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Report on
Geotechnical Investigation and Preliminary Acid Sulfate Soils Assessment

Vantage Estate, Stage 2 - Proposed External Trunk Gravity Sewer
Christensen Road South, Yatala

Prepared for
Frasers Property Industrial Pty Ltd

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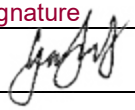
Author		23 February 2022
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Report on Geotechnical Investigation and Preliminary Acid Sulfate Soils Assessment

Vantage Estate, Stage 2 - Proposed External Trunk Gravity Sewer

Christensen Road South, Yatala

1. Introduction

This report presents the results of a geotechnical investigation and preliminary acid sulfate soils (ASS) assessment undertaken for a proposed external trunk gravity sewer at Christensen Road South, Yatala. The investigation was commissioned in an email dated 19 October 2021 by Kelly Chan of Frasers Property Industrial Pty Ltd (FPI) and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal 206529.00 dated 8 July 2021.

It is understood that the proposed pipeline is approximately 1.3 km long, comprising two 'dog legs' at either end and a 'T' joint at chainage (CH) 642. The proposed invert levels are between approximate depths of 1.5 m and 7.0 m. The pipeline diameters comprise 225 mm and 300 mm.

The aim of the investigation was to carry out a geotechnical investigation and preliminary ASS assessment and comment on the following:

- regional geology;
- site description;
- field work methods;
- subsurface conditions including groundwater (if encountered);
- excavation characteristics, earthworks, site preparation, compaction and suitability of reuse;
- indicative presence or otherwise of ass, suitable liming rates and the requirement, if any, to prepare an acid sulfate soils management plan (ASSMP);
- exposure classification for buried steel and concrete;
- temporary batter slopes and retention options for trenches (if required); and
- allowable bearing pressures for access pits and thrust blocks.

The investigation comprised the drilling of nine boreholes (designated Bores 1 to 9) at client nominated locations. Details of the field work and laboratory testing are presented in this report, together with comments and recommendations on the items listed above.

This report must be read in conjunction with all of the notes in Appendix A and should be kept in its entirety without separation on individual pages or sections.

2. Site Description

The site of the proposed pipeline alignment was located to the rear of an existing industrial subdivision west-southwest of Christensen Road South, Yatala (refer Drawing 1 I Appendix B). The site, at the time of the investigation, comprised relatively level bushland with thick undergrowth and small to tall trees and shrubs throughout. Several unsealed tracks were observed across the site.

Figure 1 and Figure 2 indicate typical site conditions encountered during the investigation.

Figure 1: Looking southwest towards Bore 8.

Figure 2: Looking southwest from Bore 4.

3. Regional Geology and ASS Map Review

Based on the Geological Survey of Queensland 1:100 000 series, Beenleigh Sheet, the site is in areas of Alluvium, comprising *'gravel, silt, mud, clay:* underlain by the Neranleigh-Fernvale beds, typically comprising *'greywacke, argillite, quartzite, chert, shale, sandstone and greenstone'*. Residual soil is expected to overlie weathered rock. The subsurface conditions encountered during the field work, (refer Section 5), are in general agreement with the above anticipated and described geology, and encountered localised fill underlain by alluvial and residual soils, and metasandstone, albeit the rock description is a slight variation to the arenite description from the geological map.

The QLD Government Department of Natural Resources and Mines published Acid Sulfate Soils Map Tweed Heads to Redcliffe, 1:100 000 scale, indicates the site lies near the border of areas mapped as *'low probability of ASS'* and *'land not assessed'.*

4. Field Work Methods

The field work was undertaken between 17 and 20 January 2022 and comprised the drilling and sampling of nine boreholes (designated Bores 1 to 9) as close as practical to the client nominated locations. The boreholes were drilled using a large track mounted drilling rig utilising flight auger, mud rotary methods and NMLC rock coring to depths between 3.5 m and 8 m. Bores 1 to 4 and 8 were drilled to target depths of between 3.5 m and 6.0 m using solid flight augers with a tungsten carbide bit. Bores 5, 7 and 9 required auger and rotary washboring to achieve target depths of between 7.5 m and 8 m, and Bore 6 used NMLC coring to achieve the target depth of 7.2 m. Standard penetration tests (SPTs) were carried out at 1.5 m depth intervals in each borehole.

For the ASS assessment, soil samples were collected at select depth intervals while auger drilling at shallow depth, and then recovered from the SPT samples therefater. All samples were stored in airtight plastic bags and placed immediately on ice after sampling. The samples were then transported to a select environmental soils laboratory where field screening tests (pH_F and pH_{FOX}) were carried out on each sample. The field work for the ASS soil aspect of the investigation was carried out in general accordance with the QASSIT *'Guidelines for Sampling and Analysis of low land Acid Sulfate Soils (ASS) in Queensland'* 1998.

Groundwater monitoring wells were installed in Bores 4, 5, 8 and 9 to depths of between 3.5 m and 8 m and comprised a 50 mm diameter class 18uPVC casing with a factory slotted screen. The annulus of the wall was backfilled using sand and sealed with bentonite to the surface with a PVC 'stickup' and cap. The remaining boreholes were backfilled with drill spoil after checking for the presence of groundwater.

Strata identification was carried out through observation of recovered auger cuttings and SPT and rock core samples. All field work was undertaken by experienced geotechnical personnel who logged the bores and collated samples for tactile assessment.

The test locations and surface levels were recorded and located using a hand held DGPS RTK GNSS receiver. The coordinates and site level for each borehole are presented on the borehole logs in Appendix C, and the test locations are indicated on Drawing 1 in Appendix B.

5. Field Work Results

The subsurface conditions encountered in the boreholes are described in detail on the borehole logs in Appendix C and are summarised in Table 1 and shown graphically in Figure 3.

Table 1: Summary of Subsurface Conditions

Bore	Strata/Depth Range (m)[i]						Depth to GW (m)
	Fill/Topsoil	Clayey/Silty Sand		Silty/Sandy Clay		Metasandstone	
		Loose	Medium dense to very dense	Soft to firm	Stiff (or stronger)	very low strength (or stronger)	
1	0.0 – 0.7[ii]	-	0.7 – 1.4	-	-	1.4 – 4.04[iii]	NE
2	0.0 – 2.1	-	-	-	2.1 – 5.0	5.0 – 6.5[iii]	NE
3	0.0 – 1.3	-	1.7 – 5.0[iii]	-	1.3 – 1.7	-	NE
4	0.0 – 0.2[ii]	-	-	0.2 – 2.4	2.4 – 3.5[iii]	-	NE
5	0.0 – 0.5	-	2.1 – 7.5[iii]	-	0.5 – 2.1	-	4.5
6	0.0 – 0.2[iii]	0.2 – 0.7	1.5 – 5.6	-	0.7 – 1.5	5.6 – 7.2[iii]	NE
7	0.0 – 1.6	-	1.6 – 2.4	-	2.4 – 7.45[iii]	-	NE
8	-	-	3.0 – 5.95[iii]	-	0.0 – 3.0	-	5.0
9	-	-	-	0.0 – 4.0 6.1 – 8.0[iii]	4.0 – 6.1	-	1.5

Notes (i) All depths were measured from existing site level at the time of the investigation.
(ii) Topsoil encountered between 0.1 m and 0.2 m depth.
(iii) Limit of investigation.
GW = groundwater NE = not encountered while auger drilling (depth auger drilling)

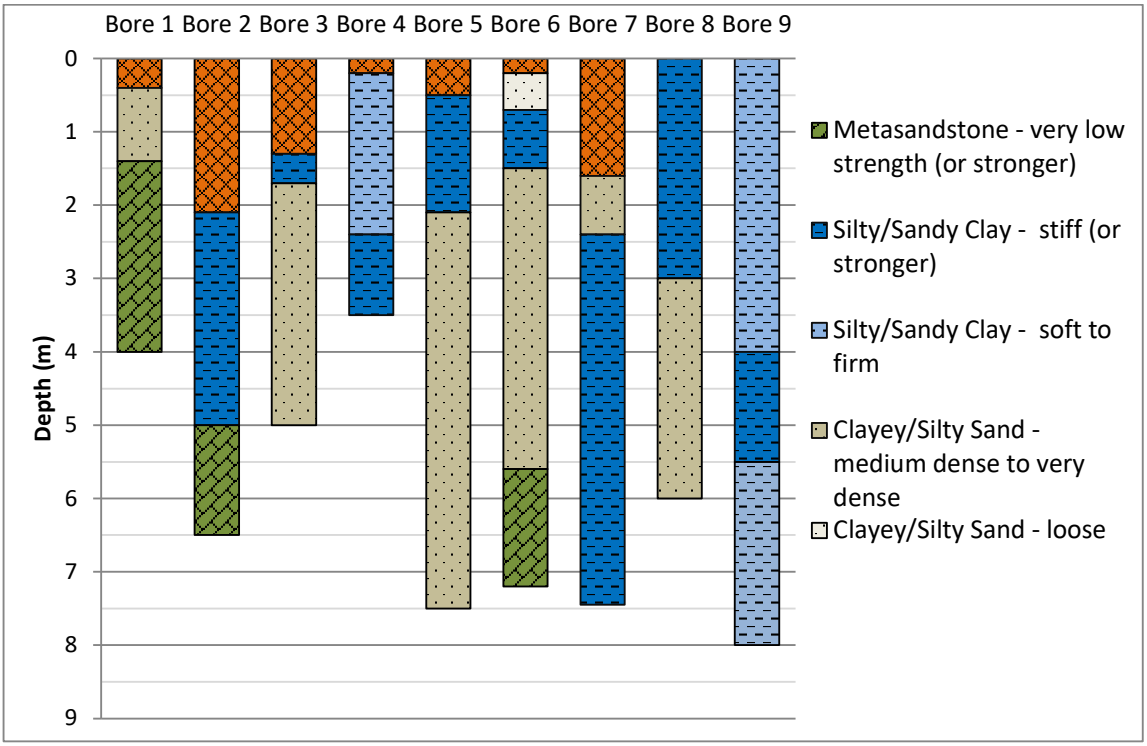

Figure 3: Graphical summary of subsurface conditions.

In the absence of documentation to confirm the fill was engineered and placed under 'controlled' conditions and meets the requirements of structural fill in AS 3798 (2007), it must be deemed 'uncontrolled'\.

Groundwater was encountered in Bores 5, 8 and 9 at respective depths of 4.5 m, 5.0 m and 1.5 m. No groundwater was encountered within the remaining boreholes while auger drilling (i.e. prior to the introduction of drilling mud). It should be noted that groundwater depths and ground moisture conditions are affected by climatic conditions, human influences, surface and subsurface drainage and soil permeability may therefore vary with time. Seepage may also occur along the fill/natural and soil/rock interface during and after periods of wet weather. Further investigation may be required to confirm on site groundwater levels.

6. Laboratory Testing

Laboratory testing was performed on selected disturbed soil samples from the bores and comprised the following:

- Emerson Class Number;
- Atterberg limits;
- Particle size distribution;
- Soil aggressivity testing - pH, Chloride and Sulfate;

- ASS field screening after the addition of distilled water (pH_F) and peroxide (pH_{Fox}); and
- ASS analytical Chromium reducible sulfur (S_{CR}) suite.

Preliminary field screening and chemical laboratory tests for ASS were carried out with reference to the QASSIT Guidelines (1995), the Soil Management Guidelines (2014) and the Laboratory Methods Guidelines (2004). In total, 163 samples recovered from the boreholes were submitted for field screening (pH_F and pH_{FOX}).

Based on the results of the field screening tests and visual inspection of the samples, 29 samples were submitted for more rigorous Chromium reducible sulfur (S_{CR}) analytical testing. Results of the screening tests (pH_F and pH_{FOX}) and S_{CR} tests are presented in Table 2 in Appendix D along with the detailed laboratory report sheets. It should be noted that S_{CR} testing was conducted on the predominant soil types encountered during the investigation. The results of all ASS testing are discussed in Section 8.0 of this report.

Results of the soil aggressivity, Atterberg Limits, Emerson Class Number and particle size distribution tests are summaried in Tables 3 and 4 and are provided in detail in the attached laboratory report sheets in Appendix D.

