Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Due Diligence Assessment

Proposed Industrial Development
1030-1048 Mamre Road, Kemps Creek

Prepared for
ESR Australia

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Report on Geotechnical Due Diligence Assessment
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1. Introduction

This report presents the results of a geotechnical due diligence investigation undertaken by Douglas Partners Pty Ltd (DP) for a proposed industrial development at 1030-1048 Mamre Road, Kemps Creek (the site). The work was commissioned by ESR Australia (ESR) and was carried out in accordance with the scope of works outlined in DP's proposal (Ref: 211619.00.P.001.Rev0 dated 9 December 2021).

It is understood that the proposed development includes four industrial warehouses across the site with associated offices, loading docks, car parking and access pavements. The three easternmost buildings will extend onto the property to the south, which was previously investigated by DP for due diligence purposes. New site access roads are also proposed for construction through the site extending from Abbotts Road to the north. The proposed building footprints are shown on Drawing 1, in Appendix B.

A geotechnical investigation was undertaken to provide preliminary information on the subsurface conditions and included the excavation of test pits, laboratory testing and engineering assessment. Details of the field work and comments relevant to design and construction practice are given herein.

A preliminary site investigation for contamination was undertaken by DP in conjunction with the geotechnical work. The results of the contamination investigation are presented in DP's Report on Pre-Purchase Due Diligence Contamination Assessment (Ref: 211619.01.R.001.Rev0 dated March 2022).

2. Site Information

2.1 Site Details

Site Address	1030-1048 Mamre Road, Kemps Creek
Legal Description	Lot 3, Deposited Plan 250002
Area	11.6 Hectares
Zoning	Zone IN1 General Industrial
Local Council Area	Penrith City Council
Current & Surrounding Land Use	Rural Residential & Mamre Road

An aerial view of the site is shown in Figure 1.

Figure 1: Site Location

2.2 Site Description

A site walkover was undertaken by a principal geotechnical engineer on 13 December 2021. The site is an irregularly shaped lot with approximately 200 m of street frontage on the eastern side of Mamre Road and a length of about 700 m. The lot is predominantly cleared and grassed, and essentially undeveloped with the exception of a small, open sheet metal clad and steel framed shelter on the central northern side of the lot.

There is evidence of a previous unfinished road construction centrally through the site, which includes a cul-de-sac shape that has been excavated to a preliminary subgrade level with the stripped topsoil apparently placed in two large stockpiles on either side of the cul-de-sac near Mamre Road. In addition, stockpiles of ripped shale and concrete blocks (etc.) are scattered throughout the western part of the site, and a small dam is present in the north-eastern part.

The general site topography is relatively flat throughout most of the site with ground surfaces falling towards Mamre Road at an average slope of about two degrees over the western 600 m, increasing to approximately seven degrees over the remaining 100 m length. Ground surface levels range between reduced levels of RL 82 and RL 43 relative to the Australian height datum (AHD). Regional topography generally slopes gently to the west towards Kemps Creek.

3. Review of Published Data

3.1 Geology

Reference to the Penrith 1:100,000 Series Geological Sheet indicates that the site is underlain by Bringelly Shale. Properties to the west of Mamre Road are mapped as being underlain by alluvial flood plain deposits and it is possible that the alluvial soils also encroach on to the eastern side of Mamre Road.

Bringelly Shale typically comprises shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff, while the alluvial flood plain deposits typically comprise silt, very fine to medium-grained lithic to quartz rich sand and clay.

3.2 Soil Landscape

Reference to the Penrith 1:100,000 Series Soils Landscape Sheet indicates that the site is underlain by Blacktown and Luddenham soils.

The Blacktown soil landscape underlies the lower western half of the site and is typically a residual landscape associated with gently undulating rises on Wianamatta Group Shales with local relief to 30 m and surface slopes of greater than 5%. Soil types typically include red to brown podzolic soil on crests grading to yellow podzolic soils on lower slopes and along drainage lines. The soils are not typically affected by high erosion but do have high plasticity and are of moderate reactivity.

The Luddenham soil landscape underlies the higher eastern part of the site and is an erosional landscape typically associated with low to rolling hills overlying the Wianamatta Group shales with local relief of 50 m to 80 m and surface slopes of between 5% and 20%. Soil types typically include shallow dark podzolic or massive earthy clays on crests, moderately deep red-brown podzolic soils on upper slopes, and moderately deep yellow podzolic soils on lower slopes and along drainage lines. The soils are typically highly erodible, of low permeability, high plasticity and moderately reactive.

3.3 Acid Sulphate Soils

Reference to the 1:25 000 Acid Sulphate Soils (ASS) Risk map indicates that the site is within an area of no known occurrence of ASS.

3.4 Salinity

The NSW Salinity Potential map for Western Sydney indicates a moderate salinity potential category is relevant for the site and its immediate surroundings.

3.5 Hydrogeology

A search of nearby groundwater bores did not identify any registered wells within 300 m of the site. The closest wells were identified some 900 m to the south.

Based on the site topography, surface water is expected to partly flow across the surface and partly infiltrate into the near-surface soils, collect in the dam present on site and sheet into creek lines that connect to the closest surface water receptor (Kemps Creek, 250 m west of site).

4. Field Investigation

4.1 Field Work Methods

The field work for the geotechnical investigation was conducted over two days on 13 and 14 December 2021, and included:

- Walkover inspection by a principal geotechnical engineer;
- Excavation of 10 test pits (TP1 to TP10) using a small excavator fitted with a 600 mm wide toothed bucket. The test pits were excavated to depths of between 2.1 m and 3 m to identify the upper subsoil profile.
- Dynamic cone penetrometer (DCP) testing was undertaken within each of the test pits to a depth of 1.2 m to assess the in situ consistency of the near-surface soils.
- Sampling of soils to assist in logging and to provide specimens for laboratory testing of soil plasticity, aggressivity, salinity and California bearing ratio (CBR) tests.

The ground surface levels at the test pits were measured relative to AHD using a differential global positioning system (dGPS) receiver, which is generally accurate to within ±0.1 m in plan and elevation. Coordinates for each of the test pits are measured with reference to Map Grid of Australia MGA94, Zone 56. Coordinates and ground surface levels are recorded on the test pit logs presented in Appendix C. The test pit locations are shown in Drawing 2, in Appendix B.

In addition, a further 11 test pits (TP11 to TP21) were excavated using the same excavator as part of the preliminary contamination assessment. Three of these test locations (Test Pits 11, 16 and 21) were excavated to depths of between 0.5 m and 1.2 m, at targeted locations in areas of possible previous site filling. The remaining eight test pits were excavated into the existing stockpiles to allow inspection and contamination sampling. The additional test locations are also shown in Drawing 1, presented in Appendix B.

4.2 Field Work Results

The subsurface conditions encountered in the test pits are described in the test pit logs in Appendix C, together with notes defining classification methods and descriptive terms.

A summary of the typical sequence of subsurface conditions at the site is presented below:

Topsoil:	Grey and dark brown silty clay was encountered in geotechnical test pits 1, 2 and 5 to 9, as well as environmental test pits 11 and 21. The topsoil included grass roots and rootlets, was soft and typically 0.2 m thick.
Fill:	Grey and brown clayey gravel fill was encountered to a depth of 0.7 m in environmental test pit 16 only. The material was a mixture of ripped shale gravels and cobbles with clay and was of moderate compaction. The fill was located near a larger stockpile of fill within the south-western part of the site and may represent localised site regrade, although this requires further confirmation.
Natural Clays: (Alluvial and Residual)	Generally, orange-brown, yellow-brown, grey-brown and pale grey clay and silty clay of medium to high plasticity, trace siltstone gravel in all test locations except those excavated in the stockpiles. Generally firm to stiff in the upper 0.5 m and then stiff to very stiff below. Natural clays were generally moist to wet and extended to depths of 1.8 m to more than 3 m.
Weathered Rock:	Pale grey-brown siltstone was encountered at depths of 1.8 m and 1.9 m in test pits 2 and 3 only in the south-eastern part of the site. Estimated as initially of very low to low strength.

The natural clays encountered in the test pits represent both alluvial and residual soils. The two soil types are quite similar in appearance and it was, at times, difficult to delineate between the two. It is inferred, however, that the near-surface clays in the eastern part of the site and the full depth of the soils within the western part of the site are alluvial. Deeper clay soils within the central and eastern parts appear residual.

Groundwater seepage was observed during the excavation of test pit 1 at a depth of 3 m and test pits 4, 7 and 8 at 2.5 m depth. Groundwater was not observed in any other test pit. Groundwater conditions are typically affected by factors such as soil permeability and seasonal weather conditions and will vary with time. Groundwater monitoring was beyond the scope of this investigation.

5. Laboratory Testing

Laboratory testing was carried out on selected soil samples collected from the test pits. Geotechnical laboratory testing included:

- Atterberg limits;
- Linear shrinkage;
- CBR; and
- Shrink swell index.

Soil tests undertaken to assess physical and chemical properties under the effects of water movement included:

- Cation Exchange Capacity (CEC) – Sodium, Calcium, Magnesium and Potassium; and
- Exchangeable Sodium Percentage (ESP) – Sodicity.

Tests undertaken to assess the potential for salt release and the effect of water on soil chemistry and structures included:

- Aggressivity – pH, chlorides (Cl) and sulphates (SO_4);
- Salinity – electrical conductivity and soil texture classification.

The detailed laboratory test results are presented in Appendix D and are summarised in Tables 1 to 4.

Table 1: Summary of Atterberg Limits and CBR Test Results

Test Pit	Depth (m)	Soil Description	LL (%)	PL (%)	PI (%)	LS (%)	CBR (%)	Swell (%)
TP1	0.3 – 0.8	Clay	67	22	45	17.5	4.5	2.0
TP7	0.3 – 0.7	Clay	47	17	30	15.0	1.5	3.0

Where: LL = Liquid Limit PL = Plastic Limit PI = Plastic Index LS = Linear Shrinkage CBR = California Bearing Ratio

Table 2: Shrink Swell Index Test Results

Test Pit	Depth (m)	Soil Description	Moisture Content (%)	Shrinkage Strain (%)	Swell (%)	I_{ss} (%)
TP8	0.5 – 0.8	Clay	15.5	3.7	1.6	2.5
TP10	0.5 – 0.75	Silty Clay	18.0	3.1	1.0	2.0

Where: I_{ss} = Shrink Swell Index

Table 3: Summary of Sodicity Test Results

Test Pit	Depth (m)	ESP (%)	Sodicity*
TP2	0.0 – 0.2	4	Non-sodic
TP2	0.4 – 0.5	7	Sodic
TP2	0.9 – 1.0	24	Highly Sodic
TP2	1.4 – 1.5	24	Highly Sodic
TP9	0.0 – 0.1	1	Non-sodic
TP9	0.4 – 0.5	19	Highly Sodic
TP9	0.9 – 1.0	26	Highly Sodic
TP9	1.9 – 2.0	28	Highly Sodic

Where: ESP = Exchangeable Sodium Percentage,
*As per Department of Land and Water Conservation (2002), Site Investigation for Urban Salinity.

