

Appendix 3

Karuah South Quarry Resource Assessment

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Karuah South Quarry

Resource Assessment

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LIST OF ABBREVIATIONS

AHD	Australian Height Datum
AIG	Australian Institute of Geoscientists
Ausrocks	Ausrocks Pty Ltd, Consulting Mining Engineers
The AusIMM	The Australasian Institute of Mining and Metallurgy
bcm	bank cubic metre
EPA	NSW Environment Protection Authority
DNRm	Department of Natural Resources and Mines
JORC	Joint Ore Reserves Committee of The Australasian Institute of Mining & Metallurgy, Australian Institute of Geoscientists and Mineral Council of Australia
M	million
NSW R&E	NSW Resources and Energy
RL	Surface elevation relative to Australian Height Datum (m AHD)
RMS	Roads and Maritime Services

1 INTRODUCTION

Ausrocks Pty Ltd (Ausrocks) has been commissioned by Wedgerock Pty Ltd (Wedgerock) to complete a resource assessment for quarry materials within Lot 11 DP1024564 (the Site) at Karuah, NSW. This report covers all known resources within the property, primarily the 'pillar' between the proposed Stage 1 of the extraction area within the Karuah South Quarry and the existing Karuah Quarry operated by Hunter Quarries (HQ) Pty Ltd. The region contains a vast Rhyodacitic Ignimbrite resource which is suitable for quarrying. To the north there is an existing quarry (Karuah Quarry) which is operated by HQ under a lease agreement with Wedgerock (Landholder). To the east of Lot 11 is a new quarry (East Karuah Quarry) also operated by HQ. Exploration drilling has been completed on the southern part of the Lot 11, in addition to geological face mapping on the existing faces of the Karuah Quarry extraction area to document the resource on the southern side of the Karuah Quarry.

A site visit of the Site and the existing Karuah Quarry was conducted on 20th of September 2017 with a LiDAR survey conducted shortly after on the 22nd of September 2017. The LiDAR data was used to create a Digital Elevation Model (DEM) to complete volume estimates on the site in GDA94 (zone 56) coordinate system on UTM Projection/Australian horizontal datum. This site-specific data was used in conjunction with topographic data sourced from the Geoscience Australia Elevation Information System database. The site resource estimation and extraction area design was completed using Surpac software (version 6.6.1) and Global Mapper GIS Software (version 19).

1.1 LOCATION AND ACCESS

The Site is located within the Mid-Coast Council Local Government Area approximately 40 km north east of Newcastle on Lot 11 DP1024564. The property is an elongated wedge-shaped parcel of land decreasing in width from south to north. The proposed resource lies partially within the existing Karuah Quarry and the land to the south which is also owned by Wedgerock. The property covers a total area of 38.78 ha, of which approximately 10.60 ha is already disturbed by the existing Karuah Quarry operations. The proposed Karuah South Quarry will be located within the 21ha Site which overlaps partly with the southern boundary of the Karuah Quarry. The haul route is defined as Blue Rock Close, Andersite Road, Branch Lane then the Pacific Highway.

The entrance to the proposed quarry will be via the south-western corner of Lot 11. The site is bounded to the south by the newly formed Blue Rock Close which runs parallel to the Pacific Highway. To the north, the property is bounded by The Branch Lane which is a local gravel road. On both sides the property is bounded by adjacent landholders including land owned by Hunter Quarries. The southern part of the Site is currently used by the landowner for rural purposes and contains two sheds. **Figure 1.1** and **Figure 1.2** detail the site location.

FIGURE 1.1 - SITE LOCATION MAP

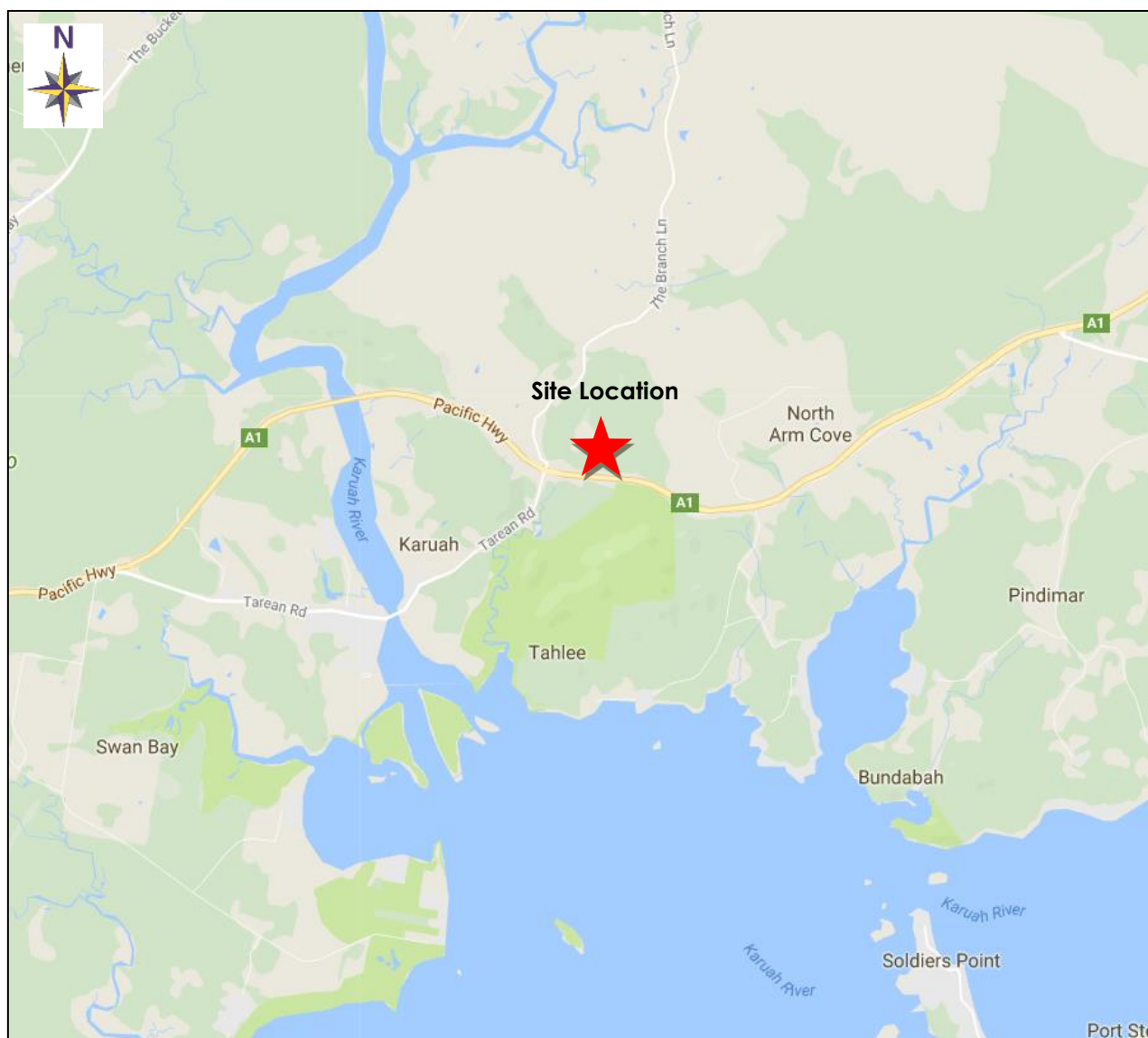
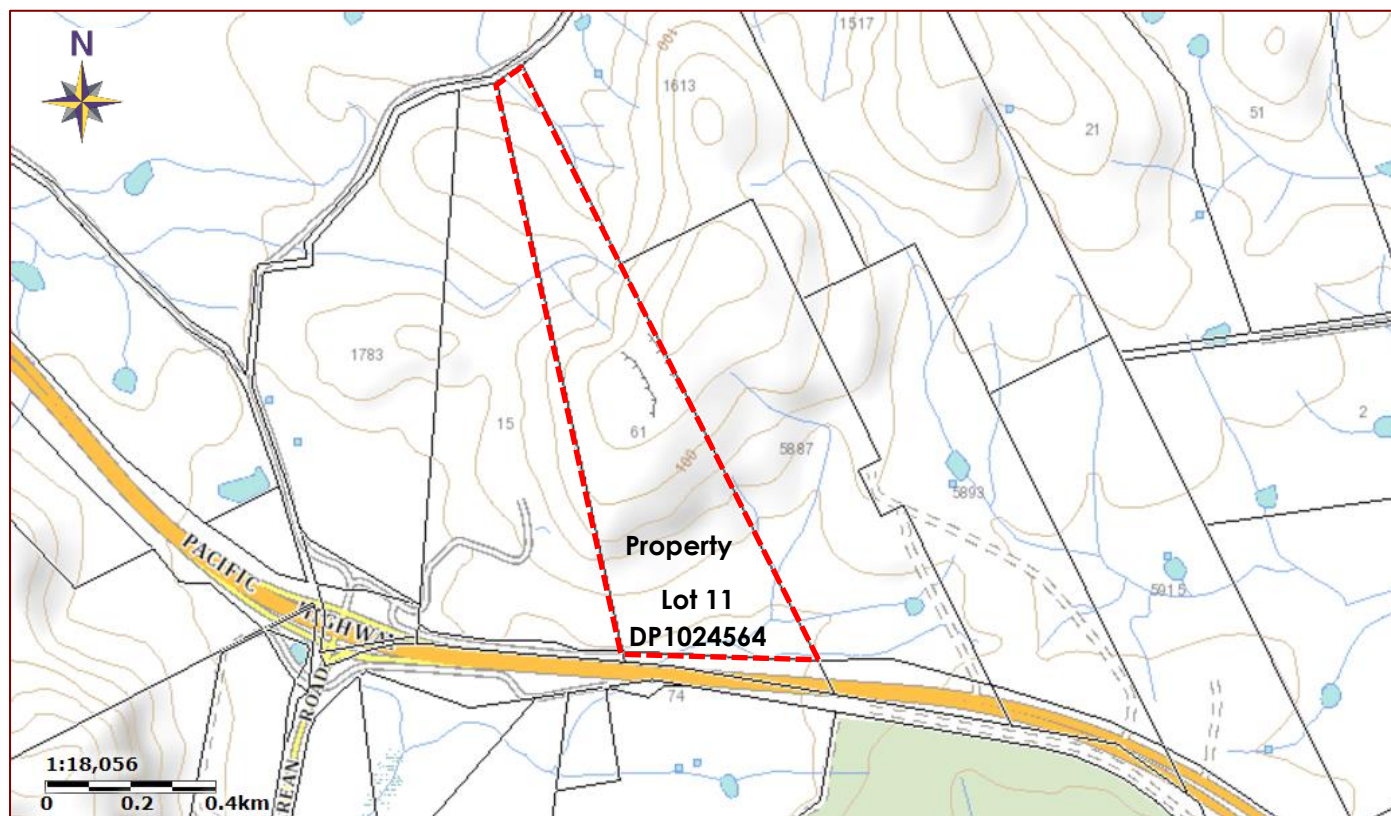


FIGURE 1.2 - SITE CADASTRAL MAP


The following table provides an overview of site information;

TABLE 1.1 - SITE INFORMATION

Locality	40 km North East of Newcastle
Property Description	Lot 11 DP1024564
Name of Quarry	Karuah South Quarry
Contact	Michael Kiely
Telephone	0416 134 314
State	NSW
Local Government	Mid-Coast Council

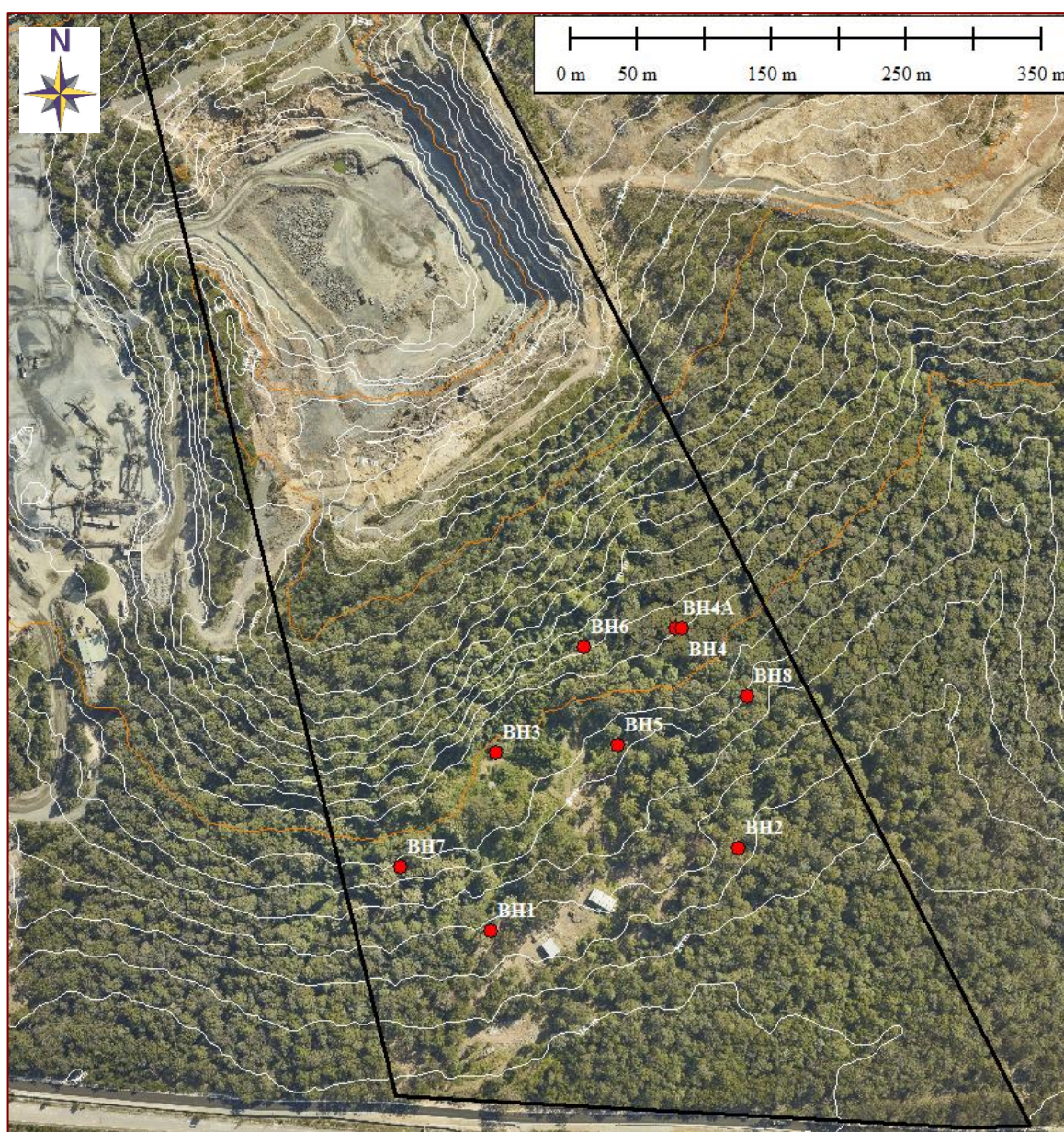
1.2 TOPOGRAPHY

The Site is located to the south of the existing Karuah Quarry and north of the Pacific Highway, approximately 4km north-west of Karuah. The lowest point of the Site is approximately 13m AHD with the highest point within the Site boundary being approximately 120m AHD.