Table 3: Summary of Soil Aggressivity Test Results for Soil and Water

Bore	Depth (m)	Material Description	pH	Moisture Content (%)	Sulfate (mg/kg)	Chloride (mg/kg)
2	2.5	Sandy Clay	4.7	16.2	<10	250
2	4.0	Silty Clay	5.4	12.6	50	20
3	2.5	Silty Sand	5.5	4.6	10	100
3	4.0	Clayey Sand	5.7	9.4	50	300
4	1.0	Clayey Sand	5.8	12.4	20	30
4	2.5	Sandy Clay	5.2	12.3	20	10
5	4.0	Clayey Sand	5.3	12.7	100	850
7	4.0	Metasandstone	5.2	12.7	50	450
8	2.5	Sandy Clay	5.5	11.4	90	620
8	5.5	Clayey Sand	7.2	12.9	90	730
9	2.5	Silty Clay	5.2	24.4	330	320
9	7.0	Sandy Clay	6.9	24.6	330	850
5	4.5	Water	6.3	NA(i)	59	908
9	1.5	Water	5.6	NA(i)	249	1150

Note (i) NA – Not Applicable

Table 4: Results of Atterberg Limits, Linear Shrinkage, Particle Size Distribution and Emerson Class Number

Bore	Depth (m)	W_L (%)	PI (%)	LS (%)	Clay/Silt (%)	Sand (%)	Gravel (%)	Emerson Class Number
2	2.5	47	31	6.0	67	4	29	4
2	4.0	36	20	11.0	69	30	1	2
4	1.0	19	5	3.0	48	50	2	2
4	2.5	28	13	9.5	60	40	-	2
8	1.0	19	8	5.5	38	61	1	2
8	4.0	-	-	-	34	66	-	2
9	4.0	33	20	8.5	-	-	-	2

Legend: W_L – liquid limit PI – plasticity index LS – linear shrinkage

7. Comments

7.1 Open Trench Excavation

7.1.1 Excavatability

It is understood that up to 7 m depth of trench excavation may be required. Based on the conditions encountered in the boreholes, it is anticipated that bulk excavation of the existing fill, natural soils and very low strength rock, could be undertaken by medium sized equipment such as 20-30 tonne hydraulic excavators. The use of a ripping tine and rock hammer would assist with productivity rates, partivcualy in confined excavation such as trenches, and manhole pits.

It should be recognised that the above excavatability estimates are based on the materials encountered at the test locations only and that conditions may prove more difficult (or easier) between and beyond these test locations.

7.1.2 Re-Use of Cut Materials and Workability

Based on the subsurface soil profiles encountered in the boreholes, it is expected that the material won from any excavation will comprise existing fill, silty/clayey sand, low to high plasticity clays and weathered rock. If required, it is expected that the excavated materials, with the exception of the topsoil and organic bearing soils, could all be re-used as trench backfill. During excavation and handling, any oversize rock (i.e. >150 mm) should be excluded and spoiled, or broken down to a maximum particle size of 75 mm. In this regard, track rolling of any very low strength rock with the aforementioned recommended medium sized excavation plant should assist in braking down larger sized fragments .

Such re-use is contingent upon the fill being free of any unsuitable materials, particle size distribution being controlled along with moisture content, and upon minimum placement and compaction

requirements as per AS 3798 (2007). Re-use of wet materials would require moisture conditioning by drying, prior to re-use or mixing with dry soils. The low to high plasticity clay materials on site will be untrafficable to tyred vehicles during and after periods of rainfall or other increases in subgrade moisture content, and hence, the use of tracked plant is recommended. Soils which become wet will need to be allowed to dry out or be replaced.

7.1.3 Batter Slopes

The trenching batter angles indicated in Table 5, for a maximum cut depth of 3 m, are recommended for preliminary design of non-surcharged excavations in the predominant material types encountered during the investigation. Deeper cuts will require specific geotechnical assessment. Alternatively, excavations could be benched to form an equivalent slope with bench heights not exceeding 1 m in the fill, soft to firm clays and loose sand, and 1.5 m in the stiff (or stronger) clays, medium dense or denser sands and weathered rock. These slopes are appropriate for excavations that are not surcharged and are not close to movement sensitive infrastructure such as services, roads and buildings; where excavation is close to movement sensitive infrastructure, positive support (refer below) may be required.

Table 5: Recommended Trench Batter Slopes

Material Description	Short Term
Fill and Sandy/Silty Clay – firm to soft	1V:2H(i) 1V:3H(ii)
Sandy/Silty Clay – stiff (or stronger)	1V:1H(i) 1V:2H(ii)
Silty/Clayey Sand – loose	1V:2H(i) 1V:3H(ii)
Silty/Clayey Sand - medium dense (or denser)	1V:1.5H(ii) 1V:2.5H(iii)
Metasandstone – very low strength (or stronger)	1V:1H(i)(ii)

Notes (i) Dry and moist conditions, including with dewatering.
(ii) Saturated conditions (below water table).
(iii) Batter slopes in very low (or stronger) rock are contingent upon geotechnical inspections during construction to verify that no adverse jointing and/or defects are present in the batter face.

The above angles should be considered indicative and would require more detailed assessment if an open trenching construction is to be considered.

7.1.4 Positive Support (Trench Retention)

Retention systems should be specifically engineer designed as follows, with design carried out in accordance with AS 4678 (2002):

- Induced lateral soil parameters are discussed below in Sections 7.1.5 and 7.1.6;
- Passive resistance to lateral movement of the toe embedment of the lateral support can be calculated based on the ultimate passive earth pressure co-efficient (Kp) values, presented in

Table 6 below. These are based on a level, un-surcharged ground surface behind the retention system. Note that these values are ultimate values and should incorporate a factor of safety of at least two to limit movement of the retention system, or else the embedment depth should be increased. Alternatively, for short-term resistance only (i.e. against transient loadings), in cohesive soils (i.e. sandy/silty clays) the passive pressures (P_P) contained in Table 6 could be used.

- Where well existing fill or natural soil is to be retained behind the retention system, bulk unit weight should be used above the groundwater table, effective unit weight below the groundwater table.
- Due allowance should be made for surcharge loadings (over and above the lateral earth pressure coefficients referred above), such as from heavy machinery, stockpiles, or traffic. In general, cantilever retention design should not be used to support neighbouring footings and multi-propped shoring systems may be more appropriate (refer Section 7.1.6).
- Allowance should be made for differential hydrostatic pressure between the outside and inside of the excavation, and potential for boiling/heave over the excavation base.
- Preference should be given to adopting thin soil layers and using small hand-held compaction equipment during filling against the outside of retention systems using cohesive soils (clays and silts). This is in order to limit the stress applied during construction. Should heavy compaction be required, then retention system stresses will be well in excess of Ko, and temporary propping should be used.
- Retention systems should be designed to withstand a full height of hydrostatic pressure against them, such as for retention systems located within the range of the highest expected flood level.
- Additional guidelines on retention system drainage are provided in Appendix G of AS 4678 (2002).

As well as design with an adequate factor of safety against sliding and overturning, consideration should be given to bearing capacity of any footings, and an assessment of overall stability.

7.1.5 Cantilevered Design

For retention systems that are to be cantilevered or single prop cantilevered, but not multi-propped, design should utilise a triangular load distribution with depth (refer below) and either of the following lateral soil pressures:

Ko = ‘at rest’ condition, which will apply when the wall is restrained from horizontal movement and rotation.

Ka = ‘active’ condition, which will apply when the wall is free to rotate or move laterally and hence allow stresses to dissipate from the ‘at-rest’ condition.

For short term or transient loading, ultimate pressures are calculated based on the undrained shear strength and are constant with depth.

The above coefficients should be applied to the effective overburden pressure to obtain lateral loading which will have a triangular distribution (increasing with depth) for a cantilevered or single propped cantilever support design. The lateral earth co-efficient values and pressures suggested for the soils encountered at the site are contained in Table 6.

Table 6: Lateral Earth Coefficients and Pressures

Material Description	Bulk Density (kN/m^3)	Lateral Earth Pressure Coefficient (K)			Ultimate Passive Pressure (KPa) (Pp) (Temporary Loading Only)
		Ka	Ko	Kp	
'Uncontrolled' Fill and Sandy/Silty Clay –soft to firm	16	0.55	0.7	2.0	25
Sandy/Silty Clay – stiff or (stronger)	19	0.4	0.6	2.5	100
Silty/Clayey Sand – loose	17	0.36	0.5	2.7	25
Silty/Clayey Sand – medium dense (or denser)	18	0.30	0.47	3.2	100
Metasandstone – very low strength (or stronger)	22	0.27	0.43	3.7	400

It is recommended that a factor of safety of 2 be applied for cantilever retaining walls.

7.1.6 Multi-Propped Design

Where trench shoring support is to include internal propping at least at the top and bottom, the lateral pressure distribution will be approximately constant with depth, with ultimate values for stiff or stronger clays, medium dense sands, and weathered rock, and should be taken as below (where H is the depth of the trench in metres):

- stiff clays (or stronger) – 6H kPa plus the addition of any surcharge;
- medium dense sand (or denser) 4.5H KPa plus the addition of any surcharge; and
- weathered rock – 3H kPa plus the addition of any surcharge.

Where layers of 'uncontrolled' fill, soft to firm clay or loose sands are encountered, a triangular distribution will apply (refer Section 7.1.5) and a Ko value of 0.7 should be used.

If dewatering is to be carried out within the temporarily shored excavation below the water table, then it would be prudent to also allow for some differential hydrostatic pressure between the outside and inside of the temporary shoring.

Lateral load due to adjacent structures or footings (if present) should also be considered in temporary excavation shoring design.

7.2 Tunnel Boring

Based on the materials encountered within the boreholes it is considered that the existing fill, soils and rock encountered within the limits of the investigation, should be suitable for tunnel boring methods subject to acceptable machine selection. The presence of strong rock is noted in part of the route and

will require particular care with machine selection. It is recommended that a specialist tunnel boring contractor be provided with this report in full as part of any machine selection and tender process.

Excavation for the pipeline will alter in-situ stresses around the bore, causing slight movement and may result in slight differential movement of the ground surface. Where the pipe is less than about four diameters in depth below the ground surface there is a risk of ground instability if casing (e.g. by pipe jacking) is not used along these sections. Where required, grouting should be carried out immediately after pipe installation.

It would be normal good practice to undertake precise levelling during tunnel boring activities in order to monitor ground surface movements. We suggest that the accuracy of this survey levelling should be to 5 mm or better, with baseline readings established along the proposed alignment prior to the commencement of construction activities.

7.3 Pits and Trust Blocks

Depending on structural loads, either high level or deep level footings may be appropriate to support any proposed pits or thrust blocks associated with the pipeline.

It is essential that foundation excavations (where applicable) be inspected by experienced geotechnical personnel to ensure the design parameters adopted are suitable for the ground conditions and to ensure that there is no soft or loose material remaining at the base of excavations. Ground conditions can vary, and it is essential that adequate provision be made through the project to vary foundations to suit differencing ground conditions.

The allowable parameters shown in Table 7 may be used for spread footing design up to 2 m width.

Table 7: High Level Footing Design Bearing Pressures (Allowable)

Material Description	Maximum Allowable Bearing Pressure (kPa)
'Uncontrolled' Fill, Silty/Clayey sand – loose and Sandy/Silty Clay –soft to firm	Not Recommended
Silty/Clayey Sand – medium dense (or denser) and Sandy/Silty Clay – stiff (or stronger)	100
Metasandstone – very low strength (or stronger)	400

For spread footings founded in the materials as given in the above table, it is considered that settlements under such applied lading will be less than 1% to 2% of footing width.

Should high level footings not be feasible, suitable piled foundation options may comprise bored piles for larger loads (if large structures are required).

Experience indicates that settlements of properly constructed piles are unlikely to exceed the order of 1% of the pile diameter.

If required, bored piles would need to be founded to a minimum of three pile diameters into the relevant founding soil layer or one pile diameter into rock to achieve the allowable parameters given in Table 8. It should be noted that bored piles may be unsuitable below the groundwater table and construction would require full length liners to prevent hole collapse and submissible pumps to control water inflow.