Table 4: Results of Chemical Laboratory Test Results

Test Pit	Depth (m)	$EC_{1:5}$ (dS/m)	Texture Class	EC_e (dS/m)	pHw (1:5)	Cl (mg/kg)	SO_4 (mg/kg)	CEC (meq%)	Comments	
									Salinity	Acidity
TP2	0.0 – 0.2	0.02	LMC	0.2	6.9	<10	<10	13	NS	Neutral
TP2	0.4 – 0.5	0.04	LMC	0.3	6.4	20	20	13	NS	Sl.Ac
TP2	0.9 – 1.0	0.46	MC	3.2	5.1	450	83	12	SS	St.Ac
TP2	1.4 – 1.5	0.56	LMC	4.5	5.0	580	78	9.8	MS	VSt.Ac
TP9	0.0 – 0.1	0.03	LC	0.3	6.2	<10	<10	11	NS	Sl.Ac
TP9	0.4 – 0.5	0.30	MC	2.1	5.7	320	38	15	SS	M.Ac
TP9	0.9 – 1.0	0.63	MC	4.4	5.5	710	36	12	MS	St.Ac
TP9	1.9 – 2.0	0.80	MC	5.6	7.1	900	25	9.9	MS	Neutral

Where

$EC_{1:5}$ = Electrical Conductivity
EC_e = Electrical Conductivity corrected for texture
pHw = pH in water
Cl = Chloride
SO_4 = Sulphate
CEC = Cation Exchange Capacity
dS/m = Deci-Siemens per Metre
LC = Light Clay
MC = Medium Clay
NS = Non-saline
SS = Slightly Saline
MS = Moderately Saline
Sl.Ac = Slightly Acidic
M.Ac = Moderately Acidic
St.Ac = Strongly Acidic
VSt.Ac = Very Strongly Acidic
LMC = Light Medium Clay

6. Proposed Development

It is understood that the proposed development includes four industrial warehouses across the site with associated offices, loading docks, car parking and access pavements. The three easternmost buildings will extend onto the property to the south, which was previously investigated by DP for due diligence purposes. New site access roads are also proposed for construction through the site extending from Abbotts Road to the north. The proposed building footprints are shown on Drawing 1, in Appendix B.

The site currently falls from reduced levels (AHD) of approximately RL 60 m and RL 84 m at the north-eastern and south-eastern corners of the site respectively to approximately RL 43 at the western end adjacent to Mamre Road. The proposed earthworks will shape the land into four near-level building pads, which will extend onto the property to the south. Preliminary design finished surface levels for the building pads are RL 49, RL 52, RL 60 and RL 70, progressing higher towards the east. Earthworks are therefore likely to include cuts of up to 14 m depth at the eastern end of the site. Filling on the western side of each building pad will be in the order of 4 m to 6 m thick.

Perimeter and internal retaining walls are anticipated on the downhill sides of each bench level. Trenching and the installation of new services will also be required in a range of ground conditions, including controlled fill, natural soils and in situ rock of varying type and strength (i.e. very low to medium and possibly high strength).

7. Comments

7.1 Geotechnical Model

Based on the subsurface conditions encountered during the investigation and from other investigations undertaken on nearby sites, it is evident that the soil profile throughout the site is relatively consistent and predominantly comprises natural alluvial and residual clay overlying siltstone. Some localised areas of fill are likely, as identified in test pit 16 and possibly near the existing dam, and a number of stockpiles are present on the western half of the site.

Subject to the total depths of excavation required (i.e. to achieve design bulk earthworks levels) excavations are anticipated to expose the full range of soil and rock outlined in Section 4.2. Subsurface conditions will generally include a thin surficial layer of root affected dark grey-brown silty clay topsoil overlying alluvial and residual silty clay and clay with siltstone bedrock likely present from depths of about 1.8 m in the eastern end of the site, deepening to more than 3 m throughout the central and western areas.

Stockpiles on the site comprise mostly silty clay soils that are consistent with the topsoil surface across the greater site. It is inferred that the two larger stockpiles in the western part of the site comprise topsoil and near-surface soils excavated from the unfinished cul-de-sac alignment. Other smaller stockpiles comprise concrete blocks. All such materials will need to be moved prior to commencing bulk earthworks and then reused subject to geotechnical and contamination assessment.

Topsoils comprise dark grey-brown silty clay and is typically 200 mm thick but ranged in thickness from 150 mm to 300 mm. The topsoil supports a thick grass cover and is heavily root affected. The condition of the topsoil on the site is such that after the stripping of organic and root affected ground, the remaining materials could be reintroduced into the general fill volume provided it is suitably blended. Blending ratios would need to be determined by earthworks trials during construction, although a preliminary blend ratio of no more than one part topsoil with six parts natural soil/ripped rock is suggested (subject to the recommendations of DP's preliminary contamination assessment report). This also applies to the two larger topsoil stockpiles present in the western part of the site.

Only one area of fill was identified, which is inferred to be relatively localised. Other localised areas of fill should be anticipated, although other than the previous excavation for the cul-de-sac, there is no obvious indication of previous ground disturbance. Given the nature of the site, any existing fill that is found is likely to be poorly to moderately compacted only.

The natural clays encountered in the test pits represent both alluvial and residual soils. Given the similarity between the two soil types, delineation between the two soil types is not clear, however, it is inferred (simply) that the near-surface clays in the eastern part of the site, together with full depth of the soils within the test pit limits in the western part of the site are alluvial. Deeper clay soils within the central and eastern parts appear residual.

The upper 0.5 m or so of the clay is typically firm to stiff, and of medium to high plasticity. Due to the site's relatively low setting in comparison to the elevation of Mamre Road, the near-surface soils are likely to be softer due to regular surface water ponding following rainfall. Deeper clays are stiff to very stiff and predominantly of high plasticity. The medium and high plasticity clays are typical of those encountered within the local Kemps Creek area and are generally susceptible to changes in volume (shrink-swell) with variations in soil moisture content. Some effort may be required when moisture

conditioning the soils to bring them close to their optimum moisture content to facilitate compaction of fill and subgrades. Current soil moisture contents are estimated as being at or slightly wet of their Standard optimum moisture contents (OMC).

The underlying siltstone is generally of very low to low strength. Based on our general knowledge of the region, it is estimated that the rock strength is likely to remain of very low and low strength within the upper 1 m or so after which a gradual increase to medium and possibly high strength is anticipated within a further 1 m to 3 m. Investigations nearby have also identified sandstone below the siltstone. Construction on or within the underlying residual clays and siltstone and possibly sandstone bedrock should be relatively straightforward. The possibility of high strength rock at bulk excavation level at the eastern end of the site will add to the complexity of subgrade preparations prior to the anticipated earthworks, so further geotechnical investigations will be required to quantify these rock conditions and strength variations with depth.

It is expected that the regional groundwater table in the area would be relatively deep and within the underlying rock. Perched seepage flows are anticipated to occur along the soil and rock interface and may also occur within the bedrock. Seepage flows are likely to increase following periods of extended wet weather. Isolated occurrences of groundwater (in test pits 1, 4, 7 and 8) may be affected by topographical features including hillside run-off at the east, the existing dam in the north-east and surface ponded waters on alluvial soils in the west. Perched seepage is likely to pose some difficulty for excavations and fill placement, however, should be appropriately managed through normal catch drain methods. Any near-surface groundwater, including the removal of waters from the existing dam, may pose trafficability and material management issues if not properly controlled during the bulk earthworks.

Further considerations for site earthworks will need to include the management of moderately saline soils and mild soil aggressivity towards on-grade and buried structures, including slabs, pavements, footings and services.

Table 5: Summary of Geotechnical Model

Material	Depth (m) Reduced Level, m AHD To Top of Each Profile in Each Test Pit												
	1	2	3	4	5	6	7	8	9	10	11	16	21
Topsoil	(0) 58.9	(0) 61.7	-	-	(0) 47.7	(0) 45.4	(0) 42.4	(0) 52.8	(0) 47.1	-	(0) 42.2	-	(0) 55.2
Fill	-	-	-	-	-	-	-	-	-	-	-	(0) 45.7	-
Natural Soil	(0.2) 58.7	(0.2) 61.5	(0) 56.5	(0) 53.6	(0.2) 47.5	(0.1) 45.3	(0.1) 42.3	(0.2) 52.6	(0.15) 46.95	(0) 43.7	(0.1) 42.1	(0.7) 45.0	(0.3) 54.9
Siltstone	-	(1.8) 59.9	(1.9) 54.6	-	-	-	-	-	-	-	-	-	-

Where: - = Not encountered or not observed due to discontinuation of test pit

7.2 Site Excavation

7.2.1 Excavation Conditions

Excavation will include the removal of existing stockpiles, stripping of all vegetation and organic / root affected topsoil and localised areas of fill, as encountered across the site. Bulk excavation at the eastern end of the site will require excavations of up to 14 m depth encountering some alluvial and mostly residual soils, and rock likely grading from very low to high strength. Further detailed excavations for footings and service trenches will also be required on completion of the bulk earthworks once building pads have been created for each warehouse.

Subject to the condition of the site at the time of excavation, some trafficability issues are likely to be experienced when stripping or excavating within the vicinity of existing dams and the lower lying areas in the western part of the site. Further, trafficability will likely be problematic when dewatering and desilting the dam floor.

Based on the test pit logs and anticipated development, excavation is likely to extend through all units outlined in Section 4.2. The excavatability of the materials be encountered during the bulk excavation works is summarised in Table 6.

Table 6: Summary of Soil and Rock Excavatability

Material	Excavatability
Fill / Topsoil / Clay	Readily excavated using toothed buckets fitted to conventional excavators of medium or larger size.
Very Low to Low (VL-L) Strength Siltstone	The very low strength layers may be excavated using toothed buckets fitted to excavators, particularly if fitted with 'rock teeth'. Medium sized plant may be capable of completing excavation work but larger plant may be required to achieve economic production.
Medium Strength (M) and Stronger Siltstone	Large plant combined with heavy ripping, progressing towards the use of hydraulic rock hammers for upper medium and high strength rock, and for rock with few defects / discontinuities.