The Site forms part of the topographic high area with a prominent northeast / southwest ridgeline with a spur to the south-west containing the existing Karuah Quarry. Natural watershed in the area of interest is to the south from the southern edge of the Hunter Quarries extraction area. In the south-eastern corner of the lot lies a natural depression.

The entrance to the proposed quarry will be via the south-western corner of the lot at around 15m AHD. It then slopes back down to approximately 40m AHD in the northern portion of the lot. Natural slopes within the southern portion of the lot exceed 1:3 (V:H) which will require careful planning to overcome. **Figure 1.3** shows the site topography data as provided by Atlass-Aerometrix (Atlass) 2017.

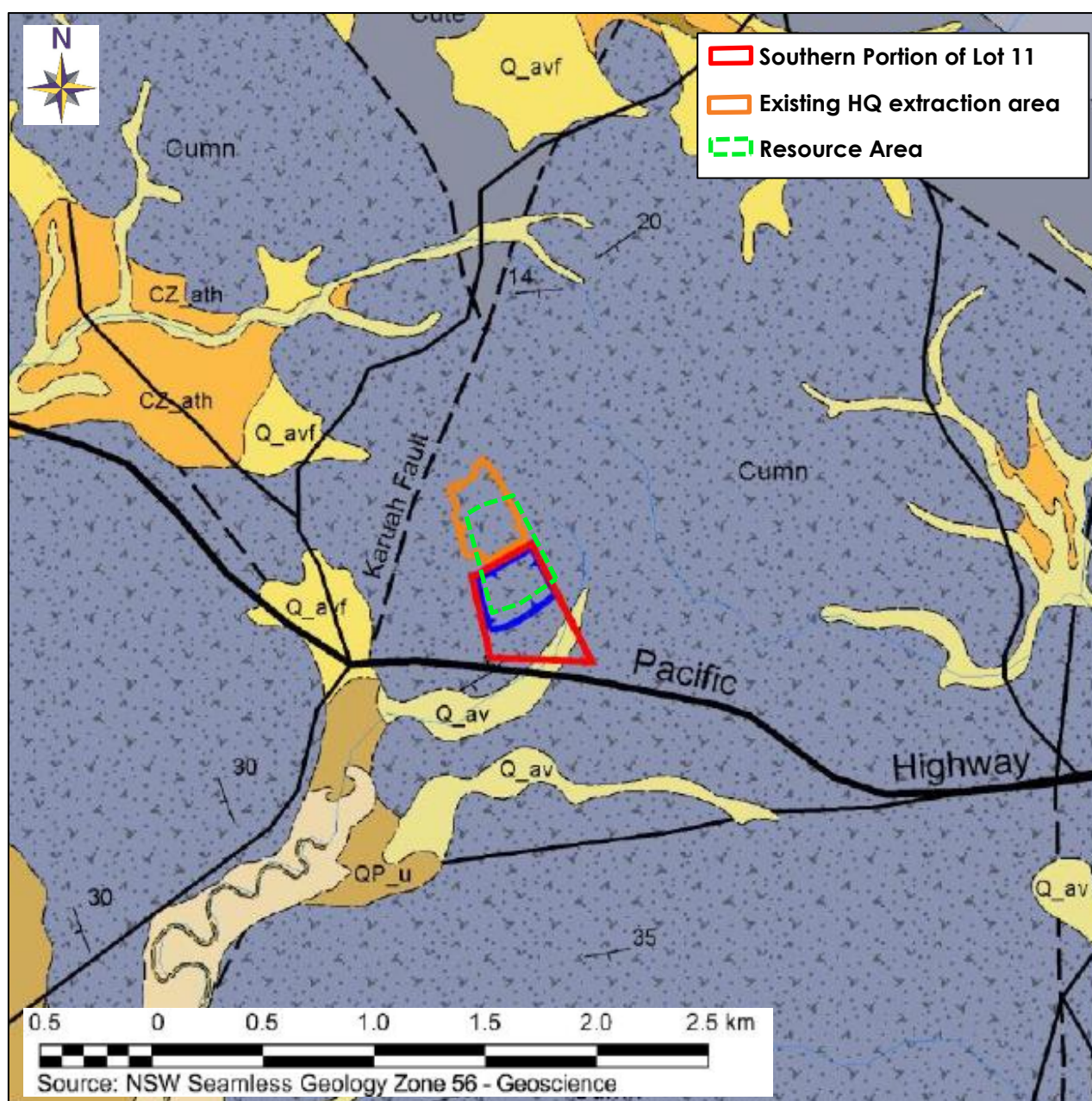
FIGURE 1.3 - SITE TOPOGRAPHY



2 GEOLOGY

The reader is referred to the Newcastle 1:250,000 Geology Map (1966). The Site is underlain by a sequence of Carboniferous volcanics and interbedded tuffaceous and clastic sedimentary rocks. The rock sequence is located in the Myall Structural Block part of the Tamworth Belt in the southern part of the New England Fold Belt. The principal unit is the Nerong Volcanics which comprise dominantly dense terrestrial rhyodacitic ignimbrite. The Nerong Volcanics is disconformably overlain by the Karuah Formation and the Booti Booti Sandstone and conformably overlies the Conger Formation and Boolambayte Formation. The stratigraphic sequence beneath the Site dips gently to the south-southeast. The Regional geology is shown in **Figure 2.1** (Refer RW Corkery PEA, 2017).

FIGURE 2.1 - REGIONAL GEOLOGY



Source: RW Corkery & Co Pty Ltd, Preliminary Environmental Assessment 2017

The most informed geological mapping is inferred mapping undertaken by Coffey Geotechnics in 2012 as part of an Environmental Assessment (EA) for the then proposed hard rock quarry identified as the Karuah East Quarry owned by Karuah East Quarry Pty Ltd. The then proposed quarry is located east of the Project Site in Lot 12 D P1024564. The inferred local geology is annotated in **Figure 2.2**.

State government regional geological mapping indicates that the Site is located in close proximity to a north-northeasterly trending fault which partly dissects the Carboniferous Nerong Volcanics in the local area.

The rhyodacitic ignimbrite belonging to the Nerong Volcanics is the principal geological unit quarried in the district and is extracted and processed to produce an extensive range of aggregates used for concrete, road bases, asphalt and armour stone applications. The rhyodacitic deposit in the local area is broadly tabular in shape which is consistent with the mode of formation – an aerially extensive, blanket-type ignimbrite-style eruption emanating from a nearby volcano/s.

Results of a nine-hole drilling program on the Site by Wedgerock Pty Ltd and a 14-hole drilling program peripheral to the Project Site by Hunter Quarries indicates a minimum 42m thickness of rhyodacite with a dip of between 5 and 10 degrees to the south-southeast (155 degrees azimuth). A 1m to 5m-thick strongly weathered rhyodacite at surface grades down into slightly weathered to relatively fresh rhyodacite.

Petrographic analysis of drill core acquired from the Project Site in 2010 describe the volcanics as dacite showing phenocrysts of euhedral to semi-euhedral green hornblende, plagioclase, less common opaque minerals and rare quartz set in a very fine grained, turbid, felsic ground mass.

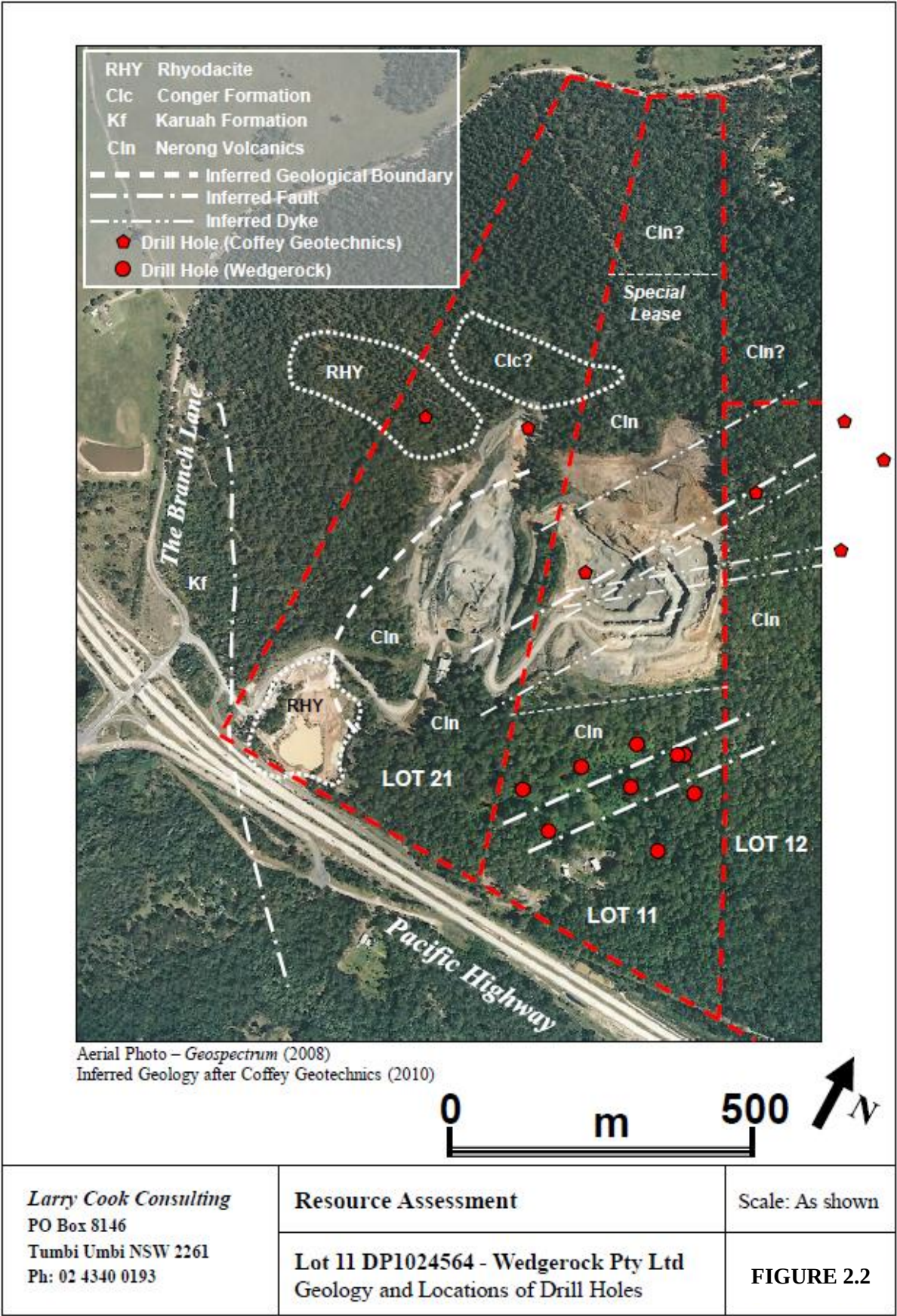
Interbeds of sandstone, conglomerate and volcanoclastic (tuffaceous) siltstone have been reported by Coffey Geotechnics and Wedgerock. These interbedded units are generally 3m to 5m in thickness.

Geological mapping by Coffey Geotechnics in 2010, in the Karuah Quarry on Lot 11, revealed the existence of a 5m-wide shear zone within the southern bench that exhibits intense sub-vertical fracturing. Igneous dykes were also identified within the then existing quarry walls and reported in drill hole logs. The inferred locations of the shear zones and dykes are shown in **Figure 2.2**. Two types of dykes were documented:

- Dark grey (mafic) dykes generally 0.3m to 0.5m wide hosting networks of white veins and multiple fracture planes; and
- A pale brown to white (felsic) dyke up to 4m wide, strongly weathered to sandy clay in exposure.

The results of exploration on the Site south of the existing quarry infer the existence of an east-northeast trending geological structure, possible a fault (**Figure 2.2**). The inferred structure is represented in aerial photos as a lineament defined by colour, texture and apparent vegetation contrast. This inferred geological structure is sub-parallel to a set of dykes mapped by Coffey Geotechnics to the north in the then existing quarry.