Table 8: Allowable Bored Pile Design Parameters

Material Description	Allowable Shaft Adhesion (kPa)[(i)(ii)]	Allowable End Bearing (kPa)
'Uncontrolled' Fill, Silty/Clayey Sand - loose and Sandy/Silty Clay – soft to firm	Not Recommended	Not Recommended
Silty/Clayey Sand – medium dense (or denser) and Sandy/Silty Clay – stiff (or stronger)	15[(iii)]	150
Metasandstone – very low strength (or stronger)	20	600

Notes (i) It is recommended that the upper 0.75 m (i.e. cracking depth) or 1.5 times pile diameter, whichever is greater, of shaft be ignored in pile shaft adhesion calculations due to the effects of load development and seasonal moisture variation. (ii) Ignore if temporary or sacrificial liners are used during construction. (iii) value should be halved for tension capacity in sands.

Ultimately piling contractors should be contacted to confirm suitable piling types and pile capacities.

For limit state design, the above allowable bearing pressures should be multiplied by the adopted factor of safety of 2.5 to equate to ultimate values. A geotechnical strength reduction factor (ϕ_g) of 0.45 is recommended for limit state design of piles in accordance with AS 2159 (2009). This is based on the data presented in this report, the method of soil strength assessment used in this investigation and after assessing the overall design average risk rating (ARR) for the site, design and installation risk factors anticipated. Higher values of ϕ_g may be applied if additional investigation is carried out at the site or if selected piles are to be subjected to confirmatory load testing.

7.4 Allowable Horizontal Bearing Capacity

The horizontal bearing capacity to resist possible horizontal loads may be calculated using the parameter provided in Table 9.

Table 9: Soil Parameters for Calculation of Allowable Horizontal Bearing Capacity

Material Description	Moist Bulk Unit Weight γ (kN.m^3)	Undrained Cohesion (Cu) (kPa)	Allowable Passive Resistance (kPa)
'Uncontrolled' Fill and Sandy/Silty Clay –soft to firm and Silty/Clayey Sand - loose	16	12	Not Recommended
Sandy/Silty Clay – stiff (or stronger)	19	75	2 Cu + γZ/2.5
Silty/Clayey Sand – medium dense (or denser)	18	-	3.2γZ/2.5
Metasandstone – very low strength (or stronger)	21	200	2 Cu + γZ/2.5

Notes (i) Z – depth below design surface level

Any areas of 'uncontrolled' fill, soft clay or loose sand should not be relied upon for lateral support of thrust blocks or other structures.

The 'uncontrolled' fill, soft to firm clays and loose sands may be replaced using approved engineered fill and compacted under 'Level 1' inspection and testing in accordance with AS 3798 (2007). Removal and replacement of a sufficient depth and width of 'uncontrolled' fill and firm or softer clays around each thrust block is important so that all exerted pressures on the thrust blocks are absorbed by the 'controlled' fill, and not the surrounding firm or softer clays. The use of a bridging layer of crushed rock encapsulated by geofabric for separation may be necessary within areas of 'poor' ground conditions.

The depth and width of the replacement fill will depend on the size of the thrust block and applied loading. For preliminary guidance, replacement fill employed to resist lateral loadings would require to extend outward from the thrust block face by a distance of approximately two to three times the depth to the base of the thrust block. This is based on a triangle projected at an angle of (45° - Φ'/2) from the upper, outer edge of the thrust block below horizontal, where Φ' is the effective friction angle of the replacement fill. It is recommended that the replacement fill also extend to at least 0.3 m below the base of the thrust block. As above, a geofabric wrapped bridging layer of crushed rock would probably be required across the base of the area excavated for replacement, in order to provide a working platform. An indicative arrangement for replacement fill is presented in Figure 4.

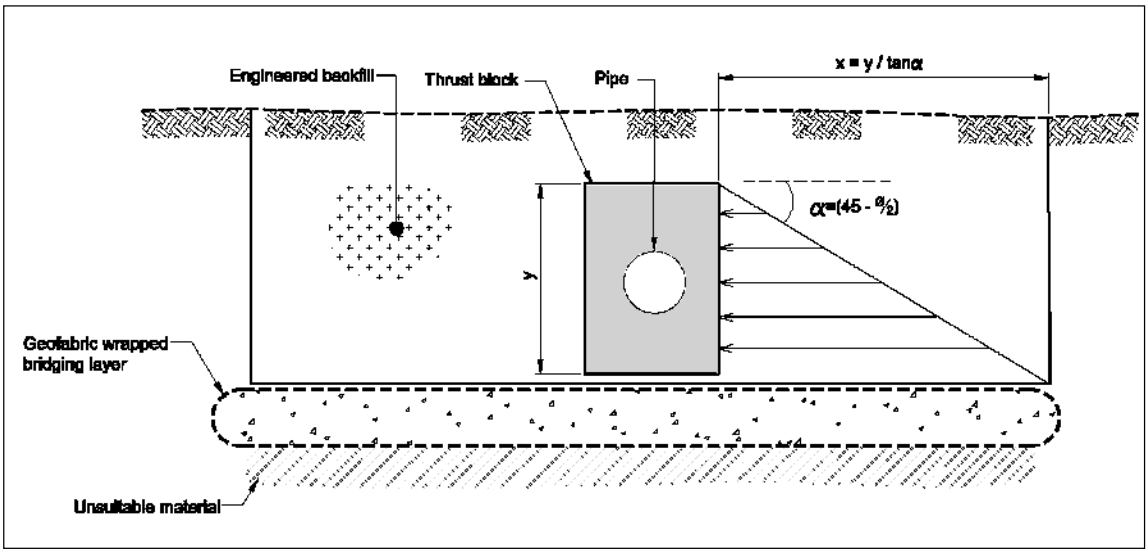

Figure 4: Indicative Replacement Arrangement (Not to Scale).

7.5 Soil Aggressivity

Based on the results of the laboratory aggressivity testing (Table 3 above) and the groundwater conditions, the exposure classification for the soils and water tested would be deemed to be 'non aggressive' to 'moderate' for both buried concrete and steel for soil and 'moderate' for concrete in water and 'non' aggressive to 'moderate' for steel for water, in accordance with AS 2159 (2009). The 'moderate' exposure classicisation for buried concrete is due the pH result.

7.6 Preliminary Assessment of ASS Results

7.6.1 General

A preliminary ASS investigation was carried out during the geotechnical investigation to assess the presence of ASS.

7.6.2 Soil pH Screening Tests

Results of the screening tests (pH_F, pH_{FOX}) were assessed based on the recommendations in the Department of Mines and Natural Resources Publications with regards to ASS to determine whether they are indicative of actual acid sulfate soils (AASS) or potential acid sulfate soils (PASS). A total of 163 samples were retrieved and tested. Testing was carried out on predominant soil horizons encountered during the investigation. The results are summarised in Table 2 in Appendix D.

- **pH in distilled water (pH_F)** measures the existing acidity of the soil and is used to help identify whether actual ASS is present. A pH_F between 4 and 5.5 indicates acidic soils. If pH_F is less than 4, it is considered that either actual ASS is present or soils contain a high organic content.

All samples recorded pH_F values of greater than 4.

The pH_F test method does not detect acidity bound within sulfides; therefore the pH_{FOX} test is undertaken as this gives an indication of any potential acid release.

- **A pH peroxide test (pH_{FOX})** value less than 3 combined with a pH_{FOX} reading at least one pH unit below pH_F (i.e. **ΔpH** >1) and a strong **reaction with peroxide**, strongly indicates the presence of potential ASS.

  Of the163 tested, six recorded pH_{Fox} values equal to or greater than 3.

On the basis of the qualitative pH screening results, the likelihood of actual ASS to occur is considered to be generally 'low' on the majority of samples.

7.6.3 Chromium Reducible Sulfur Suite Analysis of Soils

To confirm the screening test results, 52 samples from Bores 1, 2, 4, 6, 8 and 9 were selected for more rigorous and quantitative chromium suite testing to determine more definitively if AASS or PASS are present. These samples represent predominant soil profiles encountered during the investigation.

The action criterion on which the presence of ASS, is made from the chromium suite test results with the results that may trigger a requirement for an ASSMP based on the Soil Management Guidelines (SMG) and the Laboratory Methods Guidelines. The Soil Management Guidelines, (2014) indicate that the assessment of whether or not a soil is AASS or PASS should be determined using only the 'existing plus potential' acidity calculation, and not the former 'net acidity' calculation, unless the ANC term (as used in the 'net acidity' calculation) meets certain requirements. The SMG indicates that the ANC term is only used if the soil contains fine (i.e. <0.5 mm in size) shell fragments or other similar fine calcium carbonate material, such as skeletal fragments, coral and foraminifera. Furthermore, SMG specifically cautions against relying on the ANC term when the material comprises a clay without any discernible carbonate material.

In the absence of the site soils meeting the above, the existing plus potential acidity equation (i.e. S_{CR} + TAA + S_{NAS}) of greater than or equal to 0.03%S (sulfur trail) or 18 mol H^+/tonne (acid trail) has been adopted for this site.

Where: S_{CR} = Chromium Reducible Sulfur
TAA = Titratable Actual Acidity
S_{NAS} = Net Acid Soluble Sulfur (retained acidity)

Based on the above the existing plus potential acidity was calculated (refer Table 2 in Appendix D) to be equal to or greater than 0.03%S in 32 samples tested. Further examination of the S_{CR} results indicates that the elevated existing plus potential acidity, with the exception of a single sample in Bore 9 at 7.25 m depth is due solely to TAA and therefore the soil is assessed to be naturally acidic, non-acid sulfate soils. The sample at Bore 9 at 7.25 m depth indicates the sample was PASS.

Based on results of this testing, an acid sulfate soils management plan (ASSMP) will not be required at this site. However, due to the natural acidity in the soil including those at and near surface, measures to prevent potential environmental harm will be prudent including if the material is to be moved off site or is left exposed and disturbed or stockpiled for longer than 48 hrs. If excavations in the vicinity of Bore 9 are to exceed 6.0 m, it is recommended that further targeted investigation be carried out in the area to confirm the extent of PASS and provide an acid sulfate soil management plan, if required.

With reference to the guidelines, a neutralising agent (generally aglime) should be applied during site works (refer below). The TAA results can be used to guide liming rates to achieve desired pH levels. Thorough mixing, a safety factor and a fully contained treatment pad would generally not be necessary. Instead, neutralising agent may be:

- spread in key areas as part of the filling operations to intercept any acidic leachate flow;
- added to truckloads of disturbed material while being moved, thus achieving a degree of mixing during transport and placement;
- spread and tined into the upper 0.3 m depth as a guard layer under (5 kg/m^2 – Aglime) any temporary or permanent stockpiles or treatment areas and any exposed earthworks surfaces;
- incorporated as lime-enriched perimeters around temporary or permanent stockpiles or treatment areas; and
- positioned in drains and areas most likely to experience water runoff.

Using the highest reported level of soil acidity (i.e. existing plus potential) determined by the laboratory test results, a preliminary neutralisation rate of 9.5 kg of lime per tonne of soil is required (in-situ). Assuming an overall stockpile density, after 'bulking up', of approximately 1.6 tonnes/m^3, this equates to a lime application value of 15.5 kg/m^3.

If excavations in the vicinity of Bore 9 are to exceed 6.0 m, it is recommended that further targeted investigation be carried out in the area to confirm the extent of PASS and provide an acid sulfate soil management plan, if required.

7.6.4 Groundwater

The presence of ASS could lead to leaching of acid and metals during and after rainfall events. Accordingly, groundwater should not be discharged off site without prior testing in order to confirm the suitability of the water quality in accordance with Council guidelines/criteria.

8. Limitations

Douglas Partners (DP) has prepared this geotechnical investigation and preliminary acid sulfate soil assessment report for this project at Stapylton Jacobs Well Road, Yatala in accordance with DP's proposal 206529.00 dated 19 October 2021 and acceptance received from Frasers Property Industrial dated 8 July 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use Frasers Property Industrial for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk

and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

9. References

Ahern, C R, Ahern, M R, and Powell, B, 'Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998', QASSIT, Department of Natural Resources, Resources Sciences Centre, Indooroopilly, October 1998.

Dear S-E., Ahern, C.R., O'Brien, L.E., Dobos, S.K., McElnea, A.E., Moore, N.G. & Watling, K.M., 'Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines'. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government, 2014.

Ahern, C R McElnea, A E and Sullivan, L A '*Acid Sulfate Soils Laboratory Methods Guidelines'* in 'Queensland Acid Sulfate Soils Manual 2004', Department of Natural Resources, Mines and Energy, Indooroopilly, June 2004.

AS 2159 (2009), *Piling – Design and Installation*, Standards Australia.

AS 3798 (2007), *Guildelines on Earthworks for Commercial and Residential Developments,* Standards Australia.