At this early stage of the project, it is not yet possible to accurately differentiate between the rock strengths and excavation volumes within the cuttings. Further geotechnical investigation will be required to provide this information, including the drilling of cored boreholes in areas of deep cuts. For preliminary planning, however, it is considered that medium strength or stronger rock is likely to be encountered from depths of about 1.5 m to 2 m below the rock surface and will require extensive ripping or hammer excavation.

7.2.2 Disposal of Excavated Material

It should be noted that any off-site disposal of spoil will generally require assessment for re-use or classification in accordance with current *Waste Classification Guidelines* (NSW EPA 2014).

7.2.3 Vibration

Noise and vibration will be caused by excavation work in rock, the effects of which are largely dependent on the timing of the work and the types and locations of structures on the adjoining sites at that time. If the proposed development proceeds before developments are commenced on the adjoining properties, then there is unlikely to be any adverse effects of vibration on the adjoining properties. However, if development of this site occurs after the adjoining sites have been redeveloped, then further consideration of the effects of vibrations may be necessary.

The following paragraphs are provided in the event that rock excavation work on this site occurs after adjoining sites have been redeveloped.

Precautions will be required when excavating close to site boundaries, particularly where adjacent buildings are nearby and where existing retaining walls are to be retained (i.e. as may occur along property boundaries). The level of acceptable vibration is dependent on various factors including the type of building / structure (e.g. reinforced concrete, brick, etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s peak particle velocity (PPVi). This is generally much lower than the vibration levels required to cause structural damage to buildings. The Australian Standard AS2670.2-1990 *Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)* indicates an acceptable day time limit of 8 mm/s PPVi for human comfort.

Based on the experience of DP and with reference to AS2670, it is suggested that a maximum PPVi of 8 mm/s (applicable at the foundation level of existing buildings) be adopted at this site for both architectural and human comfort considerations, although this vibration limit may need to be reduced if there are sensitive structures or equipment in the area.

Subject to the conditions of the adjoining sites at the time of rock excavation the need for a vibration trial should be assessed to determine if smaller or different types of excavation equipment should be used for bulk (or detailed) excavation purposes.

7.3 Site Preparation

Preliminary planning generally indicates four benched building pads will be created at reduced levels of between RL 49 to RL 70, increasing in level towards the east. The differences in finished levels between adjacent pads range between 3 m and 10 m. Based on existing and proposed surface levels, the western part of the site will generally require approximately 1 m to 6 m of filling while the far eastern part of the site will likely require approximately 14 m of cutting, subject to perimeter batter design. Intermediate fill depths within the central two building pads are estimated to range between 1 m and 5 m, however deeper fill may be required behind proposed retaining walls or within batters.

It is anticipated that proposed structures and pavements within the site will probably be supported by shallow spread footings founding on deep controlled fill, shallow reworked or natural clay of a typical stiff consistency and weathered bedrock within cuts of more than 2 m to 3 m depth. The preferred bearing stratum will depend on actual column loads, which have not been advised at this stage.

Adopting the above approach, DP proposes the following site preparation measures:

- Remove all existing stockpiles, vegetation and root affected soils, topsoils and existing fill from the development footprint and stockpile for reuse, or remove from site, as per the following requirements and those outlined in the preliminary contamination assessment report.
- Proof roll the exposed surface using a minimum 10 tonne smooth drum roller in non-vibration mode. The surface should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical engineer to detect any soft or heaving areas. Remove any additional unsuitable soil identified during proof rolling.
- Compact the exposed base of any rework area to a minimum dry density ratio of 98%, relative to Standard compaction, maintaining the moisture content of the filling within 2% of Standard OMC. Do not exceed a maximum compaction value of 103% Standard.
- Place suitable site materials, or suitable imported filling, within the rework depth in 300 mm maximum thickness layers and compact to a minimum dry density ratio of 98%, relative to Standard compaction, maintaining the moisture content of the filling within 2% of Standard OMC. Do not exceed a maximum compaction value of 103% Standard.
- Place sufficient additional layers of filling to achieve design bulk earthworks levels and compact as outlined above. Ensure any reintroduction of non-organic topsoil into the fill is restricted to a maximum blend frequency, as determined during on-site trials.
- Rip and recompact, or over excavate and replace all exposed rock surfaces created by site excavation to a depth of at least 0.3 m below bulk earthworks levels to provide a uniform surface that can be reliably trimmed to accommodate design grades and cross falls at the finished surface below proposed pavements and floor slabs. This will alleviate the possibility of rainfall seepage being collected in isolated low points within an otherwise uneven rock surface at subgrade level, which could lead to pavement and floor slab deterioration and cracking along pavement joints.

In addition, it is recommended that consideration is given to placing a 0.5 m thick capping of granular fill across the completed site surface to reduce the effects of soil plasticity, site reactivity and low CBR values on floor slab, footing and pavement design. It is possible that ripped rock (preferably sandstone) sourced from the deep cuts in the eastern part of the site may be suitable for this purpose, although additional geotechnical testing should be undertaken during construction to confirm this preliminary advice. Testing should include 10-day soaked CBR and plasticity index tests, particularly for ripped siltstone rock. Consideration should also be given to pre-treating the lab samples by way of artificial weathering and repeated compaction prior to conducting the tests if they comprise shale and siltstone. Additional volumes of ripped rock may need to be sourced from off-site.

Geotechnical inspection and testing of the filling should be carried out in accordance with a Level 1 standard, as defined in AS3798-2007 Guidelines for Earthworks for Commercial and Residential Developments. Site stripping should be assessed by a geotechnical engineer, who should also advise on the specific requirements for material reuse, particularly in relation to dam sediments and reuse of existing fill materials.

The highly plastic nature of the natural clays is such that very poor trafficability conditions should be expected when this material is exposed to wet weather. The use of a minimum 150 mm thick layer of strong, durable crushed rock fill or recycled concrete as a protective running surface may allow all-weather access to the site following wet weather.

7.4 Batter Slopes and Retaining Walls

During bulk excavation and earthworks, it is recommended that temporary batters of up to 4 m in height do not exceed the grades outlined in Table 7.

Table 7: Recommended Maximum Batter Grades for Exposed Material (up to 4 m high)

Exposed Material	Maximum Temporary Batter Grade (H:V)	Maximum Permanent Batter Grade (H:V)
Existing Fill & Topsoil	1.5:1	2:1
Natural Soil & Controlled Fill	1:1	2:1
VL-L (Class IV[#]) Rock	0.75:1*	1:1
M (or stronger) Rock	0.25:1 to Vertical*	0.25:1 to Vertical*

Note: * Subject to further geotechnical investigation and inspections during excavation / construction.
[#] Rock classification as suggested by Pells et al

For higher batters, DP's preliminary advice is that 4 m wide level benches should be created at maximum height intervals of 4 m, which should be verified during construction by detailed geotechnical slope stability analysis. This is particularly required for the perimeter of the deep cut that is proposed across most of the eastern end of the site. For permanent batters up to 4 m high, a flatter grade of 3H:1V (18 degrees) should be adopted if maintenance access is required (i.e. mowing, or similar). Permanent batters of more than 4 m high are not anticipated for this development.

Competent medium strength or stronger rock (if present) may generally be stable when cut vertically (or near-vertically) provided there are no adversely oriented joints or other defects. All such faces in all rock types should be inspected by an experienced geotechnical engineer or engineering geologist as the excavation progresses in depth intervals of no deeper than 1.5 m. The purpose of the inspection is to check for the presence of any adverse defects that daylight into the excavation face, which may require additional stabilisation measures (such as rock bolts and/or shotcrete). It is recommended that a provisional allowance for some rock stabilisations be made for this development.

Retaining walls may also be required to provide retention and facilitate benching between the proposed building pads and may be designed on the basis of the parameters outlined in Table 8.

Table 8: Recommended Design Parameters for Retaining Walls

Material	Unit Weight (kN/m^3)	Earth Pressure Coefficient		Effective Cohesion c' (kPa)	Effective Friction Angle (Degrees)
		Active (K_a)	At Rest (K_o)		
Existing Fill & Topsoil	20	0.4	0.6	0	20
Natural Soil & Controlled Fill	20	0.3	0.5	0	25
VL-L (Class IV) Rock	22	0.2	0.25	10	25
M (or stronger) Rock*	24	0.2 to 0	0.25 to 0	20 – 30	30 – 40

Notes: VL = Very Low Strength, L = Low Strength, M = Medium Strength
* Subject to jointing assessment by experienced Geotechnical Engineer / Engineering Geologist

In addition, a coefficient of passive earth pressure (K_p) equal to 2.5 may be assumed within very stiff to hard clay and well compacted filling, to which a factor of safety must be applied in recognition of the fact that large movements are required to mobilise the full passive resistance. Ultimate passive pressures for rock may be taken as equal to 400 kPa in very low to low strength rock and 2000 kPa in medium strength or stronger rock.

The above parameters do not include any allowance for hydrostatic pressure due to groundwater behind retaining walls, which should be included in the design unless adequate drainage is provided to prevent the build-up of hydrostatic pressures.

The design of batter slopes and retaining walls should account for surcharge loads, including storage of construction materials, adjacent pavements, access roads, buildings or similar. Design should also consider the effects of plant operating above the excavation and/or retaining wall during construction.

Subject to the type of retaining wall that is proposed for the perimeter of the deep cut at the eastern part of the site, additional geotechnical advice may be required, particularly if anchored shotcrete walls are preferred for permanent protection of rock faces.

7.5 Footings

7.5.1 Bearing Pressures

The results of the investigation have shown that the site is underlain by natural clay soils and then weathered siltstone bedrock. Accordingly, it is anticipated that footings for the new warehouses will most likely comprise shallow pads founding within the upper 1 m of the new controlled filling (western and central areas of the site), natural clays (central to eastern areas of the site) and weathered bedrock (mostly in the far eastern part of the site). Alternatively, bored piles founding within the upper 1 m to 2 m of bedrock could be adopted, particularly in areas of deep filling, subject to column loads.

The parameters listed in Table 9 are suggested for footing design.

