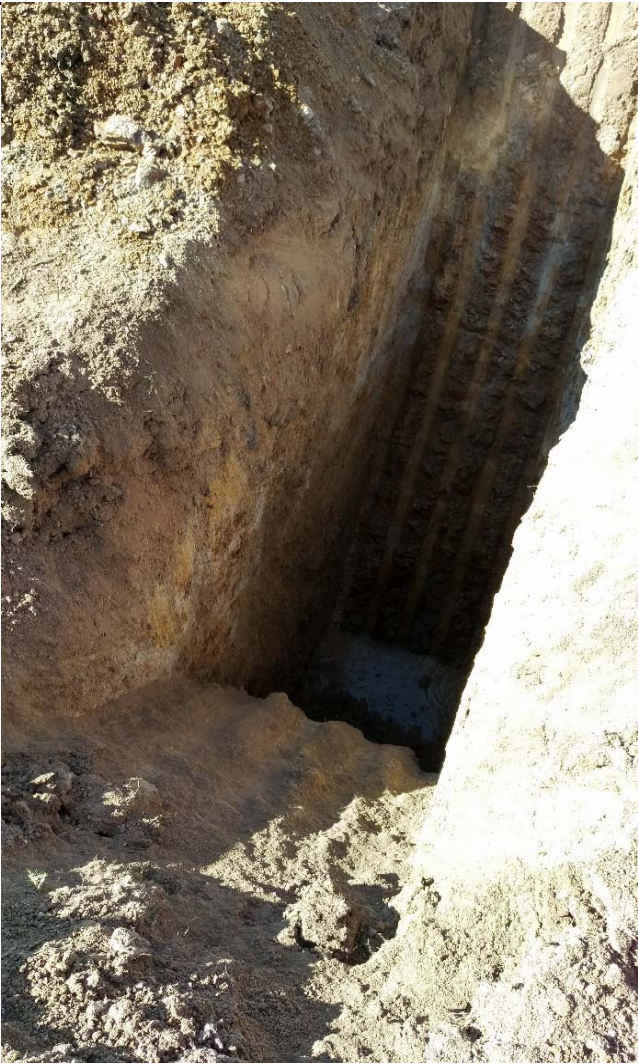
10 Columar Court
Burnie Tasmania 7320

Client	Huon Aquaculture
Project	Huon Aquaculture New Wastewater Dam
Figure No	TP04

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		
This drawing should be read in conjunction with report number 32/18804						

TP04

Photographic Log





GHD Pty Ltd

10 Columar Court
Burnie Tasmania 7320

Client

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP05

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

This drawing should be read in conjunction with report number 32/18804

TP05

Photographic Log





GHD Pty Ltd

10 Columar Court
Burnie Tasmania 7320

Client

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP06

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

This drawing should be read in conjunction with report number 32/18804

TP06

Photographic Log





GHD Pty Ltd

10 Columbar Court
Burnie Tasmania 7320

Client	Huon Aquaculture
Project	Huon Aquaculture New Wastewater Dam
Figure No	TP07

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

This drawing should be read in conjunction with report number 32/18804

TP07

Photographic Log





GHD Pty Ltd

10 Columbar Court
Burnie Tasmania 7320

Client

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP08

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

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TP08

Photographic Log





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10 Columar Court
Burnie Tasmania 7320

Client

Huon Aquaculture

Project

Huon Aquaculture
New Wastewater Dam

Figure No

TP09

Drawn	CC	Date	6/02/2019	Job Number	32/18804	A4
Checked		Date				
Revision	A	Date	43502	Cad Reference		

This drawing should be read in conjunction with report number 32/18804

TP09

Photographic Log

Appendix E – Laboratory test certificates

ADG LABORATORIES

Unit 8a 121 Mornington Rd

Ph (03) 6244 6884 Fax 03 6245 1498

Ph (03) 64254185 Fax (03) 64251498

ACN 117 593 254



Client	GHD
Project	New waste water dam
Location	Huon Aquaculture
Project No.	0047/18/11H
Sample No.	H18/352
Date Received	18/5/18
Date Tested	25/5/18
Sample Description	Brown Sandy silty clay
Sampled By	client
Sample Identification	TP2 0.7 - 0.8m
Test Report No.	0047/18/11H/AA

Test Description	Test Method	Results	Units	Remarks
	AS 1289			
Liquid Limit	3.1.2	54	%	Air dried dry sieved
Plastic Limit	3.2.1	26	%	
Plasticity Index	3.3.1	28	%	
Linear Shrinkage	3.4.1	13	%	curling n cracking n crumbling n
Emerson Class Number	3.8.1	4		deionised water used
Moisture Content	2.1.1	33.3	%	as received
Particle Size Distribution	3.6.1			
finer than mm				
100			%	
75			%	
53			%	
37.5			%	
26.5			%	
19			%	
13.2			%	
9.5			%	
6.7			%	
4.75		100	%	
2.36		99	%	
1.18		99	%	
0.600		98	%	
0.425		98	%	
0.300		96	%	
0.150		91	%	
0.075		88	%	

Preliminary Report Issued? **yes** If Yes, Replaces Preliminary Report No. **P 0047/18/11H**



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Accreditation No 16752

[Signature]

Approved Signatory
D L Maundrill

31/5/18

Date of issue

ADG LABORATORIES

Unit 8a 121 Mornington Rd

Ph (03) 6244 6884 Fax 03 6245 1498

Ph (03) 64254185 Fax (03) 64251498

ACN 117 593 254

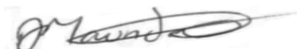
Client	GHD
Project	New waste water dam
Location	Huon Aquaculture
Project No.	0047/18/11H
Sample No.	H18/353
Date Received	18/5/18
Date Tested	25/5/18
Sample Description	Brown Clayey sandy silt
Sampled By	client
Sample Identification	TP4 0.7 - 0.8m
Test Report No.	0047/18/11H/AB

Test Description	Test Method	Results	Units	Remarks
	AS 1289			
Liquid Limit	3.1.2	21	%	Air dried dry sieved
Plastic Limit	3.2.1	15	%	
Plasticity Index	3.3.1	6	%	
Linear Shrinkage	3.4.1	4	%	curling n cracking y crumbling n
Emerson Class Number	3.8.1	4		deionised water used
Moisture Content	2.1.1	15.4	%	as received
Particle Size Distribution	3.6.1			
mm				
finer than 100			%	
75			%	
53			%	
37.5			%	
26.5			%	
19			%	
13.2			%	
9.5			%	
6.7		100	%	
4.75		99	%	
2.36		98	%	
1.18		97	%	
0.600		96	%	
0.425		96	%	
0.300		94	%	
0.150		89	%	
0.075		86	%	

Preliminary Report Issued? ☒ yes If Yes, Replaces Preliminary Report No. **P 0047/18/11H**



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Unit 8a 121 Mornington Rd

Ph (03) 6244 6884 Fax 03 6245 1498

Ph (03) 64254185 Fax (03) 64251498

ACN 117 593 254



Client	GHD
Project	New waste water dam
Location	Huon Aquaculture
Project No.	0047/18/11H
Sample No.	H18/354
Date Received	18/5/18
Date Tested	25/5/18
Sample Description	Brown Gravelly Silty Sand
Sampled By	client
Sample Identification	TP4 2.3 - 2.4m
Test Report No.	0047/18/11H/AC

Test Description	Test Method	Results	Units	Remarks
	AS 1289			
Liquid Limit	3.1.2	not tested	%	Air dried dry sieved
Plastic Limit	3.2.1	-	%	
Plasticity Index	3.3.1	-	%	
Linear Shrinkage	3.4.1	-	%	curling - cracking - crumbling -
Emerson Class Number	3.8.1	-		deionised water used
Moisture Content	2.1.1	18.4	%	as received
Particle Size Distribution	3.6.1			
mm				
finer than 100			%	
75			%	
53			%	
37.5			%	
26.5			%	
19		100	%	
13.2		98	%	
9.5		83	%	
6.7		72	%	
4.75		65	%	
2.36		57	%	
1.18		51	%	
0.600		47	%	
0.425		46	%	
0.300		44	%	
0.150		39	%	
0.075		34	%	

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ADG LABORATORIES

Unit 8a 121 Mornington Rd

Ph (03) 6244 6884 Fax 03 6245 1498

Ph (03) 64254185 Fax (03) 64251498

ACN 117 593 254



Client	GHD
Project	New waste water dam
Location	Huon Aquaculture
Project No.	0047/18/11H
Sample No.	H18/355
Date Received	18/5/18
Date Tested	25/5/18
Sample Description	Brown Gravelly Silty Sand
Sampled By	client
Sample Identification	TP6 1.6 - 1.7m
Test Report No.	0047/18/11H/AD

Test Description	Test Method	Results	Units	Remarks
	AS 1289			
Liquid Limit	3.1.2	not tested	%	Air dried dry sieved
Plastic Limit	3.2.1	-	%	
Plasticity Index	3.3.1	-	%	
Linear Shrinkage	3.4.1	-	%	curling - cracking - crumbling -
Emerson Class Number	3.8.1	-		deionised water used
Moisture Content	2.1.1	24.8	%	as received
Particle Size Distribution	3.6.1			
mm				
finer than 100			%	
75			%	
53			%	
37.5			%	
26.5			%	
19		100	%	
13.2		99	%	
9.5		90	%	
6.7		79	%	
4.75		71	%	
2.36		60	%	
1.18		54	%	
0.600		50	%	
0.425		48	%	
0.300		46	%	
0.150		43	%	
0.075		41	%	

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ADG LABORATORIES

Unit 8a 121 Mornington Rd

Ph (03) 6244 6884 Fax 03 6245 1498

Ph (03) 64254185 Fax (03) 64251498

ACN 117 593 254

Client	GHD
Project	New waste water dam
Location	Huon Aquaculture
Project No.	0047/18/11H
Sample No.	H18/356
Date Received	18/5/18
Date Tested	25/5/18
Sample Description	Brown Sandy Silty Clay
Sampled By	client
Sample Identification	TP7 0.7 - 0.8m
Test Report No.	0047/18/11H/AE

Test Description	Test Method	Results	Units	Remarks
	AS 1289			
Liquid Limit	3.1.2	33	%	Air dried dry sieved
Plastic Limit	3.2.1	19	%	
Plasticity Index	3.3.1	15	%	
Linear Shrinkage	3.4.1	8	%	curling n cracking n crumbling n
Emerson Class Number	3.8.1	5		deionised water used
Moisture Content	2.1.1	23.1	%	as received
Particle Size Distribution	3.6.1			
mm				
finer than 100			%	
75			%	
53			%	
37.5			%	
26.5			%	
19			%	
13.2			%	
9.5			%	
6.7			%	
4.75		100	%	
2.36		99	%	
1.18		98	%	
0.600		94	%	
0.425		92	%	
0.300		89	%	
0.150		85	%	
0.075		81	%	

Preliminary Report Issued? **yes** If Yes, Replaces Preliminary Report No. **P 0047/18/11H**



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Accreditation No 16752

[Signature]

Approved Signatory
D L Maundrill

31/5/18

Date of issue

2 Specimen remoulded to a target density of 98% Standard Compaction



Particle Size Distribution & Plasticity Index tests

Terra Firma Laboratories
47 National Avenue, Pakenham VIC 3810

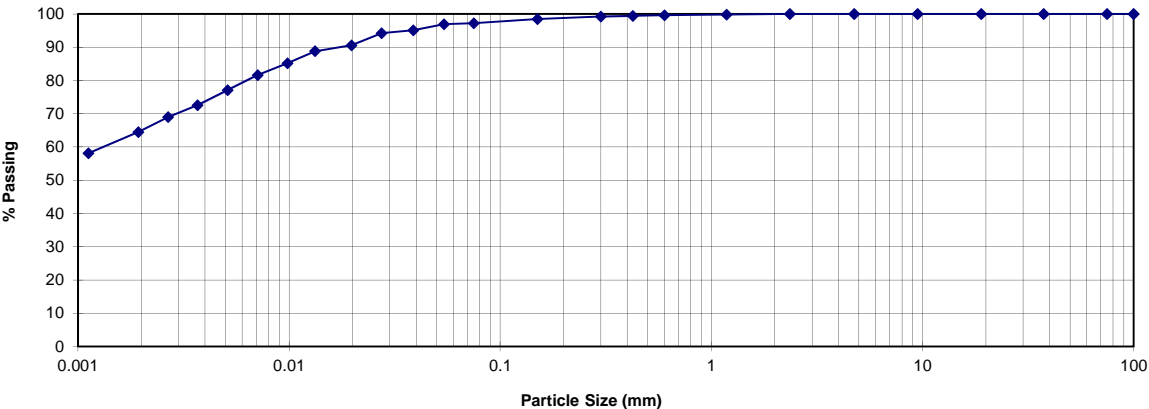
Phone 03 9769 5799 www.terrafirmalabs.com.au

Job No: 10311
Report No: 10311-1
Sample No: TF/P/18/05200
Issue Date: 30-May-2018

Client: ADG Laboratories
Address: Unit 8A, 121 Mornington Road, Mornington, 7018
Project: Waste Water Dam
Location: Huon Agriculture

Sample Location: TP2
Sample Depth (m): 0.7-0.8m

Sieve Analysis	AS 1289.3.6.1	Hydrometer	AS1289.3.6.3	
Sieve Size (mm)	% Passing	Diameter (mm)	% Passing	
75.0	100	0.054	97	
37.5	100	0.039	95	
19.0	100	0.027	94	Plasticity index tests
9.5	100	0.020	91	AS 1289
4.75	100	0.013	89	Liquid limit 3.1.2
2.36	100	0.010	85	Plastic limit 3.2.1
1.18	100	0.007	82	Plasticity index 3.3.1
0.600	100	0.005	77	Linear shrinkage 3.4.1
0.425	99	0.004	73	
0.300	99	0.003	69	AS 1289.3.5.1
0.150	99	0.002	64	Assumed Soil Particle Density
0.075	97	0.001	58	2.66 gm/cm ³



The results of the tests, calibrations and/or measurements included in this document are traceable to Australian National Standards.
Accredited for compliance with ISO/IEC 17025- Testing

LABORATORY ACCREDITATION No 15357

Sampling Procedure: Tested as received

Approved signature
S Benbow

Appendix F – Geotechnical standard notes

DYNAMIC CONE PENETROMETER (DCP) TESTING



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SCOPE

The Dynamic Cone Penetrometer (DCP) test comprises the measurement of the soil resistance to a steel rod driven into the ground by a dropped weight.

The DCP test is a simple manual test used in both sandy and clayey soils. The test is a measure of the shear strength of the soil at relatively shallow depth.

EQUIPMENT AND METHOD

A general description of the dynamic penetrometer apparatus used by our firm is presented in Australian Standard AS 1289.6.3.2. The equipment utilises a 9 kg sliding weight with a drop height of 510 mm. It is fitted with a conical tip. The equipment can be adjusted for a fall of 600 mm and use of a blunt tip in accordance with AS 1289.6.3.3.

The test data are generally recorded as the number of blows (n) per 50 mm of penetration. For specific applications (such as pavement investigations), the data may be collected in the reverse form, i.e. as mm per blow. The results are presented either in tabular or graphic form for reporting purposes.

INTERPRETATION

The interpretation of the DCP results is generally based on the assumption that the measured resistance is a function of soil strength. A profile of soil strength (cohesive soils) or density index (cohesionless soils) can thus be established. The test often can be used to qualitatively indicate the presence of soft or loose zones within a soil profile.

The energy of the system per unit area is similar to that of the larger Standard Penetration Test (SPT). Thus, the common relationships of SPT and other parameters can be used as a means of estimating soil properties, after appropriate site specific consideration. The interpretations from the test are approximate only, and this is particularly pertinent to sand profiles where the magnitude of confinement stress is important in the assessment of the results.

Interpretation of the DCP penetration rate at depth must be conducted with due regard to rod friction effects. In particular, care must be exercised with soft clay profiles where rod resistance may have an unconservative impact on the results. Care must also be exercised with soil profiles containing larger particles such as gravels and cobbles where penetration rate can be affected if the DCP tip strikes or glances off such particles.

In-situ California Bearing Ratio (CBR) values of clay soil subgrades are sometimes interpreted directly from DCP test results for use in road pavement design. In this case, the correlation between DCP and CBR based on that published in AUSTROADS Pavement Structural Design guide (AGPT02-17 Part 2) may be applied. This correlation should be verified by site specific laboratory testing, where appropriate. In addition, the effects of moisture content variations (in-situ versus design conditions) must be considered, as the DCP test only reflects the shear strength of the soil at the time of testing. Further information can be found in AUSTROADS Geotechnical Investigation and Design guide (AGRD07-08 Part 7).

GENERAL NOTES



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The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water depths presented on the test hole logs are the depths of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater depth may differ from this recorded depth depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this depth could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities such as a change in ground surface level. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate surveys, instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in ground conditions do occur in the natural environment, particularly between discrete test hole locations or available observation sites. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural processes.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to GHD for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

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LABORATORY TESTING



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GENERAL

Samples extracted during the fieldwork stage of a site investigation may be “disturbed” or “undisturbed” (as generally indicated on the test hole logs) depending upon the nature and purpose of the sample as well as the method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results, which must of necessity, reflect the effects of such disturbance.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory test results provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and project in hand.

TESTING

Laboratory testing is normally carried out in accordance with Australian Standard AS 1289 as amended, or in NSW, Roads and Maritime Services (RMS) standards when specified. The routine Australian Standard tests are as follows:

Moisture Content	AS1289 2.1.1	collectively known as Atterberg Limits
Liquid Limit	AS1289 3.1.1	
Plastic Limit	AS1289 3.2.1	
Plasticity Index	AS1289 3.3.1	
Linear Shrinkage	AS1289 3.4.1	collectively, Dispersive Classification
Particle Density	AS1289 3.5.1	
Particle Size Distribution	AS1289 3.6.1, 3.6.2 and 3.6.3	
Emerson Class Number	AS1289 3.8.1	
Percent Dispersion	AS1289 3.8.2	collectively, Dispersive Classification
Pinhole Dispersion Classification	AS1289 3.8.3	
Hole Erosion (HE)	GHD Method	
No Erosion Filter (NEF)	GHD Method	
Organic Matter	AS1289 4.1.1	collectively, Dispersive Classification
Sulphate Content	AS1289 4.2.1	
pH Value	AS1289 4.3.1	
Resistivity	AS1289 4.4.1	
Standard Compaction	AS1289 5.1.1	collectively, Dispersive Classification
Modified Compaction	AS1289 5.2.1	
Dry Density Ratio	AS1289 5.4.1	
Minimum Density	AS1289 5.5.1	
Density Index	AS1289 5.6.1	collectively, Dispersive Classification
California Bearing Ratio	AS1289 6.1.1 and 6.1.2	
Shear Box	AS1289 6.2.2	
Undrained Triaxial Shear	AS1289 6.4.1 and 6.4.2	
One Dimensional Consolidation	AS1289 6.6.1	collectively, Dispersive Classification
Permeability Testing	AS1289 6.7.1, 6.7.2 and 6.7.3	

Where tests are used which are not covered by appropriate standard procedures, details are given in the report.

LABORATORIES

Our Australian laboratories are NATA accredited to AS ISO / IEC17025 for the listed tests.

The oedometer, triaxial and shear box equipment are fully automated for continuous operation using computer controlled data acquisition, processing and plotting systems.

SOIL DESCRIPTION AND CLASSIFICATION



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Soil is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical Site Investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines soil as particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking. Classification of the soil is undertaken following description.

SOIL DESCRIPTION

The soil description includes a) Composition, b) Condition, c) Structure, d) Origin and e) Additional observations. 'FILL', 'TOPSOIL' or a 'MIXTURE OF SOIL AND COBBLES / BOULDERS' (with dominant fraction first) is denoted at the start of a soil description where applicable.

a) Soil Composition (soil name, colour, plasticity or particle characteristics, secondary and then minor components)

Soil Name: A soil is termed a *coarse grained soil* where the dry mass of sand and gravel particles exceeds 65% of the total. Soils with more than 35% fines (silt or clay particles) are termed *fine grained soils*. The soil name is made up of the primary soil component (in BLOCK letters), prefixed by applicable secondary component qualifiers. Minor components are applied as a qualifiers to the soil name (using the words 'with' or 'trace').

Particles are differentiated on the basis of size. 'Boulders' and 'cobbles' are outside the soil particle range, though their presence (and proportions) is noted. While individual particles may be designated as silt or clay based on grain size, fine grained soils are characterised as silt or clay based on tactile behaviour or Atterberg Limits, and not the relative composition of silt or clay sized particles.

Colour: The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Roughly equally proportioned colours are prefixed by (spotted, mottled, streaked etc.). Colour is described in its moist condition, though both wet and dry colours may also be provided if appropriate.

Plasticity: Fine grained soils are designated within standard ranges of plasticity based on tactile assessment or laboratory assessment of the Liquid Limit.