AS 4678 (2002), *Earth-Retaining Structures,* Standards Australia

Douglas Partners Pty Ltd

Appendix A

About This Report
Sampling Methods
Soil and Rock Descriptions
Symbols and Abbreviations

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $Is_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections > 100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

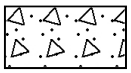
Symbols & Abbreviations

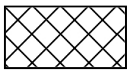
Graphic Symbols for Soil and Rock

General

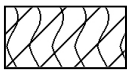

Asphalt

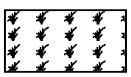

Road base

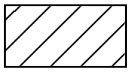

Concrete

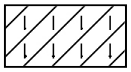

Filling

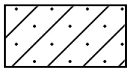
Soils


Topsoil

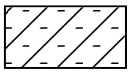

Peat

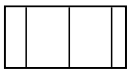

Clay

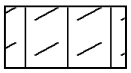

Silty clay

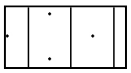

Sandy clay

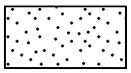

Gravelly clay

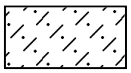

Shaly clay

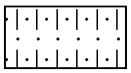

Silt


Clayey silt


Sandy silt

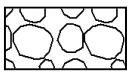

Sand

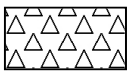

Clayey sand


Silty sand


Gravel

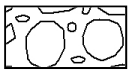

Sandy gravel


Cobbles, boulders

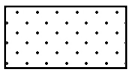

Talus

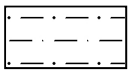
Sedimentary Rocks

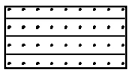

Boulder conglomerate

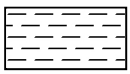

Conglomerate


Conglomeratic sandstone

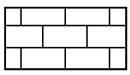

Sandstone


Siltstone

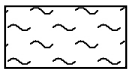

Laminite

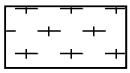

Mudstone, claystone, shale

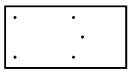

Coal


Limestone

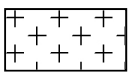
Metamorphic Rocks

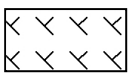

Slate, phyllite, schist

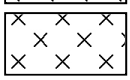

Gneiss

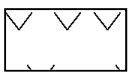

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

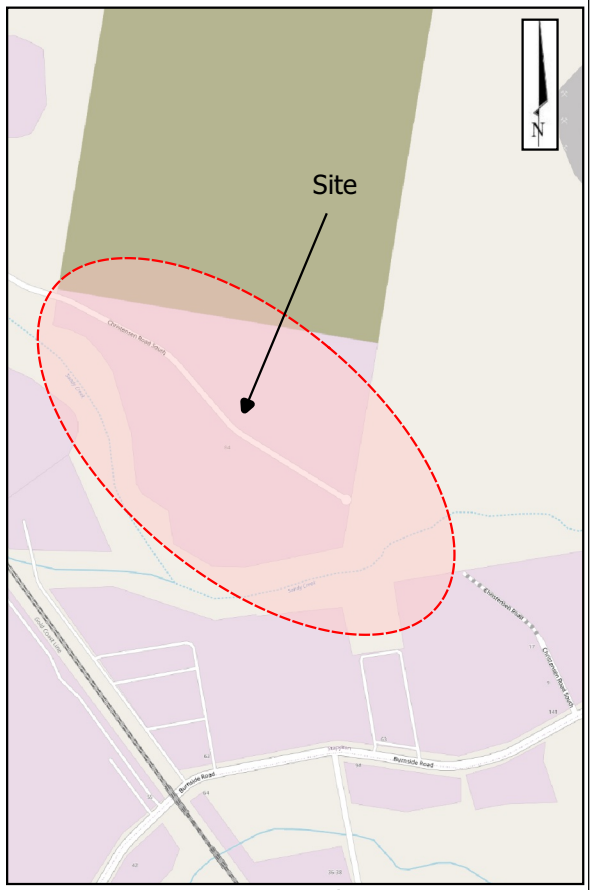

Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Drawing 1 – Site and Test Location Plan



Site Locality

Legend:

Approximate borehole location and number

Image taken from metro map dated 24/09/21

Site locality not to scale. Obtained from Open Street Map

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Frasers Property Industrial Pty Ltd
OFFICE:	Gold Coast
DATE:	February 2022

Site and Test Location Plan

Proposed External Trunk Gravity

Christensen Road South, Yatala

PROJECT No:	206529.00
DRAWING No:	1
REVISION:	0

Appendix C

Borehole Logs (Bores 1 to 9)
Rock Core Photographs

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 15.1 AHD
EASTING: 523781
NORTHING: 6931243
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 206529.00
DATE: 17/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
15	0.0	FILL/Sandy CLAY (CL): low to medium plasticity, dark grey, fine to medium sand, w>PL, appeared well compacted. Root zone to 0.2m		D	0.25		Samples collected at 0.25 m depth intervals to 4 m depth		
	0.4	- mottled orange, w=PL							
	0.7	Silty SAND (SM): fine to coarse grained, grey, moist, dense, residual			1.0				
14	1			S	1.27		11,30/120 mm refusal		1
	1.4	METASANDSTONE: fine grained, grey-yellow, very low strength, highly weathered (Neranleigh Fernvale Formation)							
13	2								2
	2.3	- pale yellow		S	2.5		30/120 mm refusal		
					2.62				
12	3								3
	3.1	- medium to coarse grained							
11	4			S	4.0		30/40 mm refusal		4
	4.04	Bore discontinued at 4.04m. Limit of Investigation			4.04				
10	5								5
9	6								6
8	7								7
7	8								8
6	9								9

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed at the time of drilling

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 17.8 AHD
EASTING: 523923
NORTHING: 6931123
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 206529.00
DATE: 17/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
17	0.75	FILL/Clayey SAND (SC): fine to coarse grained, dark brown-pale grey, moist, appeared well compacted		D	0.25		Samples collected at 0.25 m depth intervals to 5.5 m depth		
				S	1.0		4,5,5 N = 10		
16	1.5	- fine to medium grained, brown, trace sandstone fragment			1.45				
	2.1	- trace silt							
15		Silty CLAY (CI): medium plasticity, brown, with fine to medium sand, w>PL, stiff, residual		S	2.5		3,4,5 N = 9		
	3.5				2.95				
14		- trace gravel, stiff to very stiff							
	4.1			S	4.0		8,16,19 N = 35		
13		Silty CLAY (CI): medum plasticity, brown-grey, moist, w>PL, very stiff, residual			4.45				
	5.0								
12		METASANDSTONE: fine grained, grey-yellow, very low to medium strength, highly weathered (Neranleigh Fernvale Formation)		S	5.5 5.52		30/20 mm refusal		
	6.5								
11		Bore discontinued at 6.5m. Limit of Investigation							
10									
9									
8									

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed at the time of drilling

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 14.4 AHD
EASTING: 523974
NORTHING: 6930903
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 206529.00
DATE: 17/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
14	0.0	FILL/Clayey SAND (SC): fine to coarse grained, pale brown, moist, estimated well compacted		D	0.25		Samples collected at 0.25 m depth intervals to 4 m depth		
	0.9	- trace clay lumps		S	1.0		7,7,9 N = 16		
13	1.3	Sandy CLAY (CH): high plasticity, brown, fine to medium sand, w>PL, stiff, residual			1.45				
	1.7	Silty SAND (SM): fine sand, grey-white, moist, medium dense, residual							
12	2.0	- very dense, tending to weathered rock		S	2.5		17,30/150 mm refusal		
					2.8				
11	3.0	Clayey SAND (SC): fine to coarse sand, brown, moist, dense to very dense, residual, tending to weathered rock		S	4.0		10,14,27 N = 41		
10					4.45				
	5.0	Bore discontinued at 5.0m. Limit of Investigation							

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed at the time of drilling

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 13.9 AHD
EASTING: 524025
NORTHING: 6930784
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 206529.00
DATE: 18/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
13	0.2	TOPSOIL/Clayey SAND (SC): fine to coarse sand, pale brown, moist		D	0.25		Samples collected at 0.25 m depth intervals to 3.5 m depth		Concrete
		Sandy CLAY (CL): low plasticity, dark grey, fine to coarse sand, w>PL, firm, alluvial							Blank Bentonite
	0.8	- trace rootlets							
12	1			S	1.0		4,3,3 N = 6		
	1.5	- mottled grey-white			1.45				
11	2								Sand Screen
	2.4	Silty CLAY (CH): high plasticity, dark brown with fine to coarse sand, w>PL, very stiff, residual		S	2.5		3,7,11 N = 18		
	3				2.95				
10	3.5	Bore discontinued at 3.5m. Limit of Investigation							End Cap
9	4								
8	5								
7	6								
6	7								
5	8								
4	9								

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed at the time of drilling

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 6.1 AHD
EASTING: 524133
NORTHING: 6930743
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 206529.00
DATE: 18/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILL/Clayey SAND (SC): fine to coarse sand, pale grey, moist, estimated well compacted		D	0.25		Samples collected at 0.25 m depth intervals to 4.5 m depth		Concrete
	0.5	Sandy CLAY (CH): high plasticity, dark brown, medium to coarse sand, w>PL, very stiff, alluvial		S	1.0		3,7,10 N = 17		Bentonite
					1.45				
	1.7	- mottled orange, estimated firm to stiff							
	2.1	Clayey SAND (SC): medium-coarse grained, brown, moist, dense, alluvial		S	2.5		11,15,18 N = 33		Blank
					2.95				
	3.3	- grey							
				S	4.0		9,20,18 N = 38		Sand
					4.45				
	4.8	- coarse sand, alluvial							
				S	5.5		17,28,30/150 mm refusal		Screen
	5.9	- very dense			5.95				
	6.8	- medium dense		S	7.0		7,11,15 N = 26		
	7.45	Bore discontinued at 7.45m. Limit of Investigation			7.45				End Cap

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** HW to 0.8 m

TYPE OF BORING: Auger to 4.5 m, then wash bore

WATER OBSERVATIONS: Free groundwater observed at 4.5 m depth

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 5.4 AHD
EASTING: 524254
NORTHING: 6930760
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 206529.00
DATE: 18 - 19/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.2	TOPSOIL/Clayey SAND (SC): fine sand, pale brown, moist. Root zone to 0.2m							D			Samples collected at 0.25 m depth intervals to 5.5 m depth
	0.7	Clayey SAND (SC): fine sand, pale brown, moist, loose, residual										
	1	Sandy CLAY (CH): high plasticity, dark brown, fine sand, w>PL, stiff, residual							S			5,12,22 N = 34
	1.5	Clayey SAND (SC): medium to coarse grained, brown, moist, dense to medium dense, residual										
	3.8	- coarse, grey							S			9,7,16 N = 23
	4.7	Silty SAND (SM): fine to coarse grained, grey, moist, medium dense, residual										
	5.6	METASANDSTONE: medium to coarse grained, grey-orange, highly fractured, very low strength, highly weathered (Neranleigh Fernvale Formation)						5.6m: J, 5°, pl, ro 6m: J, 5°, pl, ro 6.2m: J, 10°, pl, ro 6.4m: J, 15°, pl, ro	C	100	100	PL(A) = 0.01 PL(D) = 0.04 PL(A) = 0.09 PL(D) = 0.04
	6.33	- orange										
	6.4	- grey							C	100	100	PL(A) = 0.02 PL(D) = 0.02 PL(A) = 0.01 PL(D) = 0.01 PL(A) = 0.01 PL(D) = 0.02
	7.2	Bore discontinued at 7.2m. Limit of Investigation						7.1m: J, 15°, pl, ro				

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** NW to 7 m

TYPE OF BORING: Auger to 5.6m, then NMLC rock core

WATER OBSERVATIONS: No free groundwater observed at the time of drilling

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 4.5 AHD
EASTING: 524375
NORTHING: 6930811
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 206529.00
DATE: 19/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILL/Clayey SAND (SC): fine sand, pale grey, moist, appeared well compacted		D	0.25		Samples collected at 0.25 m depth intervals to 6 m depth		
				S	1.0		5,7,12 N = 19		
	1.6	Clayey SAND (SC): fine grained, pale brown, moist, medium dense, residual			1.45				
	2.4	Sandy CLAY (CH): high plasticity, dark brown, coarse sand, w>PL, very stiff, residual		S	2.5		13,14,9 N = 23		
	3.7	- mottled brown			2.95				
				S	4.0		11,11,13 N = 24		
	4.5	- dark grey			4.45				
	5.5	- hard		S	5.5		6,30/140mm		
					5.79				
	7.0	- very stiff		S	7.0		6,8,11 N = 19		
	7.45	Bore discontinued at 7.45m. Limit of Investigation			7.45				