FIGURE 2.2 - INFERRED LOCAL GEOLOGY



3 SITE INVESTIGATION

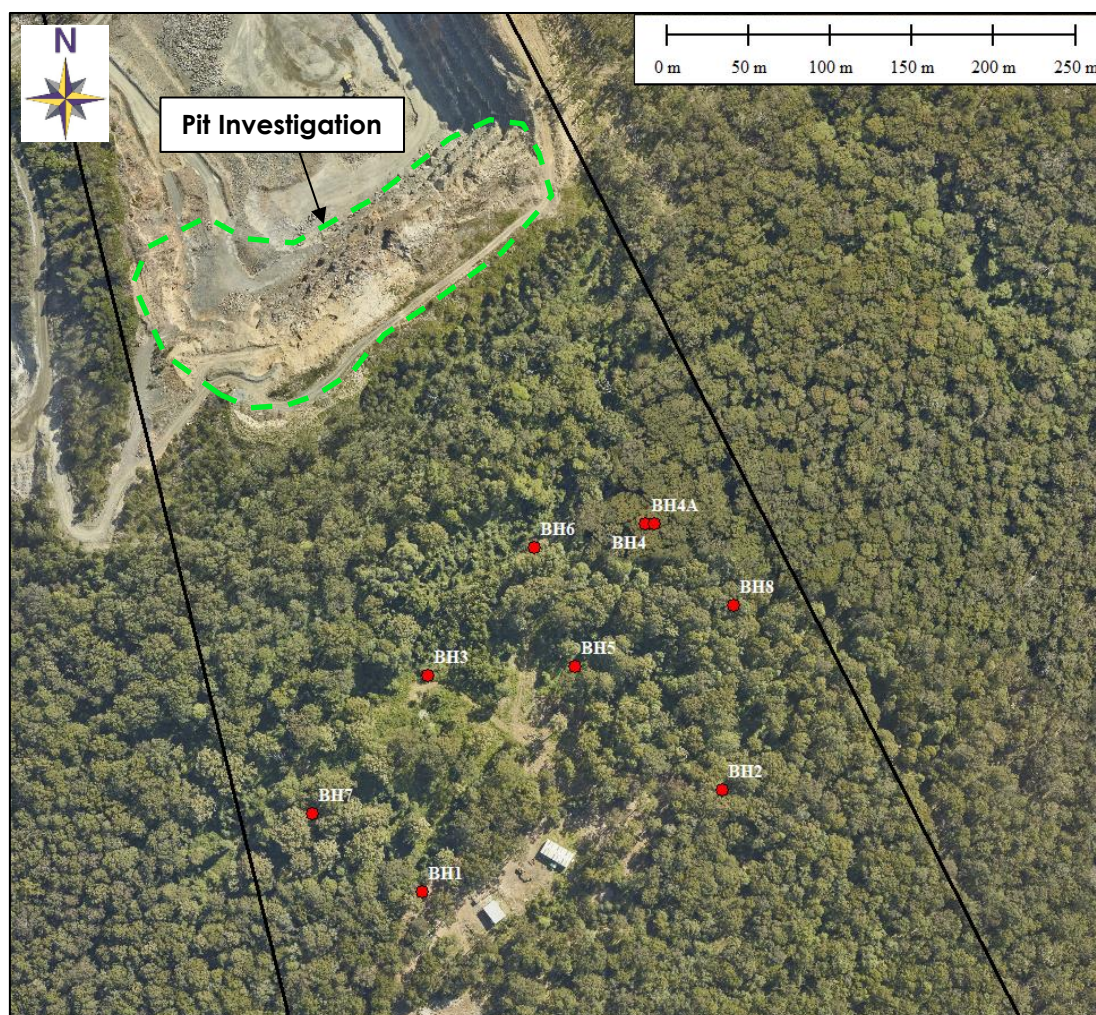
3.1 FIELD WORK

Prior to Ausrocks involvement in the project significant work was completed by others including;

- Bertann Pty Ltd – Quarry Rock Investigation on Lot 11, Pacific Highway Karuah 2009.
- Larry Cook Consulting Pty Ltd – Potential Resource Estimate Lot 11 DP1024564 Blue Rock Close Karuah 2010.
- Cadence Consulting Surveyors Pty Ltd – Topography survey of Karuah Hard Rock Quarry 2014.
- Geospectrum (Australia) Pty Ltd (now AAM Group) – High resolution aerial photo surveys 2007-2012.
- Quarry Mining Systems Pty Ltd - North Karuah Hard Rock Deposit – Stage 1 & 2 Due Diligence Reports for National Maritime Services 2015.

Various investigation campaigns have been carried out on site by different parties for different purposes. Ausrocks have reviewed this data and selected valid relevant data for input to the resource assessment along with input from our own field work. The original drilling was logged by Bert Brink (Bertann Pty Ltd), subsequent drilling was logged by Larry Cook (Larry Cook Consulting Pty Ltd), who has co-authored this report. A total of nine boreholes (core & percussion) were used as a main input to model the resource. The drilling was undertaken on the southern part of Lot 11 DP1024564, with access limited due to the steep terrain, Refer **Appendix A**. The location of boreholes and pit investigation is shown in **Figure 3.1**.

FIGURE 3.1 - BOREHOLE LOCATION PLAN



A site visit in May 2017 was conducted by Ausrocks and Larry Cook Consulting to view core samples and the drilled area as well as attempt to locate the drill collar positions. Unfortunately, at that time the collars were not identified due to the overgrown vegetation and lack of permanent markings but subsequent review of photos from the drilling campaign have confirmed the locations. A detailed assessment was undertaken of the existing core samples with checks against the logs for consistency. The nine drillholes covered a significant portion of the potential resource area, however to increase the level of geological understanding, the southern wall of the existing Karuah Quarry extraction area was mapped paying specific attention to the base of the resource, geological structures and depth of weathering. The pit investigation was carried out by Ausrocks and Larry Cook Consulting in September 2017 with the location shown in **Figure 3.1**.

3.2 SAMPLING

All drill holes were recorded, photographed, logged and sampled by Bert Brink and/or Larry Cook between 2009 and 2017. Samples were taken from the material that was drilled and recorded and submitted for testing. All remaining core samples are kept in core trays for future reference and/or testing. Ausrocks did not directly handle any of the material used for the testing as it was prior to our involvement with the project.

It is noted that the samples used in the Coffey 2009 testing (WARA095-07569) and summarised in the Quarry Mining Systems (QMS) Stage 1 Report did not have suitable cross reference to a location on-site. However, the results of this sample have only cautiously been used for Ausrocks' resource assessment. Instead samples from hole BH4A were predominantly utilised which are appropriately tracked (refer QMS Stage 2 Report) and are located centrally in the resource area. Two zones were identified in this core hole, the upper (6m to 21m) and the lower (21m to 42m). Photos are included in the reference document of where the samples were taken from the cored rock and Ausrocks considers the sample selection to be representative of the wider resource based on visual classification.

3.3 LABORATORY TESTING

Laboratory testing has been completed at various stages of the project predominantly on core samples from drilling campaigns. Ausrocks completed a review of historical data and found that sufficient testing was available with appropriate quality control to enable assessment for resource purposes. Therefore, Ausrocks have not completed further testing at this stage. Testing utilised in this resource assessment has been carried out at the following laboratories;

- Coffey Testing Pty Ltd – Warabrook NSW (NATA #431)
- Boral Construction Materials – Baulkham Hills NSW (NATA #547)
- ARRB Group Materials Laboratories – Vermont South VIC (NATA #9594)
- Hensel Geosciences – Gold Coast QLD
- Robin Offler (Petrography) – University of Newcastle NSW

It appears that three separate campaigns of testing were undertaken, the first managed by Coffey in 2009 for Michael Kiely using samples that were labelled WARA095-07570, WARA095-07569 and WARA095-07568. A wide range of testing was completed including quarry and mineral uses. Unfortunately, these samples were not linked to a sample location on site. Reading the test sheets (samples described as 'cobbles delivered by client') and reviewing photos of core samples after testing, it is assumed that samples were sourced from weathered float rock rather than core samples. The reliability of these tests is uncertain and therefore use should be cautioned.

The second phase of testing was organised by Larry Cook in 2010 and was predominantly targeting Zeolites (minerals). However, this testing did include one Petrographic assessment from BH4A at 18.19m depth which is of use for consistency given it was completed through a separate petrographic lab (R. Offler).

The third and most comprehensive testing phase was managed by QMS in 2015 and was split into Stage 1 and Stage 2. The intention of this testing was to determine the rock's suitability for quarry purposes and there is a good chain of custody for sample locations. For Stages 1 & 2 (June 2015) material from BH4A was used in two sections including and upper (6m - 21m) and a lower (21m - 42m) which covers a significant portion of the resource depth. Test results were predominantly good with only Alkali Silica Reaction (ASR) outside of acceptable levels.

Testing was conducted to determine the physical and chemical suitability of the material for use as various quarry products, refer **Appendix B**. The summary results of the testing are shown in **Table 3.1**.

TABLE 3.1 - SUMMARY TEST DATA

Method	Property	Specification	Sample			Result
			QMS 2015		Coffey 2009	
			BH4A/6.0-21.0 (Upper Zone)	BH4A/21.0-42.0 (Lower Zone)	WARA09S-07568 (Unknown location)	Pass/Fail
AS1141.22 Wet/ Dry (-19 + 9.5)	Wet Strength (kN)	>150	204	207	137	Pass, Pass, Fail
	Dry Strength (kN)		230	229	162	
	Variation (%)	<25	11	10	16	Pass
AS1141.24	Sodium Sulphate Soundness Total Weighted Loss (%)	<6% (Exposure C)	0.7	0.7	-	Pass
AS1141.41/42 Polished Aggregate Friction Value	PAFV after Polishing	> 48 highest spec: Other >44min	51	48	46	Pass, Pass, Partial Pass
AS1141.23	Los Angeles Value	>25%			25	Pass
AS1141.4	Uncompacted Bulk Density (t/m3)				1.2	
	Compacted Bulk Density (t/m3)	1.2 (t/m3) minimum			1.47	Pass
AS1141.6.1	Apparent Particle Density- Coarse (t/m3)	2.1 (t/m3) minimum			2.57	Pass
	Particle Density Dry (t/m3)				2.55	Pass
	Particle Density SSD (t/m3)				2.56	Pass
	Water Absorption (%)	<2%			0.4	Pass
RMS T363-AMBT Aggregate	Potential Classification (%)	<0.1 @ 10 and 21 days = Non-Reactive	0.285% @ 21 days	0.13% @10 days	0.035@ 10 days & 0.061% @ 21 days	Fail, Fail, Pass

The results presented show consistent high quality quarry materials that are suitable for a range of products. It is noted that the 2015 QMS test results for the RMS T363 Accelerated Mortar Bar Test for Aggregates exceeded the limits and are considered reactive and required supplementary treatment. However, the Coffey 2009 results from sample WARA09S-07569 returned a pass result. Further testing is not recommended since this is an outdated test and alternative test methods may be required. Note that the adjacent Karuah Quarry operating in the same resource is able to comply with concrete aggregate suitability.

Density reporting in the above results is considered relatively low for fresh Dacite and suggests that the material used for Coffey 2009 testing was not from the core drilling. Ausrocks would conservatively estimate the density around 2.6t/m³ which is consistent with the Bertann estimate.

3.4 INVESTIGATION RESULTS

By reviewing the existing data available and the new data collected during field visits, Ausrocks has prepared the following summary;

- The extent of the resource is confirmed laterally:
 - The resource is assumed to continue between the northernmost drillhole (BH6) and the exposed face in the Karuah Quarry extraction area, no known geological structures exist in this area that could modify the resource orientation.
 - To the east the resource continues past the property boundary as evidenced by the resource drilling on the adjacent property.
 - To the west at least until the property boundary due to the proximity of BH7 with good quality results.
 - To the south the resource is assumed to terminate prior to BH1 and BH2 due to drillhole results.
- The extent of the resource is confirmed vertically:
 - Underlying conglomerate layer was observed in the northern portion of the Hunter Quarries extraction area at approximately 60m AHD.
 - Verbal confirmation of the base below the current floor in the Hunter Quarries extraction area at around 40 - 50m AHD.
 - The base of the drillholes in the southern portion of the resource area have identified suitable rock to a depth of at least 10m AHD and lower in some instances.
 - Depth of weathering ranges from 5m to 20m based on the borehole logs and visual assessment of the Karuah Quarry extraction area.
 - The resource is assumed to be tabular in shape with a dip of 5 - 10 degrees and a strike of 155 degrees.
- Consistency of the rock quality has been proven through the borehole logs and material testing. It is likely that low grade material including weathered overburden will be able to be used for low value quarry products.

Notwithstanding these assumptions, it cannot be ruled out that geological anomalies could lie between the data points and have positive or negative impacts on the resource. Past literature has also noted interbeds of sedimentary material and dykes (including infill) which is likely to dilute the resource by a small margin. It is considered that the occurrence of these non-economic materials will be minimal and are likely to be handled in the everyday management of the quarry.

The summary of drillhole data is shown in **Table 3.2** below and photos of the available core trays are in **Appendix C**.

TABLE 3.2 - DRILLHOLE DATA

Hole ID	Co-ordinates (GDA94 zone 56)		Collar Height (m AHD)	Depth (m)	Base of Hard Rock (m AHD)
	Northing	Easting			
BH1	6,389,122	406,618	28.3	15	N/A
BH2	6,389,185	406,802	27.1	15	N/A
BH3	6,389,254	406,622	49.2	40	9.2
BH4	6,389,348	406,759	55.1	16	N/A
BH4A	6,389,348	406,754	54.6	42	12.6
BH5	6,389,260	406,712	40.8	34	N/A
BH6	6,389,342	406,644	58.7	49	9.7
BH7	6,389,169	406,551	42.8	40	6.8
BH8	6,389,298	406,807	39.2	32	N/A

4 RESOURCE MODELLING AND ESTIMATION

4.1 RESOURCE MODELLING

This resource assessment was based on field observations from existing excavation at the Karuah Quarry, drilling completed in previous campaigns, laboratory test results and previous experience and extent of the quarrying operations. With bounds of the resource modelling determined by the extent of resource defined by drilling to the south, the existing Hunter Quarries extraction area to the north and a 10m offset from the eastern and western property boundaries. These boundaries were drawn as a 2D string file and used to constrain the Resource. **Figure 4.1** shows the Resource Boundary in blue.

The Resource was modelled using Surpac Software version 6.6.1. Information from the drill logs including Easting, Northing, elevation of the upper and lower resource surface and weathered material thickness were input to the software. From this information a Surpac surface terrain model was generated for both the upper and lower boundaries of the resource. A calculation was then performed to estimate the volume between the two surfaces constrained by the Resource Boundary.

Geological work and interpretation for this assessment ascribes a deposit ranging from approximately 20m to 50m in thickness, shallow dipping with continuity throughout from north to south for approximately 350m, and the east to west for 300m. In essence the deposit is rectangular and relatively simple. **Figure 4.2** and **Figures 4.3-4.7** detail the cross sections through the Resource model showing the natural topography and the modelled depth of weathering, lower resource boundary and design of the extraction area from west to east and north to south respectively.