Particle Characteristics: The particle shape, particle distribution and particle size range within a coarse grained soil is described using standard terms. Particle composition may be described using rock or mineral names, with specific terms for carbonate soils.

Secondary and Minor Components: The primary soil is described and modified by secondary and minor components, with assessed ranges as tabulated.

Carbonate Soils: Carbonate content can be assessed by use of dilute '10%' HCl solution. Resulting clear sustained effervescence is interpreted as a *Carbonate soil* (approximately >50% carbonate), while weak or sporadic effervescence indicates *Calcareous soil* (< 50% carbonate). No effervescence is interpreted as a non-calcareous soil.

Organic and Peat Soils: Where identified, organic content is noted. *Organic soil* (2% to 25% organic matter) is usually identified by colour (usually dark grey/black) and odour (i.e. 'mouldy' or hydrogen sulphide odour). *Peat* (>25% organic matter) is identified by a spongy feel and fibrous texture. Peat soils' decomposition may be described as '*fibrous*' (little / no decomposition), '*pseudo-fibrous*' (moderate decomposition) or '*amorphous*' (full decomposition).

Fraction	Components		Particle Size (mm)
Oversize	BOULDERS		> 200
	COBBLES		63 - 200
Coarse grained soil particles	GRAVEL	Coarse	19 - 63
		Medium	6.7 -19
		Fine	2.36 - 6.7
	SAND	Coarse	0.6 - 2.36
		Medium	0.21 - 0.6
		Fine	0.075 - 0.21
Fine grained soil particles	SILT		0.002 - 0.075
	CLAY		< 0.002

Plasticity Terms (Fine Grained Soils)		Laboratory Liquid Limit Range
Silt	Clay	
N/A	N/A	(Non Plastic)
Low Plasticity	Low Plasticity	≤ 35%
	Medium Plasticity	> 35% and ≤ 50%
High Plasticity	High Plasticity	> 50%

Particle Distribution Terms (Coarse Grained Soils)	
Well graded	good representation of all particle sizes
Poorly graded	one or more intermediate sizes poorly represented
Gap graded	one or more intermediate sizes absent
Uniform	essentially of one size

Particle Shape Terms (Coarse Grained Soils)		
Rounded	Sub-angular	Flaky or Platy
Sub-rounded	Angular	Elongated

Secondary and Minor Components for Coarse Grained Soils			
Fines (%)	Modifier (as applicable)	Accessory coarse (%)	Modifier (as applicable)
≤ 5	'trace silt / clay'	≤ 15	'trace sand / gravel'
> 5, ≤ 12	'with clay / silt'	> 15, ≤ 30	'with sand / gravel'
> 12	prefix 'silty / clayey'	> 30	prefix 'gravelly / sandy'

Secondary and Minor Components for Fine Grained Soils	
% Coarse	Modifier (as applicable)
≤ 15	add "trace sand / gravel"
> 15, ≤ 30	add "with sand / gravel"
> 30	prefix soil "sandy / gravelly"

SOIL DESCRIPTION AND CLASSIFICATION



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b) Soil Condition (moisture, relative density or consistency)

Moisture: Fine grained soils are described relative to plastic or liquid limits, while coarse grained soils are assessed based on appearance and feel. The observation of seepage or free water is noted on the test hole logs.

Moisture - Coarse Grained Soils			Moisture - Fine Grained Soils		
Term		Tactile Properties	Term		Tactile Properties
Dry	('D')	Non-cohesive, free running	Moist, dry of plastic limit	('w < PL')	Hard and friable or powdery
Moist	('M')	Feels cool, darkened colour, tends to stick together	Moist, near plastic limit	('w ≈ PL')	Can be moulded
			Moist, wet of plastic limit	('w > PL')	Weakened, free water forms on hands with handling
Wet	('W')	Feels cool, darkened colour, tends to stick together, free water forms when handling	Wet, near liquid limit	('w ≈ LL')	Highly weakened, tends to flow when tapped
			Wet, wet of liquid limit	('w > LL')	Liquid consistency, soil flows

Relative Density (Non Cohesive Soils): The Density Index is inherently difficult to assess by visual or tactile means, and is normally assessed by penetration testing (e.g. SPT, DCP, PSP or CPT) with published correlations. Assessment may be affected by moisture and *in situ* stress conditions. Density Index assessment may be refined by combination of *in situ* density testing and laboratory reference maximum and minimum density ranges.

Consistency (Cohesive Soils): May be assessed by direct measurement (shear vane, CPT etc.), or approximate tactile correlations. Cohesive soils include fine grained soils, and coarse grained soils with sufficient fine grained components to induce cohesive behaviour. A 'design shear strength' must consider the mode of testing, the *in situ* moisture content and potential for variations of moisture which may affect the shear strength.

Relative Density (Non-Cohesive Soils)			Consistency (Cohesive Soils)		
Term and (Symbol)		Density Index (%)	Term and (Symbol)		Undrained Shear Strength
Very Loose	(VL)	≤ 15	Very Soft	(VS)	< 12 kPa
Loose	(L)	> 15 and ≤ 35	Soft	(S)	12 - 25 kPa
Medium Dense	(MD)	> 35 and ≤ 65	Firm	(F)	25 - 50 kPa
Dense	(D)	> 65 and ≤ 85	Stiff	(St)	50 - 100 kPa
Very Dense	(VD)	> 85	Very Stiff	(VSt)	100 - 200 kPa
Consistency assessment can be influenced by moisture variation.			Hard	(H)	> 200 kPa
			Friable	(Fr)	-

c) Structure (zoning, defects, cementing)

Zoning: The *in situ* zoning is described using the terms below. 'Intermixed' may be used for an irregular arrangement.

'layer' (a continuous zone across the exposed sample)

'pocket' (an irregular inclusion of different material).

'lens' (a discontinuous layer with lenticular shape)

'interbedded' or "interlaminated" (alternating soil types)

Defects: Described using terms below, with dimension orientation and spacing described where practical.

'parting' (an open or closed surface or crack sub parallel to layering with little / no tensile strength - open or closed)

'softened zone' (in clayey soils, usually adjacent to a defect with associated higher moisture content)

'fissure' (as per a parting, though not parallel or sub parallel to layering – may include desiccation cracks)

'tube' (tubular cavity, singly or one of a large number, often formed from root holes, animal burrows or tunnel erosion)

'sheared seam' (zone of sub parallel near planar closely spaced intersecting smooth or slickensided fissures dividing the mass into lenticular or wedge shaped blocks)

'tube cast' (an infilled tube – infill may vary from uncemented through to cemented or have rock properties)

'sheared surface' (a near planar, curved or undulating smooth, polished or slickensided surface, indicative of displacement)

'infilled seam' (sheet like soil body cutting through the soil mass, formed by infilling of open defects)

Cementation: Soils may be cemented by various substances (e.g. iron oxides and hydroxides, silica, calcium carbonate, gypsum), and the cementing agent shall be identified if practical. Cemented soils are described as:

'weakly cemented' easily disaggregated by hand in air or water

'moderately cemented' effort required to disaggregate the soil by hand in air or water

Materials extending beyond 'moderately cemented' are encompassed within the rock strength range. Where consistent cementation throughout a soil mass is identified as a duricrust, it is described in accordance with duricrust rock descriptors. Where alternate descriptors of cementation development are applied for consistency with regional practices or geology, or client requirements, these are outlined separately.

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d) Origin

An interpretation is provided based on observations of landform, geology and fabric, and may further include assignment of a stratigraphic unit. The use of terms 'possibly' or 'probably' indicates a higher degree of uncertainty regarding the assessed origin or stratigraphic unit. Typical origin descriptors include:

<i>Residual</i>	Formed directly from in situ weathering with no visible structure or fabric of the parent soil or rock.
<i>Extremely weathered</i>	Formed directly from in situ weathering, with remnant and/or fabric from the parent rock.
<i>Alluvial</i>	Deposited by streams and rivers (may be applied more generically as transported by water).
<i>Estuarine</i>	Deposited in coastal estuaries, including sediments from inflowing rivers, streams, and tidal currents.
<i>Marine</i>	Deposited in a marine environment.
<i>Lacustrine</i>	Deposited in freshwater lakes.
<i>Aeolian</i>	Transported by wind.
<i>Colluvial and Slopewash</i>	Soil and rock debris transported down slopes by gravity (with or without assistance of water). Colluvium is typically applied to thicker / localised deposits, and slopewash for thinner / widespread deposits.
<i>TOPSOIL</i>	Surficial soil, typically with high levels of organic material. Topsoils buried by other transported soils are termed ' <i>remnant topsoil</i> '. Tree roots within otherwise unaltered soil does not characterise topsoil.
<i>FILL</i>	Any material which has been placed by anthropogenic processes (i.e. human activity).

e) Additional Observations

Additional observations may be included to supplement the soil description. Additional observations may consist of notations relating to soil characteristics (odour, contamination, colour changes with time), inferred geology (with delineation of soil horizons or geological time scale) or notes on sampling and testing application (including the reliability, recovery, representativeness, or condition of samples or test conditions and limitations). If the material is assessed to be not representative, terms such as 'poor recovery', 'non-intact', 'recovered as' or 'probably' are applied.

SOIL CLASSIFICATION

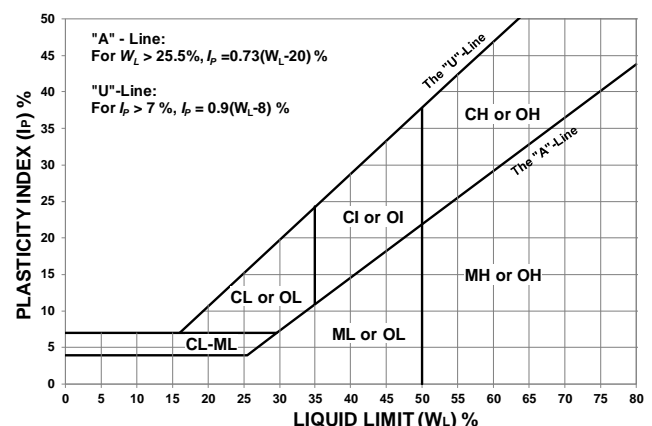
Classification allocates the material within distinct soil groups assigned a two character Group Symbol:

Coarse Grained Soils (sand and gravel: more than 65% of soil coarser than 0.075 mm)			Fine Grained Soils (silt and clay: more than 35% of soil finer than 0.075 mm)		
Major Division	Group Symbol	Soil Group	Major division	Group Symbol	Soil Group
GRAVEL (more than half of the coarse fraction is > 2.36 mm)	GW	GRAVEL, well graded	SILT and CLAY (low to medium plasticity)	ML	SILT, low plasticity
	GP	GRAVEL, poorly graded		CL	CLAY, low plasticity
	GM	Silty GRAVEL		CI	CLAY, medium plasticity
	GC	Clayey GRAVEL		OL	Organic SILT
SAND (more than half of the coarse fraction is < 2.36 mm)	SW	SAND, well graded	SILT and CLAY (high plasticity)	MH	SILT, high plasticity
	SP	SAND, poorly graded		CH	CLAY, high plasticity
	SM	Silty SAND		OH	Organic CLAY / SILT
	SC	Clayey SAND	Highly Organic	Pt	PEAT

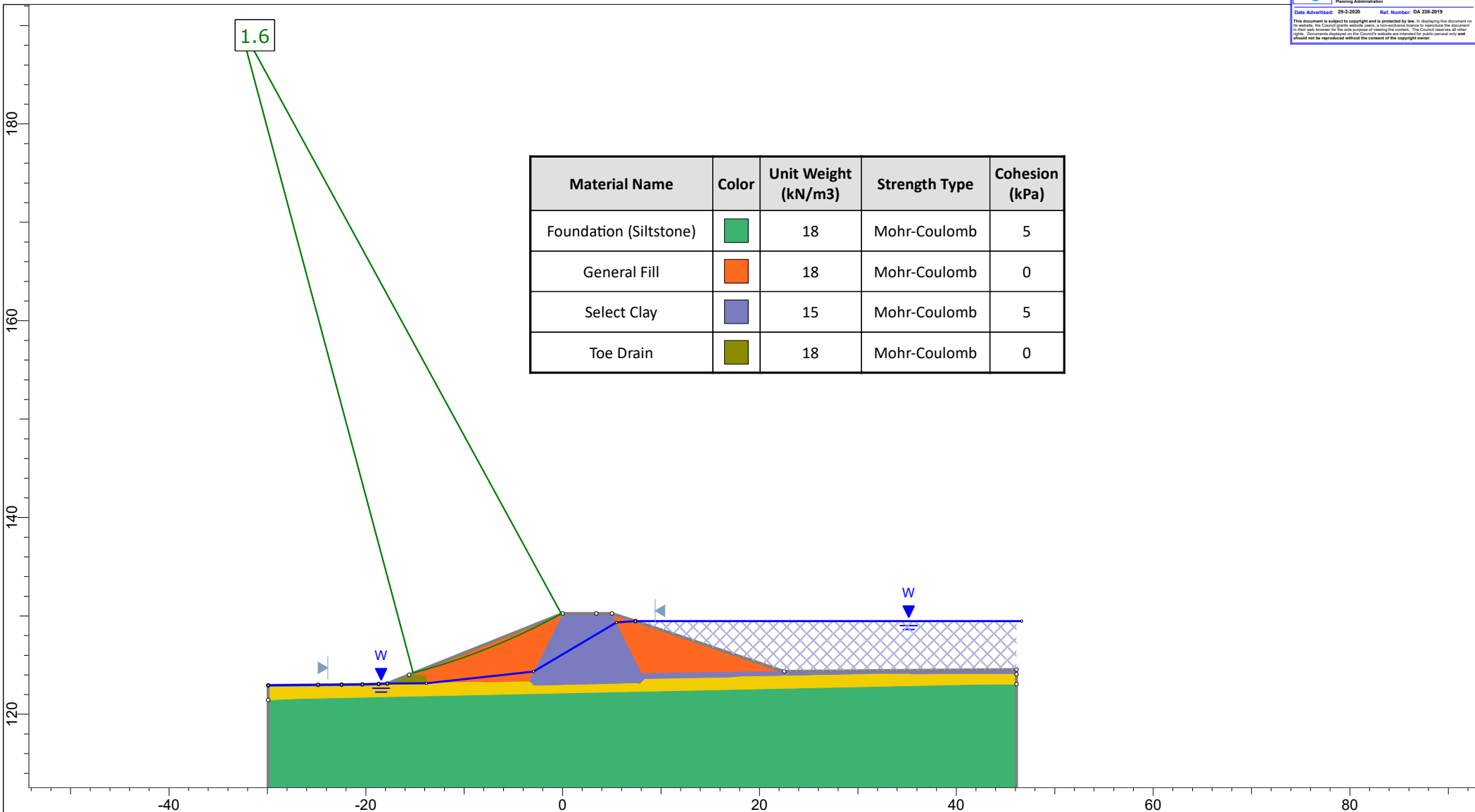
Coarse grained soils with fines contents between 5% and 12% are provided a dual classification comprising the two group symbols separated by a dash, e.g. for a poorly graded gravel with between 5% and 12% silt fines (poorly graded 'GRAVEL with silt'), the classification is GP-GM.

For the purpose of classification, *poorly graded, uniform, or gap graded* soils are all designated as poorly graded. Soils that are dominated by boulders or cobbles are described separately and are not classified.


Classification is routinely undertaken based on tactile assessment with the soil description. Refinement of soil classification may be applied using laboratory assessment, including particle size distribution and Atterberg Limits. Atterberg Limits testing is applied to the sample portion finer than 0.425 mm. Fine grained soil components are assessed on the basis of regions defined within the Modified Casagrande Chart.

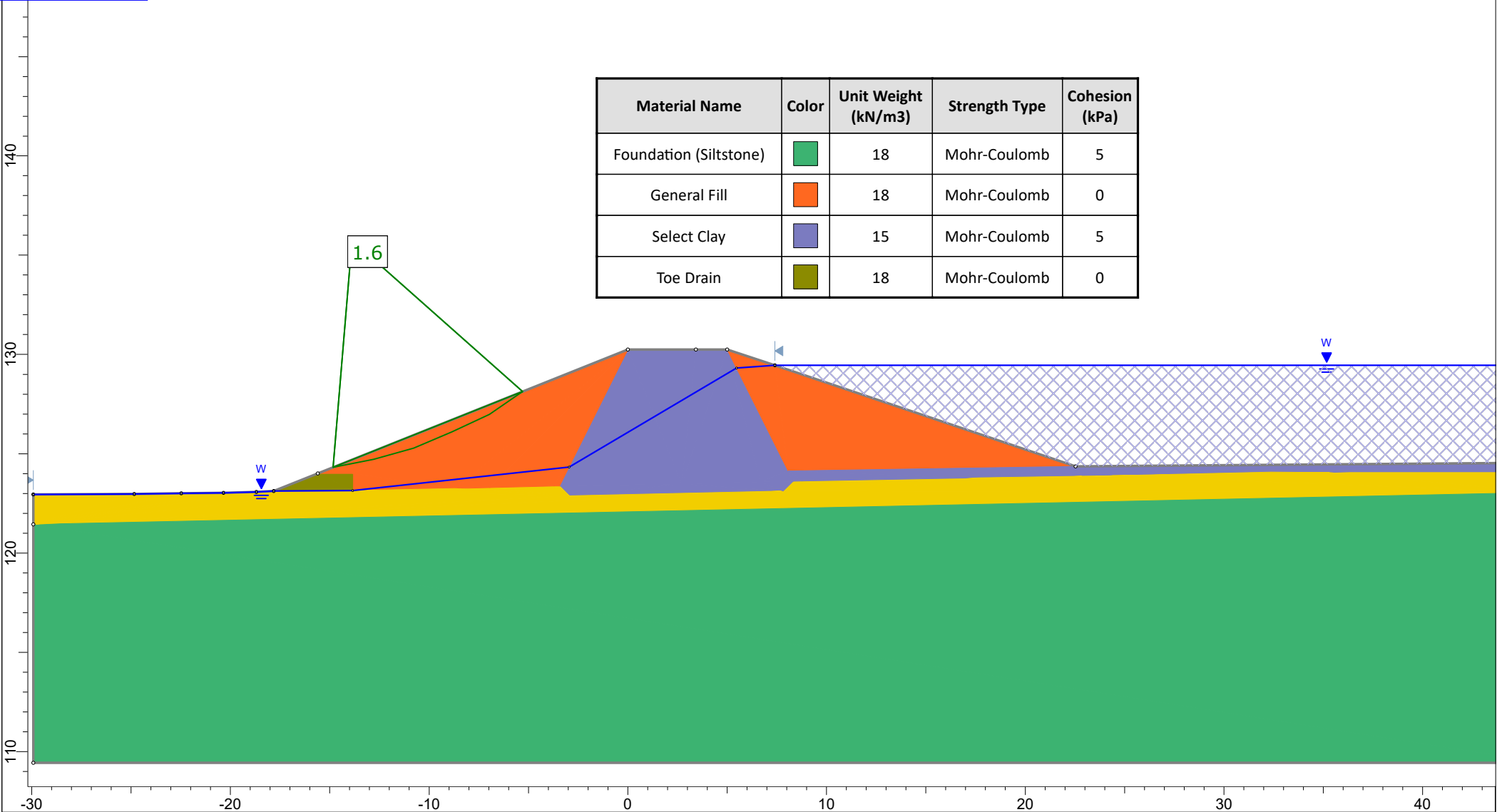


Appendix G - Stability modelling results



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)
Foundation (Siltstone)		18	Mohr-Coulomb	5
General Fill		18	Mohr-Coulomb	0
Select Clay		15	Mohr-Coulomb	5
Toe Drain		18	Mohr-Coulomb	0

	Project			
	Huon Aquaculture			
	Analysis Description			
	New Winter Storage Dam - Drained			
	Drawn By	C Cahill	Scale	1:541
Date		10/01/2019, 4:08:27 PM		Company
				GHD
				File Name
				huon stability - drained.slm