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** Uncased

TYPE OF BORING: Auger to 6 m, then washbore

WATER OBSERVATIONS: No free groundwater observed at the time of drilling

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 7.6 AHD
EASTING: 524451
NORTHING: 6930896
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 206529.00
DATE: 19/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		Sandy CLAY (CL): low plasticity, brown, fine to medium sand, w>PL, very stiff, alluvial		D	0.25		Samples collected at 0.25 m depth intervals to 6 m depth		Concrete
									Bentonite
				S	1.0		6,11,9 N = 20		
	1.6				1.45				Blank
		- coarse sand, dark grey							
	2.2								
		- mottled brown		S	2.5		4,7,11 N = 18		
	3.0				2.95				Sand
		Silty SAND (SM): fine grained, pale grey, white, moist, medium dense, alluvial							
	3.5								
		Clayey SAND (SC): fine grained, grey, moist, medium dense, alluvial		S	4.0		9,13,14 N = 27		
					4.45				Screen
	5.1							▼	
		- wet							
				S	5.5		7,10,14 N = 24		
	5.95				5.95				End Cap
		Bore discontinued at 5.95m. Limit of Investigation							

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: Free groundwater observed at 5 m depth

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Frasers Property Industrial Pty Ltd
PROJECT: Proposed External Trunk Gravity Sewer
LOCATION: Christensen Road South, Yatala

SURFACE LEVEL: 3.1 AHD
EASTING: 524590
NORTHING: 6930810
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 206529.00
DATE: 20/1/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	Sandy CLAY (CH): high plasticity, dark grey, coarse sand, moist, w>PL, soft, alluvial		D	0.25		Samples collected at 0.25 m depth intervals to 6 m depth		Concrete
	0.7	Silty CLAY (CL): high plasticity, dark grey, moist, w>PL, firm, alluvial							Bentonite
				S	1.0		2,2,3 N = 5		Blank
					1.45			▼	
	1.6	- wet, w=LL							
				S	2.5		2,3,4 N = 7		
					2.95				
	4.0	- stiff		S	4.0		2,4,6 N = 10		Sand
					4.45				Screen
				S	5.5		3,3,4 N = 7		
	6.1	Sandy CLAY (CH): high plasticity, dark grey, fine to medium sand, wet, w=LL, soft, alluvial			6.0				
				S	7.0		2,2,1 N = 3		
					7.45				
	8.0	Bore discontinued at 8.0m. Limit of Investigation							End Cap

RIG: Track Rig 05 **DRILLER:** Dan - NCDW **LOGGED:** AB **CASING:** HW to 0.9 m

TYPE OF BORING: Auger to 6 m, then wash bore

WATER OBSERVATIONS: Free groundwater observed at 1.5 m depth

REMARKS: Surface level recorded using an RTK GNSS receiver

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Project Name:	Proposed Trunk Gravity Sewer
Location:	6 Christensen Road South, Stapylton
Project No:	206529.00
Client:	Frasers Property Pty Ltd
Date:	19/2/22

Douglas Partners
Geotechnics / Environment / Groundwater

Bore: 6
Box: 1 of 1
Depth: 5.6 m to 7.2 m

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Frasers Property Industrial P/L	**Core Photograph – Bore 6**	PROJECT No: 206529.00
	OFFICE: Gold Coast	**Proposed Trunk Gravity Sewer**	Box No: 1 of 1
	DATE: February 2022	**Christensen Road South, Stapylton**	REVISION: 0

Appendix D

Table 2 and Laboratory Test Results

Douglas Partners
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Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
2/3 Distribution Avenue
Molendinar QLD 4214
Phone (07) 5568 8900

FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 1	Bore 1	Bore 1	Bore 1	Bore 1			
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25			
Soil Description	Silty Clay	Silty Sandy Gravel	Silty Sandy Gravel	Silty Sandy Gravel	Clayey Sandy Gravel			
Field pH (pH_F)	6.4	5.9	5.7	5.9	5.9			
Oxidised pH (pH_{FOX})	4.2	4.0	4.3	4.1	4.0			
Reactivity Code (see below)	1	1	1	2	2			
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

Douglas Partners
Geotechnics / Environment / Groundwater

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Sandy Gravelly Clay	Sandy Gravelly Clay	Sandy Gravelly Clay	Sandy Gravelly Clay	Sandy Gravelly Clay	Gravelly Clay	Sandy Gravelly Clay	Sandy Gravelly Clay
Field pH (pH_F)	6.0	5.9	6.3	6.0	5.8	5.9	5.4	5.5
Oxidised pH (pH_{FOX})	4.1	4.0	4.8	5.9	5.1	4.5	3.5	4.8
Reactivity Code (see below)	1	1	1	1	2	2	2	2
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22
Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2	Bore 2
Offest (m)								
Level of test (m)(RL)	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
Soil Description	Gravelly Clay	Gravelly Clay	Gravelly Clay	Gravelly Clay	Gravelly Clay	Gravelly Clay	Gravelly Clay	Gravelly Clay
Field pH (pH_F)	5.3	5.6	5.4	5.6	6.1	6.1	5.7	5.3
Oxidised pH (pH_{FOX})	3.4	3.4	3.5	3.1	4.1	3.9	4.2	3.1
Reactivity Code (see below)	2	2	3	3	1	2	2	2
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 2	Bore 2	Bore 2					
Offest (m)								
Level of test (m)(RL)	4.25	4.50	4.75					
Soil Description	Gravelly Clay	Sandy Clay	Sandy Clay					
Field pH (pH_F)	5.8	5.9	5.8					
Oxidised pH (pH_{FOX})	4.1	3.9	4.5					
Reactivity Code (see below)	2	2	2					
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22
Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 3	Bore 3	Bore 3	Bore 3	Bore 3	Bore 3	Bore 3	Bore 3
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Sandy Clay	Sandy Clay	Sandy Clay	Silty Sandy Clay	Sandy Silty Clay	Sandy Gravelly Clay	Silty Sand	Sandy Clay
Field pH (pH_F)	5.2	5.5	5.7	6.3	6.4	6.1	6.5	6.8
Oxidised pH (pH_{FOX})	4.4	4.1	4.4	5.3	5.1	4.6	5.3	5.0
Reactivity Code (see below)	2	2	2	2	1	2	1	2
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 3	Bore 3	Bore 3					
Offest (m)								
Level of test (m)(RL)	2.25	2.50	4.00					
Soil Description	Sand	Sand	Gravelly Sand					
Field pH (pH_F)	6.7	6.5	6.4					
Oxidised pH (pH_{FOX})	4.8	4.8	4.3					
Reactivity Code (see below)	1	1	1					
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22
Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 4	Bore 4	Bore 4	Bore 4	Bore 4	Bore 4	Bore 4	Bore 4
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Gravelly Sand	Gravelly Sand	Sandy Silt	Sandy Silt	Sandy Clay	Sandy Silty Clay	Sandy Silty Clay	Sandy Silty Clay
Field pH (pH_F)	5.6	5.7	5.6	5.7	5.4	6.0	5.3	5.1
Oxidised pH (pH_{FOX})	3.6	4.0	3.6	3.6	3.5	3.6	3.4	2.7
Reactivity Code (see below)	2	2	2	2	2	2	2	3
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 4	Bore 4	Bore 4	Bore 4	Bore 4	Bore 4		
Offest (m)								
Level of test (m)(RL)	2.25	2.50	2.75	3.00	3.25	3.50		
Soil Description	Sandy Silty Clay	Sandy Silty Clay	Sandy Silty Clay	Sandy Silty Clay	Sandy Silty Clay	Sandy Silty Clay		
Field pH (pH_F)	5.0	5.1	5.5	4.2	5.1	5.3		
Oxidised pH (pH_{FOX})	2.7	3.0	2.9	3.5	3.4	3.1		
Reactivity Code (see below)	2	2	3	2	2	2		
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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Molendinar QLD 4214
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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22
Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Sandy Silty Clay	Silty Clay	Gravelly Clay	Silty Clay	Silty Clay	Silty Clay	Sandy Clay	Sandy Clay
Field pH (pH_F)	7.0	5.9	6.1	5.4	5.3	5.0	5.6	5.6
Oxidised pH (pH_{FOX})	5.4	3.5	4.3	4.2	3.7	3.8	3.7	3.9
Reactivity Code (see below)	3	2	2	1	1	1	2	1
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

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FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5
Offest (m)								
Level of test (m)(RL)	2.25	2.5(D)	2.5(SPD)	2.75	3.00	3.25	3.50	3.75
Soil Description	Sandy Clay	Sandy Clay	Sandy Clay	Silty Clay	Sandy Clay	Clayey Sand	Clayey Sand	Clayey Sand
Field pH (pH_F)	5.6	5.2	5.5	6.6	5.4	5.6	5.5	5.7
Oxidised pH (pH_{FOX})	3.8	3.7	4.3	5.2	4.1	4.0	4.5	4.3
Reactivity Code (see below)	1	2	1	1	2	1	1	2
AASS / PASS (see below)								

Reactivity codes: 1 = None to slight 2 = Moderate, 3 = Vigorous, 4 = Very vigorous (gas & heat generated)

F= Bubbling/ Frothy Reaction (organics) , N/A = Not Assessed

ASS / PASS intereptation : if pHf < 4.0 = ASS (actual acid sulphate soil) if pHfox < 3.0 = PASS (potential acid sulphate soil)

CHECKED BY:.....CW.....

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
2/3 Distribution Avenue
Molendinar QLD 4214
Phone (07) 5568 8900

FIELD pH SCREENING - ACID SULFATE SOILS

Client : Frasers Property Pty Ltd
Project : Vantage Yatala Stage 2 - External Trunk Gravity Sewer Alignment
Location : Christensen Road, South Stapylton

Project No. : 206529.00
Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22

Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	Bore 5	
Offest (m)								
Level of test (m)(RL)	4.00	4.25	4.50	4.75	5.50	6.00	7.00	
Soil Description	Gravelly Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	
Field pH (pH_F)	6.3	6.0	6.5	6.5	7.1	6.9	6.7	
Oxidised pH (pH_{FOX})	4.7	4.8	4.9	5.3	5.7	5.6	5.3	
Reactivity Code (see below)	1	1	1	1	2	2	1	
AASS / PASS (see below)								

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Report No. : 206529.00-1
Report Date: 3.2.22

Tested By: CH
Date Tested: 2.2.22
Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Silty Clay	Gravelly Sandy Clay	Silty Clay	Silty Sandy Clay	Silty Sandy Clay	Silty Sandy Clay	Clayey Sand	Clayey Sand
Field pH (pH_F)	6.7	6.8	5.7	5.5	5.9	5.7	6.1	6.4
Oxidised pH (pH_{FOX})	4.2	4.7	3.7	4.2	4.6	4.5	4.4	4.6
Reactivity Code (see below)	3	3	2	3	1	1	1	1
AASS / PASS (see below)								

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Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6	Bore 6
Offest (m)								
Level of test (m)(RL)	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
Soil Description	Gravelly Sand	Gravelly Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	Gravelly Clay	Clayey Sand	Gravelly Clay	Gravelly Clay
Field pH (pH_F)	6.2	6.1	6.6	6.5	6.8	6.9	6.6	6.3
Oxidised pH (pH_{FOX})	5.5	5.4	5.4	5.5	5.5	5.7	5.7	5.2
Reactivity Code (see below)	1	2	1	1	1	1	2	2
AASS / PASS (see below)								

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Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 6	Bore 6	Bore 6	Bore 6				
Offest (m)								
Level of test (m)(RL)	4.25	4.50	4.75	5.00				
Soil Description	Gravelly Clay	Gravelly Clay	Gravelly Sandy Clay	Gravelly Sandy Clay				
Field pH (pH_F)	6.7	6.8	7.0	6.9				
Oxidised pH (pH_{FOX})	5.6	5.7	5.6	5.5				
Reactivity Code (see below)	2	1	1	2				
AASS / PASS (see below)								