Table 9: Suggested Footing Design Parameters

Material	End Bearing (kPa)		Shaft Adhesion (kPa)	
	Allowable	Ultimate	Allowable	Ultimate
Existing Fill & Topsoil	0	0	0	0
Natural (Stiff or better) Soil & Controlled Fill	150	500	15	25
VL-L (Class IV) Rock	1000	3000	100	150
M (or stronger) Rock	2000 – 3500	10 000 – 20 000	100 - 350	300 – 600

Notes: VL = Very Low Strength, L = Low Strength, M = Medium Strength
The values listed in Table 9 are subject to confirmation during construction.
Values for medium and stronger rock assume a minimum 0.5 m penetration of the footing into rock.

To confirm the appropriateness of the adopted design footing parameters, it is recommended that all footing excavations are subjected to geotechnical inspection and dynamic cone penetrometer testing (DCP, where applicable) during construction to verify that the listed bearing pressures are available.

Shallow footings founding near excavations (i.e. lift wells / pits, service trenches, OSD tanks or similar) must have all loads transferred to below an influence line inclined upwards at 45 degrees commencing from the lowest and closest side of the excavation or trench base. Pad footings can be deepened to accommodate this load transfer or alternatively pile footings may be used.

Local variations in rock strength and depth may occur across the site. All pile or footing excavations in weathered rock should be inspected by a geotechnical engineer or engineering geologist and approved prior to concreting to confirm reduced pressures are not warranted due to extensively weathered or jointed zones.

7.5.2 Settlements

Footings designed in accordance with the allowable parameters listed in Table 9 can be considered to undergo elastic settlements in the order of 1% of the footing width. In addition to elastic settlements, creep settlements may be experienced in controlled fills with total depths of more than about 5 m.

7.5.3 Site Classification

Although the proposed development will be of an industrial warehouse nature, it is important to note that the results of the shrink swell index, Atterberg limits and CBR tests have indicated a high susceptibility of the natural clays to undergo considerable shrink and swell movement as a result of changes in ground moisture contents (i.e. seasonal, or otherwise).

Based on the test results and ignoring any stockpiles or areas of localised existing fill, the plasticity and thus reactivity of the soils at the site are generally considered representative of Class M conditions when assessed in accordance with AS2870-2011. Considering the need for extensive fill placement, ground movements due to shrink and swell will increase to the Class H1 range. Appropriate consideration of soil plasticity and reactivity should be accounted for in the design of all structures and services. Further geotechnical advice should be sought during the detailed design of footing systems.

7.6 Salinity

7.6.1 Salinity Test Results

The NSW Salinity Potential map for Western Sydney indicates a moderate salinity potential category is relevant for the site and its immediate surrounds. The test results obtained for samples subjected to salinity analysis indicate ranged from non-saline to moderately saline, suggesting that the mapping is generally an accurate representation of the salinity conditions.

Soil salinity is assessed with respect to electrical conductivity after conversion of the result to EC_e (electrical conductivity of a saturated extract) by multiplication with a factor dependent on soil texture. Once converted, the EC_e value is compared to the guideline ranges listed within Table 10.

Table 10: Soil Salinity Classification

Class	EC_e (dS/m)	Implication
Non-Saline	<2	Salinity effects mostly negligible
Slightly Saline	2 – 4	Yields of sensitive crops effected
Moderately Saline	4 – 8	Yields of many crops effected
Very Saline	8 – 16	Only tolerant crops yield satisfactorily
Highly Saline	>16	Only a few very tolerant crops yield satisfactorily

During the site assessment, samples from the upper 2 m of the soil profile were collected. Eight samples underwent chemical testing in an attempt to 'ground truth' the relevance of the mapped conditions. The results of the testing (Section 5, Table 4) show that non, slightly and moderately saline soil conditions are present throughout.

Eight samples equate to approximately one laboratory analyses sample for every 1.5 hectares of land proposed for development. Two detailed soil profiles (i.e. test pits) were used to obtain the samples, which equates to one full profile laboratory analysis per 6 hectares. This frequency equates to the minimum testing frequency listed in the *Site Investigations for Urban Salinity* guideline booklet (commonly adopted and published by the Department of Land and Water Conservation [DLWC], 2002). The results, therefore, are considered to be an appropriate representation of the site. Given the results obtained, it is recommended that an appropriate salinity management plan (SMP) is prepared to guide the civil constructions and earthworks during site development.

7.6.2 Assessment of Salinity Risks

With respect to salinity risks, the site has been preliminarily assessed by chemical means, indicating that non, slightly and moderately saline soils are present, with moderately saline soils typically present below a depth of 1 m. The results suggest that the salinity of the soil increases with depth.

In consideration of salinity risk management, strategies are required for salinity levels of moderately saline and higher. The assessment has shown that soils below a depth of 1 m typically fall into this category. Accordingly, where fill is to be placed, moderately saline soils will only be an issue if detailed excavations or services trenches are extended through the fill and for more than 1 m into the underlying natural soils. Where cutting is required to depths of more than 1 m, however, moderately saline soils will be routinely intersected and probably transported to adjacent fill areas. Earthworks should be designed so that the moderately saline soils are preferentially excavated and placed deep within fill areas and below the influence zone of new structures and their associated excavation and trenching depths. This may require some specific consideration during the positioning of any proposed buried on-site detention tanks.

Earthworks design further highlights the need for the preparation of a salinity management plan. Control measures that are likely to form part of the plan may include the use of higher strength concrete in footings and buried services / pipes, the potential lining of service trenches and controls on the order of excavation and replacement of site soils during earthworks.

7.7 Soil Aggressivity

Provided the samples analysed represent the broader soils present at the site, then the soil conditions can be considered as being mostly non-aggressive to buried concrete and steel elements. However, with reference to the laboratory test results listed in Table 2 (Section 5) and the guidelines given within Australian Standard AS2159 (2009), samples from test pits 2 and 9 indicated pH values in the mildly aggressive range for concrete. In addition, three samples from the same test pits indicated resistivity values in the mildly aggressive range for steel.

7.8 Pavements

Subject to earthworks and the final condition of the soils within the upper 1 m of design subgrade level, natural and filled subgrades at this site can be assigned a preliminary design CBR value of 3%, which is higher than the lowest laboratory test result of 1.5% to account for variations in the filling and the probability that some gravel content will result from mixing of the soils and underlying weathered bedrock during excavation and filling. To maintain this preliminary design value, or any other amended or alternative design CBR value, it will be necessary to prepare the subgrade soils into a well compacted condition that is free of significant adverse long-term or differential settlements and/or deflection under service loading. Verification testing should also be conducted during construction to confirm that the design CBR value has been achieved post earthworks. The pavement designer should consider the following:

- The loads applied to the various pavements over their design life, including normal road vehicle pavements, commercial in-service truck loads and possibly construction machinery loads.
- The magnitude and frequency of load repetitions of the various vehicles using each pavement.
- The need to provide edge constraints to the pavement, particularly along the crest of batters, immediately behind retaining walls and along the edge of landscaped areas.
- The position and grading of subsurface drainage lines, particularly with reference to pavement edges and internal landscaped openings (where relevant).
- Pavement surface gradients and water flow to drainage lines. One-way cross falls may be beneficial, otherwise regularly spaced and centralised drainage collection pits should be installed.
- The backfilling and compaction of service trenches, particularly below heavily loaded pavements.
- The ability of any filled subgrade to carry the load of the pavement.

In addition, a regular and long-term inspection and maintenance programme of the pavement should be adopted by the operator of the pavement. This maintenance programme should be primarily aimed at limiting the amount of moisture infiltrating to the subgrade (e.g. inspecting drainage lines and repairing as required, maintaining construction joints and sealing or repairing cracks as they develop).

7.9 Drainage

Surface and subsoil drainage should be incorporated into the pavement and floor slab designs to prevent the ingress of moisture into the pavement and sub-floor working platform layers and any subsequent weakening of the pavement and subgrade layers.

8. Limitations

Douglas Partners (DP) has prepared this report for this project at 1030-1048 Mamre Road, Kemps Creek in accordance with DP's proposal (Ref: 211619.00.P.001.Rev0 dated 9 December 2021) and acceptance received from Daniel Galea dated 10 December 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of ESR Australia 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.

Douglas Partners Pty Ltd

Appendix A

About This Report

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.

Copyright

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

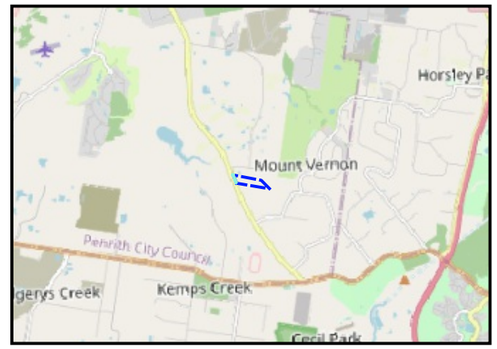
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate 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.

Appendix B

Drawings



LOCALITY MAP

Legend

- Site Boundary
- Adjacent Lot Boundaries
- Proposed Development Building Footprints
- Property Fenceline / Road Easement

0 50 100 150 200 m

1:3500 @ A3

Notes:
1. Basemap from MetroMap (dated 15/08/2021)
2. Boundaries are approximate only

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	ESR Australia		
OFFICE:	Sydney	DRAWN BY:	RCB
SCALE:	1:3500 @ A3	DATE:	16/02/2022

TITLE: **Site Plan and Proposed Development Layout**
Proposed Industrial Development
1030-1048 Mamre Road, Kemps Creek

N

PROJECT No:	211619.00
DRAWING No:	1
REVISION:	0

Legend

- Site Boundary
- Property Fenceline / Road Easement
- Geotechnical Test Pits Locations
- Environmental Test Pit Locations
- Surface Sample Locations

0 50 100 150 200 m

1:3000 @ A3

Notes:
1. Basemap from MetroMap (dated 15/08/2021)
2. Boundaries and test locations are approximate only

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	ESR Australia		
OFFICE:	Sydney	DRAWN BY:	RCB
SCALE:	1:3000 @ A3	DATE:	16/02/2022

TITLE: **Approximate Test Pit and Sampling Locations**
Proposed Industrial Development
1030-1048 Mamre Road, Kemps Creek