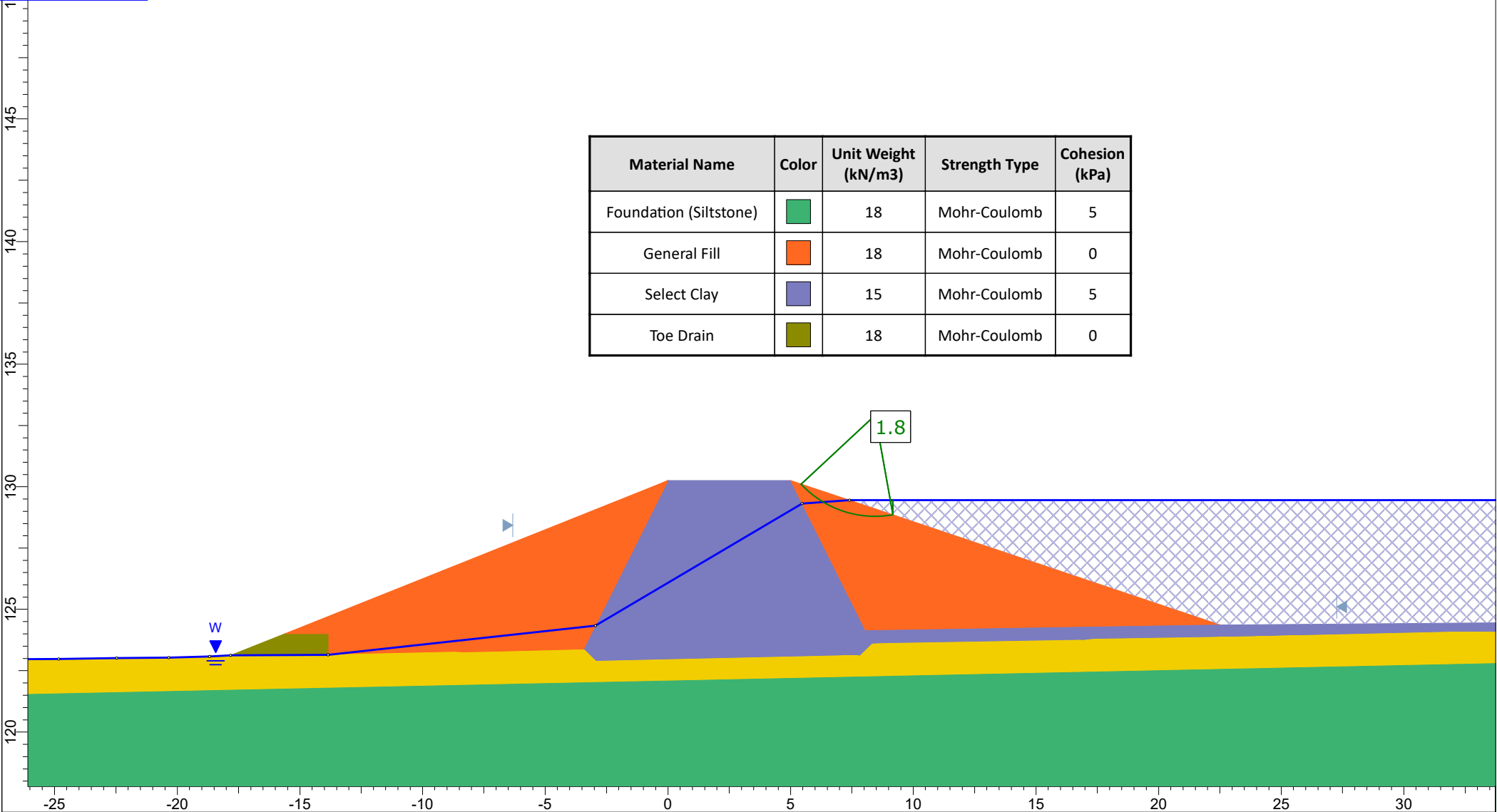


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)
Foundation (Siltstone)	<div></div>	18	Mohr-Coulomb	5
General Fill	<div></div>	18	Mohr-Coulomb	0
Select Clay	<div></div>	15	Mohr-Coulomb	5
Toe Drain	<div></div>	18	Mohr-Coulomb	0



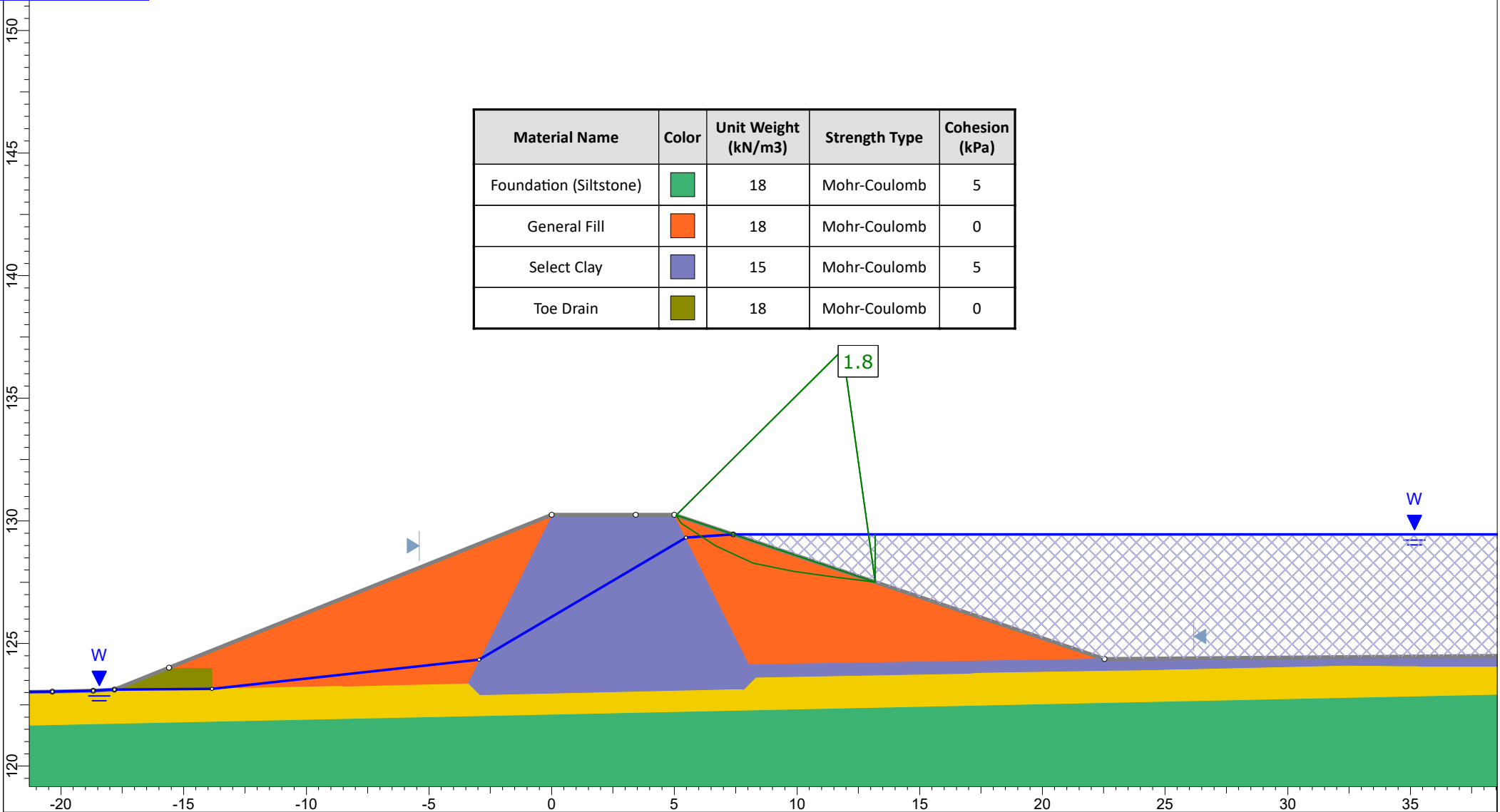
SLIDEINTERPRET 8.018

Project		Huon Aquaculture	
Analysis Description		New Winter Storage Dam - Drained	
Drawn By	C Cahill	Scale	1:271
		Company	GHD
Date	10/01/2019, 4:08:27 PM		File Name
			huon stability - drained.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)
Foundation (Siltstone)	<div></div>	18	Mohr-Coulomb	5
General Fill	<div></div>	18	Mohr-Coulomb	0
Select Clay	<div></div>	15	Mohr-Coulomb	5
Toe Drain	<div></div>	18	Mohr-Coulomb	0

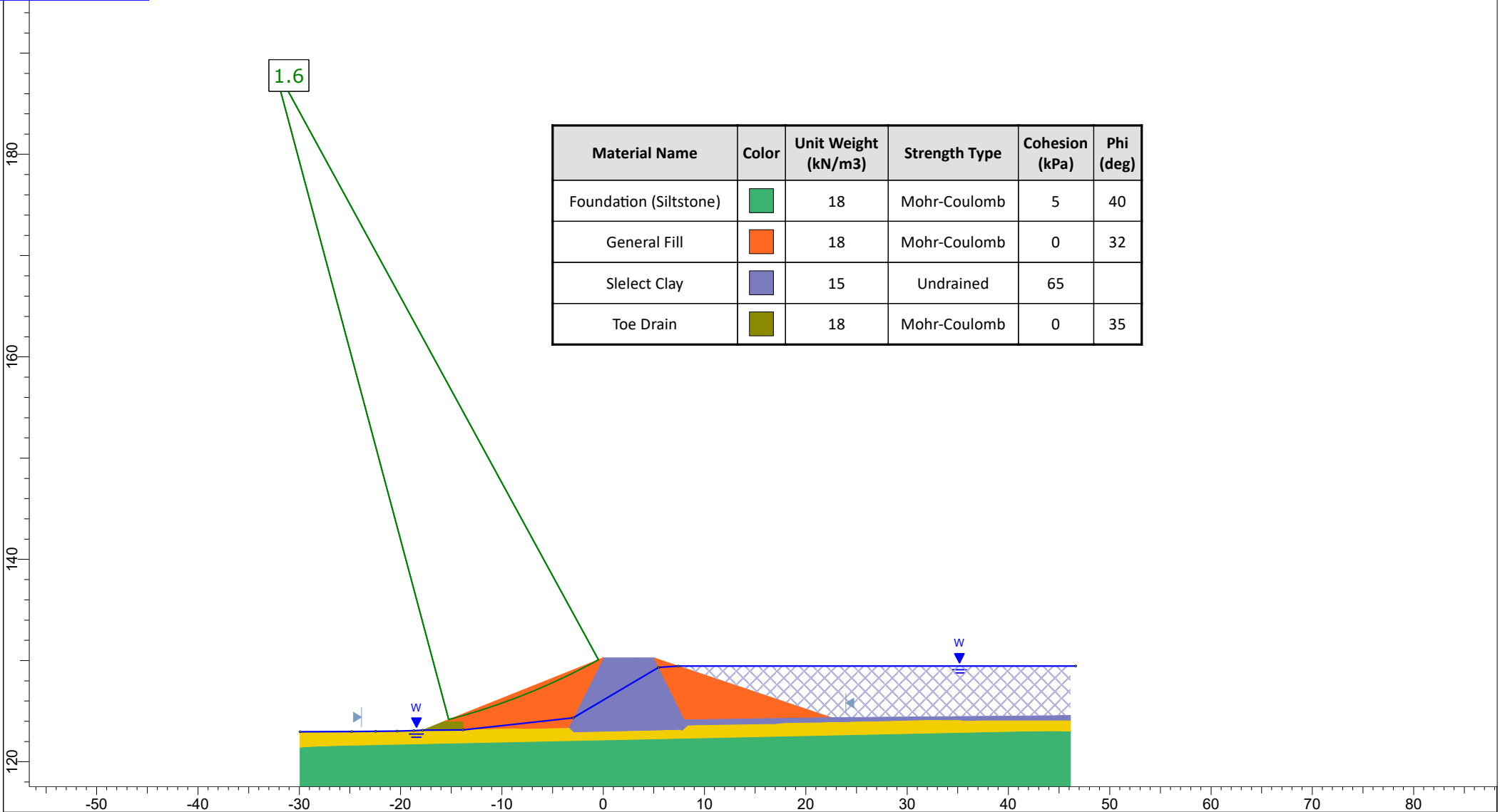
<div><div></div><div>rocscience</div></div>	ProjectHuon Aquaculture		
	Analysis DescriptionNew Winter Storage Dam - Drained		
	Drawn ByC Cahill	Scale1:220	CompanyGHD
	Date10/01/2019, 4:08:27 PM	File Namehuon stability - drained.slmd	



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)
Foundation (Siltstone)	<div></div>	18	Mohr-Coulomb	5
General Fill	<div></div>	18	Mohr-Coulomb	0
Select Clay	<div></div>	15	Mohr-Coulomb	5
Toe Drain	<div></div>	18	Mohr-Coulomb	0



Project		Huon Aquaculture	
Analysis Description		New Winter Storage Dam - Drained	
Drawn By	C Cahill	Scale	1:220
Date		Company	GHD
		File Name	huon stability - drained.slmd

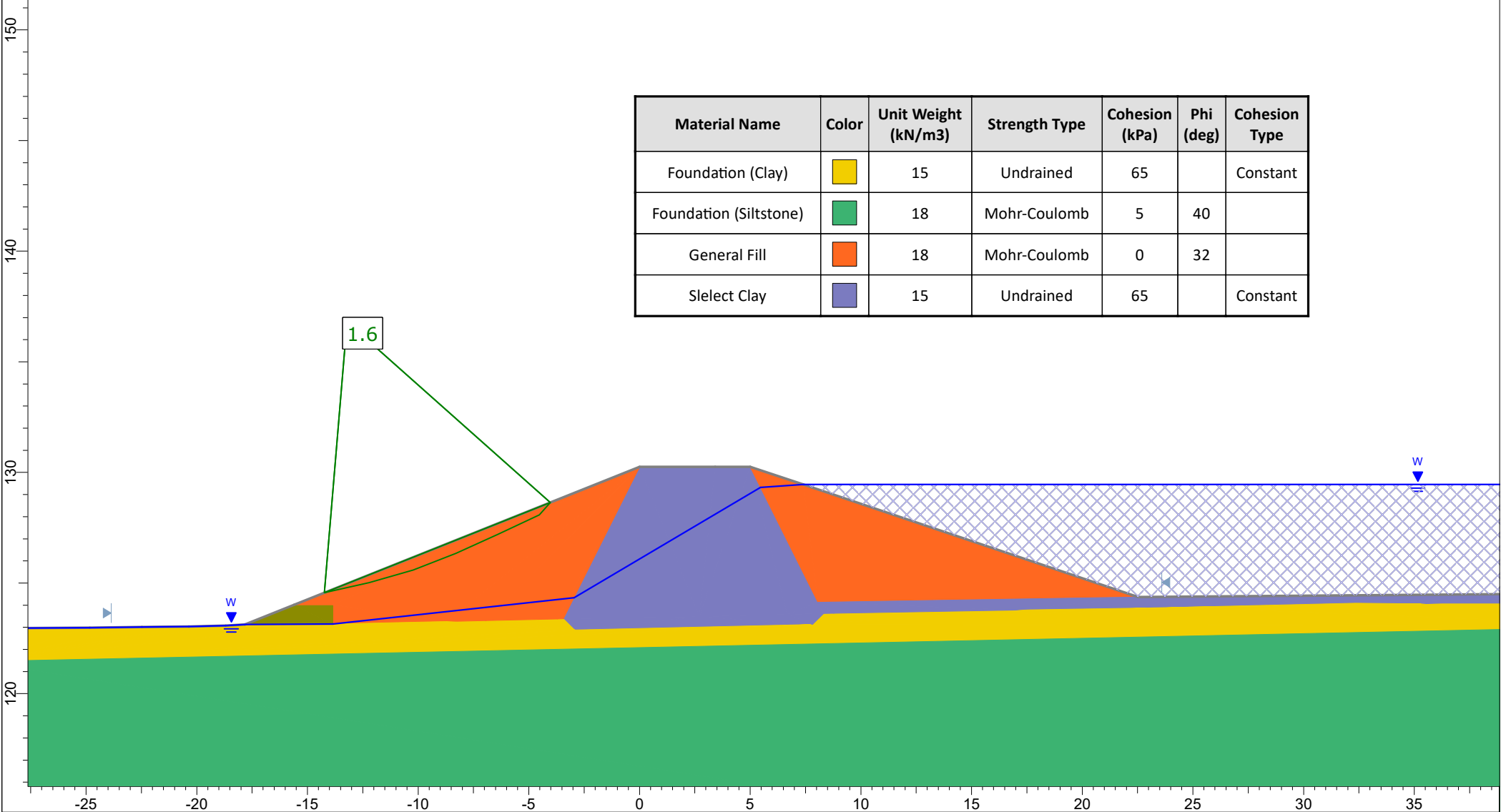



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Foundation (Siltstone)	<div></div>	18	Mohr-Coulomb	5	40
General Fill	<div></div>	18	Mohr-Coulomb	0	32
Select Clay	<div></div>	15	Undrained	65	
Toe Drain	<div></div>	18	Mohr-Coulomb	0	35



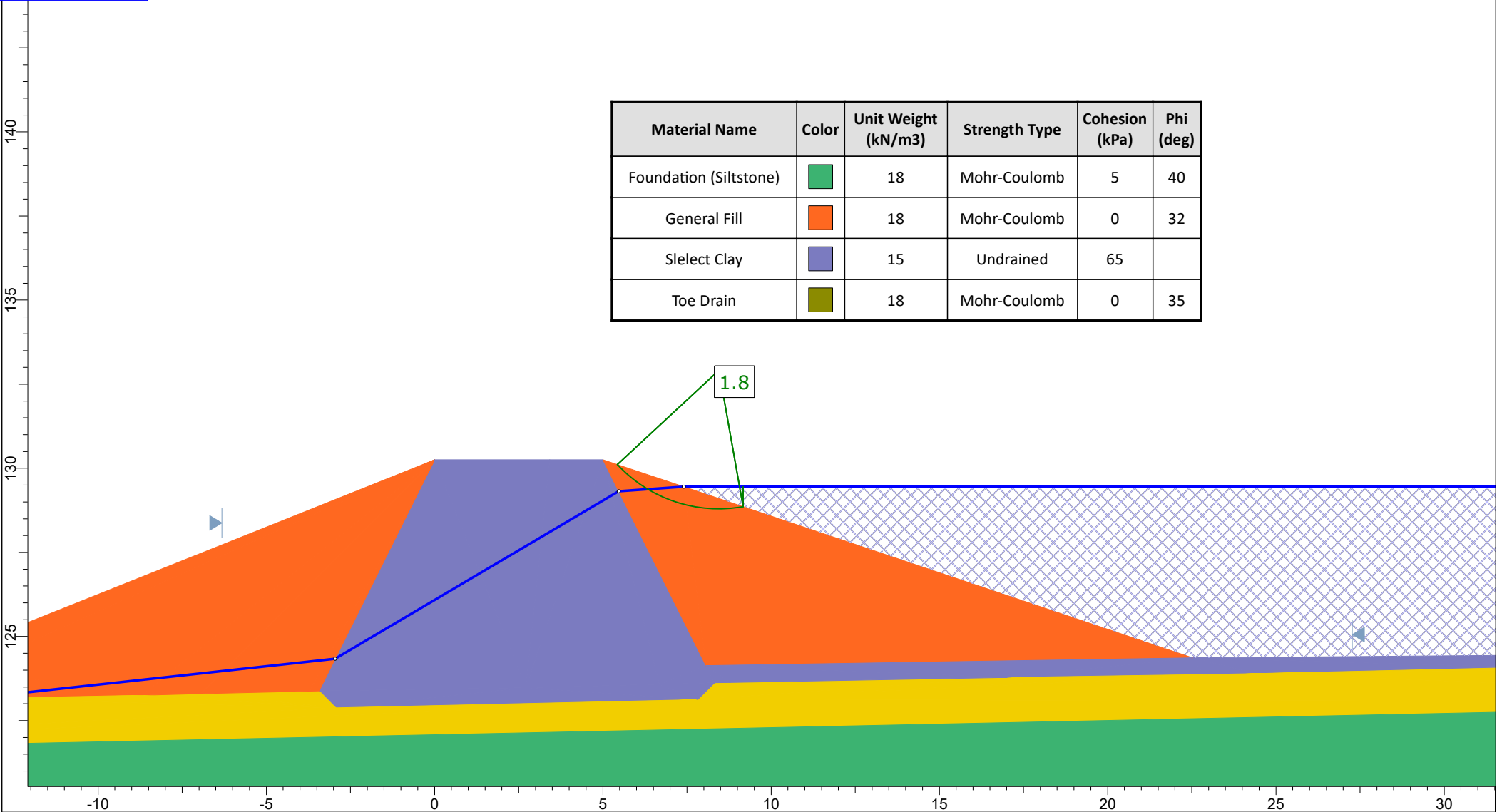
SLIDEINTERPRET 8.018

Project	Huon Aquaculture		
Analysis Description	New Winter Storage Dam		
Drawn By	C Cahill	Scale	1:532
		Company	GHD
Date	10/01/2019, 4:08:27 PM		File Name
			huon stability - undrained.slmd




	Project					
	Huon Aquaculture					
	Analysis Description					
	New Winter Storage Dam					
	Drawn By		C Cahill	Scale	1:244	Company
Date		10/01/2019, 4:08:27 PM			File Name	huon stability - undrained.slmd