FIGURE 4.1 - CROSS SECTION LOCATION PLAN

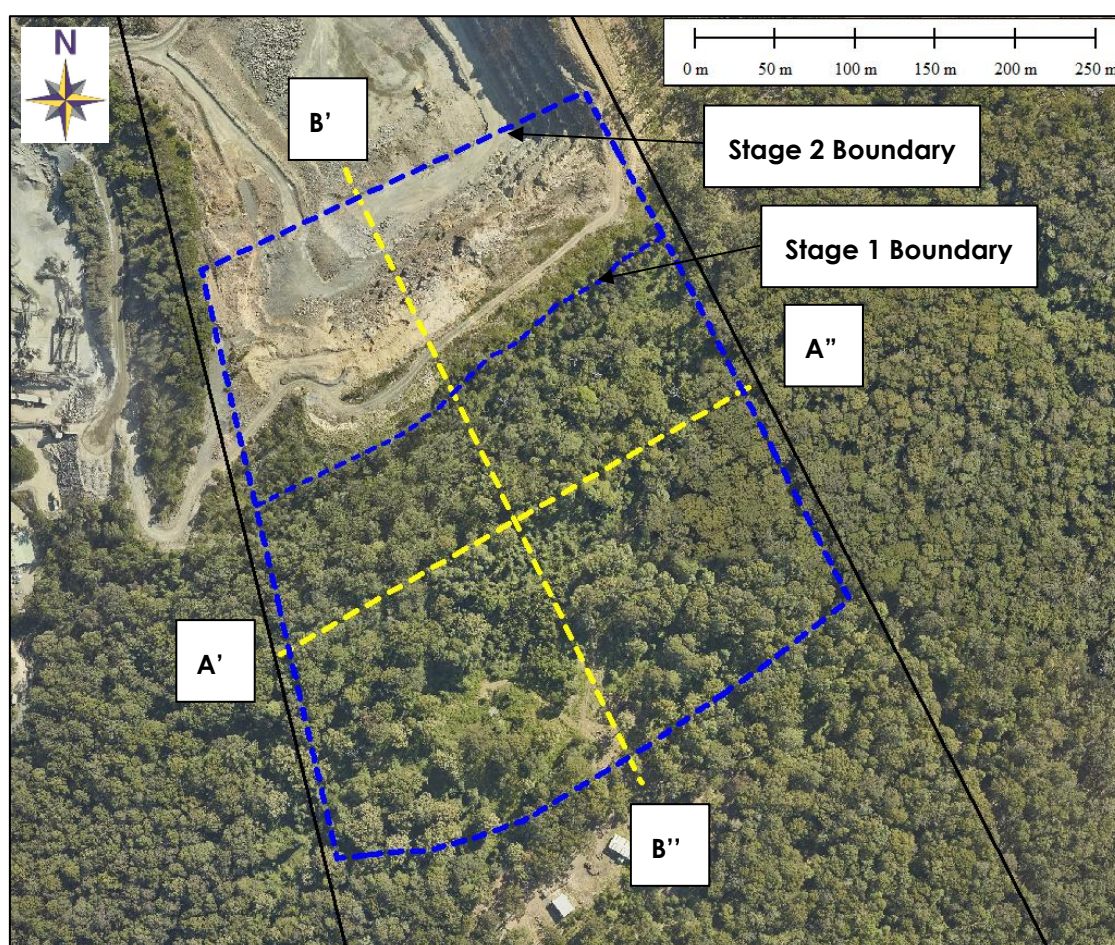


FIGURE 4.2 - CROSS SECTION A'-A'' – STAGE 2

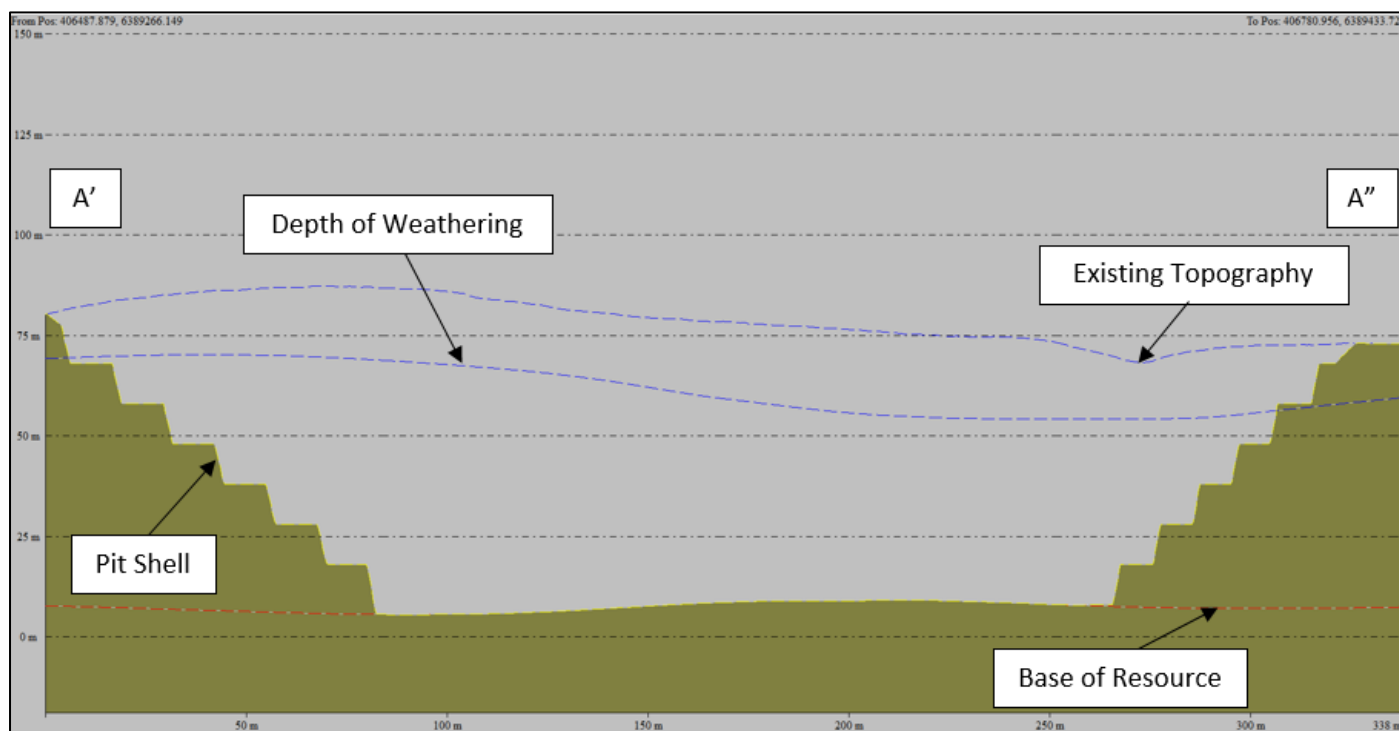


FIGURE 4.3 - CROSS SECTION B'-B'' – STAGE 1A

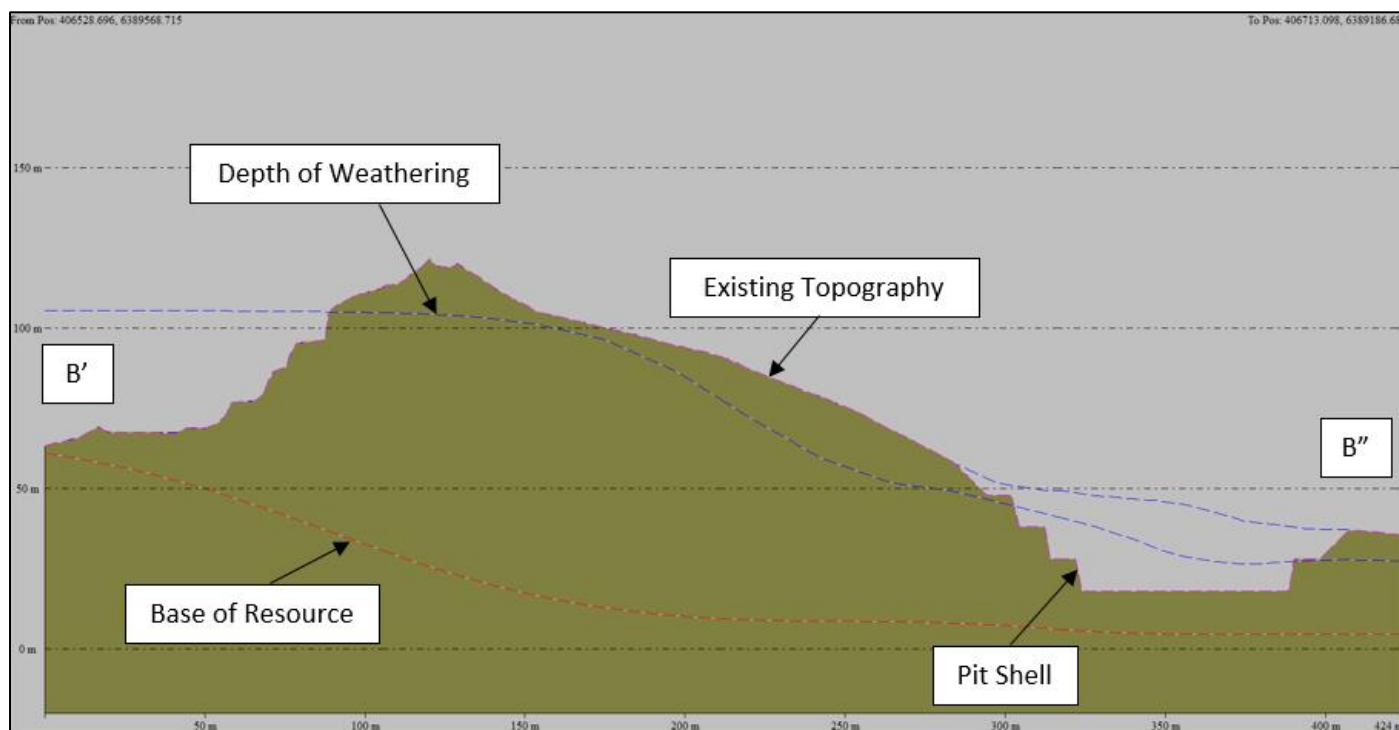


FIGURE 4.4 - CROSS SECTION B'-B'' – STAGE 1B

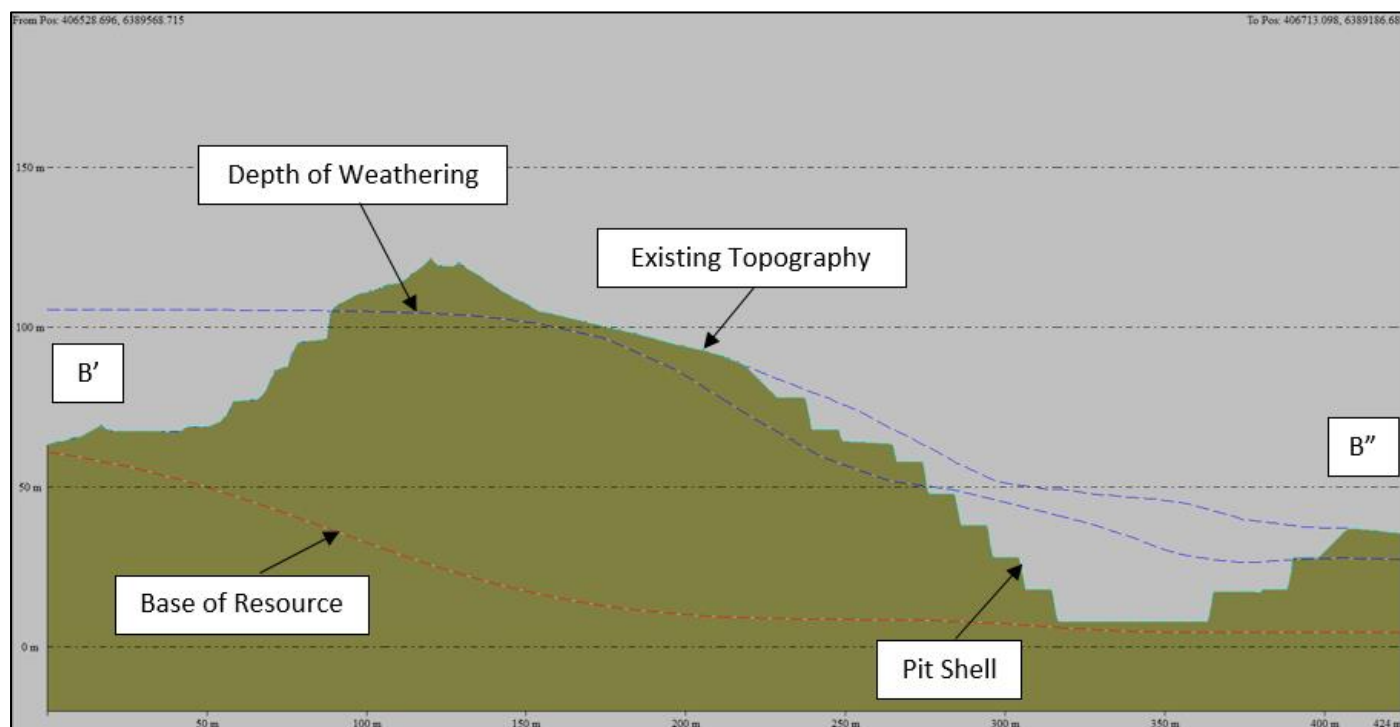


FIGURE 4.5 - CROSS SECTION B'-B'' – STAGE 1C

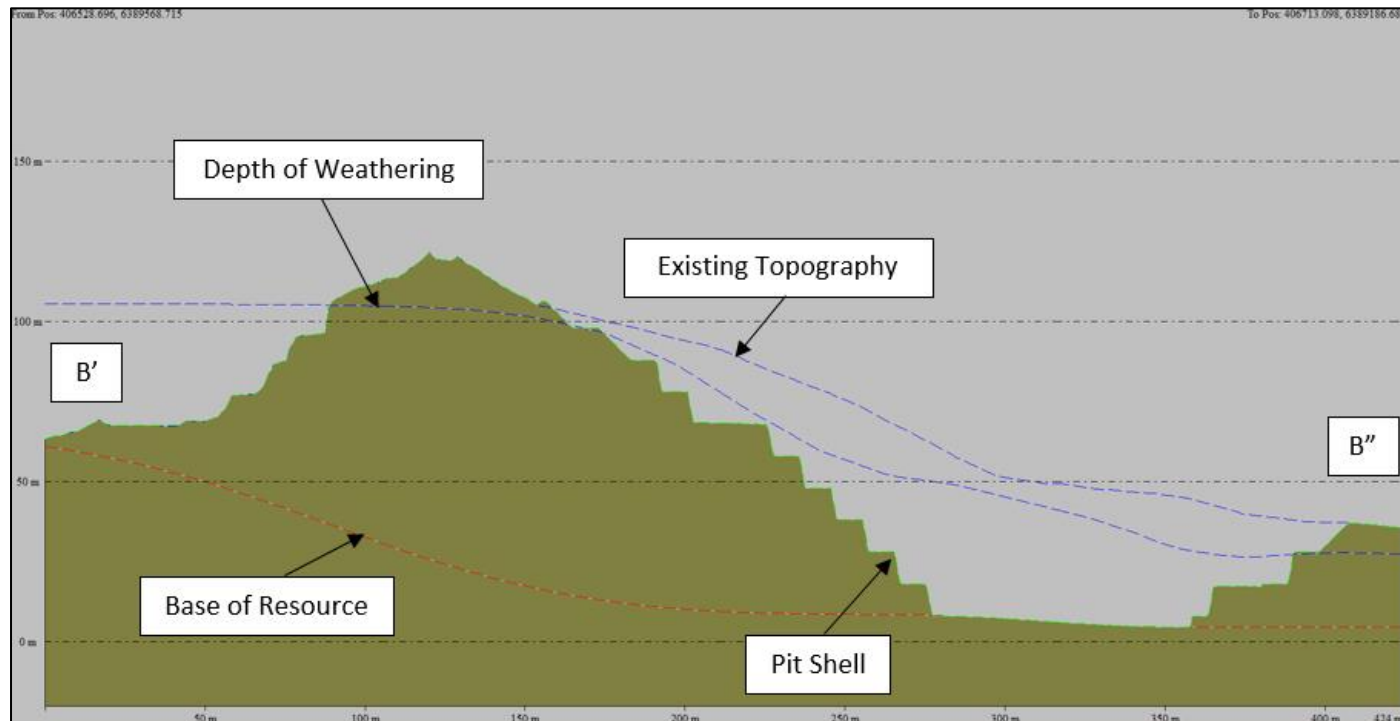
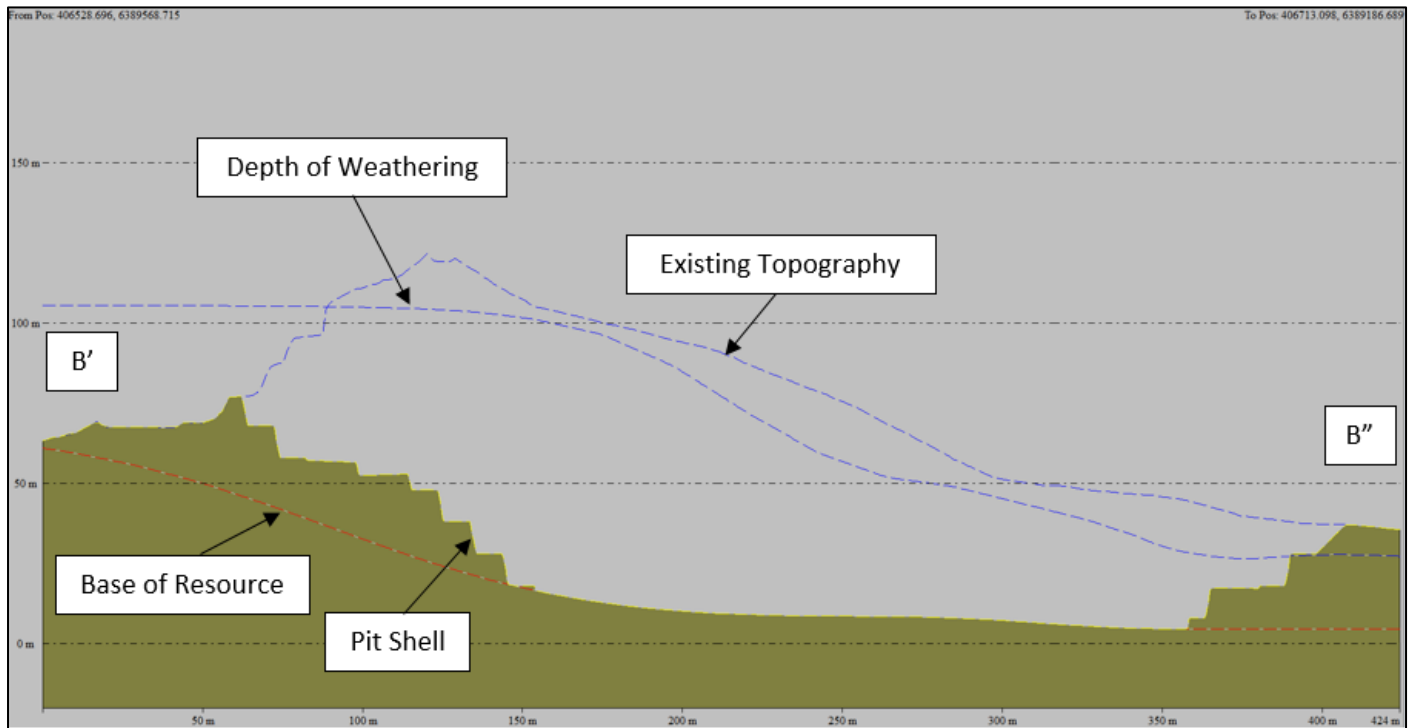


FIGURE 4.6 - CROSS SECTION B'-B'' - STAGE 2



4.2 RESOURCE ESTIMATION

Based on the above assumptions, a Surpac terrain model was generated for the surface and the base of the resource layers, the surface and base of the resource was modelled from the drilling that has been previously conducted with interpretation and interpolation. The design of the extraction area was then used to constrain the lower surface of the resource. The generated surfaces were used to estimate the volume of materials between surfaces and within Resource boundary string as shown in **Figure 4.1**. For the material occurring between the surface and the depth of weathering, an estimate was made based on the quantity of competent material logged in the boreholes and from site observations. Of the weathered material, 55% is estimated to be suitable for weathered rock products and 45% as overburden. Due to there being only one density testing result from an unknown source, the resource has been reported in volumes. For convenience typical densities have been nominated and a summary of Estimated Tonnage is provided in **Table 5.1** along with the Estimated In situ Resource Volumes shown in **Table 5.2**.

TABLE 5.1 - ESTIMATED TONNAGE

Stage/Phase	Fresh Rock (t)	Weathered Rock (t)	Overburden		Total (t)
			(t)	(m ³)	
Stage 1A	118 000	263 000	197 000	90 000	578 000
Stage 1B	615 000	136 000	102 000	46 000	853 000
Stage 1C	490 000	99 000	74 000	33 000	663 000
Stage 1 Sub-Total	1 223 000	498 000	373 000	169 000	2 094 000
Stage 2A	1 580 000	254 000	190 000	87 000	2 024 000
Stage 2B	3 630 000	347 000	261 000	118 000	4 238 000
Stage 2C	3 707 000	157 000	117 000	53 000	3 981 000
Stage 2 Sub-Total	8 917 000	758 000	568 000	258 000	10 243 000
Total	10 140 000	1 256 000	941 000	427 000	12 337 300

* Densities have been based on 2.6 t/m³ for fresh rock, 2.4 t/m³ for weathered rock and 2.2 t/m³ for overburden.

TABLE 5.2 - ESTIMATED IN SITU RESOURCE VOLUMES

Stage/Phase	Fresh Rock (m ³)	Weathered Rock (m ³)	Overburden (m ³)	Total (t)
Stage 1A	45 385	109 583	90 000	244 968
Stage 1B	236 538	56 667	46 000	339 205
Stage 1C	188 462	41 250	33 000	262 712
Stage 1 Sub-Total	470 385	207 500	169 000	846 885
Stage 2A	607 692	105 833	87 000	800 526
Stage 2B	1 396 154	144 583	118 000	1 658 737
Stage 2C	1 425 769	65 417	53 000	1 544 186
Stage 2 Sub-Total	3 429 615	315 833	258 000	4 003 449
Total	3 900 000	523 333	427 000	4 850 333

* Densities have been based on 2.6 t/m³ for fresh rock, 2.4 t/m³ for weathered rock and 2.2 t/m³ for overburden.

The volumes provided in **Table 5.2** show resources at the date of the survey in September 2017. It is understood that HQ continues to operate within a portion of this resource area and that available resources for the Karuah South Quarry will be diminished by the volume that HQ removes.

It is anticipated that due to the nature of the assessment all the Rhyodacitic Ignimbrite volume will be used as product and therefore will be included in the Resource assessment. As such, the estimated in situ volumes are equivalent to "Mineral Resources" as defined by the JORC Code (2012).

In accordance with the JORC Code (2012) the classification of mineral resources is a function of the level of geological knowledge and confidence. With increasing level of geological knowledge and confidence the mineral resources are classified as "Inferred", "Indicated" and "Measured Mineral Resources". Both the geological knowledge and the level of confidence are a function of the complexity of the mineral resource and the amount of exploration/investigation carried out.

Available exploration data for Karuah South Quarry indicates that the rock mass has a relatively uniform lithological composition and its extent and volume can be relatively easily estimated using readily available topographic data sets. Based on available subsurface information and the reliability of the geological model, the calculated mineral resources, as shown in **Table 5.2** above, are considered as an in situ **"Inferred Mineral Resource"**.

The lack of quantitative drill data between BH6 and the Hunter Quarries extraction area face, restricts the level of resource category that can be applied. In additional density testing for the Overburden, Weathered Rock and Fresh Rock is required to classify the tonnage of the resource. However, if additional drill data or density testing is provided or carried out by the operator an upgrade to Indicated and/or Measured Resources can be readily achieved along with a revision of this report.

Further, with the application of data on quarrying, economic, marketing, legal, environmental, social and governmental factors from current operations, an upgrade of a part of the Mineral Resources to Ore Reserves could be readily achieved. JORC Table 1 (Appendix C) shows the checklist used by the Competent Person and the associated criteria used in this assessment.

5 COMPETENT PERSON STATEMENT

The information in this report that relates to Mineral Resources is based on information compiled by Larry Cook from Larry Cook Consulting Pty Ltd.