N

PROJECT No:	211619.00
DRAWING No:	2
REVISION:	0

Appendix C

Field Work Results

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

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

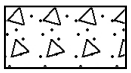
Symbols & Abbreviations

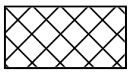
Graphic Symbols for Soil and Rock

General

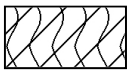

Asphalt

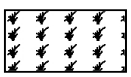

Road base

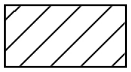

Concrete

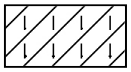

Filling

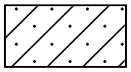
Soils


Topsoil

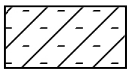

Peat

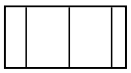

Clay

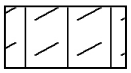

Silty clay

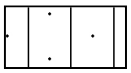

Sandy clay

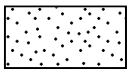

Gravelly clay

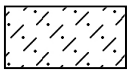

Shaly clay

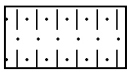

Silt


Clayey silt


Sandy silt

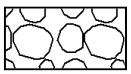

Sand

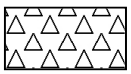

Clayey sand


Silty sand


Gravel

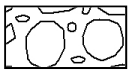

Sandy gravel


Cobbles, boulders

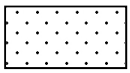

Talus

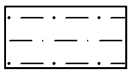
Sedimentary Rocks

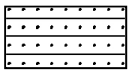

Boulder conglomerate

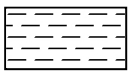

Conglomerate


Conglomeratic sandstone

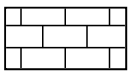

Sandstone


Siltstone

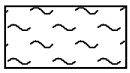

Laminite

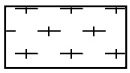

Mudstone, claystone, shale

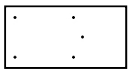

Coal


Limestone

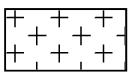
Metamorphic Rocks

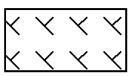

Slate, phyllite, schist

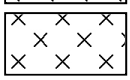

Gneiss

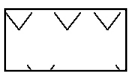

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 58.9 AHD
EASTING: 296309
NORTHING: 6251198

PIT No: TP1
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
58	0.0	TOPSOIL/Silty CLAY: low plasticity, grey, approximately 30% silt, trace grass and grass roots, w>PL, moist, soft		A	0.0				
	0.2	CLAY CI: medium plasticity, grey brown, trace silt, moist, w~PL, apparently firm, residual (possibly alluvial)		A	0.2		Bulk sample collected at 0.3-0.8m		
	0.5	CLAY CH: high plasticity, pale brown, w~PL, stiff, residual		A	0.4				
	1	Below 1.2m: becoming very stiff		A	0.5				
				A	0.9				
				A	1.0				
				A	1.4				
	1.5	CLAY CH: high plasticity, mottled brown pale grey, w~PL, apparently very stiff, residual		A	1.5				
57				A	1.9				
	2			A	2.0				
				A	2.4				
				A	2.5				
56				A	2.9				
	3				3.0			13-12-21	
	3.0	Below 3.0m: becoming wet Pit discontinued at 3.0m - Limit of excavation							
55	4								
54									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Free groundwater observed at 3.0m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 61.7 AHD
EASTING: 296306
NORTHING: 6251094

PIT No: TP2
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
61	0.0	TOPSOIL/Silty CLAY: low plasticity, grey, approximately 30% silt, trace grass and grass roots, w~PL, apparently soft		A/E	0.0		PID<5ppm		
	0.2	CLAY CI: medium plasticity, orange brown, trace silt, w~PL, firm, residual		A/E	0.2 0.4 0.5		PID<5ppm		
	0.8	CLAY CH: high plasticity, mottled brown pale grey, w~PL, stiff, residual At 1.2m: very stiff		A	0.9 1.0				1
60	1.8	SILTSTONE/CLAY: low plasticity, approximately 20% ironstone band, w<PL, hard, residual (possibly extremely weathered siltstone)		A	1.4 1.5				2
59	2.1	Pit discontinued at 2.1m - Bucket refusing		A	1.9 2.0				3
58									4
57									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 56.5 AHD
EASTING: 296245
NORTHING: 6251152

PIT No: TP3
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
									5 10 15 20
		CLAY CH: high plasticity, pale brown, w~PL, firm, residual		A/E	0.0 0.2		PID<5ppm		
	0.4	CLAY CI: medium plasticity, red brown and orange brown, trace silt and ironstone gravel, w~PL, stiff, residual		A/E	0.4 0.5		PID<5ppm		
56									
	1	Below 1.2m: becoming yellow brown and very stiff to hard		A	0.9 1.0				1
				A	1.4 1.5				
55	1.9	SILTSTONE: pale grey brown, very low and low to medium strength, Bringelly Shale		A	1.9 2.0				
	2								2
	2.2	Pit discontinued at 2.2m							
54									
	3								3
53									
	4								4
52									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 53.6 AHD
EASTING: 296161
NORTHING: 6251173

PIT No: TP4
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
53	0.0	CLAY CH: high plasticity, pale brown, w=PL, firm to stiff, residual (possibly alluvial)		A/E	0.0		PID<5ppm		
					0.2				
	0.4	CLAY CI: medium plasticity, pale grey brown, trace silt and ironstone gravel, w~PL, stiff, residual (possibly alluvial)		A/E	0.4		PID<5ppm		
					0.5				
	0.9	CLAY CL: low plasticity, pale brown, approximately 20% ironstone gravel and silt, w~PL, very stiff, residual (possibly alluvial)		A	0.9				
52	1				1.0				1
				A	1.4				
					1.5				
				A	1.9				
51	2	2.0 Gravelly CLAY CL: low plasticity, brown, >30% ironstone gravel and silt, w>PL, hard, residual (possibly alluvial)			2.0				2
		Below 2.5m: becoming wet						13-12-21	
				A	2.9				
50	3	3.0 Pit discontinued at 3.0m			3.0				3
	4								4
49									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Free groundwater observed at 2.5m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 47.7 AHD
EASTING: 295946
NORTHING: 6251162

PIT No: TP5
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.2	TOPSOIL/Silty CLAY: low plasticity, grey, trace grass roots, w~PL, soft to firm		A/E	0.0		PID<5ppm		
		CLAY CI: medium plasticity, orange/yellow brown, trace silt and ironstone gravel, w=PL, firm to stiff, residual (possibly alluvial)			0.2				
				A/E	0.4		PID<5ppm Bulk sample collected at 0.3-0.8m		
	0.75	CLAY CI: medium plasticity, red brown, slightly silty, trace ironstone gravel, w<PL, stiff to very stiff, residual (possibly alluvial)			0.5				
46	1			A	0.9 1.0				1
				A	1.4 1.5				
	2			A	1.9 2.0				2
45	2.5	CLAY CI: medium plasticity, yellow brown, approximately 20% ironstone gravel, w<PL, apparently hard, residual (possibly alluvial)							
	3			A	2.9				3
	3.0	Pit discontinued at 3.0m			3.0				
44	4								4
43									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 45.4 AHD
EASTING: 295861
NORTHING: 6251228

PIT No: TP6
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
45	0.1	TOPSOIL/Silty CLAY: medium plasticity, pale grey, w<PL, firm		A/E*	0.0		PID<5ppm		
		CLAY CI: medium plasticity, orange brown, slightly silty, w~PL, stiff, residual (possibly alluvial)			0.1				
	0.5			A/E	0.4		PID<5ppm		
		CLAY CH: high plasticity, grey brown, w~PL, stiff, residual (possibly alluvial)			0.5				
44	1			A	0.9				1
					1.0				
	1.5			A	1.4				
		CLAY CH: high plasticity, mottled brown pale grey, w~PL, very stiff, residual			1.5				
43	2			A	1.9				2
					2.0				
	3			A	2.9				3
	3.0	Pit discontinued at 3.0m			3.0				
42	4								4
41									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Field replicate BD1/20211213 taken from 0.0-0.1m.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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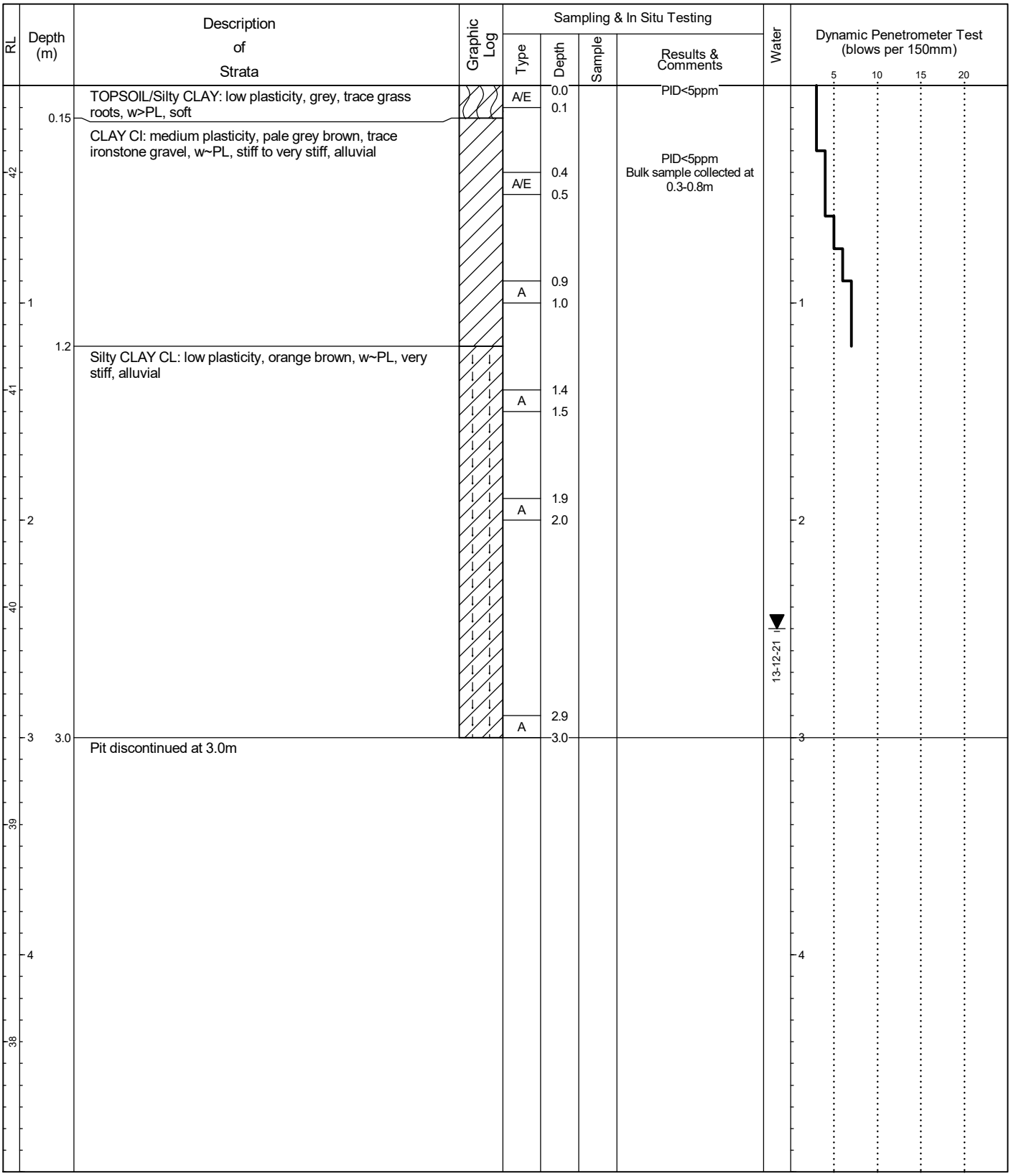
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 42.4 AHD
EASTING: 295717
NORTHING: 6251227