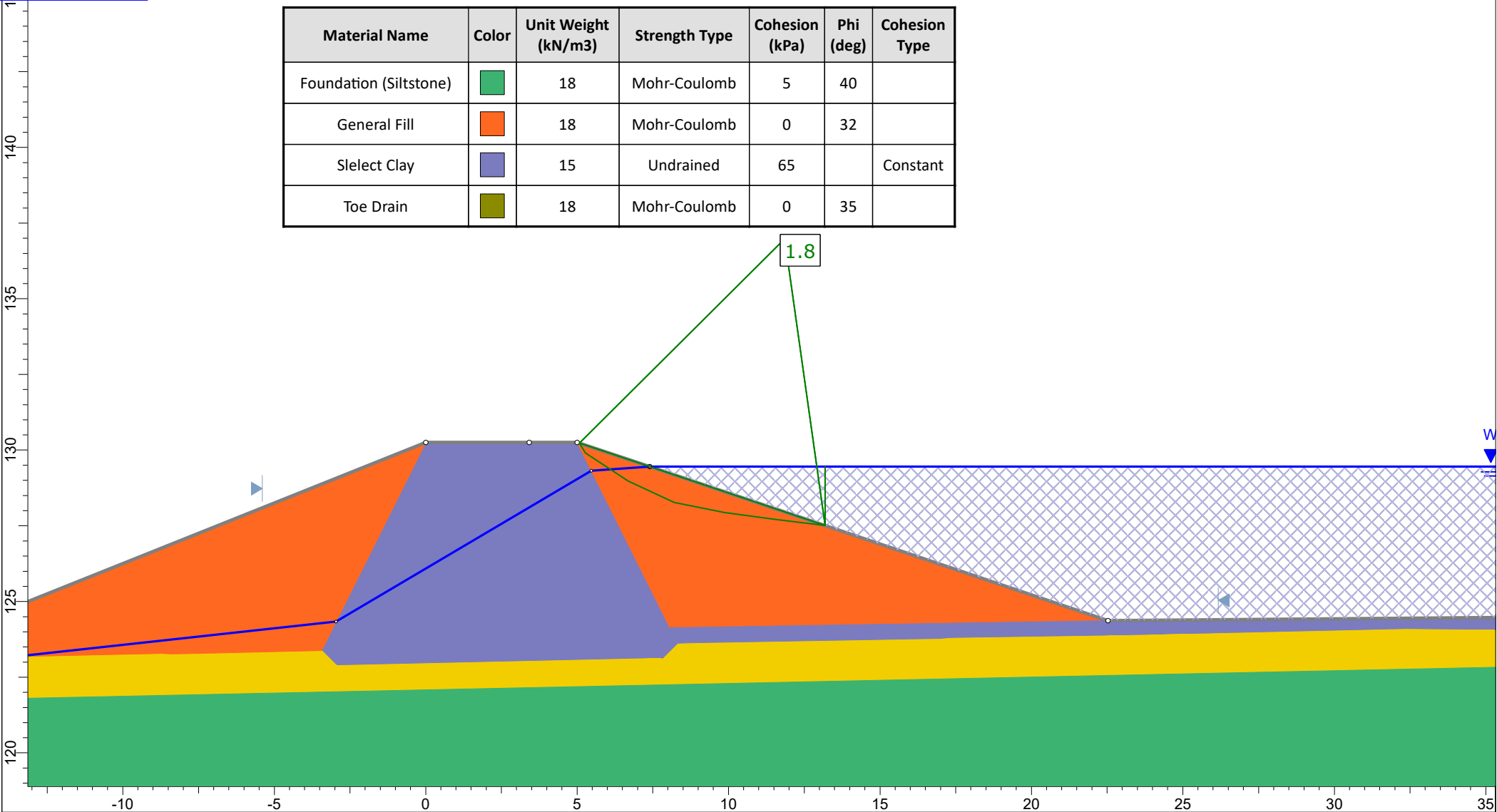
SLIDEINTERPRET 8.018




Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Foundation (Siltstone)		18	Mohr-Coulomb	5	40
General Fill		18	Mohr-Coulomb	0	32
Slect Clay		15	Undrained	65	
Toe Drain		18	Mohr-Coulomb	0	35

	<i>Project</i>		
	Huon Aquaculture		
	<i>Analysis Description</i>		
	New Winter Storage Dam		
<i>Drawn By</i>	C Cahill	<i>Scale</i>	1:160
		<i>Company</i>	GHD
<i>Date</i>	10/01/2019, 4:08:27 PM		<i>File Name</i>
			huon stability - undrained.slmd

SLIDEINTERPRET 8.018



	Project					
	Huon Aquaculture					
	Analysis Description					
	New Winter Storage Dam					
	Drawn By		C Cahill	Scale	1:178	Company
Date		10/01/2019, 4:08:27 PM			File Name	huon stability - undrained.slmd

SLIDEINTERPRET 8.018

Appendix H – Risk register



HSE040 Safety in Design Risk Assessment

Notes: *Designs with significant quantities of dangerous goods may require detailed risk assessments under Dangerous Goods or Major Hazard legislation
* Most industrial processes will require an industry specific assessment, e.g. HAZOP and/or Quantitative Risk Assessment for facilities that have chemical or high-pressure processes under Dangerous Goods or Major Hazard legislation.

Design Life Cycle:	Investigation and Design	Setup, Construction and Commissioning	Operation	Maintenance	Disposal		Date:	24/07/2019	Revision No:	1					
Job Name:	Huon Aquaculture - New Wastewater Dam		Job No:	3218804	Client	Huon Aquaculture		Design:	New Wastewater Dam						
People involved in Risk Assessment:															
Design Ref	Design Life Cycle Stage <small>(Select from Drop Down Box)</small>	Hazards <small>What could cause injury or ill health, damage to property or damage to the environment</small>	Risk <small>What could go wrong and what might happen as a result</small>	Existing Control Measures	Initial Risk Rating			Potential Control Measures <small>(Consider Hierarchy of Control - Elimination, Substitution, Isolation, Engineering Controls, Administrative Controls, PPE)</small>	Responsibility	By When	Decision / Status	Residual Risk Rating			Comments
					C	L	RR					C	L	RR	
001	Operation	Drowning	Huon personnel or member of public slip/fall into lagoon or drive vehicle into lagoon whilst liquid trade waste is impounded. Potential injury or death.	Flat 3H:1V batters on the upstream batter. Batter constructed with gravel/rockfill which is unlikely to be slippery.	E- Catastrophic	1 - Very Unlikely	Moderate	- Huon to develop and implement reservoir access procedures.	Huon	Prior to commissioning	Ongoing	E- Catastrophic	1 - Very Unlikely	Moderate	
002	Operation	Environmental Impacts from release of contaminate liquid to environment	Dam failure, spill or seepage results in release of contaminated liquid to Parramatta Creek causing environmental impacts to aquatic species	- GHD design of lagoon to be in accordance with ANCOLD Guidelines - CCL to limit seepage. - Consider automated pond level and alarm	C- Severe	3 - Possible	Moderate	-GHD design to include spillway or provide sufficient freeboard to store design events -Huon to develop OM&S manual for lagoon outlining safe operating rules for lagoon and regular routine inspections. - Seepage to be monitored if observed. - Groundwater monitoring	GHD/Huon	Prior to construction	Ongoing	C- Severe	2 - Unlikely	Low	Huon to provide acceptable spill frequency. GHD to determine required freeboard.
003	Setup, Construction and Commissioning	Services	Contact with overhead or underground services (i.e. electrical) potentially resulting in injury or death	- DBYD undertaken and Huon have locations of known services in the vicinity - Indicative locations of existing known services shown on design drawings	E- Catastrophic	2 - Unlikely	Significant	- Huon to ensure contractor locates and demarcates all services on site prior to any ground works beginning	Huon	Prior to construction	Ongoing	E- Catastrophic	2 - Unlikely	Significant	
004	Setup, Construction and Commissioning	Excavation	Excavation collapse resulting in engulfment of personnel	Adopt stable slopes for excavations	E- Catastrophic	1 - Very Unlikely	Moderate	Engage competent contractor with appropriate HSE procedures and able to comply with Huon site safety standards and relevant HSE regulations	Huon	Prior to Construction	Ongoing	E- Catastrophic	1 - Very Unlikely	Moderate	
005	Operation	Chemical/Biological	Contact with liquid waste or solid residue causes illness/disease	Risk identified	B - Major	3 - Possible	Low	Design to limit need for operator contact with liquid trade waste or solid residue	GHD/Huon	Submission of Detailed Design	Closed	B - Major	2 - Unlikely	Negligible	
006	Operation	Slips/Trips/Falls	Huon personnel or member of public slip/fall into lagoon whilst it is empty resulting in injury	Risk identified	C- Severe	3 - Possible	Moderate	GHD Design to include: -Security fencing to restrict access. -Bollard & Chain on crest to mitigate vehicle access. Huon to develop and implement reservoir access procedures.	Huon	Prior to commissioning	Ongoing	C- Severe	2 - Unlikely	Low	GHD design includes safety provisions. Huon to develop access procedures
007	Operation	Odour	Odour from Lagoon Operation impacts community	Risk identified	A - Minor	3 - Possible	Negligible	Huon to advise GHD whether cover/treatment is required.	Huon	n/a	Closed	A - Minor	2 - Unlikely	Negligible	Cover not required

Design Ref	Design Life Cycle Stage (Select from Drop Down Box)	Hazards What could cause injury or ill health, damage to property or damage to the environment	Risk What could go wrong and what might happen as a result	Existing Control Measures	Initial Risk Rating			Potential Control Measures (Consider Hierarchy of Control - Elimination, Substitution, Isolation, Engineering Controls, Administrative Controls, PPE)	Responsibility	By When	Decision / Status	Residual Risk Rating			Comments
					C	L	RR					C	L	RR	
008	Setup, Construction and Commissioning	Overtopping of plant	Plant overtops during operation on steep ground	Risk identified	E- Catastrophic	2 - Unlikely	Significant	Engage competent contractor with appropriate HSE procedures and able to comply with Huon site safety standards and relevant HSE regulations	Huon	Prior to Construction	Ongoing	E- Catastrophic	1 - Very Unlikely	Moderate	
009	Operation	Dam Failure	Clean water diversion rain becoming blocked during PMF event. Overflows into the dam and overtops embankment.	Drain suitably sized for PMF and designed to be maintainable	E- Catastrophic	2 - Unlikely	Significant	Huon to inspect drain during routine inspections and clean out drain as required.	Huon	Ongoing	Ongoing	E- Catastrophic	1 - Very Unlikely	Moderate	
10	Investigation and Design	Dispersive Soil	Dispersive Soils used for construction of the embankment core with no filter - potential failure risk	Emerson class testing performed during design phase.	E- Catastrophic	2 - Unlikely	Significant	Recommend undertaking pinhole dispersion test with site waste water prior to construction.	GHD/Huon	Ongoing	Ongoing	E- Catastrophic	1 - Very Unlikely	Moderate	
11	Investigation and Design	No filter	No filter could allow piping failure of the embankment	Conservatively wide clay core adopted for the design to limit risk of piping. Pond level can be drawn down should any piping issues be identified during operation.	E- Catastrophic	1 - Very Unlikely	Moderate	Recommend first fill is undertaken progressively to allow ongoing inspection and identification of any seepage. Slow first fill will allow rectification of issues before they can progress.	GHD/Huon	Ongoing	Ongoing	E- Catastrophic	1 - Very Unlikely	Moderate	
12	Investigation and Design	Desiccation Cracking and Erosion of CCL	Potential for erosion of CCL due to wave action and desiccation cracking when the water level is low.	CCL will be covered by 300 to 600 mm of gravel to limit erosion and desiccation cracking potential.	C- Severe	2 - Unlikely	Low	Ongoing monitoring by Huon Personnel during routine inspections - early identification of issues is key to repairing before significant damage to the CCL could occur.	Huon	Ongoing	Closed	C- Severe	1 - Very Unlikely	Low	Gravel cover will need to be monitored during operations and repaired if erosion occurs.
13	Investigation and Design	Groundwater	Risk of high groundwater level damaging CCL during low pond levels or creating difficult construction conditions	Risk identified	C- Severe	3 - Possible	Moderate	Review groundwater conditions during construction to determine if additional measures are required, such as sub-soil drainage and blanket filters below CCL	GHD/Huon	Construction	Ongoing	C- Severe	2 - Unlikely	Low	
14	Investigation and Design	Drawdown	Rapid drawdown could results in shallow slumps at the toe of the upstream batter	Risk identified	D - Critical	3 - Possible	Significant	Standard operation is expected to use the full irrigation season to drawdown the storage. Regular inspections should monitor for any signs of slumping. Any slumps can be repaired	Huon	Ongoing	Ongoing	D - Critical	1 - Very Unlikely	Moderate	
15	Setup, Construction and Commissioning	Available Clay Volume	Insufficient volume of clay available for constuction	Risk identified	D - Critical	3 - Possible	Significant	Modify pond floor levels based on additional geotech investigation results to optimise clay volumes required. Alternate borrow areas could established if required.	Huon	Ongoing	Ongoing	D - Critical	1 - Very Unlikely	Moderate	

Appendix I – Technical specification



Huon Aquaculture Company

Winter Storage Dam Technical Specification

July 2019

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Locality Plan.....

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1. Description

1.1 Purpose of documents

This Specification contains the requirements for materials and procedures to be implemented during the construction of a new lined Winter Storage Dam at Huon Aquaculture's Parramatta Creek Site.

1.2 Location of site

Huon Aquaculture is located a Parramatta Creek, Tasmania on the Bass Highway. Access to the new dam site is through the processing plant area. The location of the dam is shown in Figure 1-1.

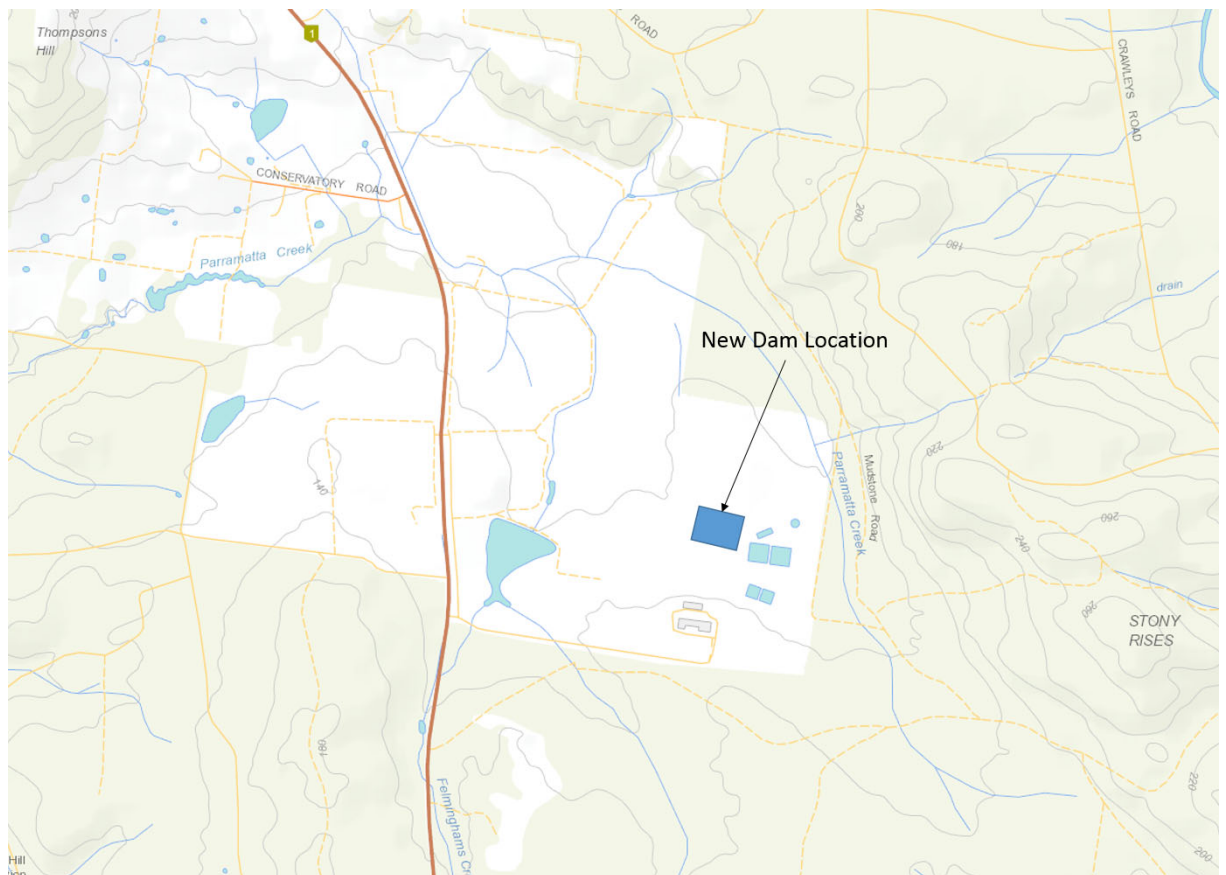


Figure 1-1 Locality plan

1.3 Summary of works

Waste water from processing operations at Parramatta Creek are currently stored within 4 dams on site. The current storage is not sufficient and an additional 72ML is required. The wastewater is mixed with fresh water and used for irrigation on surrounding land.

The civil works associated with the construction of the Winter Storage Dam include:

- Construction of a new 75 ML winter storage dam with a zoned embankment and CCL.
- Construction of reinforced grass spillway.

1.4 Documentation available

The following documentation outlines the requirements for the project:

- i. Drawings; and
- ii. Technical Specification.

Where the Specification and any other Contract documentation do not agree, the Contractor shall seek clarification from the Superintendent.

1.5 General construction

In addition to the Specification, all Works shall comply with the current applicable Australian Standard in effect at the time of construction. Where the current applicable Australian Standard in effect at the time of construction and the Contract documentation do not agree, the Contractor shall seek clarification from the Superintendent.

The Contractor is fully responsible for choosing the appropriate plant, equipment and work methods for the purpose and environment for which they are to be used. The Contractor shall be fully responsible for the construction of the works and ensure acceptable work practices are used.

The Contractor will meet all Huon safety requirements, and prepare an appropriate safety and environmental management plan for approval by Huon.

There is no general power, water or amenities available at the site.

1.6 Adjacent activities

The existing waste network and irrigation systems at the site is to remain operational and without interference from the Contractor's activities during construction of the works. The Contractor shall be responsible for the planning and construction of the Works so as to ensure that the daily operational requirements of the site are not interrupted by the Contractor's operations. The contractor shall liaise with Huon to ensure that existing lines are isolated whilst new connections are made. The Contractor shall take the necessary precautions to ensure that no liquid (with the exception of direct rainfall) enters the dam until the dam is commissioned.

1.7 Survey and setting out

All survey, including setting out, shall be arranged by the Contractor and shall be carried out by appropriately qualified personnel.

All survey shall be to MGA and levels shall be based on Australian Height Datum (AHD).

The Contractor shall set out the Works from the data shown on the Contract Drawings.

Spot levels shall take precedence over contours.

Set out of the dam constitutes a HOLD POINT.

1.8 The Site Engineer

The Site Engineer refers to the person responsible for technical supervision of the works. The Site Engineer shall be nominated by the Principal and will have appropriate qualifications that satisfy relevant legislative and competency requirements for the works.

1.9 Workplace Health and Safety

The Contractor shall comply with and ensure that its employees, subcontractors and their employees comply with all provisions of the Tasmanian Work Health and Safety Act 2012 (the "Act"), Tasmanian Work Health and Safety Regulations 2012 (the "Regulations") and Huon's site specific Health and Safety requirements.

The Contractor shall be responsible for running the project in accordance with:

- Work Health and Safety Act 2012
- Work Health and Safety Regulations 2012
- Construction Work Code of Practice July 2012
- All relevant Huon Safety Management Plans, systems and procedures including Huon's works permitting system
- The Contractor's project specific Contract Management Plan (CMP)
- All other relevant Legislation and Codes of Practice required by Workplace Standards Tasmania.

The Contractor shall:

- Include in the CMP a WHS Management Plan in accordance with the Act, Regulations, site specific documentation and current industry practice.
- Prepare Safe Work Method Statements for all works.
- Submit the WHS Management Plan to the Superintendent:
 - (i) Within 10 working days of commencement of contract; and
 - (ii) Prior to taking Possession of Site.

The Superintendent may at any time request an amendment of the Plan. The Contractor shall forthwith amend the Plan in accordance with the Superintendent's request or provide written justification as to why the Plan should not be amended.

The Contractor shall comply with any instructions from the Principal regarding safety issues or directed at improving the safety of the systems of work.

2. Quality requirements

2.1 Scope

This section describes the Quality Assurance requirements for the Works.

2.2 Quality Standard

The Contractor shall plan, develop and maintain a documented quality system in accordance with this Technical Specification and with the Australian Standard for Quality Systems applicable to the Works as specified.

2.3 Construction Quality Assurance

The Principal may engage an independent organisation e.g. CQA Consultant, under contract to the Principal, who may conduct additional independent Quality Assurance (QA) monitoring, observation, testing and documentation on behalf of the Principal. The Contractor shall cooperate fully with the Superintendent and all QA representatives during any independent QA sampling, testing, and certification and shall assure, at all times, safe access to the Works for the purpose of monitoring, observation, and CQA implementation.