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Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Gravelly Sand	Gravelly Clay	Clay	Clay	Clay	Clayey Sand	Clayey Sand	Clayey Sand
Field pH (pH_F)	5.7	5.9	6.1	5.8	5.5	5.9	6.2	5.2
Oxidised pH (pH_{FOX})	4.6	4.6	5.1	4.6	5.2	5.4	5.2	5.4
Reactivity Code (see below)	2	2	3	3	1	1	1	2
AASS / PASS (see below)								

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Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7
Offest (m)								
Level of test (m)(RL)	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
Soil Description	Clayey Sand	Clayey Sand	Sandy Clay	Sandy Clay	Gravelly Clay	Gravelly Sandy Clay	Gravelly Sandy Clay	Gravelly Sandy Clay
Field pH (pH_F)	5.9	5.4	5.6	5.6	5.4	5.3	5.5	5.5
Oxidised pH (pH_{FOX})	5.3	5.8	5.2	5.1	5.2	4.9	4.9	5.4
Reactivity Code (see below)	1	1	1	1	1	1	2	1
AASS / PASS (see below)								

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Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	Bore 7	
Offest (m)								
Level of test (m)(RL)	4.25	4.50	4.75	5.00	5.25	5.50	5.75	
Soil Description	Gravelly Clay	Silty Gravelly Clay	Silty Gravelly Clay	Silty Gravelly Clay	Silty Gravelly Clay	Silty Clay	Silty Clay	
Field pH (pH_F)	6.0	6.2	7.2	6.7	6.5	6.8	6.7	
Oxidised pH (pH_{FOX})	5.0	5.5	5.4	5.5	5.6	5.5	5.5	
Reactivity Code (see below)	2	1	1	1	2	2	1	
AASS / PASS (see below)								

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Tested By: CH
Date Tested: 2.2.22
Reported By: CW
Date Reported: 3.2.22

Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.0(SP)	1.0(D)	1.25	1.50	1.75
Soil Description	Sandy Clay	Sandy Clay	Sandy Clay	Silty Clay	Sandy Clay	Silty Clay	Sandy Clay	Sandy Clay
Field pH (pH_F)	5.8	5.9	5.8	5.9	6.0	5.6	6.2	5.9
Oxidised pH (pH_{FOX})	4.4	4.1	4.3	4.4	5.3	4.5	5.1	5.1
Reactivity Code (see below)	2	2	1	1	1	1	1	1
AASS / PASS (see below)								

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Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8
Offest (m)								
Level of test (m)(RL)	2.00	2.25	2.50	2.75	3.25	3.50	3.75	4.00
Soil Description	Gravelly Sandy Clay	Gravelly Sandy Clay	Sandy Gravelly Clay	Sandy Gravelly Clay	Clayey Sand	Clayey Sand	Silty Clayey Sand	Gravelly Sandy Clay
Field pH (pH_F)	6.8	6.2	6.3	6.2	6.8	6.2	6.5	6.8
Oxidised pH (pH_{FOX})	5.5	5.3	5.7	5.8	5.6	5.6	5.6	5.7
Reactivity Code (see below)	2	3	1	1	2	2	1	1
AASS / PASS (see below)								

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Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8	Bore 8
Offest (m)								
Level of test (m)(RL)	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
Soil Description	Gravelly Sandy Clay	Gravelly Sandy Clay	Silty Sandy Clay	Silty Gravelly Clay	Silty Gravelly Clay	Silty Gravelly Clay	Silty Gravelly Clay	Silty Gravelly Clay
Field pH (pH_F)	6.7	6.3	7.0	7.1	7.0	7.1	7.6	7.1
Oxidised pH (pH_{FOX})	5.5	5.6	5.7	5.7	5.7	5.7	5.8	5.7
Reactivity Code (see below)	1	2	1	1	2	1	1	3
AASS / PASS (see below)								

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Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9
Offest (m)								
Level of test (m)(RL)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Soil Description	Sandy Silty Clay	Sandy Silty Clay	Silty Clay	Silty Clay	Silty Sandy Clay	Silty Sandy Clay	Silty Sandy Clay	Silty Clay
Field pH (pH_F)	5.6	5.5	5.9	5.5	6.0	6.4	5.7	5.6
Oxidised pH (pH_{FOX})	2.0	2.0	5.5	3.4	3.8	3.6	3.5	3.4
Reactivity Code (see below)	4	4	2	2	1	1	2	2
AASS / PASS (see below)								

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Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9
Offest (m)								
Level of test (m)(RL)	2.25	2.50	3.25	3.50	3.75	4.00	4.25	4.50
Soil Description	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay
Field pH (pH_F)	5.5	5.0	5.7	5.8	5.8	5.6	6.7	7.3
Oxidised pH (pH_{FOX})	4.5	3.7	5.3	4.0	3.4	4.2	5.3	6.7
Reactivity Code (see below)	1	3	1	1	1	2	2	2
AASS / PASS (see below)								

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Sample No.	1	2	3	4	5	6	7	8
Chainage (m)								
Location	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9	Bore 9
Offest (m)								
Level of test (m)(RL)	4.75	5.00	5.25	5.5(D)	5.5(SPY)	5.75	6.00	7.25
Soil Description	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay
Field pH (pH_F)	6.9	5.9	6.5	7.4	7.0	6.5	7.0	6.7
Oxidised pH (pH_{FOX})	5.9	4.6	5.3	6.6	4.3	4.8	5.4	1.3
Reactivity Code (see below)	4	2	2	2	4	2	3	4
AASS / PASS (see below)								

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MAZLAB Pty Ltd
Environmental Testing, Sampling and Drilling (Vibracore)
ABN 58 706 135 201 ACN 654 173 529

U1/ 33 MACHINERY DR., TWEED HEADS SOUTH, 2486
PO BOX 6879 TWEED HEADS SOUTH MC., 2486
PHONE: (07) 55239922 FAX: (07) 55239822
EMAIL: mazlab@bigpond.com

Client: Douglas Partners **Project:** Vantage Yatala – Stage 2 (206529.00)

Mazlab Job No: DPB3194(1/2) **Date:** 11/02/2022

LABORATORY TEST RESULTS
Certificate of Test Results – Chromium Reducible Sulphur

Sample No.	Client I.D	Soil Description (truncated)	pH KCL	SCr mol (H+/t) %S	TAA mol (H+/t)	SNAS %S	ANC mol (H+/t) NA= Scr< action limit	Net Acidity mol (H+/t)	Liming Rate (Kg/ dry/ t)
46908	BH1-1.0	Silty SAND(SM) Grey	3.9	<2 <0.01%	63 0.10%	<0.02%	-	63 0.10%	4.7
46909	BH2-0.25	Clayey SAND(SC) Dark brown-pale grey	3.8	<2 <0.01%	50 0.08%	<0.02%	-	50 0.08%	3.8
46910	BH2-0.75	Clayey SAND(SC) Dark brown-pale grey	4.2	<2 <0.01%	20 0.03%	<0.02%	-	20 0.03%	1.5
46911	BH2-1.25	Clayey SAND(SC) Dark brown-pale grey	3.9	<2 <0.01%	51 0.08%	<0.02%	-	51 0.08%	3.8
46912	BH2-1.75	Clayey SAND(SC) Dark brown-pale grey	3.4	<2 <0.01%	75 0.12%	<0.02%	-	75 0.12%	5.6
46913	BH2-2.25	Sandy CLAY(CH) Brown	3.6	4 <0.01%	80 0.13%	<0.02%	-	84 0.13%	6.3
46914	BH2-2.75	Sandy CLAY(CH) Brown	3.6	<2 <0.01%	87 0.14%	<0.02%	-	87 0.14%	6.5
46915	BH2-3.00	Sandy CLAY(CH) Brown	3.5	4 <0.01%	109 0.18%	<0.02%	-	113 0.18%	8.5
46916	BH2-3.50	Sandy CLAY(CH) Brown	3.5	<2 <0.01%	89 0.14%	<0.02%	-	89 0.14%	6.7
46917	BH2-4.00	Sandy CLAY(CH) Brown	4.1	<2 <0.01%	58 0.09%	<0.02%	-	58 0.09%	4.4
46918	BH2-4.50	Silty CLAY(CH) Brown-grey	3.5	<2 <0.01%	67 0.11%	<0.02%	-	67 0.11%	5.0
46919	BH4-0.25	Clayey SAND(SC) Pale brown	4.3	3 <0.01%	30 0.05%	<0.02%	-	33 0.05%	2.5
46920	BH4-0.75	Clayey SAND(SC) Dark grey	4.2	<2 <0.01%	38 0.06%	<0.02%	-	38 0.06%	2.9
46921	BH4-1.25	Clayey SAND(SC) Dark grey	4.2	<2 <0.01%	37 0.06%	<0.02%	-	37 0.06%	2.8
46922	BH4-1.75	Clayey SAND(SC) Dark grey – mottled grey-white	4.2	<2 <0.01%	43 0.07%	<0.02%	-	43 0.07%	3.2
46923	BH4-2.00	Clayey SAND(SC) Dark grey – mottled grey-white	4.6	<2 <0.01%	24 0.04%	-	-	24 0.04%	1.8
46924	BH4-2.25	Clayey SAND(SC) Dark grey – mottled grey-white	3.7	<2 <0.01%	94 0.15%	<0.02%	-	94 0.15%	7.1
46925	BH4-2.75	Sandy CLAY(CH) Dark brown	3.6	<2 <0.01%	75 0.12%	<0.02%	-	75 0.12%	5.6

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46926	BH4-3.25	Sandy CLAY(CH) Dark brown	3.7	<2 <0.01%	64 0.10%	<0.02%	-	64 0.10%	4.8
46927	BH6-0.50	Clayey SAND(SC) Pale brown	4.9	<2 <0.01%	20 0.03%	-	-	20 0.03%	1.5
46928	BH6-1.00	Sandy CLAY(CH) Dark brown	3.9	<2 <0.01%	40 0.06%	<0.02%	-	40 0.06%	3.0
46929	BH6-1.50	Clayey SAND(SC) Brown	4.3	<2 <0.01%	20 0.03%	<0.02%	-	20 0.03%	1.5
46930	BH6-2.00	Clayey SAND(SC) Brown	4.7	<2 <0.01%	15 0.02%	-	-	15 0.02%	Nil
46931	BH6-2.50	Clayey SAND(SC) Brown	5.3	<2 <0.01%	5 <0.01%	-	-	5 <0.01%	Nil
46932	BH6-3.00	Clayey SAND(SC) Brown	5.7	<2 <0.01%	5 <0.01%	-	-	5 <0.01%	Nil
46933	BH6-3.50	Clayey SAND(SC) Brown	5.4	<2 <0.01%	7 0.01%	-	-	7 0.01%	Nil
46934	BH6-4.00	Clayey SAND(SC) Grey	6.0	<2 <0.01%	2 <0.01%	-	-	2 <0.01%	Nil
46935	BH6-4.50	Clayey SAND(SC) Grey	6.6	<2 <0.01%	-	-	N/A	<2 <0.01%	Nil
46936	BH6-5.00	Silty SAND(SM) Grey	5.3	<2 <0.01%	5 <0.01%	-	-	5 <0.01%	Nil

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Client: Douglas Partners **Project:** Vantage Yatala – Stage 2 (206529.00)