*Larry Cook has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity for which he is undertaking to qualify as a Competent Person as defined in the 2012 edition of the **Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (The JORC Code)**.*

Larry Cook consents to the inclusion in the report on the matters based on their information in the form and context in which it appears.

6 REFERENCES

The JORC Code 2012 Edition, 2012, The AusIMM.

Brink, B, 2009, Quarry Rock Investigation on Lot 11, Pacific Highway, Karuah, Bertann Pty Ltd

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Quarry Mining Systems Pty Ltd, 2015, North Karuah Hard Rock Deposit – Stage 2 Due Diligence Report for National Maritime Services.

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Coffey Geotechnics, 2012, Proposed Karuah East Hard Rock Quarry Groundwater Impact Assessment. Ref. GEOTWARA 21232AA-AG (Rev. 4).

Rose, G., Jones W.H and Kennedy D.R., 1966, Newcastle 1:250,000 Geological Sheet SI/56-02. 1st Edition, Geological Survey of New South Wales, Sydney.

APPENDIX A | BOREHOLE LOGS AND PHOTOS

ABN: 66086 340392

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Log of Bore Hole BH1 Wedgerock, Karuah August 2009 Auger bore

<u>Depth</u>	<u>Description</u>
0.0 - 1.5	Clay, O/R/B, soft, wet/moist, plastic
1.5 - 3.0	As above, slightly lighter colours, moist
3.0 - 4.5	Clay, G/W/B, very stiff, moist/damp
4.5 - 6.0	Clay, G/W, very stiff/hard, gritty texture, grades into
6.0 - 11.0	Clay, G/Y, dry/moist, gritty but no quartz. Water at 11.0 m
11.0 - 15.0	No cuttings owing to water, but probably clay Brown
	End of hole at 15.0m

H0001	Exploration_licence_data_header_file							
H0002	Version	2						
H0003	Date_generated	20/05/2014						
H0004	Reporting_period_end_date	Oct-11						
H0005	State	NSW						
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H0101	Tenement_holder	Michael John Kiely						
H0102	Project_name	Karuah North						
H0106	Tenement_Operator	Michael John Kiely						
H0001	Exploration_licence_data_header_file							
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H0106	Tenement_Operator	Michael John Kiely						
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H0201	End_date_of_data_acquisition	23/11/2010						
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H0301	Location_data_file							
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H0304	Downhole_survey_data_file							
H0400	Drill_code	percussion						Add additional drilling codes across the page, as required.
H0401	Contractor	Total Drilling Pty Ltd						Add additional drilling contractors across the page, as required.
H0402	Description	Percussion						Add additional drilling descriptions across the page, as required.
H1000	Hole_ID	From	To	Recovery	Lithology	Drill_code	Colour	Add additional columns here for additional lithological descriptions
H1001	Units	Metres	metres	%				
H1004	Accuracy			0.01				
D	BH1	0	1.5		clay	auger	O/R/B	soft, wet/moist, plastic
D	BH1	1.5	3		clay	auger	O/R/B	soft, wet/moist, plastic
D	BH1	3	4.5		clay	auger	G/W/B	very stiff, moist/damp
D	BH1	4.5	6		clay	auger	G/W	very stiff/hard, gritty texture, grades downwards
D	BH1	6	11		clay	auger	G/Y	dry/moist.gritty but no quartz. Water at 11.0m
D	BH1	11	15		no return	auger		no cuttings owing to water, but probably clay brown

http://www.ga.gov.au/geodesy/datums/redfearn_grid_to_geo.jsp

coordinates MGA

406618 E

6389122 N

-32 ° 37 ' 53.54024 "

152 ° 0 ' 16.20215 "

32 37'53.54"S, 152 0'16.20"E

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Log of Bore Hole BH2 Wedgerock, Karuah August 2009 Auger bore

<u>Depth (m)</u>	<u>Description</u>
0.0 – 4.5	Clay, orange/red, slightly gritty, plastic, stiff
4.5 – 8.0	Clay, grey/yellow, slightly gritty, some quartz, plastic, sedimentary
8.0 – 14.0	Clay, yellow, gritty, dry/moist but water at 12.0m
14.0 – 15.0	Clay, brown, plastic, organic – old soil profile? Grades into black peaty clay
	End of hole at 15.0m

Samples

1	0.0 – 4.0m
2	4.0 – 8.0m
3	8.0 – 14.0m
4	14.0 – 15.0m

H0001	Exploration_licence_data_header_file							
H0002	Version	2						
H0003	Date_generated	20/05/2014						
H0004	Reporting_period_end_date	Oct-11						
H0005	State	NSW						
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H0101	Tenement_holder	Michael John Kiely						
H0102	Project_name	Karuah North						
H0106	Tenement_Operator	Michael John Kiely						
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H0301	Location_data_file							
H0303	Downhole_geochem_data_file							
H0304	Downhole_survey_data_file							
H0400	Drill_code	percussion			Add additional drilling codes across the page, as required.			
H0401	Contractor	Total Drilling Pty Ltd			Add additional drilling contractors across the page, as required.			
H0402	Description	Percussion			Add additional drilling descriptions across the page, as required.			
H1000	Hole_ID	From	To	Recovery	Lithology	Drill_code	Colour	Add additional columns here for additional lithological descriptions
H1001	Units	Metres	metres	%				
H1004	Accuracy			0.01				
D	BH2	0	4.5		clay	Auger	orange/red	slightly gritty, plastic, stiff
D	BH2	4.5	8		clay	Auger	grey/yellow	slightly gritty, some quartz, plastic, sedimentary
D	BH2	8	14		clay	Auger	yellow	gritty, dry/moist, water at 12.0m
D	BH2	14	15		clay	Auger	brown	plastic, organic (old soil profile?) grades into black peaty clay
coordinates MGA								
406802 E		-32 ° 37 ' 51.55054 "	32 37'51.55054"S					
6389185 N		152 ° 0 ' 23.28536 "	152 0'23.28536E					