2.4 Quality Plan

2.4.1 Submission of Quality Plan

The Contractor shall prepare a Quality Plan for the Contract, to cover all work both on site and off site to be carried out for the purposes of the Contract.

A controlled copy of the Quality Plan shall be provided to the Site Engineer for review and approval prior to substantial commencement of the works.

Approval of the Quality Plan constitutes a HOLD POINT.

2.4.2 Quality Plan contents

The Quality Plan shall show how the Contractor intends to assure that the requirements of the Technical Specification are met. No provision of the Quality Plan shall over-rule the requirements of the Technical Specification.

The Quality Plan shall describe the application of the Contractor's Quality System to the Contract.

The Quality Plan shall describe how the Quality System elements given in the relevant Quality Standard are to be applied to the contract, and shall include in particular details listed in the following clauses.

2.5 Inspection and Test Plan

The Contractor shall develop Inspection and Test Plans (ITPs) as part of the Quality Plan.

2.6 Hold Points

Definition: Those points beyond which the work shall not proceed without review and release by the Site Engineer.

All hold points identified in the Technical Specification shall be defined in the Quality Plan, including information to be supplied at the hold point and who shall be responsible for its approval.

Except where specifically amended, the following conditions shall apply to hold points listed below.

The Contractor shall give at least 48 hrs prior notice of the Hold Point.

All relevant test and verification results shall be available for inspection by the Site Engineer at the time of the Hold Point.

The Contractor shall allow for one working day at the Hold Point for the Site Engineer to attend the site and inspect the work and documentation.

Where the Hold Point relates to the condition of a surface or installed material, the Contractor shall verify that the completed surface has achieved full conformance with the Contract Documents. Hold Points may be released for part of the Works Area only, as defined by the Superintendent, so that the Works can be completed in a sequenced manner. The Superintendent's approval of the completed items is required prior to the release of each Hold Point.

Hold Points as a minimum shall include:

1. Pre-Construction meeting prior to start of works
2. Approval of Contractor's Quality Plan and Risk Assessment
3. Provision of all specified certificates for materials used in the Works, prior to delivery of the materials to the Site, including all geosynthetics, drainage aggregate, pipework, valves, pumps and other specified materials
4. Demarcation of buried services
5. Set out of dam
6. Following stripping of embankment footprint
7. Approval of embankment materials
8. Following subgrade preparation (Proof roll inspection)
9. Survey of completed subgrade
10. Pipework prior to placement of trench backfill material
11. Pressure testing of pipework
12. Pipework shop drawings
13. Approval of finished levels, slopes and drainage measures
14. Practical completion after clean-up
15. Additional as requested by the Site Engineer

The Contractor may initiate additional hold points if considered necessary.

2.7 Non-conformance

The Contractor shall promptly notify the Site Engineer of any product and service non-conformances, except where conformance is to be achieved by a continuation of the original process. Notification shall be submitted as Non-conformance Reports and shall indicate the proposed method of rectification for approval by the Site Engineer.

The Contractor shall prepare and use standard forms approved by the Site Engineer for Non-conformance reports.

A hold point shall apply prior to covering up rectification work to allow the Site Engineer to inspect the work.

3. Care of the works

3.1 General

The contractor shall assume responsibility for construction and maintenance of all diversion and protective works and shall furnish all materials required.

The Contractor shall furnish, install, maintain and operate all necessary pumping and other equipment for dewatering the various parts of the works, and for maintaining free from water, as required for constructing each part of the works and as required after any part of the work is completed, for inspection or for any reason determined to be necessary by the Site Engineer.

The Contractor shall be responsible for, and shall repair at their own expense, any damage to foundations or any other part of the works, either permanent or temporary, caused by water, flooding or failure of any part of the diversion or protection works.

3.2 Sediment management

The Contractor shall follow the Department of Primary Industries, Parks, Water and Environment (DPIPWE) “*Guidelines for Developing a Sediment and Erosion Control Plan for Dam Works Sites*”, January 2016.

The Contractor shall construct temporary silt traps from approved material on all drainage paths impacted by the works in order to minimise contamination of natural water courses.

The installation of sediment traps on drainage paths constitutes a HOLD POINT.

The Contractor shall implement a monitoring scheme for regular inspection of all temporary silt traps during the construction and maintenance periods. Where deemed necessary the contractor shall remove sediment and cart to an approved dump.

3.3 Reinstatement and seeding

All disturbed surfaces are to be reinstated to their condition prior to commencement of works or better. All exposed earthworks (i.e. cut batters, pipe alignment, and embankment downstream batters) shall be seeded with approved grass seed, and maintained during the construction and maintenance periods.

4. Earthworks

4.1 General

Excavations at the site of the works shall be in the areas and to the extent shown on the drawings, or as approved by the Site Engineer.

On completion of the works, excavated surfaces that will remain permanently exposed shall be finished off to the lines and grades shown on the drawings, or as directed by the Site Engineer.

4.2 Definitions

4.2.1 Required excavation

Required excavations include the removal of all soil or rock from the required foundations and excavated surfaces for the Permanent Works.

Required excavation does not include excavation in borrow areas and stockpiles, or any other excavation performed at the option of the Contractor to secure access to required work or for disposal of material excavated.

4.2.2 Topsoil

The surface or top layer of soil including fine roots, the herbaceous vegetation and overlying grass and is characterised by the presence of organic matter.

4.3 Services

Prior to the commencement of any work on site, the Contractor shall confirm the location and depth of all services and utilities. During the Works, the Contractor shall take every precaution that is necessary to protect existing services and utilities, both underground and overhead, from damage. The Contractor shall comply with the Statutory Regulations for maintaining safe working clearance to overhead electrical services. Damage to existing services and utilities shall be repaired by the Contractor to the satisfaction of the Superintendent and/or the relevant authority.

The demarcation of buried services constitutes a HOLD POINT.

4.4 Clearing, grubbing and stripping

All areas required for construction works including borrow areas, surface of stockpile sites and all other areas deemed necessary shall be cleared, grubbed and stripped by the Contractor to the satisfaction of the Site Engineer.

Clearing shall consist of removing materials from the ground surface, such as trees, shrubs, logs and stumps.

Grubbing shall consist of removing to a depth 300 mm below the ground surface, all objectionable material which interferes with required excavations or embankments, including stumps, roots and logs.

Stripping shall consist of the removal of the organic layer of material.

The Contractor shall take all precautions to ensure that the stripped vegetation and topsoil is not mixed with the underlying soil.

No trees shall be cut down without the prior approval of the Site Engineer and all trees designated by the Site Engineer shall be protected carefully from damage by the Contractor's operations.

Once cleared, grubbed and stripped, such areas shall be maintained until the contract has been completed, unless otherwise approved by the Site Engineer.

Vegetation and topsoil shall be stripped and stockpiled as directed by the Site Engineer.

Stripping of the embankment footprint constitutes a HOLD POINT.

4.5 Disposal and temporary stockpiles

If required, the Contractor shall dispose of excess cut and locate temporary stockpiles where directed by the Site Engineer to avoid exacerbating landslide risk.

The Contractor shall be required to maintain and operate all stockpiles in a neat compact manner such that they occupy as little area as practicable and are at all times adequately sealed and graded to shed rainfall without erosion.

4.6 Required excavations generally

4.6.1 General

Required excavation shall be to the lines and grades shown on the drawings, or as established by the Site Engineer. During the progress of the work it may be found necessary or desirable to vary the slopes or the dimensions of the excavations from those shown on the drawings or established by the Site Engineer.

Approval of finished levels, slopes and drainage measures constitutes a HOLD POINT.

4.6.2 Over excavation

All over-excavation shall be backfilled with approved material from excavations as directed by the Site Engineer.

4.6.3 Contractors access to site of works

Any excavation, or embankment construction performed at the option of the Contractor to secure access to required work, for the disposal of materials excavated, or for any other purposes, shall be kept within limits approved by the Site Engineer.

4.6.4 Stability of excavations

The Contractor shall be entirely responsible for the stability and safety of all excavations. If the contractor has stability concerns regarding the proposed cut or fill batters, these should be raised with the Site Engineer.

4.7 Equipment

All earthworks shall be undertaken using conventional earthmoving equipment and methods e.g. excavators and other equipment typical to this type of project. Blasting is not permitted.

4.8 Work method statement

The Contractor shall submit a work method statement to the Superintendent detailing how they propose to undertake the works prior to the works commencing.

4.9 Quantities

The Contractor shall monitor all earthworks and shall be responsible for verifying the quantities of materials used for constructing the finished subgrade.

4.10 Nature of excavated materials

The Contractor shall be responsible for any assumptions made in relation to the nature, hardness and types of materials to be encountered in excavations and the bulking and compaction characteristics of materials.

4.11 Extent of disturbed area

The Contractor shall confine machinery operations within the Work Area as shown on the Contract Drawings.

4.12 Lines and levels

The extent of earthworks shall be to the lines and levels shown in the Contract Drawings. Compacted areas shall be trimmed to line and level by machine and/or hand as necessary to produce profiles to the accuracy required by the Specification.

4.13 Tolerances

Unless specified otherwise, the tolerance for finished surfaces shall be:

Table 1 Allowable tolerances

Element	Level
Subgrade	+/- 100 mm
Embankment Crest	+ 100 mm
Spillway/Outlet	+/- 20 mm

4.14 Embankment fill

4.14.1 General fill

Embankment Fill shall comprise fill material sourced from within the proposed storage area as agreed with the Superintendent. Embankment Fill shall contains no particles greater than 200 mm, be free of organic material. If necessary, the Contractor shall use appropriate working methods to yield material for the earthfill by breaking down oversize rock or by other means to ensure that the material conforms to the requirements of this Clause.

Rocks or rock fragments greater than 37.5 mm in any dimension shall be removed from the fill and disposed of as directed by the Superintendent or designated representative. Rocks or rock fragments less than 37.5 mm shall be distributed evenly throughout the fill. "Nesting" of rock or rock fragments shall not be permitted. These provisions, allowing incorporation of rock or rock fragments within the fill shall not relieve the Contractor of the responsibility to prepare the final subgrade surface for composite liner installation in accordance with other provisions of these Specification

4.14.2 Select Clay and Compacted Clay Liner

The select clay and compacted clay liner will comprise of clay material sourced from the storage area as agreed with the superintendent. Clay shall be free of organic material, sharp objects that may damage the liner and not have particles greater than 37.5 mm in size. Clay shall have a minimum of 30% passing 0.075 mm sieve.

Clay shall have a minimum permeability of 1×10^{-9} m/s and shall be tested in situ to ensure this is met.

Clay shall have a minimum undrained shear strength of 65 kPa, to be tested using a shear vane during construction.

4.14.3 CCL Cover Material

CCL Cover Material shall be sourced on site from Mud Stone won from excavation, nominally the material shall be Well graded gravel with cobbles up to 200 mm. The material shall be free of debris, pockets of clay and other deleterious or organic material. The material shall be approved by the superintendent prior to use.

4.15 Drainage aggregate

Drainage aggregate shall consist of free draining aggregate, free of debris, pockets of clay and other deleterious or organic material, of nominally 7-10 mm. A PSD of sample material shall be submitted to the superintendent prior to use.

Sand drainage material shall be well graded sand, free of debris, pockets of clay and deleterious or organic material. A PSD of sample material shall be submitted to the superintendent prior to use.

4.16 Filling

Filling includes all operations associated with the preparation of the Works, on which fill material is to be placed, and the placing and compacting of approved material to the alignment, grading and dimensions shown on the Contract Drawings, including any pre-treatment such as breaking down, blending or drying out material containing excess moisture.

All fill shall be placed, spread, mixed, watered and compacted in accordance with the Specification.

The ground surface prepared to receive fill shall be firm and unyielding. This shall be determined by undertaking compaction testing.

4.17 Compaction

Unless otherwise specified, fill material shall be placed in thin lifts with a maximum compacted layer thickness of 200 mm. Each layer shall be spread evenly and thoroughly mixed to obtain a near uniform condition in each layer. In areas of excess lift thickness, regrading of the surface to the maximum lift thickness shall be completed prior to construction of additional lifts.

Each layer shall be compacted to equal to or greater than 98% of its standard maximum dry density. At the time of placement, the materials shall be damp or moist but shall not contain excessive free water. A smooth drum vibratory roller shall be used for compacting the material unless otherwise directed by the Superintendent.

4.18 Acceptance criteria

Acceptance of the completed earthfill construction shall be based on visual inspection by the Site Engineer.

4.19 Subgrade preparation

The Contractor shall prepare the subgrade to provide a uniform surface, free of defects, or imperfections that may result in damage to the overlying layers.

The finished surface shall be free from abrupt breaks, sharp objects, or other foreign material. All construction stakes, hubs, or other items used for grade control shall be removed and the void filled with processed material. The subgrade shall be unyielding, smooth, and uniform. The surface shall not be pebbly, or tracked and rutted by equipment. Pockets, holes, or discontinuities shall be repaired. No loose, coarse-grained material shall remain on the surface of the subgrade.

4.20 Proof rolling

Following subgrade preparation proof rolling of the subgrade shall be undertaken. An 8 tonne smooth drum compactor shall be driven over the liner subgrade to identify weaker zones which may deform and damage the liner when loaded. In areas where heaving is observed and where the application of additional compactive effort is unable to remedy, then over excavation and replacement of the unsuitable material with an engineered subgrade may be required.

Proof rolling of the subgrade constitutes a HOLD POINT.

4.21 Survey of completed subgrade

After completion of subgrade preparation works a survey shall be carried by the Contractor's surveyor prior to placing the overlying layers. The agreed survey shall be used to check the final levels and floor slopes of the overlying layers.

Survey of the completed subgrade constitutes a HOLD POINT.

5. Pipework

5.1 Standards

REFERENCED DOCUMENTS: The following standards are referred to in this section:

AS 1260	Unplasticized PVC (uPVC) pipes and fittings for sewerage applications
AS 1281	Cement Mortar Lining of Steel Pipes and Fittings
AS 1289	Methods of Testing Soils for Engineering Purposes
AS 1315	Portland Cement
AS 1326	Polyethylene (Polythene) Film for Packaging and Allied Purposes
AS 1477	uPVC Pipes and Fittings for Pressure Applications
AS 1579	Arc Welded Steel Pipe for Water and Wastewater
AS 1646	Rubber Joint Rings for Water Supply, Sewerage and Drainage Purposes
AS 2032	Code of Practice for Installation of uPVC pipe system
AS 2033	Installation of Polyethylene Pipe Systems
AS 2129	Flanges for Pipes, Valves and Fittings
AS 2280	Ductile Iron Pressure Pipes and Fittings
AS 2566	Plastics Pipe laying Design
AS 2638	Sluice Valves for Waterworks Purposes
AS 2758	Aggregate and Rock for Engineering Purposes
AS/NZS 2845 Backflow prevention devices performance	
AS/NZS 3500.1 Plumbing and Drainage. Water Services	
AS/NZS 3500.1 Plumbing and Drainage. Sanitary plumbing and drainage	
AS 3725	Loads on Buried Concrete Pipes
AS 3902	Quality Systems for Production and Installation
AS 4058	Precast Concrete Pipes
AS 5200.053	Plumbing and drainage products, Part 053: Stainless steel pipes and tubes for pressure applications
AS/NZS 4130	Polyethylene Pipes for Pressure Pipes and Fittings
AS/NZS 4131	Polyethylene Compounds for Pressure Pipes and Fittings
AS/NZS 4441	Orientated PVC (OPVC) pipes for pressure applications
AS/NZS 4765	Modified PVC (PVC-M) pipes for pressure applications

5.2 General requirements

METHOD: Supply and install the pipework in a safe manner, without interfering with or damaging adjacent pipework or structures, using methods complying with the requirements of appropriate Standards for materials, construction, fabrication and installation.

LOCATIONS, LEVELS AND DIMENSIONS: Construct the pipework to the locations, levels and trench depths specified and shown on the Drawings, and listed in the Specification.

VARIATION DRAWINGS: If it is proposed to change the installation from that shown on the drawings, or if a change is required by a Regulatory Authority, prepare and submit a variation drawing showing the proposed change, and obtain prior written approval from the Superintendent.

5.3 Quality Assurance

REQUIREMENT: Where there is a recognised quality assurance program applicable to a specified product, provide assurance of product quality under the authority of that program. The program shall be one in which the manufacturer has in place a quality control management system which is subject to continual monitoring through quality audits by a recognised independent organisation.

Provide test certificates prepared by an independent testing authority to show that materials comply with the relevant standards.

5.4 Pipework assembly drawings

REQUIREMENT: Submit all pipework assemblies in detail on fabrication drawings for acceptance prior to fabrication and installation. The drawings shall include set-out dimensions, pipe inverts/centreline levels, valve and fitting details, supports/anchors, coating/wrapping details, joint details, etc. No pipework shall be installed without the prior approval, in writing, of the Superintendent.

5.5 Inspections

NOTICE: Give the Superintendent at least twenty four (24) hours notice so that inspections may be made of the following items:

- Trenches excavated and ready for backfilling
- Laying and jointing pipes
- Work ready for specified testing
- Enclosed work ready to be covered up or concealed
- Concrete ready to be placed
- Works affecting the existing pipe system.

5.6 DICL pipes and fittings

STANDARD: To AS 2280

PIPE CLASS: K9 (Rubber Ring), K12 (Flanged)

JOINTS: Rubber ring and flanged as specified.

LINING: Cement lined to AS 1281.

COATING: Buried: Bitumen/tar dipped.

Exposed: Fusion bonded epoxy.

QUALITY ACCREDITATION: The pipe supplier shall be accredited to AS 3902 quality requirements.

5.7 Stainless steel piping

STANDARD: To AS 5200.053 and the standards referenced within.

PIPE AND FITTINGS CLASS: Grade 316L Schedule 10.

JOINTS: Welded or flanged as shown on Drawing Nos 32-17980-C411 and C412. All welding to be undertaken by a certified welder experienced with SS pipework.

5.8 uPVC sewer pipes and fittings

STANDARD: AS 1260

INTENDED APPLICATION: Subsoil drains (pipes slotted as specified)

PIPE CLASS: Dia. 100 SN10
Dia. 150 SN8

Greater than Dia. 150 Ultra Rib or approved equal.

JOINTS: Rubber ring unless otherwise specified.

DRAINCOIL PIPE: Class 400

QUALITY ACCREDITATION: The pipe supplier shall be accredited to AS 3902 quality requirements.

5.9 uPVC pressure pipes and fittings

STANDARD: AS 1477

INTENDED APPLICATION: Water and Wastewater

PIPE SIZE/CLASS: As specified on Drawings. Class 12 minimum unless otherwise specified on the drawings.

Ductile iron compatible.

JOINTS: Rubber ring unless otherwise specified.

QUALITY ACCREDITATION: The pipe supplier shall be accredited to AS 3902 quality requirements.

5.10 Polyethylene pipes and fittings

PRODUCT: High Density Polyethylene.

STANDARD: AS4129 and POP004A

CLASS: Pipe: PN 12 PE100 unless specified otherwise on the drawings.

FITTINGS: PN16 PE100 or 316 Stainless Steel.

JOINTS: Butt fusion or stub flanged with galvanised backing plates as specified on the Drawings.

Joint class to be equal to or greater than the pipe.

QUALITY ACCREDITATION: The Pipe supplier shall be accredited to AS 3902 quality requirements.

HDPE FITTINGS: All bends shall be butt welded sweep bends or fabricated bends manufactured from PN12.5 PE100 pipe material.

INSTALLATION: All HDPE installation shall be undertaken by an approved, experienced and certified installer.

5.11 Valves

5.11.1 Valve details

- VALVE ENDS: To suit the method of jointing shown on the Drawings.
- DIRECTION OF CLOSURE: Clockwise to close unless otherwise specified.
- METHOD OF OPERATION: Hand wheel, key or electrically actuated as stated on the Drawings.
- SLUICE VALVES: To AS 2638
 - Flanged: AVK Resiliant Seat Gate Valve: Class 16 with handwheel.
- NON RETURN VALVES: Ball Type: AVK Ball Check Valve PN10 approved equal.
- COATING: Fusion bonded epoxy or approved equivalent unless noted otherwise.
- VALVE ACTUATION

5.11.2 Manual actuation

- General: Where designated as manually activated, all valves shall be fitted with a handwheel other than those either under or in ground where a valve key drive shall be provided, or where shown on the Drawings or detailed in the Specification to have other than a handwheel. The handwheel shall be fitted to the vertical spindle by means of a square key drive.
- Marking: Mark all manually operated valves with an engraved label to show the direction of closing.
- Type: Geared or travelling nut handwheel operation with totally enclosed mechanism.
- Position indicator: Include in the actuator mechanism a suitable indicator device to indicate valve position.
- Spindle Extension: Where shown on the Drawings provide spindle extensions made up from stainless steel tubes supported from permanent structures by rigid brackets incorporating provision for adjustment of the alignment of the spindle between the valve and the actuator or handwheel.
- Extension Spindle Connections: Make connections between extension spindles, valve shafts or stems and handwheels with components machined to a snug fit.
- Universal Joints: Provide universal joints to extension spindles where shown on the Drawings.