Mazlab Job No: DPB3194(2/2) **Date:** 15/02/2022

LABORATORY TEST RESULTS
Certificate of Test Results – Chromium Reducible Sulphur

Sample No.	Client I.D	Soil Description (truncated)	pH KCL	SCr mol (H+/t) %S	TAA mol (H+/t)	SNAS %S	ANC mol (H+/t) NA= SCr< action limit	Net Acidity mol (H+/t)	Liming Rate (Kg/ dry/ t)
46937	BH8-0.50	Sandy CLAY(CH) Brown	3.7	<2 <0.01%	65 0.10%	<0.02%	-	65 0.10%	4.9
46938	BH8-1.0	Sandy CLAY(CH) Brown	4.0	<2 <0.01%	30 0.05%	<0.02%	-	30 0.05%	2.3
46939	BH8-1.50	Sandy CLAY(CH) Brown	4.4	<2 <0.01%	10 0.02%	<0.02%	-	10 0.02%	N/A
46940	BH8-2.00	Sandy CLAY(CH) Dark grey	4.5	<2 <0.01%	10 0.02%	-	-	10 0.02%	N/A
46941	BH8-2.50	Sandy CLAY(CH) Dark grey with mottled brown	4.5	<2 <0.01%	10 0.02%	-	-	10 0.02%	N/A
46942	BH8-3.25	Silty SAND(SM) Pale grey	6.4	4 <0.01%	3 <0.01%	-	-	7 0.01%	N/A
46943	BH8-3.75	Clayey SAND(SC) Grey	6.3	<2 <0.01%	2 <0.01%	-	-	2 <0.01%	N/A
46944	BH8-4.25	Clayey SAND(SC) Grey	6.7	4 <0.01%	-	-	N/A	4 <0.01%	N/A
46945	BH8-4.75	Clayey SAND(SC) Grey	6.9	<2 <0.01%	-	-	N/A	<2 <0.01%	N/A
46946	BH8-5.25	Clayey SAND(SC) Grey	6.8	<2 <0.01%	-	-	N/A	<2 <0.01%	N/A
46947	BH8-5.75	Clayey SAND(SC) Grey	6.9	<2 <0.01%	-	-	N/A	<2 <0.01%	N/A
46948	BH9-0.50	Sandy CLAY(CH) Dark grey	3.7	3 <0.01%	35 0.06%	<0.02%	-	38 0.06%	2.9
46949	BH9-1.00	Silty CLAY(CL) Dark grey	3.4	<2 <0.01%	124 0.20%	<0.02%	-	124 0.20%	9.3
46950	BH9-1.50	Silty CLAY(CL) Dark grey	3.8	<2 <0.01%	33 0.05%	<0.02%	-	33 0.06%	2.5
46951	BH9-2.00	Silty CLAY(CL) Dark grey	3.9	<2 <0.01%	34 0.05%	<0.02%	-	34 0.05%	2.6
46952	BH9-2.50	Silty CLAY(CL) Dark grey	3.8	<2 <0.01%	25 0.04%	<0.02%	-	25 0.04%	1.9
46953	BH9-3.50	Silty CLAY(CL) Dark grey	3.8	<2 <0.01%	30 0.05%	<0.02%	-	30 0.05%	2.3
46954	BH9-4.00	Silty CLAY(CL) Dark grey	5.4	<2 <0.01%	7 0.01%	-	-	7 0.01%	N/A

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46955	BH9-4.50	Silty CLAY(CL) Dark grey – stained black	6.2	<2 <0.01%	2 <0.01%	-	-	2 <0.01%	N/A
46956	BH9-5.00	Silty CLAY(CL) Dark grey – stained black	5.4	<2 <0.01%	8 0.01%	-	-	8 0.01%	N/A
46957	BH9-5.50(SPT)	Silty CLAY(CL) Dark grey – stained black	5.8	17 0.03%	5 <0.01%	-	-	22 0.04%	1.7
46958	BH9-6.00	Silty CLAY(CL) Dark grey – stained black	6.3	9 0.01%	3 <0.01%	-	-	12 0.02%	N/A
46959	BH9-7.25	Sandy CLAY(CH) Dark grey	5.0	1076 1.73%	12 0.02%	-	-	1088 1.74%	81.7

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Table 2 Summary of ASS Screening and Chromium Suite Test Results

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH_F	pH_{FOX}	ΔpH	Reaction (0,1,2,3) F	pH_{KCl}	Chromium Reducible Sulfur (S_{CR})	Total Actual Acidity (TAA)	Retained Acidity (S_{NAS})	Existing plus potential Acidity
Bore 1										
0.25	Fill	6.4	4.2	2.2	1	-	-	-	-	-
0.50	Fill	5.9	4.0	1.9	1	-	-	-	-	-
0.75	Silty Sand	5.7	4.3	1.4	1	-	-	-	-	-
1.00	Silty Sand	5.9	4.1	1.8	2	3.9	<0.01	0.10	<0.02	0.10
1.25	Silty Sand	5.9	4.0	1.9	2	-	-	-	-	-
Bore 2										
0.25	Fill	6.0	4.1	1.9	1	3.8	<0.01	0.08	<0.02	0.08
0.50	Fill	5.9	4.0	1.9	1	-	-	-	-	-
0.75	Fill	6.3	4.8	1.5	1	4.2	<0.01	0.03	<0.02	0.03
1.00	Fill	6.0	5.9	0.1	1	-	-	-	-	-
1.25	Fill	5.8	5.1	0.7	2	3.9	<0.01	0.08	<0.02	0.08
1.50	Fill	5.9	4.5	1.4	2	-	-	-	-	-
1.75	Fill	5.4	3.5	1.9	2	3.4	<0.01	0.12	<0.02	0.12
2.00	Fill	5.5	4.8	0.7	2	-	-	-	-	-
2.25	Silty Clay	5.3	3.4	1.9	2	3.6	<0.01	0.13	<0.02	0.13
2.50	Silty Clay	5.6	3.4	2.1	2	-	-	-	-	-
2.75	Silty Clay	5.4	3.5	1.9	3	3.6	<0.01	0.14	-	0.14
3.00	Silty Clay	5.6	3.1	2.5	3	3.5	<0.01	0.18	<0.02	0.18
3.25	Silty Clay	6.1	4.1	2.0	1	-	-	-	-	-
3.50	Silty Clay	6.1	3.9	2.2	2	3.5	<0.01	0.14	<0.02	0.14
3.75	Silty Clay	5.7	4.2	1.5	2	-	-	-	-	-
4.00	Silty Clay	5.3	3.1	2.2	2	4.1	<0.01	0.09	<0.02	0.09
4.25	Silty Clay	5.8	4.1	1.7	2	-	-	-	-	-
4.50	Silty Clay	5.9	3.9	2.0	2	3.5	<0.01	0.11	<0.02	0.11
4.75	Silty Clay	5.8	4.5	1.3	2	-	-	-	-	-
Bore 3										
0.25	Fill	5.2	4.4	0.8	2	-	-	-	-	-
0.50	Fill	5.5	4.1	1.4	2	-	-	-	-	-
0.75	Fill	5.7	4.4	1.3	2	-	-	-	-	-
1.00	Fill	6.3	5.3	1.0	2	-	-	-	-	-
1.25	Sandy Clay	6.4	5.1	1.3	1	-	-	-	-	-

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH_F	pH_{FOX}	ΔpH	Reaction (0,1,2,3) F	pH_{KCl}	Chromium Reducible Sulfur (S_{CR})	Total Actual Acidity (TAA)	Retained Acidity (S_{NAS})	Existing plus potential Acidity
1.50	Sandy Clay	6.1	4.6	1.5	2	-	-	-	-	-
1.75	Silty Sand	6.5	5.3	1.2	1	-	-	-	-	-
2.00	Silty Sand	6.8	5.0	1.8	2	-	-	-	-	-
2.25	Silty Sand	6.7	4.8	1.9	1	-	-	-	-	-
2.50	Silty Sand	6.5	4.8	1.7	1	-	-	-	-	-
4.00	Clayey Sand	6.4	4.3	2.1	1	-	-	-	-	-
Bore 4										
0.25	Sandy Clay	5.6	3.6	2.0	2	4.3	<0.01	0.05	<0.02	0.05
0.50	Sandy Clay	5.7	4.0	1.7	2	-	-	-	-	-
0.75	Sandy Clay	5.6	3.6	2.0	2	4.2	<0.01	0.06	<0.02	0.06
1.00	Sandy Clay	5.7	3.6	2.1	2	-	-	-	-	-
1.25	Sandy Clay	5.4	3.5	1.9	2	4.2	<0.01	0.06	<0.02	0.06
1.50	Sandy Clay	6.0	3.6	2.4	2	-	-	-	-	-
1.75	Sandy Clay	5.3	3.4	1.9	2	4.2	<0.01	0.07	<0.02	0.07
2.00	Sandy Clay	5.1	2.7	2.4	3	4.6	<0.01	0.04	-	0.04
2.25	Sandy Clay	5.0	2.7	2.3	2	3.7	<0.01	0.15	<0.02	0.15
2.50	Silty Clay	5.1	3.0	2.1	2	-	-	-	-	-
2.75	Silty Clay	5.5	2.9	2.6	3	3.6	<0.01	0.12	<0.02	0.12
3.00	Silty Clay	4.2	3.5	0.7	2	-	-	-	-	-
3.25	Silty Clay	5.1	3.4	1.7	2	3.7	<0.01	0.10	<0.02	0.10
3.50	Silty Clay	5.3	3.1	2.2	2	-	-	-	-	-
Bore 5										
0.25	Fill	7.0	5.4	1.6	3	-	-	-	-	-
0.50	Sandy Clay	5.9	3.5	2.4	2	-	-	-	-	-
0.75	Sandy Clay	6.1	4.3	1.8	2	-	-	-	-	-
1.00	Sandy Clay	5.4	4.2	1.2	1	-	-	-	-	-
1.25	Sandy Clay	5.3	3.7	1.6	1	-	-	-	-	-
1.50	Sandy Clay	5.0	3.8	1.2	1	-	-	-	-	-
1.75	Clayey Sand	5.6	3.7	1.9	2	-	-	-	-	-
2.00	Clayey Sand	5.6	3.9	2.6	1	-	-	-	-	-
2.25	Clayey Sand	5.6	3.8	1.8	1	-	-	-	-	-
2.5(D)	Clayey Sand	5.2	3.7	1.5	2	-	-	-	-	-
2.5(SPD)	Clayey Sand	5.5	4.3	1.2	1	-	-	-	-	-

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH_F	pH_{FOX}	ΔpH	Reaction (0,1,2,3) F	pH_{KCl}	Chromium Reducible Sulfur (S_{CR})	Total Actual Acidity (TAA)	Retained Acidity (S_{NAS})	Existing plus potential Acidity
2.75	Clayey Sand	6.6	5.2	1.4	1	-	-	-	-	-
3.00	Clayey Sand	5.4	4.1	1.3	2	-	-	-	-	-
3.25	Clayey Sand	5.6	4.0	1.6	1	-	-	-	-	-
3.50	Clayey Sand	5.5	4.5	1.0	1	-	-	-	-	-
3.75	Clayey Sand	5.7	4.3	1.4	2	-	-	-	-	-
4.00	Clayey Sand	6.3	4.7	1.6	1	-	-	-	-	-
4.25	Clayey Sand	6.0	4.8	1.2	1	-	-	-	-	-
4.50	Clayey Sand	6.5	4.9	1.6	1	-	-	-	-	-
4.75	Clayey Sand	6..5	5.3	1.2	1	-	-	-	-	-
5.50	Clayey Sand	7.1	5.7	1.4	2	-	-	-	-	-
6.00	Clayey Sand	6.9	5.6	1.3	2	-	-	-	-	-
7.00	Clayey Sand	6.7	5.3	1.4	1	-	-	-	-	-
Bore 6										
0.25	Clayey Sand	6.7	4.2	2.5	3	-	-	-	-	-
0.50	Clayey Sand	6.8	4.7	2.1	3	4.9	<0.01	0.03	-	0.03
0.75	Sandy Clay	5.7	3.7	2.0	2	-	-	-	-	-
1.00	Sandy Clay	5.5	4.2	1.3	3	3.9	<0.01	0.06	<0.02	0.06
1.25	Sandy Clay	5.9	4.6	1.3	1	-	-	-	-	-
1.50	Clayey Sand	5.7	4.5	1.2	1	4.3	<0.01	0.03	<0.02	0.03
1.75	Clayey Sand	6.1	4.4	1.7	1	-	-	-	-	-
2.00	Clayey Sand	6.4	4.6	1.8	1	4.7	<0.01	0.02	-	0.03
2.25	Clayey Sand	6.2	5.5	0.7	1	-	-	-	-	-
2.50	Clayey Sand	6.1	5.4	1.6	2	5.3	<0.01	<0.01	-	0.01
2.75	Clayey Sand	6.6	5.4	1.2	1	-	-	-	-	-
3.00	Clayey Sand	6.5	5.5	1.0	1	5.7	<0.01	<0.01	-	0.01
3.25	Clayey Sand	6.8	5.5	1.3	1	-	-	-	-	-
3.50	Clayey Sand	6.9	5.7	1.2	1	5.4	<0.01	0.01		0.01
3.75	Clayey Sand	6.6	5.7	0.9	2	-	-	-	-	-
4.00	Clayey Sand	6.3	5.2	1.1	2	6.0	<0.01	<0.01	-	0.01
4.25	Clayey Sand	6.7	5.6	1.1	2	-	-	-	-	-
4.50	Clayey Sand	6.8	5.7	1.1	1	6.6	<0.01	-	-	0.01
4.75	Silty Sand	7.0	5.6	1.4	1	-	-	-	-	-
5.00	Silty Sand	6.9	5.5	1.4	2	5.3	<0.01	<0.01	-	0.01