PIT No: TP7
PROJECT No: 211619.00
DATE: 13/12/2021
SHEET 1 OF 1



RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Free groundwater observed at 2.5m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 52.8 AHD
EASTING: 296124
NORTHING: 6251229

PIT No: TP8
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	TOPSOIL/Silty CLAY: low plasticity, grey, trace grass roots, w~PL, very soft		A/E	0.0		PID<5ppm		
	0.2	CLAY CI: medium plasticity, yellow brown, trace ironstone gravel, w~PL, stiff, alluvial		A/E	0.2				
					0.4		PID<5ppm		
				U_{50}	0.5		pp = 300		
52	0.7	Silty CLAY CL: low plasticity, orange brown, w~PL, stiff and very stiff, alluvial			0.8				
	1			A	0.9				1
					1.0				
					1.4				
				A	1.5				
51					1.9				
	2			A	2.0				2
	2.0	Silty CLAY CL: low plasticity, pale grey brown, trace ironstone, w~PL, very stiff to hard, alluvial							
		Below 2.5m: becoming soft and wet						14-12-21	
50					2.9				
	3			A	3.0				3
	3.0	Pit discontinued at 3.0m							
49	4								4
48									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Free groundwater observed at 2.5m

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 47.1 AHD
EASTING: 295931
NORTHING: 6251295

PIT No: TP9
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
47	0.15	TOPSOIL/Silty CLAY: low plasticity, grey, trace grass roots, w~PL, soft		A/E*	0.0 0.1		PID<5ppm		
		Silty CLAY CI: medium plasticity, orange brown, trace fine ironstone gravel, w~PL, stiff then very stiff, alluvial		A/E	0.4 0.5		PID<5ppm		
46	0.9 1	Silty CLAY CI: medium plasticity, pale grey brown, w<PL, very stiff to hard, alluvial		A	0.9 1.0				1
				A	1.4 1.5				
				A	1.9				
45	2.0 2	CLAY CH: high plasticity, pale grey and brown, trace decomposed organic matter, w<PL, hard, lumpy, alluvial			2.0				2
	2.7	Pit discontinued at 2.7m on hard clay							
44	3								3
43	4								4

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Field replicate BD2/20211214 taken from 0.0-0.1m.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 43.7 AHD
EASTING: 295775
NORTHING: 6251319

PIT No: TP10
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
43	0.0	Silty CLAY CL: low plasticity, pale grey brown, trace grass roots, w<PL, firm, alluvial		A/E	0.0		PID<5ppm		
					0.2				
	0.3	Silty CLAY CL: low plasticity, orange brown, trace fine ironstone gravel, w<PL, stiff to very stiff, alluvial		A/E	0.4		PID<5ppm		
					0.5				
				U_{50}	0.75				
	0.8	CLAY CI: medium plasticity, mottled brown pale grey, trace silt, w~PL, very stiff, alluvial							
				A	0.9				
42	1				1.0				1
				A	1.4				
	1.5	CLAY CH: high plasticity, mottled brown and pale grey, w~PL, very stiff to hard, alluvial			1.5				
				A	1.9				
	2				2.0				2
41									
				A	2.7				
	2.8	Pit discontinued at 2.8m			2.8				
	3								3
40									
	4								4
39									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: SI

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 42.2 AHD
EASTING: 295719
NORTHING: 6251294

PIT No: TP11
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
42	0.1	TOPSOIL/Silty CLAY: low plasticity, grey, trace grass roots, w~PL		E	0.0		PID<5ppm		
		CLAY CI: medium plasticity, grey-brown, trace silt, decomposed organic matter, w~PL			0.1				
				E	0.4		PID<5ppm		
	0.5	Pit discontinued at 0.5m - Target depth reached			0.5				
41	1								1
40	2								2
39	3								3
38	4								4

Dynamic Penetrometer Test (blows per mm): 5, 10, 15, 20

RIG: 3.5T Excavator with 450mm bucket

LOGGED: VV/DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 46.0 AHD
EASTING: 295824
NORTHING: 6251297

PIT No: TP12
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
46	0.0	FILL/CLAY: low plasticity, dark brown, with silt, trace grass roots and rootlets, w<PL, (possibly former topsoil)		E	0.0 0.1		PID<5ppm		
	0.4	FILL/Silty CLAY: low plasticity, brown, trace rootlets, w~PL, (possibly former topsoil)		E	0.4 0.5		PID<5ppm		
45	1			E	1.4 1.5		PID<5ppm		1
44	2 2.0	Pit discontinued at 2.0m - Limit of excavation							2
43	3								3
42	4								4

5 10 15 20

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 46.1 AHD
EASTING: 295831
NORTHING: 6251268

PIT No: TP13
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
46	0.0			E	0.0		PID<5ppm		
		FILL/CLAY: low plasticity, brown, with silt, trace grass roots and rootlets, w<PL, (possibly former topsoil)			0.1				
	0.3	FILL/Silty CLAY: low plasticity, light brown, trace rootlets and piece of cloth, w~PL, (possibly former topsoil)		E	0.4		PID<5ppm		
					0.5				
45	1			E	1.0		PID<5ppm		1
					1.2				
44	2			E	2.0		PID<5ppm		2
					2.2				
	2.5	Pit discontinued at 2.5m - Limit of excavation							
43	3								3
42	4								4

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 46.8 AHD
EASTING: 295843
NORTHING: 6251273

PIT No: TP14
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
46	0.0	FILL/CLAY: low plasticity, dark brown, with silt, trace grass roots and rootlets, w~PL, (possibly former topsoil)		E	0.0 0.1		PID<5ppm		
	0.3	FILL/CLAY: low plasticity, dark grey clay, trace silt and rootlets, w~PL, (possibly former topsoil)		E	0.4 0.5		PID<5ppm		
45	1			E	1.4 1.5		PID<5ppm		
	2.0	Pit discontinued at 2.0m - Limit of excavation							
44	3								
43	4								
42									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 46.4 AHD
EASTING: 295848
NORTHING: 6251274

PIT No: TP15
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
46	0.0	FILL/Sandy CLAY: low plasticity, dark brown, fine to coarse sand, trace silt, grass roots, rootlets and shell fragments, w~PL		E	0.0 0.1		PID<5ppm		
	0.3	FILL/Clayey SAND: fine to coarse, brown, trace silt, rootlets and shell fragments, moist		E*	0.4 0.5		PID<5ppm		
45	1			E	1.5 1.7		PID<5ppm		
	2.0	Pit discontinued at 2.0m - Limit of excavation							
44	2								
43	3								
42	4								

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile. *Field replicate BD3/20211214 taken from 0.4-0.5m.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 45.7 AHD
EASTING: 295852
NORTHING: 6251185

PIT No: TP16
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
45	0.0	FILL/Clayey GRAVEL: medium to coarse shale and ironstone, grey mottled brown, trace shale cobbles and rootlets, dry		E	0.0		PID<5ppm		
	0.2				0.2				
	0.4			E	0.4		PID<5ppm		
	0.5				0.5				
	0.7	CLAY CI: medium plasticity, brown, trace ironstone gravel, w<PL, stiff to very stiff, residual, (possibly alluvial)		E	0.7		PID<5ppm		
	0.9				0.9				
	1.0	Pit discontinued at 1.0m - Target depth reached							

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 47.5 AHD
EASTING: 295858
NORTHING: 6251205

PIT No: TP17
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
47	0	FILL/CLAY: low plasticity, brown, with silt, trace grass roots and rootlets, w<PL, (possibly former topsoil)		E	0.0		PID<5ppm		
					0.2				
		At 0.8m: piece of plastic		E	0.8		PID<5ppm		
	1				1.0				1
46	1.3	FILL/CLAY: low plasticity, light grey and brown, with silt, trace rootlets, w~PL, (possibly former topsoil)		E	1.6		PID<5ppm		
					1.8				
	2	Below 2.0m: increasing silt to form silty clay		E	2.2		PID<5ppm		2
45	2.4	Pit discontinued at 2.4m - Limit of excavation			2.4				
	3								3
44	4								4
43									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 48.6 AHD
EASTING: 295867
NORTHING: 6251181

PIT No: TP18
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
48	0.0	FILL/CLAY: low plasticity, pale grey and brown, with silt, trace grass roots and rootlets, w<PL, (possibly former topsoil)		E*	0.0		PID<5ppm		
					0.2				
	0.3	FILL/Silty CLAY: low plasticity, brown, trace rootlets, w~PL, (possibly former topsoil)							
	1			E	0.7		PID<5ppm		1
					0.9				
47				E	1.5		PID<5ppm		
					1.7				
	2			E	2.0		PID<5ppm		2
					2.2				
	2.4	Pit discontinued at 2.4m - Limit of excavation							
46	3								3
45	4								4
44									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile. *Field replicate BD4/20211214 taken from 0.0-0.2m.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 47.8 AHD
EASTING: 295892
NORTHING: 6251140

PIT No: TP19
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
47	0.0	FILL/Silty CLAY: low plasticity, brown, trace grass roots and rootlets, w~PL, (possibly former topsoil)		E	0.0		PID<5ppm		
					0.2				
				E	0.7		PID<5ppm		
	1				0.9				1
	1.6	FILL/CLAY: low plasticity, grey, with silt, trace rootlets, w~PL, (possibly former topsoil)		E	1.7		PID<5ppm		
46	1.9	CLAY CL-CI: low to medium plasticity, brown, trace fine to medium ironstone gravel, w~PL, stiff to very stiff, residual (possibly alluvial)			1.9				
	2			E	2.0		PID<5ppm		2
	2.2	Pit discontinued at 2.2m - Target depth reached			2.2				
45	3								3
44	4								4
43									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 48.9 AHD
EASTING: 295942
NORTHING: 6251132