5.12 Joints

5.12.1 Flanges

- PRODUCT: Grey cast iron full face flanges either integral or screw-on type.
- TABLE: AS 4087 Class 16 except that flanges abutting to valves shall be compatible with the valve flange, in particular the limitations on the maximum inside diameter of flanges joining to ANSI valve flanges shall be observed.
- WEEP FLANGES: Shall be designed to transmit a thrust equal to the force due to the test pressure acting on the equivalent of a closed ended pipe or valve to the thrust block or pipe anchor.
- SLIP FLANGES: Shall be manufactured from steel plate or cast iron to dimensions set out in AS 4087 Class 16.

UNIFLANGES: "Uniflange" joints shall be supplied complete with rubber gasket, nuts, bolts, washers and set screws. The joints shall be designed to specifically match the outside diameter of the pipe being joined.

BOLTS, NUTS AND WASHERS: To be galvanised, unless otherwise specified in the Drawings.

FLANGE FACES: To be machined.

5.12.2 Gibault joints

PRODUCT: Cast iron gibault joints (long type) complete with rubber rings and nuts and bolts.

PRESSURE RATING: All components are to be suitably sized to resist all stresses which may be applied due to the test pressure specified.

COATING: Joints to be bitumen or tar dipped if buried or FBE if exposed.

5.12.3 Jointing rings and gaskets

PRODUCT: Rubber rings and gaskets for joints.

STANDARD: To AS 1646.

FOR POTABLE WATER PIPEWORK: Natural rubber.

FOR PROCESS PIPEWORK: Synthetic rubber compound in which the polymer shall be either chloroprene or styrene butadiene.

5.13 Identification

PIPEWORK: Supply pipes which, after lining and coating (if applicable) have been clearly stencilled by the manufacturer with an identifying mark indicating:

- The manufacturer's name or registered mark.
- The date of manufacture.
- The nominal size of the pipe.
- The class of pipe or factory test pressures if applicable.
- All other information to comply with the provisions of the relevant Australian Standard.
- FITTINGS: Supply fittings which, after lining and coating, have been clearly stencilled by the manufacturer with an identifying mark indicating:
 - The manufacturer's name or registered mark.
 - The nominal size of the fitting and the fitting identification.
 - The class of pipe or factory test pressures if applicable.

5.14 Handling

HANDLING: Use slings or forks supporting the barrel of pipes when handling pipes during storage and delivery.

Keep lifting hooks, slings or forks clear of joint surfaces at pipe ends.

Handle pipes in a manner which prevents contact with each other or hard parts of equipment.

Place suitable packing between pipes placed close to other pipes or where pipes are stacked more than one pipe high.

Do not drop or push pipes with mechanical equipment.

UNLOADING AND STACKING: Use cranes or forklift trucks when unloading and stacking pipes and fittings.

Under no circumstances unload pipes or fittings by rolling or dropping.

Any pipes or fittings which have been rolled or dropped shall be rejected immediately and removed from the site whether damage is obvious or not.

COATINGS: Support coated fittings on padded supports approved by the Superintendent.

Make good or repair any damage to pipes, fittings, coatings or linings.

5.15 Diverting water and dewatering

DIVERTING WATER: Do all work necessary to divert any water the Superintendent considers may interfere with the progress of the works and to keep the trenches free from water while the works are in progress and prevent any injury to the works by water due to floods or other causes. Dispose, without nuisance or damage to adjacent works and/or property, of all water removed from the works.

REPLACEMENT: When directed by the Superintendent, any work or material damaged by water.

COSTS: The cost of all work required by clause DIVERTING SEWAGE is to be included in the rates in the Schedule of Rates for "Excavation and Refilling of Trenches etc".

5.16 Excavation

EXCAVATION: Excavate as required for the various works and excavate the trenches for all pipes of whatever kind and, after the works have been laid, jointed, tested and approved, refill around the Works and the trenches in accordance with the requirements of the Contract.

SAFETY: Ensure that all excavation is made in a careful manner and where necessary, that it is rendered secure and safe by means of shoring, sheeting, props, wedges, packing and/or caulking.

Where necessary due to the ground conditions and/or the proximity of structures or other works, adopt forms of ground stabilisation most suitable to the conditions encountered and be responsible for their effectiveness in averting damage, injury and collapse of excavation. Where the water table during construction of excavations open to the ground surface is located above the bottom of the trench, use a system of trench support based on interlocked sheeting, or some other similar system approved by the Superintendent prior to construction.

LINES AND GRADES: Make all excavation to the lines, grades and forms shown upon the Drawings or given by the Superintendent and comply with the requirements of Statutory Authorities.

TRENCH TRIMMING: Trim the bottom of the trench neatly to slope and grade in long straights, and easy vertical curves and where bedding is not required trim to provide a bed for the barrel of the pipe.

OVER EXCAVATION: Refill to grade any part of the trench or other excavation excavated below grade with approved material and mechanically compact the refill. Over excavation under structures shall be backfilled with 15 MPa concrete or cement stabilised sand.

HAND DIGGING: Use hand digging methods where the use of mechanical excavators may cause damage to buildings and other structures.

CUTTING OF WEARING SURFACES: To minimise overbreak the wearing course of pavements shall be cut prior to the commencement of excavation, using air spades or other

approved method. Immediately prior to the reinstatement of the wearing course it shall be cut in a straight line using a power saw or other approved tools. The cuts shall be located in the positions determined by the Superintendent in the undisturbed wearing course.

BLASTING: Blasting will not be permitted.

TRENCH DEPTH AND WIDTH: Refer to the details shown on the drawings.

BACKFILL DETAIL: Refer to Clause 5.17 and the details shown on the drawings.

5.17 Trench refilling

APPROVAL: All imported materials proposed to be used for bedding, pipe surround and refill shall be submitted for approval at least two weeks prior to their proposed use and they shall not be used without the written permission of the Superintendent. Further samples may be taken during construction and the materials may be rejected at any time if they do not conform to this Specification.

SAND BEDDING AND HAUNCHING MATERIAL: Bedding and haunching material shall contain no deleterious material or clay lumps and shall comply with the following gradation;

Table 2 Bedding and haunching material gradation specification

Sieve Aperture (mm) to AS 1152	% Passing (By mass)
6.7	100
2.36	70 – 100
0.6	20 – 90
0.3	8 – 50
0.15	0 – 20
0.075	0 – 10

In the above gradings, the material passing the 0.075mm sieve shall have low plasticity as described in Appendix D of AS 1726.

SELECTED REFILL MATERIAL: Shall be material excavated from the site free from clay lumps retained on a 75mm sieve and stones retained on a 25mm sieve and be to the approval of the Superintendent. Approved materials shall be low to medium plasticity silty sand, silty clayey sand or clayey sand. The soil shall be either excavated from the works or, where insufficient suitable soil is available, imported. High plasticity material shall **not** be used.

ORDINARY REFILL: Shall comprise the material excavated from the works. Where, in the opinion of the Superintendent, this material is not considered satisfactory for use as ordinary refill the Contractor shall be required to refill above the normal limit of the selected refill with selected refill or sand refill as directed.

SUBSOIL DRAIN REFILL MATERIAL: Shall be crushed rock with a maximum particle size of 14 mm with not less than 5% by mass passing a 4.75 mm sieve.

GEOTEXTILE: Shall be Bidim A14 or approved equivalent laps to subsoil drains shall be not less than 100mm as shown on Drawing No. C14.

SUB-BASE: Consists of material satisfying the Department of Infrastructure, Energy and Resources, Tasmania (DIER) Specification R 40 Appendix A3 – Sub-Base 1.

This material shall be used to refill trenches across roads and paved areas.

REFILL PROCEDURES: Ordinary refill in trenches and shafts may be placed with the aid of mechanical plant, but care must be taken to ensure that the material is not dumped into the

trench or shaft, and that no rock shall be placed until the pipes are covered by at least 600 mm of ordinary refill.

Submit to the Superintendent for approval, prior to commencement of excavation for any drive or tunnel, details of the method of placing and compacting the refill.

When directed supply and install polyethylene pipes or similar along the roofs of drive and tunnel to facilitate the placing by pump of sand-cement slurry in the space above the refill and until it is filled to the satisfaction of the Superintendent. The whole of the cost of supply and placing of sand-cement slurry shall be included in the rates in the Schedule of Rates for "Excavation and Refilling of Trenches etc."

COMPACTION REQUIREMENTS: Place haunch and selected refill material around pipes in layers not greater than 150 mm loose thickness and hand compact to ensure the material is thoroughly compacted around the pipes. The balance of the trench refill material above the pipes shall be placed in 200 mm layers and mechanically compacted achieve the following compaction standards:

Table 3 Minimum required compaction of pipe refill (source: AS1289 - E1.1 AND E4.1)

LOCATION	COMPACTION (% of Maximum Dry Density)	COMPACTION TEST FREQUENCY
Easements within properties	90	1 test per sewer manhole length or every 50 m if more frequent
Under future or existing footpaths	95	1 test per 30 m
Road crossings and road shoulders	98	1 per crossing
Generally in road reserves	90	1 test per sewer manhole length or every 50 m if more frequent
Pump Stations (except caisson construction)	90	4 minimum or 1 per 10 m3 of refill

5.18 Laying and jointing

GENERAL: Carry out the making of all joints of whatever description with the greatest of care. Pipes, fittings and valves shall be in their correct position, alignment and grade before the joints are made except that, in special circumstances where the Superintendent is satisfied that a satisfactory result would be achieved, the jointing of groups of pipes and fittings with flanged connections may be permitted prior to placing in position.

STANDARDS: Lay and joint pipes in accordance with the following Australian Standards:

- Concrete Pipes and Fittings: AS 3725
- PVC Pipes and Fittings: AS 2032, AS 2566
- MDPE Pipes and Fittings: AS 2033, AS 2566

LAYING AND JOINTING: Lay and joint a pipeline immediately following the excavation of the trench.

JOINTS CLEANING: Before laying and jointing thoroughly clean the internal barrel and jointing faces of each component of the pipeline.

PIPE CUTTING: Should it be necessary to cut a pipe, make the cut perpendicular to the longitudinal axis, with an approved mechanical cutter, or in the case of uPVC and HDPE a saw

and mitre box and treat the cut ends in accordance with the requirements of the manufacturer prior to laying and jointing the pipe.

SEALING OPEN ENDS: When work is not actually in progress, seal open ends of pipelines with gibault blank ends, to prevent the ingress of stormwater, animals, rubbish or other foreign matter. Hessian bags or similar shall not be used to block open ends.

FIRE PLUGS AND VALVES: Protect fire plugs, valves and risers from damage during the refilling of trenches and until they are protected by permanent covers or pits. Before installation in the pipelines remove and replace damaged washers forming valve seat in fire plugs, screw down all glands on valves and remove any material that could prevent full closing.

RUBBER RING JOINTS: Make rubber ring spigot and socket joints of the 'roll-on' 'compression' 'squeeze' or 'slide on' type strictly in accordance with the pipe manufacturer's instructions for that form of joint.

Use only that lubricant specified by the manufacturer and in the quantity recommended, for a particular joint.

Drive home spigot and socket joints well with the spigot fully entered into the socket of the preceding pipe, and the spigot truly concentric with the socket. No subsequent springing of the joints will be permitted.

FLANGED JOINTS: Make flanged joints carefully with moulded rubber gaskets or O-rings or with rubber and duck insertion jointing and the bolts screwed up uniformly and tightly.

BOLTED COUPLINGS: Take care in tightening couplings such as Gibault, Multi-Fit, D.N.R., Victaulic and similar joints to ensure that the bolts are tightened evenly and to a tightness to suit the joint.

SCREWED JOINTS: Protect all screwed joints in galvanised or black steel pipes before jointing by painting with an approved jointing compound. Compounds containing lead or its derivatives shall not be used.

SOLVENT WELDED JOINTS: Clean and make solvent welded joints strictly in accordance with the pipe manufacturer's instructions for that form of joint. Take particular care to ensure that joints are made at the optimum temperature.

DENSO WRAPPING: Following the satisfactory completion of the field pressure test(s) clean all buried gibault, flanged and welded joints, tapping saddle bolts and nuts and valve stuffing boxes and the like in accordance with AS CK9 and wrap with Denso 300 Primer, 400 Mastic, 500 tape, 901 overwrap and 930 self-adhesive tape applied in accordance with the instructions of the manufacturer, Denso (Australia) Pty Ltd. Overlap shop coatings by 100mm.

DICL PIPE WRAPPING: Wrap all buried DICL pipework with polyethylene sleeving equal to "Greensleave", in accordance with the manufacturers written instructions and AS 3681.

REFILL PLACEMENT: Place the balance of the refill as soon as a satisfactory field pressure test is achieved for each section.

Unless the Superintendent directs otherwise leave the surfaces of all refilled excavations sufficiently high at the outset to allow for settlement and maintain these surfaces until the expiry of the Defects Liability Period and from time to time make good any sinkings in the surfaces and provide any additional refill material that may be necessary. Dress off all excess refill and remove before the end of the Defects Liability Period.

If in the opinion of the Superintendent the Contractor fails to restore the surfaces as directed, the Principal shall have the power to perform this work without further notice and the cost to the Principal thereof will be deducted from any moneys due to the Contractor under this Contract.

Where any such action is taken it shall not relieve the Contractor of any responsibility for damage or injury due to his failure to comply with the specified requirements.

Where the pipeline crosses a vehicular entry to any property or any footpath, refill for the width of the crossing as soon as possible after laying and jointing of that section of the pipeline.

Refill immediately any portions of the work when so directed by the Superintendent whether previously tested or not.

PLACEMENT OF SELECTED REFILL: Carefully place selected refill without misalignment or damage to the pipeline (including coatings and wrappings) in layers with 150 mm loose thickness. Compact the selected refill material the specified standard

The balance of the trench backfill shall be placed in 200 mm layers and compacted mechanically to the specified standard.

TRENCHES IN ROAD PAVEMENTS: Unless otherwise specified by the responsible Road Authority or the Superintendent, fill trenches within road pavements for the full trench depth with fine crushed rock compacted in 150 mm layers by mechanical equipment to the specified density. Maintain the surface and keep it safe to the passage of traffic.

5.19 Pipe anchorages

INSTALLATION: Install anchorages constructed from concrete at **all** bends, tees valves, ends and elsewhere shown on the Drawings and to the dimensions shown on the Drawings or nominated by the Superintendent.

POURING: Construct concrete thrust anchorages by pouring the concrete anchorage against the prepared face of the adjacent soil, which shall be vertical and free of all loose, cracked or other unsuitable material and to the approval of the Superintendent or his representative.

UNSUITABLE SOIL FACE: Where, in the opinion of the Superintendent, it is not possible to pour concrete against a suitably prepared vertical soil face, form up and pour the anchorage so as to provide a vertical concrete face and fill the intervening space between the concrete face and the adjoining soil with approved selected refill mechanically compacted to not less than ninety-five percent (95%) of maximum dry density. Prepare the adjoining soil by removing all loose and other inferior material and prepare and slope this face to the approval of the Superintendent.

5.20 Field pressure testing of pressure mains

GENERAL: The Contractor shall pressure test completed pipework using water.

PROCEDURES: The ends of each test section are to be sealed with gibault blank ends. Under no circumstances will a test section be sealed with a main line stop valve. Main line stop valves, scour valves and the isolating valve only at each air valve are to be installed prior to testing. The concrete thrust blocks and anchors shall be poured at least 7 days prior to the application of pressure to the test section.

Prior to the application of the test pressure to each test section place the selected refill to within one metre of either side of each joint and to a minimum depth of one-half metre over approximately the centre third of each standard length pipe and check the test section and adjust, to approval for compliance with the specified tolerances for line and level. Refilling adjacent to valves and fittings shall be at the direction of the Superintendent.

TEST PRESSURE: The test pressure shall be as follows:

- All pressure mains = 60 metres

The test pressure shall be applied to each test section for a period of 48 hours in the case of uPVC, ductile iron cement lined, high density polyethylene, or mild steel cement lined pipes and 5 days in the case of reinforced or prestressed concrete pipes. At the end of this period a 5 hour test will be applied irrespective of the pipe type. The test pressure will be applied at the start of the period and no water shall be added till the completion of the 5 hours when the pressure will be raised to the test pressure by the addition of a measured quantity of make up water. The quantity of make up water, measured by a suitably calibrated device in the presence of the Superintendent, shall not exceed the limits stated below. Should the limit be exceeded the fault(s) shall be located and made good to the approval of the Superintendent and test section retested.

ACCEPTANCE: The test length will be accepted provided there is no visible leakage on sweating if the amount of make-up water required after the 5 hours test does not exceed the following:

Diameter	Make-up water
Less than 375 mm diameter	0.2 litres per hour per 10 joints

5.21 Surrounds, indicator posts, & marker tape

SURROUND: Construct concrete surrounds around valves and fire plugs in accordance with the details shown on the Drawings. Construct surrounds as to avoid direct bearing on any component of the pipeline.

Use good forms and workmanship to produce surrounds true in detail and of good finish. Surrounds may be precast in which case the cast iron cover box shall be incorporated in the surround and the whole box inspected prior to delivery to the site. The exposed surfaces of surrounds shall be smooth, dense and free from honeycomb or other defects.

INDICATOR POSTS: Prepare indicator posts of treated pine approved by the Superintendent and prepared as detailed on the Drawings. Erect an indicator post opposite and facing towards every buried fire plug, stop valve, scour valve and air valve.

DETECTABLE MARKER TAPE: Install detectable marker tape to all buried pipelines and cables. Install 200 mm below finished surface level.

5.22 Painting and corrosion protection

REQUIREMENT: Exposed ductile fittings and iron pipework shall be fusion bonded polyethylene coated. Exposed pipework shall be painted as specified below:

PREPARATION:	Grit blast to Class 2 of AS 1627.
CCOATING:	Polyshield SS-100 1 mm thickness with a heavy stippled effect to enable concrete bonding.
COLOUR:	Blue

5.23 Pit construction

REQUIREMENT: Construct all pits, manholes, and the like as shown on the project drawings or as shown on LCC Standard Drawings. Confirm manhole or pit levels prior to construction. Adjust top of manhole or pit levels to match the surface levels.

Provide step irons to all manholes deeper than 1.5 metre, cast or built into the manhole walls clear of drain outlet or inlet openings. All step irons shall be approved plastic type.

Rung spacing shall be evenly spaced 300 mm maximum with the bottom rung not more than 450 mm from the floor and top rung not more than 650 mm below the surface level or as specified on the drawings.

The surfaces of manhole benching and channels shall be rendered with cement mortar consisting of one part of cement to two parts of sand before the concrete takes its final set. Full benching shall be formed to provide a smooth transition of flow through manholes. The rendering shall be finished to a smooth uniform surface with a steel float. Form the channel to at least half depth of the pipe.

5.24 Manhole covers

GENERAL: Manholes and pits shall be located in relation to the positions specified and shall be constructed in situ to the details shown on the drawings. Covers shall be Gatic or approved equal.

ROAD AND FOOTPATH LEVELS: Obtain from the responsible authority the proposed road and footpath levels to ensure covers comply with those levels. The Superintendent may require certain covers to be set after construction of the adjacent road or footpath.

APPURTENANCES: Supply and install dowels, plastic type step irons, pipe clips and brackets.

COVERS AND FRAMES: The covers and frames shall be to, and installed in accordance with, the details shown on the drawings and the manufacturer's instructions. The covers shall neatly fit the frames and shall not rock in the frame. The frames shall be firmly fixed to the surround to prevent any movement and to provide a watertight joint.

The concrete surface of each cover, frame and surround shall be finished flat and even with a wooden float to a non-slip surface. Positioning marks in both cover and frame are to be clearly visible.

Prior to fixing the frames the top surface of the manhole and pit wall shall be thoroughly cleaned down and roughened. All forms used for placing in-situ surrounds shall be of metal, well braced and be capable of being stripped without damaging the concrete. Precast frames shall be bedded on a layer of an approved epoxy-resin based mortar.

Cast iron manhole covers and frames shall be Gatic or approved equal of the size and duty rating specified on the drawings.

GREASING COVERS: After each manhole length of sewer and each section of rising main has been flushed clean, inspected and approved the upstream manhole cover of that length of sewer or the pit covers involved shall be effectively sealed with an approved grease to prevent the ingress of water, sand or other material.

BREAK INTO EXISTING SEWERS: Where it is necessary to connect a new manhole directly into an existing sewer at least 3 days notice shall be given to the Superintendent and his approval obtained to the proposed procedure before work commences. Breaking into the existing sewer and construction of the new manhole shall be carried out to the direction of the Superintendent.