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH_F	pH_{FOX}	ΔpH	Reaction (0,1,2,3) F	pH_{KCl}	Chromium Reducible Sulfur (S_{CR})	Total Actual Acidity (TAA)	Retained Acidity (S_{NAS})	Existing plus potential Acidity
Bore 7										
0.25	Fill	5.7	4.6	1.1	2	-	-	-	-	-
0.50	Fill	5.9	4.6	1.3	2	-	-	-	-	-
0.75	Fill	6.1	5.1	1.0	3	-	-	-	-	-
1.00	Fill	5.8	4.6	1.2	3	-	-	-	-	-
1.25	Fill	5.5	5.2	0.3	1	-	-	-	-	-
1.50	Fill	5.9	5.4	0.5	1	-	-	-	-	-
1.75	Clayey Sand	6.2	5.2	1.0	1	-	-	-	-	-
2.00	Clayey Sand	5.4	5.2	0.2	2	-	-	-	-	-
2.25	Clayey Sand	5.9	5.3	0.6	1	-	-	-	-	-
2.50	Sandy Clay	5.8	5.4	0.4	1	-	-	-	-	-
2.75	Sandy Clay	5.6	5.2	0.4	1	-	-	-	-	-
3.00	Sandy Clay	5.6	5.1	0.5	1	-	-	-	-	-
3.25	Sandy Clay	5.4	5.2	0.2	1	-	-	-	-	-
3.50	Sandy Clay	5.3	4.9	0.4	1	-	-	-	-	-
3.75	Sandy Clay	5.5	4.9	0.6	2	-	-	-	-	-
4.00	Sandy Clay	5.5	5.4	0.1	1	-	-	-	-	-
4.25	Sandy Clay	6.0	5.0	1.0	2	-	-	-	-	-
4.50	Sandy Clay	6.2	5.5	0.7	1	-	-	-	-	-
4.75	Sandy Clay	7.2	5.4	1.8	1	-	-	-	-	-
5.00	Sandy Clay	6.7	5.5	1.3	1	-	-	-	-	-
5.25	Sandy Clay	6.5	5.6	0.9	2	-	-	-	-	-
5.50	Sandy Clay	6.8	5.5	1.3	2	-	-	-	-	-
5.75	Sandy Clay	6.7	5.5	1.2	1	-	-	-	-	-
Bore 8										
0.25	Sandy Clay	5.8	4.4	1.4	2	-	-	-	-	-
0.50	Sandy Clay	5.9	4.1	1.8	2	3.7	<0.01	0.10	<0.02	0.10
0.75	Sandy Clay	5.8	4.3	1.5	1	-	-	-	-	-
1.00 (SP)	Sandy Clay	5.9	4.4	1.5	1	4.0	<0.01	0.05	<0.02	0.05
1.00(D)	Sandy Clay	6.0	5.3	0.7	1	-	-	-	-	-
1.25	Sandy Clay	5.6	4.5	1.1	1	-	-	-	-	-
1.50	Sandy Clay	6.2	5.1	1.1	1	4.4	<0.01	0.02	<0.02	0.02

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH_F	pH_{FOX}	ΔpH	Reaction (0,1,2,3) F	pH_{KCl}	Chromium Reducible Sulfur (S_{CR})	Total Actual Acidity (TAA)	Retained Acidity (S_{NAS})	Existing plus potential Acidity
1.75	Sandy Clay	5.9	5.1	0.8	1	-	-	-	-	-
2.00	Sandy Clay	6.8	5.5	1.3	2	4.5	<0.01	0.02	-	0.02
2.25	Sandy Clay	6.2	5.3	0.9	3	-	-	-	-	-
2.50	Sandy Clay	6.3	5.7	0.6	1	4.5	<0.01	0.02	-	0.02
2.75	Sandy Clay	6.2	5.8	0.4	1	-	-	-	-	-
3.25	Silty Sand	6.8	5.6	1.2	2	6.4	<0.01	<0.01	-	0.01
3.50	Clayey Sand	6.2	5.6	0.6	2	-	-	-	-	-
3.75	Clayey Sand	6.5	5.6	0.9	1	6.3	<0.01	<0.01	-	0.01
4.00	Clayey Sand	6.8	5.7	1.1	1	-	-	-	-	-
4.25	Clayey Sand	6.7	5.5	1.2	1	6.7	<0.01	-	-	<0.01
4.50	Clayey Sand	6.3	5.6	0.7	2	-	-	-	-	-
4.75	Sandy Clay	7.0	5.7	1.3	1	6.9	<0.01	-	-	0.01
5.00	Sandy Clay	7.1	5.7	1.4	1	-	-	-	-	-
5.25	Sandy Clay	7.0	5.7	1.3	2	6.8	<0.01	-	-	0.01
5.50	Sandy Clay	7.1	5.7	1.4	1	-	-	-	-	-
5.75	Sandy Clay	7.6	5.8	1.8	1	6.9	<0.01	-	-	0.01
6.00	Sandy Clay	7.1	5.7	1.4	3	-	-	-	-	-
Bore 9										
0.25	Sandy Clay	5.6	2.0	3.6	4	-	-	-	-	-
0.50	Sandy Clay	5.5	2.0	3.6	4	3.7	<0.01	0.06	<0.02	0.06
0.75	Silty Clay	5.9	5.5	0.4	2	-	-	-	-	-
1.00	Silty Clay	5.5	3.4	2.1	2	3.4	<0.01	0.20	<0.02	0.20
1.25	Silty Clay	6.0	3.8	2.2	1	-	-	-	-	-
1.50	Silty Clay	6.4	3.6	2.8	1	3.8	<0.01	0.05	<0.02	0.06
1.75	Silty Clay	5.7	3.5	2.2	2	-	-	-	-	-
2.00	Silty Clay	5.6	3.4	2.8	2	3.9	<0.01	0.05	<0.02	0.05
2.25	Silty Clay	5.5	4.5	1.0	1	-	-	-	-	-
2.50	Silty Clay	5.0	3.7	1.3	1	3.8	<0.01	0.04	<0.02	0.04
3.25	Silty Clay	5.7	5.3	0.4	1	-	-	-	-	-
3.50	Silty Clay	5.8	4.0	1.8	1	3.8	<0.01	0.05	<0.02	0.05
3.75	Silty Clay	5.8	3.4	2.4	1	-	-	-	-	-
4.00	Silty Clay	5.6	4.2	1.4	2	5.4	<0.01	0.01	-	0.01
4.25	Silty Clay	6.7	5.3	1.4	2	-	-	-	-	-

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH_F	pH_{FOX}	ΔpH	Reaction (0,1,2,3) F	pH_{KCl}	Chromium Reducible Sulfur (S_{CR})	Total Actual Acidity (TAA)	Retained Acidity (S_{NAS})	Existing plus potential Acidity
4.50	Silty Clay	7.3	6.7	0.6	2	6.2	<0.01	<0.01	-	0.01
4.75	Silty Clay	6.9	5.9	1.0	4	-	-	-	-	-
5.00	Silty Clay	5.9	4.6	1.3	2	5.4	<0.01	0.01	-	0.01
5.25	Silty Clay	6.5	5.3	1.2	2	-	-	-	-	-
5.5(D)	Silty Clay	7.4	6.6	0.8	2	-	-	-	-	-
5.5(SPY)	Silty Clay	7.0	4.3	2.7	4	5.8	0.03	<0.01	-	0.04
5.75	Silty Clay	6.5	4.8	1.7	2	-	-	-	-	-
6.00	Silty Clay	7.0	5.4	1.6	3	6.3	0.01	<0.01	-	0.02
7.25	Sandy Clay	6.7	1.3	5.4	4	5.0	1.73	0.02	-	1.74

Notes: (i) – 1 - denotes slight effervescence;
2 - denotes moderate reaction;
3 – denotes vigorous reaction;
4 – denotes very strong effervescence accompanied by escape of gas/heat;
F – indicates a bubbly/frothy reaction (organics).

(ii) Highlighted cell denotes level of existing plus potential acidity above threshold level of 0.03%S.

EXISTING SERVICES ASSESSMENT REPORT

For VANTAGE, YATALA – STAGE 2 TRUNK SEWER

60 Staplyton Jacobs Well Road, Yatala, QLD 4207

Lot 501 on SP295994

Prepared for Frasers Property (Australia) Pty Ltd.

March 2022

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Approval for Issue

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1.	Mitchell Gassman	Civil Project Engineer R.P.E.Q 16939		14 March 2022

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TABLE OF CONTENTS

1.0 INTRODUCTION

The Vantage Industrial development is a future industrial development, located at 60 Staplyton Jacobs Well Road, Staplyton. In order for the sewage to be discharged from Stage 2 of the development, a gravity sewage pipe measuring approximately 1,325m is required to be constructed from the Stage 2 extent located at the Northern side of Christensen Road South. This will then cross Christensen Road South and continue in a southerly direction before being connected to the existing pump station located at the Eastern side of Sandy Creek on Christensen Road South.

During the sewage gravity main construction, depth of up to 7.2 meters will be required with the methodology compromising of both open cut and tunnel boring techniques. The tunnel boring option is required due to the necessity of the main to go underneath Christensen Road South and Sandy Creek. As part of the design investigation process, detailed potholing was undertaken using vacuum excavation and recording of existing services was undertaken by land surveyors.

In order to assess the current ground conditions, Douglas Partners undertook 9 boreholes.
A map of these locations along are shown for information purposes within Appendix A.

1.1 Objectives

The objective of the report is to demonstrate the result of the location of the existing services and compare as to whether these services effect the alignment and level of the proposed gravity main.

1.2 Scope

The document will detail each location of service investigation and compare it with the design snapshot, describing the risk of the sewer gravity main construction interfering with the existing service.

The service identification will commence from the down stream end of the sewer gravity main and report a new section for each service identified.

2.0 SERVICE INVESTIGATION FINDINGS

2.1 Existing Services –Chainage 11m- 17m

An existing sewer rising main and existing water is present between 4.2 and 4.4m above the enveloper pipe. Due to the depths of separation, there is little threat posed between the services and the tunnel boring machine.

2.2 Existing Stormwater –340m-341m

Twin existing 600mm diameter stormwater pipe was discovered at 1.27m from the Stormwaters invert to the top of the proposed sewer pipe. These pipes are the outlet to an existing stormwater basin. The design and assessment confirm that the sewer is designed to comply with SEQ code.

2.3 Existing Stormwater – Chainage 513.2m

An existing 225mm stormwater pipe was discovered at 4.74m from the Stormwaters invert to the top of the proposed sewer pipe. The design and assessment confirm that the sewer is designed to comply with SEQ code. Excavation can occur at either side and under the stormwater. This area is specified to be constructed using shoring boxes due to the zone of influence on the wall. Therefore should the stormwater require to be removed during construction, reinstated is required immediately after the sewer pipe has been laid.

2.4 Existing Stormwater – Chainage 589m

An existing 225mm stormwater pipe was discovered at 4.66m from the Stormwaters invert to the top of the proposed sewer pipe. The design and assessment confirm that the sewer is designed to comply with SEQ code. Excavation can occur at either side and under the stormwater. This area is specified to be constructed using shoring boxes due to the zone of influence on the wall. Therefore, should the stormwater require to be removed during construction, reinstatement is required immediately after the sewer pipe has been laid.

2.6 Existing Potable Water and Communications – Chainage 1290m

There is an existing watermain located at Chainage 1290m, which will require to be removed to allow enough space for excavation and manhole construction. The watermain is ring fed in accordance with Council GIS information and should therefore not disrupt water supply to existing businesses. The watermain will be reinstated once sewer constructed has been completed.

2.7 Existing Potable Water and Communications – Chainage 1315-1317m

There is an existing watermain and communications located at between Chainage 1315m and 1316m, which is located approximately 5m above the enveloper pipe and 7m to 9m from structure 23/1, which will pose no threat to the service when boring or the constriction of the entry/exit pit.

APPENDIX A – OPW DRAWINGS CONTOUR AND DETAIL PLAN INCLUSIVE OF EXISTING SERVICES ALONG WITH LONGTIDUNAL SECTIONS