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Log of Bore Hole BH3 Wedgerock, Karuah August 2009 Hammer bore

<u>Depth (m)</u>	<u>Description</u>
0.0 – 5.2	Clay, R/O, bouldery, plastic with numerous white grains. At 3.5m increasingly stiff to hard. Auger refusal at 5.2m.
5.2 – 7.0	Rock, blueish grey with mainly grey and black crystalline minerals, generally 1 – 3 mm but occasional larger phenocryst. Some clay contamination from above.
7.0 – 40.0	As above, chips of hard crystalline rock Water at 16 m. End of hole at 40.0 m

Samples

1	0.0 -5.2m
2	5.2 – 7.2m
3	7.2 – 12.0m
4	12.0 – 17.0m
5	17.0 – 22.0m
6	22.0 – 27.0m
7	27.0- -32.0m
8	32.0 – 40.0m

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H0003	Date_generated	20/05/2014						
H0004	Reporting_period_end_date	Oct-11						
H0005	State	NSW						
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H0102	Project_name	Karuah North						
H0106	Tenement_Operator	Michael John Kiely						
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H0102	Project_name	Karuah North						
H0106	Tenement_Operator	Michael John Kiely						
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H0303	Downhole_geochem_data_file							
H0304	Downhole_survey_data_file							
H0400	Drill_code	percussion						Add additional drilling codes across the page, as required.
H0401	Contractor	Total Drilling Pty Ltd						Add additional drilling contractors across the page, as required.
H0402	Description	Percussion						Add additional drilling descriptions across the page, as required.
H1000	Hole_ID	From	To	Recovery	Lithology	Drill_code	Colour	Add additional columns here for additional lithological descriptions
H1001	Units	Metres	metres	%				
H1004	Accuracy			0.01				
D	BH3	0	5.2		clay	auger	red/orange	bouldery, plastic with numerous white grains. At 3.5m increasingly stiff to hard. Auger refusal at 5.2m
D	BH3	5.2	7		rock	hammer	blueish grey	rock with mainly grey and black crystalline minerals, generally 1-3mm but occasional larger phenocryst. Some clay contamination from above
D	BH3	7	40		rock	hammer	blueish grey	rock with mainly grey and black crystalline minerals, generally 1-3mm but occasional larger phenocryst. Some clay contamination from above. Chips of hard cystalline rock. Water at 16m
coordinates MGA								
406622 E		-32 ° 37 ' 49.25537 "	32 37'49.25537S					
6389254 N		152 ° 0 ' 16.40310 "	152 0'16.40310"E					

ABN: 66086 340392

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Log of Bore Hole BH4 Wedgerock, Karuah August 2009 Auger/hammer bore

<u>Depth (m)</u>	<u>Description</u>
0.0 – 2.0	Clay, yellow/brown with small white specks, wet, plastic
2.0 – 5.0	Clay, grey/yellow, increasing number of white specks, wet, plastic
5.0 – 8.0	Clay, grey/yellow, dry, relict igneous texture
8.0 – 11.0	Hammer – Rock, blue/grey, hard
11.0 – 12.0	Rock, yellow/blue, weathered band?
12.0 – 16.0	Rock, blue/grey, hard
End of hole at 16.0m	

Note: hammer button bits wearing rapidly in hard rock

Samples

1	0.0 – 2.0m
2	2.0 – 5.0m
3	5.0 – 8.0m
4	8.0 – 11.0m
5	11.0 – 12.0m
6	12.0 – 16m

H0001	Exploration_licence_data_header_file							
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H0003	Date_generated	20/05/2014						
H0004	Reporting_period_end_date	Oct-11						
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H0101	Tenement_holder	Michael John Kiely						
H0102	Project_name	Karuah North						
H0106	Tenement_Operator	Michael John Kiely						
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H0004	Reporting_period_end_date	Oct-11						
H0005	State	NSW						
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H0401	Contractor	Total Drilling Pty Ltd						Add additional drilling contractors across the page, as required.
H0402	Description	Percussion						Add additional drilling descriptions across the page, as required.
H1000	Hole_ID	From	To	Recovery	Lithology	Drill_code	Colour	Add additional columns here for additional lithological descriptions
H1001	Units	Metres	metres	%				
H1004	Accuracy			0.01				
D	BH4	0	2		clay	auger	yellow/brown	with small white specks, wet, plastic
D	BH4	2	5		clay	auger	grey/yellow	increasing number os white specks, wet, plastic
D	BH4	5	8		clay	auger	grey/yellow	dry, relict igneous texture.
D	BH4	8	11		rock	hammer	blue/grey	hard, hammer.
D	BH4	11	12		rock	hammer	yellow/blue	weathered band
D	BH4	12	16		rock	hammer	blue/grey	hard rock. Note: hammer button bits wearing rapidly in hard rock

coordinates MGA

406759 E	-32 ° 37 ' 46.24480 "	32 37'46.24480"S,
6389348 N	152 ° 0 ' 21.69385 "	152 0'21.69385"E

ABN: 66086 340392

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Log of Bore Hole BH4A Wedgerock, Karuah August 2009 Auger/core bore

Depth (m)

Description

0.0 - 6.4

Clay, orange/red at top to yellow at base - very plastic numerous white grains, probably colluvial/residual with hard boulders

6.4 - 40.0

Core - blue/grey crystalline rock, medium grained, with numerous joints/fractures horizontal to steeply inclined with brown weathered margins, faint sub-horizontal banding. Some small (up to 5cm) inclusions of fine grained rock (shale?)
at 6.5m, rock becomes increasingly massive with depth, with decreasing number of parting planes. Some thin veins filled with white mineral (calcite?) Some small patches (1 - 2cm) of black fine grained rock with crystal inclusions.
Significant water loss between 32m and 35m; no core loss but note thin band of crumbly brown weathered material at 32.4m in fracture inclined at 25-30° (regional dip?)
End of hole at 42.0m

Samples

Two pieces of core (each about 5 cm long) were removed at 6.5m and 40.0m for the preparation of thin sections and petrographic description

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H0003	Date_generated	20/05/2014							
H0004	Reporting_period_end_date	Oct-11							
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H0106	Tenement_Operator	Michael John Kiely							
H0001	Exploration_licence_data_header_file								
H0002	Version	2							
H0003	Date_generated	20/03/2014							
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H0106	Tenement_Operator	Michael John Kiely							
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H0304	Downhole_survey_data_file								
H0400	Drill_code	percussion	DD	Add additional drilling codes across the page, as required.					
H0401	Contractor	Total Drilling Pty Ltd	Total Drilling Pty Ltd	Add additional drilling contractors across the page, as required.					
H0402	Description	Percussion	HQ diamond core	Add additional drilling descriptions across the page, as required.					
H1000	Hole_ID	From	To	Recovery	Lithology	Drill_code	Colour	Add additional columns here for additional lithological descriptions	
H1001	Units	Metres	metres	%					
H1004	Accuracy			0.01					
D	BH4A	0	6.4		clay	auger	orange/red grades down to yellow	very plastic numerous white grains, probably colluvial/residual with hard boulders	
D	BH4A	6.4	42		rock	core	blue/grey	crystalline rock, medium grained, with numerous joints/fractures horizontal banding. Some small(up to 5cm) inclusions of fine grained rock(shale?). Some thin veins filled with white mineral (calcite?). Some patches(1-2cm) of black fine grained rock with crystal inclusions. Significant water loss between 32m and 35m; no core loss but note thin band of crumbly brown weathered material at 32.4m in fracture inclined at 25-30°degrees(regional dip?)	
	coordinates MGA								
	406754 E	-32 ° 37 ' 46.24329 "	32 ° 37 ' 46.24329 "S						
	6389348 N	152 ° 0 ' 21.50199 "	152 ° 0 ' 21.50199 "E						

ABN: 66086 340392

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Log of Bore Hole BH5 Wedgerock, Karuah August 2009 Auger/core bore

<u>Depth (m)</u>	<u>Description</u>
0.0 – 1.0	Soil, dark, organic clay, wet, grades into
1.0 – 6.0	Clay, O/Y with white harder grains, similar to clay in BH 1
6.0 – 19.8	Ver poor recovery, some sludge of grey/white clay with grains of red, black and white minerals: EW igneous rock?
19.8 – 23.7	Core – grey/white to grey/pink granular rock with horizontal and inclined partings. Faint dark (carbonaceous?) streaks, especially in lower part – tuffaceous sediments?
23.7 – 29.5	Claystone, pinkish purple, dark grey streaks and patches – bioturbation?, grades into
29.5 – 30.1	Dark grey, fine grained crystalline rock with grey, red and dark grains, felspathic – tuff, ignimbrite? Too soft for aggregate.
30.1 – 34.24	Grey fine grained rock, sub-horizontal partings, faint sub-horizontal banding – tuff
	End of hole at 34.24 (core being ground away)

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H0005	State	NSW							
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H0101	Tenement_holder	Michael John Kiely							
H0102	Project_name	Karuah North							
H0106	Tenement_Operator	Michael John Kiely							
H0001	Exploration_licence_data_header_file								
H0002	Version	2							
H0003	Date_generated	20/03/2014							
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H0102	Project_name	Karuah North							
H0106	Tenement_Operator	Michael John Kiely							
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H0201	End_date_of_data_acquisition	23/11/2010							
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H0304	Downhole_survey_data_file								
H0400	Drill_code	percussion	DD	Add additional drilling codes across the page, as required.					
H0401	Contractor	Total Drilling Pty Ltd	Total Drilling Pty Ltd	Add additional drilling contractors across the page, as required.					
H0402	Description	Percussion	HQ diamond core	Add additional drilling descriptions across the page, as required.					
H1000	Hole_ID	From	To	Recovery	Lithology	Drill_code	Colour	Add additional columns here for additional lithological descriptions	
H1001	Units	Metres	metres	%					
H1004	Accuracy			0.01					
D	BH5	0	1		soil	auger	dark brown	wet, grades down	
D	BH5	1	6		clay	auger	orange/yellow	with white harder grains, similar to clay in BH1	
D	BH5	6	19.8		clay	auger	grey/white	very poor recovery, some sludge of grey/white clay with grains of red, black and white minerals: EW ignous rock?	
D	BH5	19.8	23.7		core	core	grey/white - grey/pink	granual rock with horizontal and inclined partings. Faint dark(carbonaceous?) streaks, especially in lower part- tuffaceous sediments?	
D	BH5	23.7	29.5		claystone	core	pinkish/purple	claystone dark gey streaks and patches- bioturbation?,grades down	
D	BH5	29.5	30.1		rock	core	dark grey	fine grained crystalline rock with grey, red and dark grains, felspathic- tuff, ignimbrite? Too soft for aggregate.	
D	BH5	30.1	34.24		rock	core	grey	fine grained rock, sub-horizontal partings, faint sub-horizontal banding - tuff. Core being ground away at 34.24m	
coordinates MGA									
406712 E		-32 ° 37 ' 49.08792 "	32 37'49.08792"S						
6389260 N		152 ° 0 ' 19.85876 "	152 0'19.85876"E						

Larry Cook Consulting

Job No:	
Hole No:	BH7
Sheet:	1 of 1
Logged:	LLC
Date:	18.5.17

Drill Hole Lithological Log

Client:	Wedgerock	Reference:	Rep.No.
Project:	Geological Investigation	Drill Technique:	Rotary Percussion
Project Location:	Karuah North	Coordinates:	E: N:
		Surface level:	XX m AHD

Groundwater	Samples	Field Tests	Depth (m)	Graphic Log	Description	Bore Construction
					0.0-3.0 m CLAY. Dark Chocolate brown. Gritty. Speckled orange. From 2.0-3.0 m Orange Brown. Gritty. Speckled pale yellow and orange.	
			5.0		3.0-5.0 m VOLCANIC. Grey to blue-grey. Speckled pink. Moderately weathered. Medium grained and crystalline. Phenocryts euhedral feldspar and minor mafic mineral in apahanitic groundmass (porphyritic).	5.0
					5.0-9.0 Orange Brown. Gritty. Speckled pale yellow and orange.	
			10.0		9.0-10.0 No Sample	10.0
			15.0		10.0-36.0 VOLCANIC. Grey to blue-grey. Speckled pink. Moderately weathered. Medium grained and crystalline. Phenocryts euhedral feldspar and minor mafic mineral in apahanitic groundmass (porphyritic). Medium to large angular chips. From 13.0-15.0 m Common strongly weathered (bleached) medium grained volcanic.	15.0
			20.0			20.0
			25.0			25.0
			30.0		From 27.0-28.0 m Minor iron staining (coatings) on some chips	30.0
			35.0		From 35.0-36.0 Minor iron staining (coatings) on some chips	35.0
			40.0		36.0-38.0 m GRITTY CLAY and VOLCANIC. From 36.0-38.0 70% Yellow-orange grit. 30% grey to blue grey volcanic. From 38.0-40.0 20% Yellow-orange grit. 80% grey to blue grey volcanic. End of Hole 40.0 m	40.0