Prevent foreign material entering the existing sewer or immediately remove any material so entering.

5.25 Restoration

GENERAL: Concrete, bitumen, gravel and paved surfaces, and lawns, gardens and other surfaces shall be restored to the levels and condition existing prior to the commencement of the

work including where necessary the replacement of garden top-soil and sowing of grasses. All restoration shall be maintained until the issue of the Final Certificate.

STRUCTURES AND SERVICES: Reinstate structures, services and other works to the conditions existing prior to the commencement of works. Where such remedial works are considered by the Superintendent to be urgent works they shall be completed as promptly as practicable as directed by the Superintendent.

6. Geosynthetics

6.1 General

All geosynthetics shall comply with the requirements of the relevant Australian and/or International Standards e.g. ASTM.

6.2 Manufacturer's Quality Control

The manufacturer shall follow a quality control program during all phases of the manufacturing process. All geosynthetics shall be monitored throughout the manufacturing process for product integrity and consistency.

6.3 Manufacturer's Certification

Complete specifications and data covering the material furnished under the Specification shall be submitted by the Contractor for approval. Data and specifications shall include, but shall not be limited to, the following:

- Manufacturer's written certification that the geosynthetic(s)
 - Conforms to the material requirements of the Specification
 - Is similar to and of the same formulation as that for which certification is submitted
 - Has been demonstrated by actual usage to be satisfactory for the intended application
- Samples of geosynthetic material and thread
- Complete description of shipping, handling and storage procedures
- Complete description of installation procedures (including seams) and procedures for testing, repairing, or other information that shall promote proper use of the proposed material(s)
- Complete description of the Manufacturer's quality control (QC) program, procedures and/or QC plan, as applicable, for manufacturing handling, installing, testing, repairing and providing a completed liner system in accordance with the requirements of the Specification. The description shall include, where applicable, but not be limited to:
 - Product identification
 - Acceptance testing
 - Fabrication and production testing
 - Installation testing
 - Documentation of changes
 - Alterations and repairs
 - Retests and acceptance
 - Manufacturer's certification shall include the minimum average roll values for all material unless otherwise stated

6.4 Roll identification

Each roll of geosynthetic delivered to site shall be labelled or tagged with the following details, where applicable:

- Roll identification number
- Product identification number

- Name of manufacturer
- Date and location of production
- Product type and grade
- Lot number
- Physical dimensions

The label or tag information shall be affixed or attached to the roll at all times during deployment of the roll. The roll identification number and manufacturer name shall also be marked on any protective covering.

6.5 Acceptance and approval of geosynthetics

The Contractor is advised that acceptance and approval of the geosynthetics is a phased process that includes manufacturer's certifications, manufacturer's quality control testing, and manufacturer's quality control program including shipping, handling, storage, installation, field testing and independent QA testing. It is a requirement of the Specification that the manufacturer's certification(s) and quality control test results for the geosynthetics shall be received (by official submittal), reviewed, and approved by the Superintendent for 15 days prior to shipment of these materials to the site.

Delivery of geosynthetics to the site shall not be allowed until all required documentation and/or certifications are approved. It is the responsibility of the Contractor to ensure that all required documentation and/or certifications are approved prior to shipment.

6.6 Delivery and storage

Prior to delivery, all individual roll manufacturer certifications required by the Specification shall be received and approved by the Superintendent. Delivery of any unapproved roll shall not be allowed and unapproved rolls shall be transported off-site.

Each delivery shall be subjected to a visual inspection prior to being allowed into the permanent Works stocks. For each delivery a quality control certificate shall be provided. The product name shall clearly be identified on each roll. Quality control certificates shall be retained by the Principal for future management of independent quality assurance testing.

The Contractor shall ensure that storage of the geosynthetics on-site is consistent with the manufacturer's recommendations. Coordination with the Superintendent shall occur to ensure that storage space is provided in a location (or several locations) away from high traffic areas and such that on-site transportation and handling are minimised. Storage space shall be protected by the geosynthetics installer from theft, vandalism, and damage from actions of man, weather, animals and other sources. The Contractor shall ensure that the materials are not stored directly on the ground and storage of the geosynthetics is completed in a fashion that protects against damage.

6.7 Installation

All geosynthetics shall be installed in accordance with the Specification, manufacturer's recommendations, and as per the details shown on the Contract Drawings.

Sandbags or equivalent ballast shall be used as necessary to temporarily hold the geosynthetic in position under the foreseeable and reasonably expected wind conditions. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geosynthetic.

Geosynthetic placement shall not be done if moisture prevents proper subgrade preparation, panel placement or panel seaming.

A geosynthetic shall not be allowed to “bridge over” voids or low areas in the subgrade. In these areas, the geosynthetic shall be placed to allow intimate contact with the subgrade.

Wrinkles caused by geosynthetic panel placement or thermal expansion should be minimised.

Geosynthetic panel placement should take into consideration the site geometry. In general, seams are to be orientated parallel to the line of maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimised. Seams shall not be located at low points in the subgrade.

The panels shall be overlapped prior to seaming to whatever extent is necessary to effect a proper joining and allow for field testing. In no case shall this overlap be less than the manufacturer’s recommendations.

The geosynthetics shall be placed such that:

- The equipment used does not damage the geosynthetic by handling, trafficking, leakage of hydrocarbons, or by other means.
- There are no stones, construction debris, or other items beneath the geosynthetic that could cause damage.
- The geosynthetic is not dragged across an unprepared surface. If the geosynthetic is dragged across an unprepared surface, it shall be inspected for scratches and repaired or rejected, if necessary.
- The method used to unroll the panels does not cause scratches or crimps in the geosynthetic and does not damage the supporting soil surface.
- A geosynthetic shall not be deployed in the presence of excess moisture (fog, dew, mist, etc.), high winds and extreme temperatures.
- Where there is another geosynthetic layer under, the installation of the geosynthetic shall be undertaken in a manner so as not to damage the underlying layer.
- After placement the geosynthetic shall be free of irregular stressing, folds and wrinkles.

Prior to incorporation into the Works each panel of geosynthetic shall be inspected for tears, abrasion, indentation, cracks, thin spots or any other faults or defects.

6.8 Anchor trenches

Trench excavation, backfill, and compaction shall be completed to the line and grades shown on the Contract Drawings and as noted below.

- Anchor trenches shall be prepared with slightly rounded corners where the geosynthetics adjoin the trench so as to avoid sharp bends in the geosynthetic material.
- Fill material shall be placed in maximum 100 mm loose lifts if compacted with hand-operated compaction equipment, or maximum 200 mm loose lifts if compacted with a self-propelled compactor.
- Fill material shall be compacted in accordance with Section 4.14.
- Compaction equipment shall be adequate to achieve the required compaction. The Contractor shall repair or replace any damage to geosynthetics resulting from placement of backfill or compaction.
- Geosynthetics within the anchor trench shall not be overlapped.

6.9 Restriction on equipment loads

No equipment shall be used that could damage any of the geosynthetics once they have been laid.

6.10 Work method statements

Prior to the commencement of any geosynthetic installation work, the Contractor shall develop and document a work method statement for the installation of the geosynthetic for submission to the Superintendent. The manufacturer's representative shall provide instruction to the Contractor regarding appropriate installation techniques for the geosynthetic which are to be reflected in the work method statement.

The work method statement shall provide for the following minimum requirements and describe how they shall be satisfied:

- The geosynthetic shall not be dragged over the subgrade during positioning;
- The geosynthetic roll shall be freely suspended during placement;
- Prevention of environmental and mechanical damage to placed geosynthetic prior to the installation of the overlying layer;
- Relevant experience of geosynthetic installer;
- Typical installation rates (m²/day); and
- The name of the independent laboratory that is proposed for the testing required to verify the product properties.

In addition to the work method statement, the submission shall include a panel placement diagram showing the proposed panel layout and the proposed starting point and direction of working, with each panel being assigned an individual code. Slope lining works shall be aligned such that the roll is run out parallel to the slope and jointing shall be avoided if possible near areas where there are changes in slope gradient. Should it not be able to be avoided, panel diagrams shall show details of how it is proposed to shape the liner at such changes in gradient.

Any alterations to the panel diagram proposed during construction shall be subject to the approval of the Superintendent. The panel diagram shall be maintained and updated as the works progress detailing the position into which each geosynthetic roll, identified by roll label, is incorporated into the Works.

7. Geotextile

7.1 General

In addition to the general geosynthetic requirements included in Section 6 the Contractor shall meet the following additional requirements for geotextiles.

7.2 Physical properties

Geotextile materials shall be new, first quality products designed and manufactured for this project. Geotextile shall be mildew, insect and rodent resistant.

Geotextile shall be suitable and durable for the intended application as satisfactorily demonstrated by similar and prior applications. Geotextile shall be 100% polyester or polypropylene (with the exception of inhibitors and/or carbon black added for UV resistance). Polypropylene materials shall be UV stabilised. The geotextile filament shall be rot proof, chemically stable and shall have low water absorbency. They shall resist delamination and maintain their relative position.

All geotextile material shall be free of flaws that may have an adverse effect on the physical and mechanical properties of the geotextile.

The geotextile protection layer shall be guaranteed needle free.

All geotextile material shall comply with the requirements of AS 3706 and shall meet or exceed the minimum average roll values (weakest principal direction) specified in Table 4.

Table 4 Geotextile physical properties

Physical Property	Test Method	Units	Requirement
Woven/Non-woven			Non-woven
Grab Tensile Strength	AS 2001.2.3	N	> 900
Trapezoidal Tear Strength	AS 3706.3	N	> 350
CBR Burst Strength	AS 3706.4	N	> 2,000
Permittivity	AS 3706.9	s-1	> 0.5
Apparent Opening Size	AS 3706.7	µm	< 430
UV Stability	ASTM D4355	% ret. @ 500hrs	> 50

7.3 Delivery and storage

In addition to the requirements of Section 6.6, geotextiles shall be supplied with protective cover. The cover shall be waterproof, opaque and protect the geotextile from UV light.

7.4 Seams and overlaps

Where specified in the Contract Drawings geotextile seams shall be formed by mating the edges of the geotextile panels and sewing together with continuous stitches located a minimum of 100 mm from the mated edges. A 2-thread, double-locked stitch shall be used.

Sewing procedures shall conform to the latest procedures recommended by the geotextile manufacturer. Spot sewing shall not be allowed.

Seams shall provide seam strength which equals or exceeds 75 percent of parent material strength when tested in accordance with AS 3706.2 (parent material strength) and AS 3706.6 (seam strength). Horizontal seams on slopes shall not be allowed.

7.5 Thread

Thread used to sew panels of geotextile together shall be polymeric thread with physical and chemical-resistance properties that equal or exceed those of the geotextile. The thread colour shall contrast with the geotextile colour and shall be approved for use by the geotextile manufacturer.

7.6 Warranty

The geotextile Manufacturer shall furnish a written warranty for a period of 1 year. The warranty shall be against manufacturing defects of workmanship and against deterioration due to ozone, ultraviolet and/or other normal weather aging.

The warranty shall be limited to replacement of material only and shall not cover installation of said material. It shall not cover damage due to vandalism, acts of animals, natural disasters, and other unusual occurrences that are beyond the control of the Manufacturer.

8. Concrete works

8.1 General

8.1.1 Standards

DOCUMENTS: The following standards are referred to in this section.

AS 1012 Methods of Testing Concrete

AS 1214 Hot-dip Galvanised Coatings on Threaded Fasteners

AS 1302 Steel Reinforcing Bars for Concrete

AS 1303 Hard Drawn Steel Reinforcing Wire for Concrete

AS 1304 Hard Drawn Steel Wire Reinforcing Fabric for Concrete

AS 1326 Polyethylene (polythene) Film for Packaging and Allied Purposes

AS 1379 Ready Mixed Concrete

AS 1599 Pressure Sensitive Adhesive Packaging Tapes

AS 3600 Concrete Structures Code

AS 3610 Formwork Code

AS 3735 Concrete Structures for Retaining Liquids.

The Contractor shall keep on site a copy of AS 3600, AS 3610 and AS 3735.

8.1.2 General requirements

STANDARD: Construct all concrete works in a safe manner using materials and methods complying with this Specification and the relevant requirements of AS 3600 and AS 3610.

For concrete structures used for retaining liquids, comply also with the relevant requirements of AS 3735.

8.1.3 Inspections

NOTICE: Give sufficient notice so that inspections may be made of the items listed below:

- Foundations prior to the placement of blinding slabs
- Reinforcement fixed in place
- Cores and embedment's fixed in place
- Completed formwork prior to concrete placing
- Placing of concrete
- Surfaces or elements to be concealed in the final work prior to covering

Minimum notice required: 48 hours

8.1.4 Adjoining elements

REQUIREMENT: Obtain the requirements for all adjoining elements to be fixed to or supported on the concrete and provide for the required fixings. Where applicable provide for temporary support of the adjoining elements during construction of the concrete.

8.2 Quality Control

8.2.1 Quality Assurance

REQUIREMENT: Where there is a recognised quality assurance program applicable to a specified product, provide assurance of product quality under the authority of that program. The program shall be one in which the manufacturer has in place a quality control management system which is subject to continual monitoring through quality audits by a recognised independent organisation.

8.2.2 Construction proposals

REQUIREMENT: Submit for approval proposals for mixing, placing, finishing and curing concrete including those items listed below:

- Sources of materials
- Ready mixed concrete supplier
- Handling, placing, compaction and finishing methods and equipment
- Temperature control methods
- Curing and protection methods
- Target strength, slump and proposed mix for each type and grade of concrete

8.2.3 Reinforcement fabrication

BENDING SCHEDULES: If reinforcement bending schedules are required, submit marking plans and schedules showing location, shape, size and grade of all reinforcement.

CHANGES: Obtain approval for changes, if any, in the reinforcement shown on the Drawings, including additional splicing.

MECHANICAL SPLICES: If mechanical bar splices are proposed or required submit for approval details of the proposed splices and test certificates for each size and type of bar to be spliced.

8.3 Testing and assessment

8.3.1 Authority and personnel

REQUIREMENT: The organisation responsible for testing and assessment of concrete and concrete materials shall be NATA registered.

For each test, maintain the records and reports of test results as required by AS 1012. Submit a copy of each test report to the Superintendent.

8.3.2 Sampling and testing

REQUIREMENT: Undertake sampling and testing to AS 1012 Parts 1-3 inclusive.

The following minimum number of 200 mm x 150 mm diameter test cylinders shall be tested:

- One sample of 3 cylinders for each 10 m³ or part thereof placed in an essentially continuous manner
- One cylinder of the three taken shall be tested at 7 days or as directed by the Superintendent
- The remaining two cylinders shall be tested at 28 days

8.3.3 Assessment

REQUIREMENT: The test results shall be assessed in accordance with AS 3600. Should the 28 day cylinder strength as determined not comply with the specified strength, the Superintendent shall reject the concrete and direct the Contractor to remove rejected concrete from the site.

Alternatively, approval may be given to the retention of the hardened concrete liable to rejection, on the basis of:

- The criteria in AS 3600 Clause 19.1.10.3
- An appraisal of the statistical information related to the concrete strength
- Approved remedial work
- Reduction in cost

8.3.4 Surface repairs

REQUIREMENT: Concrete liable to rejection because of surface defects may in some cases be accepted subject to the specified exposure classification and the successful repair of the defects. Repairs to concrete surface shall be performed by skilled workmen.

Repairs of imperfections shall be completed within 24 hours after removal of forms.

Concrete that is honeycombed, fractured and the like, must be removed and replaced with suitable non shrinkage mortar as directed by the Superintendent.

Holes resulting from the removal of ends of form ties shall be filled with suitable approved type of non-shrinkage mortar.

Mortar shall not be used for filling behind reinforcement.

8.4 Formwork

8.4.1 General

REQUIREMENT: Design and construct formwork and falsework to the approval of the Superintendent so that concrete when case in the forms, will have the dimension, shape, and surface finish as required by the contract.

If formwork fails to meet the requirements of the contract, any concrete which has been cast in that formwork may be rejected.

If required by the Superintendent, submit formwork or falsework drawings for approval.

8.4.2 Formwork tolerances

REQUIREMENT: The finish concrete surfaces shall be within the tolerances stated in the following table:

Table 5 Formwork tolerances

Formwork Class To AS 1510	Deviation From Correct Position		Maximum Misalignment	
	Maximum:	Relative:	Between Pours:	Across Form Joints:
1	10 mm	1.5 mm	1 mm	0 mm
2	15 mm	2.5 mm	2 mm	2 mm
3	20 mm	3.5 mm	3 mm	2 mm
4	25 mm	4.5 mm	4 mm	4 mm

The deviation in beams and slabs shall be measured before the removal of falsework or shoring.

8.4.3 Formed surfaces schedule

STANDARD: The minimum standard of finishes to formed concrete shall be as follows:

Table 6 Formed surfaces schedule

Concrete Element	Formwork Class:	Colour Control Type:
Normal architectural work and surface not otherwise specified (Pump shed floor)	2	B
Civil engineering works (Internal faces of outlet and overflow pipe slab.)	3	C
Surfaces to be rendered or hidden by other finishes	4	Not Applicable
Surfaces permanently concealed (eg. Footings, rear faces of sumps)	5	Not Applicable

8.4.4 Visually important surfaces

REQUIREMENT: Visually important surfaces include concrete surfaces from AS 1510, formwork classes 1, 2, and 3.

Set out formwork to give a regular arrangement of panels, joints, bolt holes, and the like visual elements in the formed surface.

Unless otherwise specified form a 45o bevel, 25 mm on the face, by chamfering or filleting the forms.

8.4.5 Formwork construction

REQUIREMENT: All forms shall be built mortar-tight and of sufficient rigidity to prevent distortion during construction.

Where forms are re-used, their original shape, strength, rigidity and surface smoothness shall be maintained at all times.

Before placing reinforcement, all forms shall be treated with a release agent, to the interior surfaces of the formwork, except where directed by the Superintendent. Where necessary clean reinforcement to remove all traces of release agent to the satisfaction of the Superintendent.

If ties used to secure and align the formwork, effective precautions shall be taken to ensure watertightness after their removal.

STRIPPING TIMES: The period elapsing between placing concrete and removing formwork shall be as follows, unless otherwise approved in writing by the Superintendent:

Walls	72 hours
Footings	24 hours

8.4.6 Form Tie Bolts

REMOVABLE BOLTS: Remove the bolts without causing damage to the concrete.

COVER: Position formwork tie bolts left in the concrete so that the tie does not project into the concrete cover.

BOLT HOLE FILLING:

Recessed Filling: Fill or plug the hole to 6 mm below the surface level. Use material matching the surface colour.

Flush filling: Use material matching the surface colour.

8.4.7 Permanent loading

REQUIREMENT: Do not place permanent loads, including masonry walls and the like, on the concrete structure while it is still supported by framework.

8.4.8 Lost formwork

REQUIREMENT: Permanent or lost formwork, if required, shall not contain chlorides, and shall not impair the structural performance of the concrete members.

8.5 Concrete materials

8.5.1 Concrete materials generally

STANDARD: To AS 3600

RESTRICTIONS ON CHEMICAL CONTENT: Chemical admixtures shall comply with AS 1478. Use of the admixtures shall be as agreed with the Superintendent.

Fly ash or blended cement shall not be used without the written approval of the Superintendent.

AGGREGATE SIZE: Maximum aggregate size shall be 20 mm.

8.5.2 Ready mixed supply

STANDARD: To AS 1379. Deliver in agitating trucks.

ADDITION OF WATER: Obtain approval before adding water at the site.

ELAPSED DELIVERY TIME: Concrete is liable to be rejected if the elapsed time between the wetting of the mix and the discharge of the mix at the site exceeds the following:

Table 7 Elapsed delivery time exceedance

Concrete temperature (at time of discharge °C):	Maximum elapsed time (hours):
10 – 24	2.00
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

DELIVERY DOCKET: For each batch, supply a docket listing the information required by AS 1379 including the following:

- The works for which the concrete was ordered
- The total amount of water added to the plant
- The maximum amount of water permitted to be added at site
- Slump achieved and the design slump
- Cement content in the mix
- Supply the following additional information
 - the concrete element or part of the Works for which the concrete was ordered

- the total amount of water added at the plant and the maximum amount permitted to be added at the site

8.5.3 Site mixed supply

MANUFACTURE: Site mixed concrete shall not be used unless approved in writing by the Superintendent.

Mix concrete in an approved plant located on the construction site but complying with the relevant requirements of AS 1379.

HAND MIXING: Hand mixing is not permitted.

8.5.4 Grout

STANDARD: To AS 3600.

SHRINKAGE: Shall not exceed 1% value after 24 hours.

MAXIMUM WATER CEMENT RATIO: 0.45 (by weight).

MAXIMUM COMPRESSIVE STRENGTH: (75 mm cube): 24 MPa at 7 days and 40 MPa at 28 days.