PIT No: TP20
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
48	0.0	FILL/CLAY: low plasticity, grey and brown, with silt, trace grass roots and rootlets, w~PL, (possibly former topsoil)		E	0.0		PID<5ppm		
					0.2				
				E	0.6		PID<5ppm		
	0.8	Silty CLAY CL: low plasticity, brown, trace rootlets, w~PL			0.8				
47	1			E*	1.0		PID<5ppm		1
					1.2				
				E	1.7		PID<5ppm		
	2.0	Pit discontinued at 2.0m - Target depth reached			1.9				2
46	3								3
45	4								4
44									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Test pit excavated into stockpile. *Field replicate BD5/20211214 taken from 1.0-1.2m.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 1030 Mamre Road, Kemps Creek

SURFACE LEVEL: 55.2 AHD
EASTING: 296190
NORTHING: 6251199

PIT No: TP21
PROJECT No: 211619.00
DATE: 14/12/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
55	0.0	TOPSOIL/CLAY: low plasticity, dark grey and dark brown, with silt, trace grass roots and rootlets, w~PL		E	0.0		PID<5ppm		
					0.2				
	0.3	CLAY CL: low plasticity, dark brown to brown, trace silt and rootlets, w~PL, alluvial			0.4		PID<5ppm		
				E					
					0.6				
	1								1
					1.0		PID<5ppm		
54				E					
	1.2	Pit discontinued at 1.2m - Target depth reached			1.2				
	2								2
53									
	3								3
52									
	4								4
51									

RIG: 3.5T Excavator with 450mm bucket

LOGGED: DIH

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

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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Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

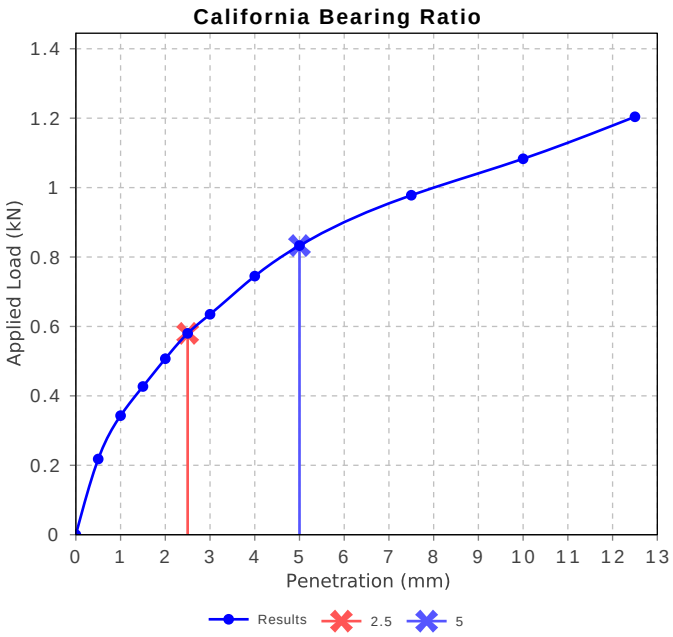
Approved Signatory: Andrew Hutchings
Laboratory Manager
Laboratory Accreditation Number: 828

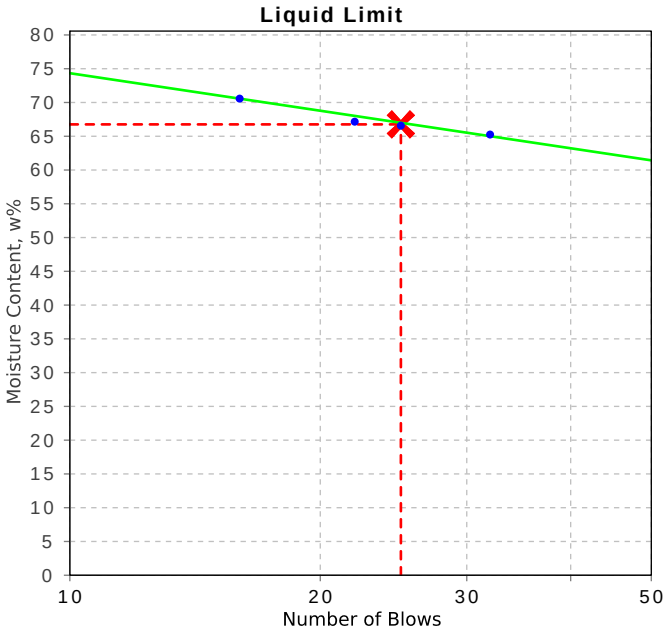
Report Number:	**211619.00-1**
Issue Number:	1
Date Issued:	27/01/2022
Client:	ESR Australia
	Level 29, 20 Bond Street, Sydney NSW 2000
Contact:	Daniel Galea
Project Number:	211619.00
Project Name:	Proposed Industrial Development
Project Location:	1030 Mamre Road, Kemps Creek NSW
Work Request:	8686
Sample Number:	SY-8686A
Date Sampled:	14/12/2021
Dates Tested:	21/12/2021 - 21/01/2022
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**TP1 (0.3-0.8m)**
Material:	CLAY: orange brown, trace silt

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.60		
Optimum Moisture Content (%)	24.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	98.5		
Dry Density after Soaking (t/m^3)	1.58		
Field Moisture Content (%)	25.9		
Moisture Content at Placement (%)	23.4		
Moisture Content Top 30mm (%)	28.5		
Moisture Content Rest of Sample (%)	24.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	119.7		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	67		
Plastic Limit (%)	22		
Plasticity Index (%)	**45**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	17.5		
Cracking Crumbling Curling	None		





Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

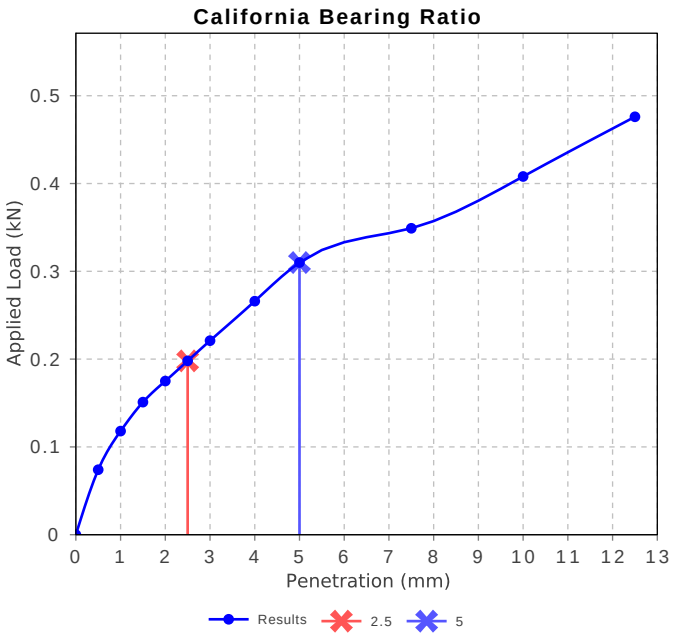
Approved Signatory: Andrew Hutchings
Laboratory Manager
Laboratory Accreditation Number: 828

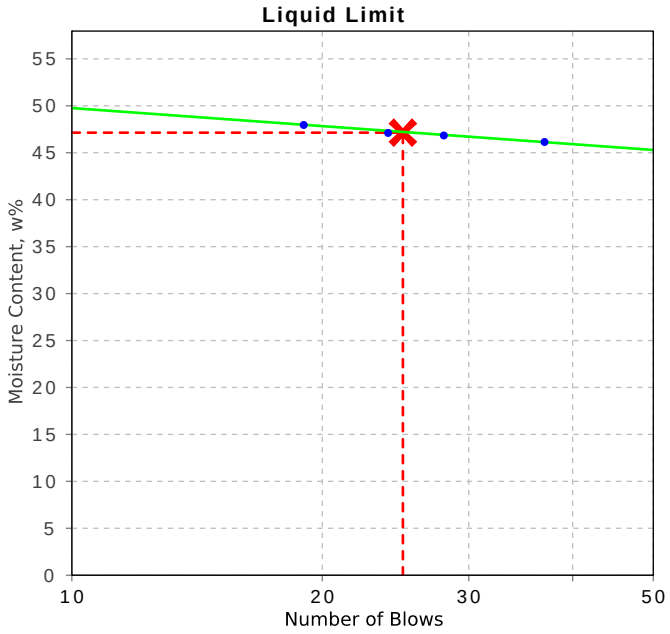
Report Number: **211619.00-1**
Issue Number: 1
Date Issued: 27/01/2022
Client: ESR Australia
Level 29, 20 Bond Street, Sydney NSW 2000
Contact: Daniel Galea
Project Number: 211619.00
Project Name: Proposed Industrial Development
Project Location: 1030 Mamre Road, Kemps Creek NSW
Work Request: 8686
Sample Number: SY-8686B
Date Sampled: 14/12/2021
Dates Tested: 21/12/2021 - 21/01/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP7 (0.3-0.7m)**
Material: CLAY: pale grey brown, trace ironstone gravel

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**1.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.73		
Optimum Moisture Content (%)	19.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.69		
Field Moisture Content (%)	19.3		
Moisture Content at Placement (%)	18.9		
Moisture Content Top 30mm (%)	26.2		
Moisture Content Rest of Sample (%)	20.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	123.7		
Swell (%)	3.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	47		
Plastic Limit (%)	17		
Plasticity Index (%)	**30**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	15.0		
Cracking Crumbling Curling	None		





Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

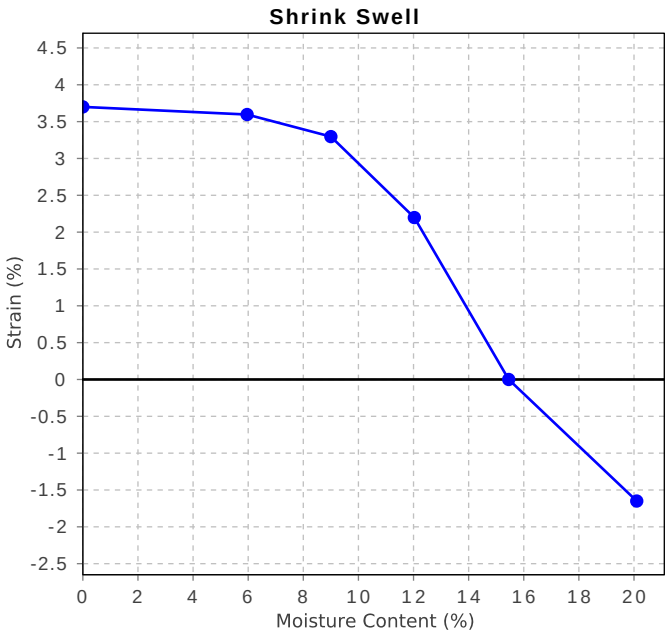
Approved Signatory: Andrew Hutchings
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**211619.00-1**
Issue Number:	1
Date Issued:	27/01/2022
Client:	ESR Australia
	Level 29, 20 Bond Street, Sydney NSW 2000
Contact:	Daniel Galea
Project Number:	211619.00
Project Name:	Proposed Industrial Development
Project Location:	1030 Mamre Road, Kemps Creek NSW
Work Request:	8686
Sample Number:	SY-8686C
Date Sampled:	14/12/2021
Dates Tested:	21/12/2021 - 19/01/2022
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**TP8 (0.5-0.8m)**
Material:	CLAY: yellow brown, trace ironstone gravel

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.5**
Visual Description	CLAY
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.7**
Estimated % by volume of significant inert inclusions	1
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	15.5

Swell Test	
Initial Pocket Penetrometer (kPa)	>400
Final Pocket Penetrometer (kPa)	>400
Initial Moisture Content (%)	16.7
Final Moisture Content (%)	20.1
Swell (%)	**1.6**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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96 Hermitage Road West Ryde NSW 2114
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Accredited for compliance with ISO/IEC 17025 - Testing

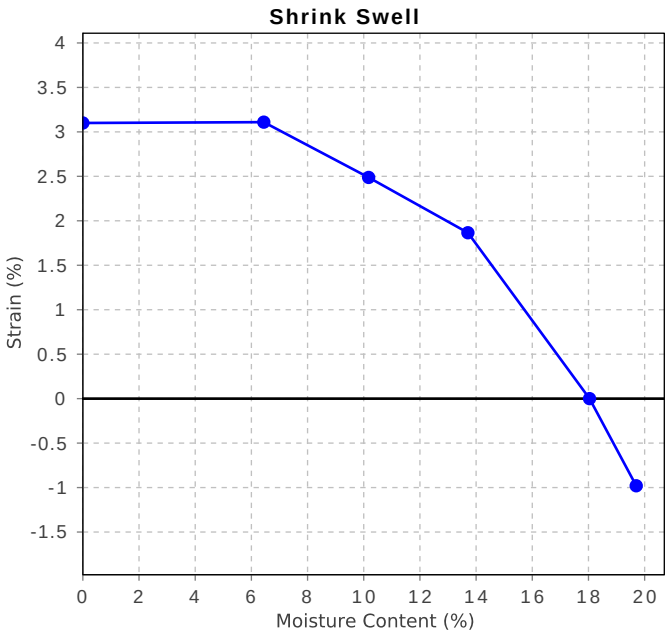
Approved Signatory: Andrew Hutchings
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**211619.00-1**
Issue Number:	1
Date Issued:	27/01/2022
Client:	ESR Australia
	Level 29, 20 Bond Street, Sydney NSW 2000
Contact:	Daniel Galea
Project Number:	211619.00
Project Name:	Proposed Industrial Development
Project Location:	1030 Mamre Road, Kemps Creek NSW
Work Request:	8686
Sample Number:	SY-8686D
Date Sampled:	14/12/2021
Dates Tested:	21/12/2021 - 19/01/2022
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**TP10 (0.5-0.75m)**
Material:	Silty CLAY: orange brown, trace fine ironstone gravel

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.0**
Visual Description	Silty CLAY
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.1**
Estimated % by volume of significant inert inclusions	10
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	18.0

Swell Test	
Initial Pocket Penetrometer (kPa)	>400
Final Pocket Penetrometer (kPa)	390
Initial Moisture Content (%)	16.2
Final Moisture Content (%)	19.7
Swell (%)	**1.0**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



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CERTIFICATE OF ANALYSIS 285880

Client Details

Client	Douglas Partners Pty Ltd
Attention	Ray Blinman
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**211619.00, Proposed Industrial Develop Kemps Creek**
Number of Samples	8 Soil
Date samples received	21/12/2021
Date completed instructions received	21/12/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	23/12/2021
Date of Issue	23/12/2021

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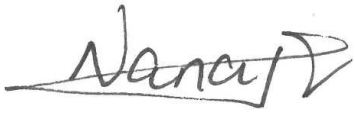
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Hannah Nguyen, Metals Supervisor
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

Soil Aggressivity						
Our Reference		285880-1	285880-2	285880-3	285880-4	285880-5
Your Reference	UNITS	TP2	TP2	TP2	TP2	TP9
Depth		0.0-0.2	0.4-0.5	0.9-1.0	1.4-1.5	0.0-0.1
Date Sampled		14/12/2021	14/12/2021	14/12/2021	14/12/2021	14/12/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.9	6.4	5.1	5.0	6.2
Chloride, Cl 1:5 soil:water	mg/kg	<10	20	450	580	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	20	83	78	<10

Soil Aggressivity				
Our Reference		285880-6	285880-7	285880-8
Your Reference	UNITS	TP9	TP9	TP9
Depth		0.4-0.5	0.9-1.0	1.9-2.0
Date Sampled		14/12/2021	14/12/2021	14/12/2021
Type of sample		Soil	Soil	Soil
pH 1:5 soil:water	pH Units	5.7	5.5	7.1
Chloride, Cl 1:5 soil:water	mg/kg	320	710	900
Sulphate, SO4 1:5 soil:water	mg/kg	38	36	25

ESP/CEC						
Our Reference		285880-1	285880-2	285880-3	285880-4	285880-5
Your Reference	UNITS	TP2	TP2	TP2	TP2	TP9
Depth		0.0-0.2	0.4-0.5	0.9-1.0	1.4-1.5	0.0-0.1
Date Sampled		14/12/2021	14/12/2021	14/12/2021	14/12/2021	14/12/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	23/12/2021	23/12/2021	23/12/2021	23/12/2021	23/12/2021
Date analysed	-	23/12/2021	23/12/2021	23/12/2021	23/12/2021	23/12/2021
Exchangeable Ca	meq/100g	4.2	2.8	0.4	0.3	5.4
Exchangeable K	meq/100g	0.3	0.1	<0.1	0.1	0.8
Exchangeable Mg	meq/100g	8.2	8.7	8.6	7.0	4.5
Exchangeable Na	meq/100g	0.5	0.9	2.9	2.3	0.2
Cation Exchange Capacity	meq/100g	13	13	12	9.8	11
ESP	%	4	7	24	24	1

ESP/CEC				
Our Reference		285880-6	285880-7	285880-8
Your Reference	UNITS	TP9	TP9	TP9
Depth		0.4-0.5	0.9-1.0	1.9-2.0
Date Sampled		14/12/2021	14/12/2021	14/12/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	23/12/2021	23/12/2021	23/12/2021
Date analysed	-	23/12/2021	23/12/2021	23/12/2021
Exchangeable Ca	meq/100g	3.0	1.3	0.99
Exchangeable K	meq/100g	0.1	0.1	<0.1
Exchangeable Mg	meq/100g	9.4	7.5	6.0
Exchangeable Na	meq/100g	2.9	3.2	2.8
Cation Exchange Capacity	meq/100g	15	12	9.9
ESP	%	19	26	28

Texture and Salinity*						
Our Reference		285880-1	285880-2	285880-3	285880-4	285880-5
Your Reference	UNITS	TP2	TP2	TP2	TP2	TP9
Depth		0.0-0.2	0.4-0.5	0.9-1.0	1.4-1.5	0.0-0.1
Date Sampled		14/12/2021	14/12/2021	14/12/2021	14/12/2021	14/12/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	22/12/2021	22/12/2021	22/12/2021	22/12/2021	22/12/2021
Date analysed	-	22/12/2021	22/12/2021	22/12/2021	22/12/2021	22/12/2021
Electrical Conductivity 1:5 soil:water	µS/cm	19	42	460	560	30
Texture Value	-	8.0	8.0	7.0	8.0	8.5
Texture	-	LIGHT MEDIUM CLAY	LIGHT MEDIUM CLAY	MEDIUM CLAY	LIGHT MEDIUM CLAY	LIGHT CLAY
ECe	dS/m	<2	<2	3.2	4.4	<2
Class	-	NON SALINE	NON SALINE	SLIGHTLY SALINE	MODERATELY SALINE	NON SALINE

Texture and Salinity*				
Our Reference		285880-6	285880-7	285880-8
Your Reference	UNITS	TP9	TP9	TP9
Depth		0.4-0.5	0.9-1.0	1.9-2.0
Date Sampled		14/12/2021	14/12/2021	14/12/2021
Type of sample		Soil	Soil	Soil
Date prepared	-	22/12/2021	22/12/2021	22/12/2021
Date analysed	-	22/12/2021	22/12/2021	22/12/2021
Electrical Conductivity 1:5 soil:water	µS/cm	300	630	800
Texture Value	-	7.0	7.0	7.0
Texture	-	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	2.1	4.4	5.6
Class	-	SLIGHTLY SALINE	MODERATELY SALINE	MODERATELY SALINE

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-123	Determined using a "Texture by Feel" method.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	285880-2
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	6.9	6.8	1	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	93	76
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	90	89

QUALITY CONTROL: ESP/CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	285880-2
Date prepared	-			23/12/2021	1	23/12/2021	23/12/2021		23/12/2021	23/12/2021
Date analysed	-			23/12/2021	1	23/12/2021	23/12/2021		23/12/2021	23/12/2021
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	1	4.2	4.3	2	111	102
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	1	0.3	0.3	0	116	102
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	1	8.2	8.5	4	111	100
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	1	0.5	0.5	0	124	106
ESP	%	1	Metals-020	[NT]	1	4	4	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			22/12/2021	1	22/12/2021	22/12/2021		22/12/2021	[NT]
Date analysed	-			22/12/2021	1	22/12/2021	22/12/2021		22/12/2021	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	19	17	11	102	[NT]
Texture Value	-		INORG-123	[NT]	1	8.0	[NT]		[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH/ec Samples were out of the recommended holding time for this analysis.