Larry Cook Consulting

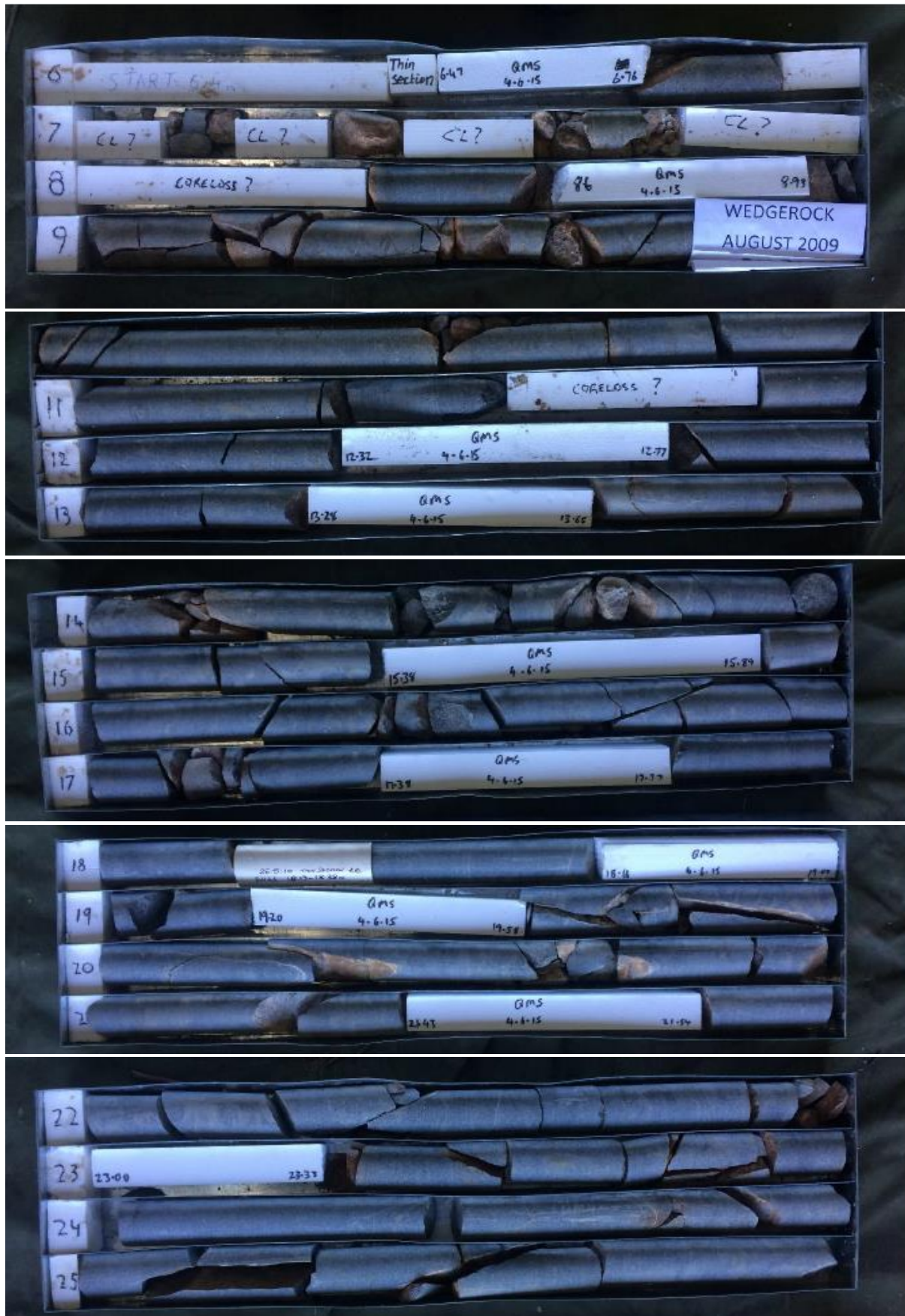
Job No:	
Hole No:	BH8
Sheet:	1 of 1
Logged:	LLC
Date:	18.5.17

Drill Hole Lithological Log

Client:	Wedgerock	Reference:	Rep.No.	
Project:	Geological Investigation	Drill Technique:	Rotary Percussion	
Project Location:	Karuah North	Coordinates:	E: _____	N: _____
		Surface level:	XX m AHD	

Groundwater	Samples	Field Tests	Depth (m)	Graphic Log	Description	Bore Construction
					0.0-7.0 m SANDY LOAM. Pale brown to patchy pale yellow. Strongly weathered. No rock chips..	
			5.0			5.0
					From 7.0-9.0 m, Yellow to pale yellow-brown. Strongly weathered. No rock chips.	
			10.0		9.0-13.0 m FINE GRAINED ROCK (Sedimentary?). Brown to khaki. Large angular chips. Very fined grained. Oxidised.	10.0
			15.0		13.0-14.0 m, SANDY LOAM. Yellow to yellow-brown. Strongly weathered. No rock chips.	15.0
					14.0-15.0 m GRIT. Pale brown to dark brown. Strongly weathered. No rock chips.	
			20.0		15.0-20.0 m FINE GRAINED ROCK (Sedimentary?). Pale brown. Very fined grained. Oxidised. From 16.0-20.0 m Brown to dark grey. Small chips.	20.0
			25.0		20.0-22.0 m VOLCANIC AND SEDIMENTARY. Grey to blue-grey. Speckled pink. Fine grained and crystalline. Small chips. Moderately weathered. Minor iron staining on fractures. Common large chips fine grained pale brown dtrongly weathered sedimentary rock.	
					22.0-27.0 m VOLCANIC. Grey to blue-grey. Speckled pink. Fine grained and crystalline. Phenocryts euhedral feldspar and minor mafic mainerl in apahanitic groundmass (porphyritic). Small chips. Moderately weathered. Minor iron staining on fractures. From 23.0-24.0 Rare large chips very fine grained pale brown rock.	25.0
			30.0		27.0-28.0 m GRIT. Pale brown to blue-grey. No chips.	30.0
					28.0-32.0 m Grey to blue-grey. Speckled pink. Moderately weathered. Fine grained and crystalline. Phenocryts euhedral feldspar and minor mafic mineral in apahanitic groundmass (porphyritic). Rare large chips pale brown very fine grained rock (sedimentary).	
			35.0			35.0
			40.0		End of Hole 32.0 m	40.0

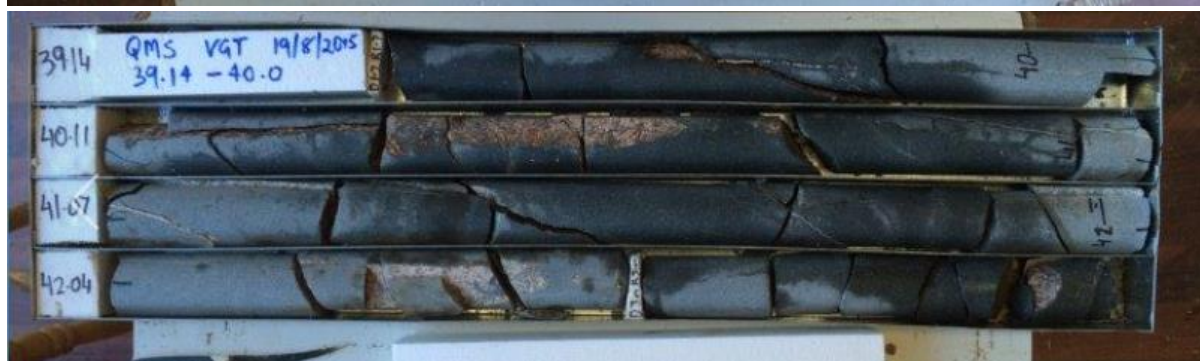
Core Trays BH4A





Core Trays BH6





Core Trays BH5



BH7 & BH8 Chip Trays



APPENDIX B | LABORATORY TEST RESULTS

• Table 1 Sample No WARA095-07568

Coffey Test Results- Karuah Quarry- Borehole unknown- WARA095-07568- Borehole?				
Material Properties				
Method	Property		Specification	Comments
AS1141.4	Bulk Density (Uncompacted)	1.20 T/m ³	>1.2 T/m ³	Light- weathered?
	Bulk Density (Compacted)	1.47 T/m ³	-	Light- weathered?
AS1141.5	Particle Density (SSD)	2.56 T/m ³	>2.1 T/m ³ <3.2 T/m ³	Lower than Expected
	Particle Density (DRY)	2.55 T/m ³	-	
	Particle Density (Apparent)	2.57 T/m ³		
	Water Absorption	0.4%	-	Low-good- fine grained
AS1141.22 Wet / Dry (-19 + 9.5)	Wet Strength	137kN	>100kN	Low rock strength
	Dry Strength	162	-	Low rock strength
	Variation	16%	<25%	OK- Not water sensitive
AS1141.23	Los Angeles Value	25%	<25%	Highly abraded – a bit soft- weathered?
AS1141.41 / 42	PAFV	46	>48	Easily polished unsuitable for sealing aggregates
Petrographic Examination	Not provided	Not provided	Not provided	Not provided
T363	AAR	0.061 @21days	<0.1 = Non-Reactive	No Action Required- Good
Amdel XRF	Chemical Constituents	Silicon (SiO ₂)	61.9%	Abrasive during crushing- wear rates on equipment

• Table 2 Sample No WARA095-07569

Coffey Test Results- Karuah Quarry- Borehole unknown- WARA095-07569- Borehole?				
Material Properties				
Method	Property		Specification	Comments
Petrographic Examination	Hornblende Dacite- Hard, Strong, Some clays- Chlorite and mica within rock mass present within rock which may be liberated into manufactured sands made from this rock? No Alkali Aggregate Reactivity conclusions provided?	32% feldspars 23% light groundmass 15% dark groundmass 12% amphibole 10% Chlorite- Bad? 3% Quartz-OK? 1% mica- Bad? 1% smectite clay-Bad?	Report	Borehole?

• Table 3 Sample No WARA095-07570

Coffey Test Results- Karuah Quarry- Borehole unknown- WARA095-07570- Borehole?				
Material Properties				
Method	Property		Specification	Comments
Petrographic Examination	Ignimbritic Hornblende Dacite Hard, Strong, but with planes of structural weakness in groundmass that affect the geotechnical properties. Some clays present within rock which may be liberated into manufactured sands made from this rock? No Alkali Aggregate Reactivity conclusions provided?	35% feldspars 35% light groundmass 14% amphibole 10% Chlorite- Bad? 2% Quartz-OK?	Report	Borehole?

7. Testing

Two samples were submitted to Coffey for testing. The hole was broken into an upper zone (6m to 21m) and lower zone (21 to 42m) hole depth and test results determined for each as per below. To maximise the test results, from the limited sample size, fractions were reused from the grading and wet dry where possible to complete the remaining tests. Sodium Sulphate samples could not re-used as they were affected by earlier chemical testing.

Upper Zone Sample		BH4A/6.0–21.0
Bag 1 (10.9kg) + Bag 2 (12.5kg)=> Total 23.4kg of sample		
No. of	Test	Detail
1	AS1141.11.1	Grading (Dry) of crushed material through lab crusher
1	AS1141.22	Wet/Dry Strength
Lower Zone Sample		BH4A/21.0– 42.0
Bag 1 (12.4kg) + Bag 2 (15.5kg)=> Total 27.9kg of sample		
No. of	Test	Detail
1	AS1141.11.1	Grading (Dry) of crushed material through lab crusher
1	AS1141.22	Wet/Dry Strength
Combined Upper and Lower Zone Sample		
No. of	Test	Detail
1	AS1141.24	Sodium Sulphate Soundness
1	AS1141.41 & 42	Polished Aggregate Friction Value (PAFV)
1	RMS T363	AMBT (using Berrima GP/SL cement only)

• Table 1 Sample Test Details

One further test, AS1141.23, Los Angeles Value was requested but sample size was not sufficient to carry out.

Result from the testing are shown in tables 2 and 3 below and test certificates are in the report appendices. The results show a strong rock that is suitable for use in multiple aggregate applications with high wet strength and a low wet/dry strength variation confirming it as not water sensitive. The Sodium Sulphate test result is extremely low and indicates that the rock will perform well if submersed in sea water or applications near ocean spray. The Polished Aggregate Friction Value (PAFV) testing result complies with the high skid resistance requirements from Roads and Maritime Services (RMS) and others, and suggests that the tested samples would be suitable for important high value bituminous sealing aggregate applications. These results are substantially different from the test results supplied by MKDI in Stage 1 of the report.

Material Testing Results			
QMS Sample ID	Sample #	BH4A Upper Zone	BH4A Lower Zone
	Date Sampled	5/06/2015	5/06/2015
Coffey Sample ID	Lab No.	WARA15S-04731-1	WARA15S-04732-1
	Sample Type	Borehole Rock	Borehole Rock
AS1141.11 - Sieve Size (mm)	37.5	100	100
	26.5	93	91
	19	79	69
	13.2	44	37
	9.5	32	25
	6.7	24	19
	4.75	18	14
	2.36	12	9
	1.18	8	6
	0.600	5	4
	0.425	4	3
	0.300	3	3
	0.150	2	1
	0.075	1	1
AS1141.22- Wet / Dry	Wet Strength (kN)	204	207
	Dry Strength (kN)	230	229
	Wet / Dry Strength Variation (%)	11	10
AS1141.24- Sodium Sulphate Soundness	Total Weighted Loss %	0.7	0.7
AS1141.41/42 Polished Aggregate Friction Value	PAFV after Polishing	51	48
RMS T363- AMBT Aggregate	Potential Classification	TBC	TBC

Note: TBC = To Be Confirmed as test results not currently available

Table 2 Sample Test Results

Test Results- Karuah Quarry- Borehole 4A					
Method	Property	Sample		Specification	Comments
		BH4A/ 6.0-21.0 (Upper Zone)	BH4A/ 21.0-42.0 (Lower Zone)		
AS1141.22 Wet / Dry (-19 + 9.5)	Wet Strength (kN)	204	207	>150	A wet strength greater than 150kN indicates a strong rock. Suitable for most applications such as concrete, asphalt and road sealing
	Dry Strength (kN)	230	229		
	Variation (%)	11	10	<25	The wet/dry variation of 10 and 11% suggest water sensitivity is not an issue for the rock tested. This shows durability of rock and is important for aggregate use in concrete.
AS1141.24	Sodium Sulphate Soundness Total Weighted Loss (%)	0.7	0.7	<6% (Exposure C)	Sodium Sulphate testing result of 0.7% is extremely low and indicates that the rock will perform well if submersed in sea water or in applications near ocean spray.
AS1141.41/ 42 Polished Aggregate Friction Value	PAFV after Polishing	51	48	> 48 highest spec ; Other >44min	PAFV results of 48 and 51 comply with the highest skid resistance requirements suggesting that the tested samples would be suitable for important bituminous pavement sealing aggregate applications.
RMS T363- AMBT Aggregate	Potential Classification (%)	=>	=>	<0.1 @ 10, and 21 days = Non- Reactive	Alkali Silica Reaction (ASR) Testing is underway but results were not available at the time of writing this report.