8.5.5 Epoxy grout

MATERIAL: An approved commercial epoxy formulation of high compressive strength.

8.6 Design of mixes

8.6.1 Class of concrete

REQUIREMENT: The target slump values, maximum water cement ratios and minimum and maximum cement contents shall be within the following values.

Table 8 Class of Concrete

Concrete Element	Footings, Slabs & Walls other than those of Water Retaining Structures	Water Retaining Structures	Anchor Blocks, Mass Concrete Fill, Benching	Blinding Concrete
Class of Concrete:	Normal	Special	Normal	Normal
Strength Grade:	N32	S40	N20	N15
Characteristic Compressive Strength f _c (MPa):	32	40	20	15
Cement Type:	GP	SR	GP	GP
Slump (mm):	80	60	80	80
Max Aggregate Size (mm):	20	20	20	20
Project Assessment:	Required	Required	Not Required	Not Required
Project Assessment Testing Frequency:	Every 10 m3 of part thereof	Every 10 m3 of part thereof	Not Required	Not Required
Early Age Strength:	Not Required	Not Required	Not Required	Not Required
Special Requirements (Special Class Concrete):				

Min Cement Content (kg/m3):	N/A	320	N/A	N/A
Max Cement Content (kg/m3):	N/A	400	N/A	N/A
Max Water/Cement Ratio:	N/A	0.50	N/A	N/A

8.6.2 Mix design and acceptance

REQUIREMENT: The Contractor shall be responsible for the design of mixes and for the production of concrete.

The Contractor shall submit for approval, details of the concrete mix proposed.

Not less than 28 days before placing concrete, the Contractor shall prepare trial mixes using the approved mix design. For each trial mix, the Contractor shall produce at least eight (8) test cylinders. The cylinders shall be tested as required by the Superintendent.

COSTS: All costs associated with the production of trial mixes and testing shall be included in the respective schedule of rates.

8.6.3 Ready mix supply

REQUIREMENT: If concrete is supplied by an approved supplier of Ready Mix Concrete, the Superintendent at his discretion may accept the results of test cylinders cast from identical mixes produced previously by the supplier.

The information and details of the mix shall nevertheless be supplied.

8.7 Reinforcement

8.7.1 Reinforcement generally

STANDARD: To AS 3600.

COVER: As specified on the Drawings and to AS 3600 or AS 3735 as applicable. Cover shall be 50 mm unless otherwise specified.

REQUIREMENT: Supply and fix reinforcement, including the necessary tie wires, support chairs, spacers and the like.

MANUFACTURER CERTIFICATION: Reinforcement shall be readily identifiable as to the grade and origin.

When requested by the Superintendent, obtain from the manufacturer and furnish a certificate of compliance with the relevant standard or furnish a test certificate to the relevant standard from an independent testing authority.

8.7.2 Fixing reinforcement

FIXING REQUIREMENTS: Secure the reinforcement against displacement by tying at intersections with annealed iron wire ties not smaller than 1.25 mm diameter, or by approved clips. Bend the ends of wire ties away from nearby faces of forms. The ends of the ties shall not project into the concrete cover.

Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections, and at other points as required.

Beams: Tie ligatures to bars in each corner of each ligature. Fix other longitudinal bars to ligatures at not more than 1000 mm intervals.

PROVISION FOR CONCRETE PLACEMENT: If spacing or cover of reinforcement do not comply with the specified cover requirements or AS 3600, respectively notify the Superintendent and obtain instructions prior to placing concrete.

TOLERANCES: To AS 3600 Clause 19.5.

WELDING OF REINFORCEMENT: Welding of reinforcement shall not be permitted without the written approval of the Superintendent.

8.7.3 Reinforcement supports

SUPPORT TYPES: Use purpose-made concrete or plastic supports. For exposure classifications more severe than A1 use plastic supports of adequate strength and of a shape appropriate to the location, or concrete supports of the same concrete quality as the concrete element.

SUPPORTS OVER MEMBRANES: Prevent damage to waterproofing membranes or vapour barriers. Place a metal or plastic plate under each support to prevent puncturing.

SUPPORT SPACING: Not more than 60 diameters for bars and 750 mm for fabric.

8.7.4 Protective coating

REQUIREMENT: Unless otherwise shown on the drawings, if an element is specified to contain protective coated reinforcement, provide the same coating type to all element reinforcement and embedded metal items including tie wires, stirrups and the like.

8.7.5 Lapping of reinforcement

REQUIREMENT: Lapping of reinforcement or fabric shall be as required by standard AS 3600.

In no case shall the lap length be less than 25 times the diameter of the reinforcement plus 150 mm.

8.7.6 Cleaning of reinforcement

REQUIREMENT: At the time concrete is placed, reinforcement shall be free from mud, oil, grease and other non-metallic coatings and rust.

8.8 Placing

8.8.1 Placing and compaction

STANDARD: To AS 3600.

GENERAL: All concrete shall be placed in dry conditions. No concrete shall be placed until the forms, reinforcing and foundations as applicable have been inspected and approved.

Place concrete in layers such that each succeeding layer is blended into the preceding one by the compaction process. Concrete exposed to rain before it has set, shall be protected by suitable covers.

HORIZONTAL MOVEMENT: Movement may be by means of suitable clean chutes, troughs or pipes. Do not use water to facilitate the movement.

VERTICAL MOVEMENT: In vertical elements, limit the free fall of concrete to 1500 mm per 100 mm element thickness, up to a maximum free fall of 3000 mm, by means such as enclosed chutes, access hatches in forms, and the like. As far as practicable keep chutes vertical and full of concrete during placement, with ends immersed in the placed concrete.

LAYERS: Place concrete in layers such that each succeeding layer is blended into the preceding one by the compaction process.

RAIN: Concrete exposed to rain before it has set, including during mixing, transport or placing, shall be liable to rejection.

COMPACTION: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove air bubbles and compact the mix. Use form vibrators where the use of immersed vibrators is impracticable. Ensure concrete is fully compacted and entrapped air removed, but avoid over vibration that may cause segregation. Do not allow vibrators to come into contact with partially hardened concrete, or reinforcement embedded in it. Do not use vibrators to move concrete along the forms.

PLACING RECORDS; Keep on site and make available for inspection a log book recording each placement of concrete including:

- date
- the portion of work
- specified grade and source of concrete
- slump measurements
- volume placed

8.8.2 Placing schedule

REQUIREMENT: Minimise shrinkage effects by pouring the sections of the work between approved construction joints in a sequence such that there will be suitable time delays between adjacent pours.

The minimum periods between placing adjacent sections shall be as follows:

Table 9 Minimum periods between placing adjacent sections

DESCRIPTION	MINIMUM PERIOD (days)
Adjacent pours abutting vertical construction joints in walls:	3
Adjacent pours abutting horizontal construction joints in floor or roof slabs.	3
“Pour Strips” and adjacent concrete:	3

8.8.3 Cold weather placing

REQUIREMENT: Maintain the temperature of the freshly mixed concrete within the limits shown in the following table. “Outdoor air temperature” shall apply to the air temperature at the time of mixing and to the predicted or likely air temperature at any time during the subsequent 48 hours:

Outdoor Air Temperature:	Temperature Of Concrete	
	Minimum:	Maximum:
Not less than 5oC	10 deg C	32 deg C
Less than 5oC	18 deg C	32 deg C

ADDITIVES: Do not use calcium chloride, salts, chemicals or other material in the mix to lower the freezing point of the concrete.

FROZEN MATERIALS: Do not allow frozen materials or materials containing ice to enter the mixer, and keep forms, materials and equipment coming in contact with the concrete free of frost and ice.

HIGH EARLY STRENGTH CEMENT: In severe weather conditions Type B high early strength Portland cement maybe used, subject to approval, to enable the concrete to develop sufficient strength to permit formwork removal within the specified time, but not as a substitute for the heating of materials or for adequate protection of placed concrete against low temperatures. Do not use high alumina cement.

HEATING: Where so directed or permitted, heat the concrete materials, other than cement, to a temperature not greater than the minimum necessary to ensure that the temperature of the placed concrete is within the limits specified in this clause. The temperature of water shall be not greater than 60°C when it is placed in the mixer.

8.8.4 Hot Weather Placing

REQUIREMENT: The provisions of this clause shall apply to concreting when the surrounding shade outdoor temperature is greater than 32 °C.

MIXING: Do not mix concrete when the outdoor shade temperature on the site exceeds 38 °C, unless otherwise approved and then only subject to such conditions as may be imposed.

HANDLING: Take precautions to prevent premature stiffening of the fresh mix and to reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete as rapidly as possible.

PLACING: Before and during placing maintain the formwork and reinforcement at a temperature not greater than 32°C by protection, cold water spraying, or other effective means. When placed in the forms, the temperature of the concrete shall not exceed the following:

Table 10 Hot weather placing

Concrete Element:	Temperature Limit:
Normal concrete in footings, beams, columns, walls and slabs	35°C
Concrete in large mass concrete sections; or Concrete of strength 40 MPa or greater, in sections exceeding 600 mm in thickness:	27°C

TEMPERATURE CONTROL METHODS: Submit for approval the proposed method or methods of maintaining the specified temperature of the placed concrete, which may include:

- using chilled mixing water
- spraying the coarse aggregate with cold water
- covering the container in which the concrete is transported to the forms
- a combination of these methods

8.9 Curing and protection

8.9.1 Curing

STANDARD: TO AS 3600.

GENERALLY: Protect fresh concrete from premature drying and excessively hot or cold temperatures. Maintain the concrete at a reasonably constant temperature with minimum moisture loss for the curing period.

CURING PERIOD (from time of placing): Commence curing immediately after finishing, and cure continuously until the cumulative number of days or fractions thereof, not necessarily

consecutive, during which the air temperature in contact with the concrete is above 10°C, totals not less than the following:

- For durability exposure categories A1 and A2: 3 days
- For durability exposure categories B1, B2, and C: 7 days
- CURING METHODS: Submit for approval the proposed method of curing, which may include the following:
 - ponding or continuous sprinkling with water (moist curing)
 - an impermeable membrane
 - an absorptive cover kept continuously wet
 - steam curing
 - an approved curing compound (not for hot weather curing)

CURING COMPOUNDS: To AS 3799. Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to concrete toppings, cement-based render and the like.

HOT WEATHER CURING: Immediately after placement cover the concrete with an impervious membrane, or hessian kept wet, until curing begins. As an alternative to immediate covering, where the temperature exceeds 25°C or where not protected against drying winds, protect the concrete with a fog spray application of aliphatic alcohol evaporation retardant.

VISUALLY IMPORTANT SURFACES: Produce uniform colour on adjacent surfaces by uniform curing methods.

8.9.2 Protection

LOADING: Protect the concrete from damage due to load over stresses, heavy shocks and excessive vibrations, particularly during the curing period. Do not place construction loads on self-supporting structures which will overstress them. Provide calculations to justify the adequacy of the structure to sustain any construction loads.

SURFACE PROTECTION: Protect finished concrete surfaces from damage from any cause, including mortar splashes and stains, timber stains, rust stains, chemical attack, additives, curing compounds, protective coatings, rain, running water, and the like.

8.10 Embedments cores and fixings

8.10.1 Fixings and embedded items

STANDARD: To AS 3600 Section 14.

SHOP DRAWINGS: If the locations of embedded items are not shown on the Drawings, or are shown diagrammatically, or if it is proposed to vary the locations shown, submit shop drawings showing the proposed locations, clearances, cover, and the like.

STRUCTURAL INTEGRITY: In locating embedded items, do not cut or displace reinforcement, or cut hardened concrete, unless prior approval has been obtained.

TOLERANCES ON PLACEMENT: Maximum deviations from correct positions:

- Embedded items generally: Plus or minus 10 mm
- Fixings, anchor bolts and the like: Plus or minus 3 mm
- Fixings and embedded items in precast units: To AS 3610 Table 3.4.3 and AS 3850.1 Clause 6.4 as applicable

8.10.2 Protection of fixings

REQUIREMENT: For all embedded and inserted ferrous fixings (other than stainless steel), provide galvanised surface coating passivated by dipping in 0.2% sodium dichromate solution.

Threaded fastenings: To AS 1214.

Structural sections: To AS 1650.

8.10.3 Inserted fixings

LIMITATION: Use fixings inserted by drilling (including masonry anchors and the like), or by explosive tools, only if specified or approved.

All masonry anchors shall be stainless steel chemical anchors.

8.11 Underlays and membranes

8.11.1 Concrete working base/blinding slab

MATERIAL: Where specified on the drawings provide 15 MPa concrete to all structures. Lay over the base or subgrade and screed to the required level.

THICKNESS: 50 mm

FINISH: Where required to support a membrane, wood float finish or equivalent.

SURFACE TOLERANCE: ± 5 mm from the correct plane, ± 5 mm from a 2 m straight edge.

8.11.2 Polymeric film underlay

MATERIAL: High-impact resistant polyethylene film, to AS 1326, grade IR3.

BASE PREPARATION: According to base type, as follows:

Graded stone base: Blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay.

Concrete working base: Remove loose material and any projections above the plane surface.

INSTALLATION: Lay over the base. Lap joints not less than 200 mm.

Face the laps away from the direction of concrete pour. Seal laps with pressure-sensitive adhesive tape to AS 1599. Similarly seal around unavoidable penetrations such as service pipes and the like. Take the underlay up vertical faces as far as the damp proof course where applicable, and fix at the top by tape sealing. Arrange to have vertical laps only on vertical or inclined surfaces. Patch or seal any punctures or tears before pouring concrete.

8.12 Joints

8.12.1 Construction joints

REQUIREMENT: Make construction joints where shown on the Drawings. Do not relocate or eliminate a construction joint without prior approval of the Superintendent.

Before fresh concrete is placed at construction joint, the Contractor shall roughen and clean the hardened concrete surface of the joint so that all loose or soft material, free water, foreign matter and laitance is removed. Just prior to placement, the Contractor shall dampen the hardened concrete surface and apply thick slurry of cement-water to a depth of 5 mm.

Unless otherwise shown on the Drawings or specified, the Contractor shall butt join the surfaces of adjoining pours. In visually important surfaces, the Contractor shall make the joint straight and true, and free from impermissible blemishes relevant to its AS 1510 Class or Type.

8.12.2 Movement joints

REQUIREMENT: Construct movement joints in the locations and to the details shown on the Drawings.

The following movement joint types are defined:

- **Contraction joint:** An unreinforced joint with a bond-breaking coating separating the concrete joint surfaces.
- **Expansion joint:** An unreinforced joint with the joint surfaces separated by a compressible filler and typically with joint sealant on the exposed surfaces.
- **Control joint:** A weakened plane contraction joint created by forming a groove, extending at least one quarter the depth of the section, either by means of a grooving tool, by sawing, or by inserting a premoulded strip.
- **Isolation joint:** A joint without keying, dowelling, or reinforcement, which imposes no restraint on movement in any plane.

8.12.3 Joint dowels

REQUIREMENT: Where shown on the Drawings, the Contractor shall provide structural grade plain round bars in expansion and contraction joints, of the sizes shown. Unless specified otherwise, the dowel bars shall be hot dip galvanised after friction cutting to length. The Contractor shall embed each dowel normal to the plane of the joint, so that half the dowel lies on each side of the joint.

The concrete face cast first, except the recess surfaces as detailed above, and protruding dowels shall be painted with two coats of a bitumen based paint to give a minimum dry film thickness of 400 microns prior to the casting of the adjoining concrete. The Contractor shall fit an expansion cap to the protruding end of the dowel.

8.12.4 Joint filling

REQUIREMENT: Joints that are to be filled shall be constructed as shown on the Drawings. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint.

The recess for later application of joint sealant shall be formed by accurately shaped formers of timber or other approved material and the concrete shall be particularly well compacted around and underneath the former when adjacent concrete is being placed so that no honeycombed or uncompacted concrete occurs in this location.

Placement of sealant shall not be carried out until all concrete construction is completed. The recess former shall be left in place until preparation of the recess prior to joint sealing is commenced. The recess surfaces shall be cleaned thoroughly, given one coat of approved primer and the recess filled with the approved sealant in accordance with the manufacturer's directions. Recess surfaces shall be kept free of bituminous paint unless the approved sealant is compatible with such paint.

SEALANTS: Joint sealants shall be "Plastijoint" for vertical joints and "Pliastic HD" for hot poured horizontal joints or "Thioflex 600" for gun application all manufactured by Fosroc Expandite or similar acceptable to the Superintendent. Details of the joint sealant and method of placing shall be submitted to the Superintendent for acceptance before delivery of any materials

to the site. Any subsidence of the filler after testing of the structure shall be made good so that all recesses are completely filled to the specific depth or if none is specified then flush with the adjacent concrete surface.

8.12.5 Waterstops

REQUIREMENT: Where shown on Drawings supply and install a waterstop in the nominated position. The waterstop shall be:

- A hydrophilic rubber sealing strip such as Hydrotite RS-0723-3.51 or similar which shall be adhered to the first cast concrete face in accordance with the manufacturer's written instructions prior to the mating concrete section being cast.

8.12.6 Jointing materials

REQUIREMENT: Use jointing materials, including sealants, mastics, primers, gaskets, compressible fillers, joint covers and the like, of the types shown on the Drawings in accordance with the written instructions of the material manufacturers for the location and type of joint, compatible when used together, and non staining to concrete in visible locations.

8.13 Integral finishes

8.13.1 Tolerance classes for finishes as laid

CLASSES: Tolerance classes determined by a straight edge placed anywhere on the surface in any direction.

CLASS A: Maximum deviation from a 3 m straight edge: 3 mm.

CLASS B: Maximum deviation from a 3 m straight edge: 6 mm.

CLASS C: Maximum deviation from a 600 mm straight edge: 6 mm.

8.13.2 Finishes as laid

SCREEDING: Finish slab surfaces by approved means to finished levels. In the absence of any other requirements produce surfaces to Class B.

STEEL TROWELLED FINISH: After screeding, produce the final finish with steel hand trowels, free of trowel marks and uniform in texture and appearance.

WOOD FLOAT FINISH: After screeding, produce the final finish with a wood float.

INTEGRAL FINISH SCHEDULE: Provide the following finishes:

Table 11 Finishes as laid

ITEM	REQUIRED FINISH
Floor Slabs to Tanks, MBR Tank Building, Amenities Area and Dewatering Room.	Steel Float
Roof slabs to Pump Stations.	Steel Float
Blinding	Wood Float

8.13.3 Scabbled surface finish

REQUIREMENT: A fully scabbled concrete surface shall consist of a complete surface intentionally roughened to a full amplitude of 5 mm and shall be clean and free from laitance to the Superintendent's approval.

8.14 Concrete protection

8.14.1 Surfaces to be doated

SCHEDULE: The following concrete surfaces shall be painted to prevent attack from liquids and vapours and gases emitted from the liquids:

- Sump pit internal and top surfaces exposed to liquids
- Inflow and overflow pipe slab top surface

The above areas, and any further areas indicated on the Drawings shall be coated with an epoxy paint system such as Epirez or approved equivalent. Application of the epoxy painting system, including surface preparation shall be strictly in accordance with the manufacturer's written instructions. Where the structure is required to undergo a test for water retention, this shall be conducted prior to application of the painting system.

8.14.2 Preparation for coating

REQUIREMENT: Grit blast to break up surface laitance and expose concrete matrix. Bag off and fill holes with a non-shrink grout equal to Epirez 633 to form a completely solid background for coating. Lightly scabble with a wire brush to remove unsound and excess bagging.

8.14.3 Coating

REQUIREMENT: Prime the bagged/grouted surface with Epirez 123 at a rate of not more than 7m²/litre.

Paint the primed surface with Epirez Supatuff HD in two coats to a thickness/coat of 150 micron DFT Colour WHITE.

8.14.4 Manufacturer's instructions for coating

REQUIREMENT: Surface preparation, application, curing times etc. for the above products shall be in strict accordance with the manufacturer's written instructions. Control of moisture and temperature level is particularly drawn to the Contractor's attention.

9. Miscellaneous works

9.1 Reservoir level

The contractor shall mount a DN110 PE100 pipe to the upstream face of the embankment to accommodate an automated reservoir level sensor (installation by others).

In addition, the contractor shall provide a visual pond level gauge on the upstream face of the embankment.

10. GHD Scope and Limitations

This report: has been prepared by GHD for Huon Aquaculture Company and may only be used and relied on by Huon Aquaculture Company for the purpose agreed between GHD and the Huon Aquaculture Company as set out in section 1.1 of this report.

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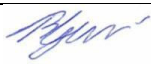

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GHD

10 Columnar Court
T: 61 3 6432 7900 F: 61 3 6432 7901 E: bwtmail@ghd.com

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	C. Cahill	T. Blyth		R. Longey		24.07.19

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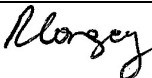


10 Columnar Court
T: 61 3 6432 7900 F: 61 3 6432 7901 E: bwtnmail@ghd.com

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