Table 3 Interpretation of Test Results from Bore Hole 4A

Appendix 1 Samples taken for testing

Samples Taken from Core Trays Stored at Karuah			
Depth from Hole Collar (m)		Weight	Bag
Upper	Lower	(kg)	(number)
Sample for testing BH4A/6.0-21.0 (Upper Zone)			
6.47	6.76	2.2	1
8.6	8.93	2.6	1
12.32	12.77	3.5	1
13.28	13.65	2.6	1
15.38	15.89	4	2
17.38	17.77	3.2	2
18.66	19	2.4	2
19.2	19.58	2.9	2
	Total	23.4	
Sample for testing BH4A/21.0-42.0 (Lower Zone)			
21.43	21.84	3.3	1
23	23.33	2.4	1
26.42	26.86	3.5	1
27.54	28	3.2	1
31.59	32	3.1	2
35	35.65	4.8	2
37.51	38	3.3	2
39.23	39.79	4.3	2
	Total	27.9	

Appendix 2 Test Results Upper Zone



Material Test Report

Client: QUARRY MINING SYSTEMS PTY LTD
PO Box 7030
Redhead NSW 2290

Principal:
Project No.: INFOWARA01492AA
Project Name: Material Testing
Lot No.: - TRN:

Warabrook, Newcastle Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
19 Warabrook Boulevard
Warabrook NSW 2304

Phone: +61 2 4016 2300
Fax: +61 2 4016 2380

Report No: WARA15S-04731-1

Preliminary Report Issued - Issue No: 1, 1, 1 Issue No: 2

This report replaces all previous issues of report no 'WARA15S-04731-1'.

Accredited for compliance with ISO/IEC 17025.



The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Chris Blackford
(Geotechnician)
NATA Accredited Laboratory Number: 431
Date of Issue: 26/06/2015

Sample Details

Sample ID: WARA15S-04731
Client Sample: -
Date Sampled: 05/06/2015
Source: On-Site
Material: Core Sample
Specification: No Specification
Sampling Method: Submitted by client
Project Location: Karuah, NSW
Sample Location: Onsite BH4A
Upper Zone 6.1 - 21.0m

Other Test Results

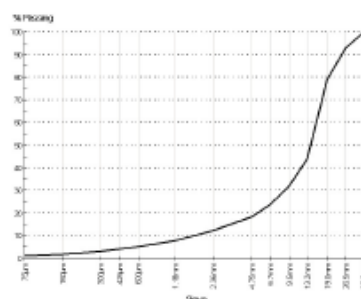
Description	Method	Result	Limits
Nominal Sample Size (mm)	AS 1141.22	20	
Nature of Sample		Crushed Rock	
Agg Size and Crush Details		Constant rate	
Fraction Size		-19.0 + 9.5 mm	
Wet Strength (kN)		204	
Dry Strength (kN)		230	
Wet/Dry Strength Variation (%)		11	
Breakdown Occurred		No	
Cylinder Size (diameter in mm)		150	
Date Tested		16/06/2015	
Sodium Sulphate Soundness	AS 1141.24		
Loss 37.5 to 26.5 mm (%)		0.5	
Loss 26.5 to 19.0 mm (%)		0.5	
Loss 19.0 to 13.2 mm (%)		0.5	
Loss 13.2 to 9.5 mm (%)		0.7	
Loss 9.5 to 4.75 mm (%)		1.0	
Loss 4.75 to 2.36 mm (%)		1.2	
Total Weighted Loss (%)		0.7	
Date Tested		26/06/2015	

Particle Size Distribution

Method: AS 1141.11.1
Drying by: Oven
Date Tested: 10/06/2015
Note: Sample Not Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	93	
19.0mm	79	
13.2mm	44	
9.5mm	32	
6.7mm	24	
4.75mm	18	
2.36mm	12	
1.18mm	8	
600µm	5	
425µm	4	
300µm	3	
150µm	2	
75µm	1	

Chart



Comments

N/A

Appendix 3 Test Results Lower Zone



Material Test Report

Client: QUARRY MINING SYSTEMS PTY LTD
PO Box 7030
Redhead NSW 2290

Principal:
Project No.: INFOWARA01492AA
Project Name: Material Testing
Lot No.: - **TRN:**

Warabrook, Newcastle Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
19 Warabrook Boulevard
Warabrook NSW 2304

Phone: +61 2 4016 2300
Fax: +61 2 4016 2380

Report No: WARA15S-04732-1

Preliminary Report Issued - Issue No.:1,1,1 Issue No: 2

This report replaces all previous issues of report no 'WARA15S-04732-1'.



Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Chris Blackford
(Geotechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 26/06/2015

Sample Details

Sample ID: WARA15S-04732
Client Sample: -
Date Sampled: 05/06/2015
Source: On-Site
Material: Core Sample
Specification: No Specification
Sampling Method: Submitted by client
Project Location: Karuah, NSW
Sample Location: Onsite BH4A
Lower Zone 21.0 - 42.0m

Other Test Results

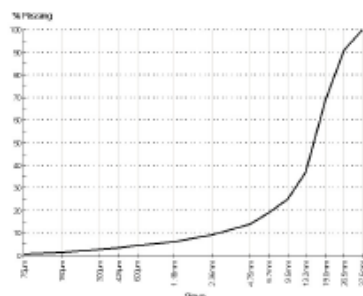
Description	Method	Result	Limits
Nominal Sample Size (mm)	AS 1141.22	20	
Nature of Sample		Crushed Rock	
Agg Size and Crush Details		Constant Rate	
Fraction Size		-19.0 + 9.5 mm	
Wet Strength (kN)		207	
Dry Strength (kN)		229	
Wet/Dry Strength Variation (%)		10	
Breakdown Occurred		No	
Cylinder Size (diameter in mm)		150	
Date Tested		16/06/2015	
Sodium Sulphate Soundness	AS 1141.24		
Loss 37.5 to 26.5 mm (%)		0.6	
Loss 26.5 to 19.0 mm (%)		0.8	
Loss 19.0 to 13.2 mm (%)		0.5	
Loss 13.2 to 9.5 mm (%)		0.8	
Loss 9.5 to 4.75 mm (%)		1.2	
Total Weighted Loss (%)		0.7	
Date Tested		26/06/2015	

Particle Size Distribution

Method: AS 1141.11.1
Drying by: Oven
Date Tested: 10/06/2015
Note: Sample Not Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	91	
19.0mm	69	
13.2mm	37	
9.5mm	25	
6.7mm	19	
4.75mm	14	
2.36mm	9	
1.18mm	6	
600µm	4	
425µm	3	
300µm	3	
150µm	1	
75µm	1	

Chart



Comments

N/A

Appendix 4 Test Results Polished Aggregate Friction Value Upper Zone

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**Boral Construction Materials
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Baulkham Hills NSW 2153 Australia
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Test Report

POLISHED AGGREGATE FRICTION VALUE

CLIENT: COFFEY TESTING PTY LTD (WARABROOK)
PROJECT: Quality Control - Testing of 14mm Aggregates
PROJECT NO: INFOWARA15W01492AA; Work Order No: WARA15W02331
SAMPLE DESCRIPTION: 14mm Aggregate - BH4A - Upper Zone 6.0-21.0m
SIZE OF AGGREGATE TESTED: -13.2mm+9.5mm
DATE TESTED: 30.6.15
CLIENT SAMPLE NO: WARA15S-04731

FILE NO: 56/15

REQUEST NO: 62764
DATE SAMPLED: 5.6.15
DATE RECEIVED: 19.6.15
LAB. SAMPLE NO: 167195
LOCATION: Unknown

Samples were prepared as per AS1141.41 and tested in a wet condition as per AS1141.42 prior to and after polishing. The sample were polished using the procedure of AS114.41.

A reference aggregate sample, "Panmure Basalt" is included with each testing run. This sample acts as a control on test performance and is used to standardise the sample results. After polishing, the samples were again tested in the wet condition according to AS1141.42.

Test Method	Test	Results for the Test Sample	Results for Panmure Reference Specimen Pan No: W-29
AS1141.41/42	Sample mean friction value corrected for temperature before polishing	79	75
	Sample mean friction value corrected for temperature after polishing	52	52
	Polished aggregate friction value (PAFV) for the test sample after polishing.	51	-

The air temperature during the friction test was 23°C.

Sample submitted by client.

C. Blackford, C. Angel, Q.C. File, File.



Approved Signatory

Date 1.7.15

Serial No.

W. Komsta

137702

Accredited for compliance with ISO/IEC 17025

NATA Accredited Laboratory

Number: 547

Quarry Mining Systems Pty Ltd

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Appendix 5 Test Results Polished Aggregate Friction Value Lower Zone

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**Boral Construction Materials
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Test Report **POLISHED AGGREGATE FRICTION VALUE**

CLIENT: COFFEY TESTING PTY LTD (WARABROOK)
PROJECT: Quality Control - Testing of 14mm Aggregates
PROJECT NO: INFOWARA15W01492AA; Work Order No: WARA15W02331
SAMPLE DESCRIPTION: 14mm Aggregate - BH4A - Lower Zone 21.0-42.0m
SIZE OF AGGREGATE TESTED: -13.2mm+9.5mm
DATE TESTED: 30.6.15
CLIENT SAMPLE NO: WARA15S-04732

FILE NO: 56/15

REQUEST NO: 62764
DATE SAMPLED: 5.6.15
DATE RECEIVED: 19.6.15
LAB. SAMPLE NO: 167196
LOCATION: Unknown

Samples were prepared as per AS1141.41 and tested in a wet condition as per AS1141.42 prior to and after polishing. The sample were polished using the procedure of AS114.41.

A reference aggregate sample, "Panmure Basalt" is included with each testing run. This sample acts as a control on test performance and is used to standardise the sample results. After polishing, the samples were again tested in the wet condition according to AS1141.42.

Test Method	Test	Results for the Test Sample	Results for Panmure Reference Specimen Pan No: W-29
AS1141.41/42	Sample mean friction value corrected for temperature before polishing	77	75
	Sample mean friction value corrected for temperature after polishing	49	52
	Polished aggregate friction value (PAFV) for the test sample after polishing.	48	-

The air temperature during the friction test was 23°C.

Sample submitted by client.

C. Blackford, C. Angel, Q.C. File, File.



Approved Signatory

Date 1.7.15

Serial No. 13 7 7 0 1

W. Komsta

Accredited for compliance with ISO/IEC 17025

NATA Accredited Laboratory

Number: 547

**PETROGRAPHIC DESCRIPTION OF 5
SAMPLES (18.19 – BH4A; 23.65; 24.5; 28.5; 30.7 –
BH5) FOR LARRY COOK & ASSOCIATES Pty Ltd.**

R. Offler

9 July, 2010

Sample 18.19

Classification Dacite

Description

This is a **dacite** showing **phenocrysts** of euhedral to semi-euhedral green **hornblende**, **plagioclase**, less common **opaque minerals** and rare **quartz** set in a very fine grained, turbid, **felsic ground mass** (Plate A). Many of the phenocrysts are **fractured** and **altered**, and commonly exhibit **embayed** boundaries. A single **lithic** (volcanic) fragment was noted as was a flow texture in one part of the slide. **Zircon** and **apatite** are accessories.

The hornblende is replaced by one or more of the following, namely **mixed-layer clay (chlorite-smectite?)**¹, **white mica**¹ (**illite?**), **chlorite** and **titanite** (Plate B). **Titanite** also rims the opaque minerals. Plagioclase on the other hand is altered to **white mica** or **albite**. The latter forms within and adjacent to the fractures in the plagioclase. .

Mineralogy	%(approx)	Grain size
Plagioclase	25	0.25 x 0.55-1.1 x 1.7mm
Hornblende	15	0.03 x 0.23-0.42 x 1.14mm
Opaques	5	0.14 x 0.28-0.15 x 0.26mm
Quartz	1	0.18 x 0.42mm
Groundmass	54	

¹ X-ray diffraction analysis required to verify identity.

Sample 23.65

Classification Litharenite

Description

This is a **litharenite** made up of subangular **quartz**, **plagioclase** and **lithic (volcanic)** clasts (Plate C). Scattered throughout are irregular or semi-euhedral **opaque minerals** and degraded **biotite**. **White mica (illite?)** fills the pore spaces between the grains and commonly replaces the lithic clasts (Plate D); small aggregates of **chlorite** occur in some pore spaces (Plate C). Most lithic clasts consist of the groundmass of **felsic volcanics**; some are porphyritic dacite. Uncommon are **quartzites** (pure and impure) and **low grade white mica-rich metamorphics**. **Zircon** and **epidote** are accessory minerals.

Mineralogy	%(approx)	Grain size
Quartz	15	0.16 x 0.25-0.14 x 0.35mm
Plagioclase	10	0.13 x 0.25-0.25 x 0.4mm
Lithics	64	0.15 x 0.2-0.25 x 0.34mm
Opaques	5	0.04 x 0.06-0.16 x 0.3mm
Biotite	1	0.05 x 0.4-0.06 x 0.15mm

Illite 5

Sample 24.5

Classification Litharenite

Description

This is a fine, even grained **litharenite** made up of interlocking mixture of angular **quartz**, **plagioclase**, less common degraded, deformed **biotite** and **lithic clasts** pervasively altered to **white mica** (illite? Plate E). A few larger clasts are also present. **Grading** of the grains can be observed in some parts of the sample. **Compaction** has produced the internal strain noted in the biotites. Throughout are areas in which very fine grained **Fe oxide** surrounds the detrital grains, elsewhere white mica rims these grains. Also present are curvi-planar, cusped **claystone "patches"** made up of extremely turbid, very fine grained aggregates of white mica and opaque minerals (Plate F). Accessories – **zircon** and **muscovite**. Clast types include felsic volcanics (common), low grade metamorphics (rare).

Mineralogy	%(approx)	Grain size
Quartz	10	0.025 x 0.075-0.08 x 0.095mm
Plagioclase	5	0.035 x 0.07-0.065 x 0.18mm
Lithics	46	0.05 x 0.085-0.075 x 0.15mm
Biotite	3	0.025 x 0.15-0.05 x 0.2mm
Muscovite	1	0.035 x 0.2mm
"Patches"	10	0.4 x 0.8-1.2 x 2.4mm
Illite	10	
Fe Oxide	15	

Sample 28.5

Classification Claystone

Description

This is a **claystone** consisting of scattered very small blades of **muscovite** and less common, more equant grains of **quartz**, rare **plagioclase** and fine grained **opaque minerals** in a **clay** matrix (Plate G). Locally, pods of **arenite** occur that are made up of angular, often cusped **quartz**, **lithic clasts** and uncommon degraded **biotite**. The lithic clasts are replaced by fine grained **white mica** (illite?). **Mudstone** pellets with cusped boundaries and containing widely separated coarse grains of **quartz**, **plagioclase** and **lithic fragments**, are also present.

Throughout the sample is a network of irregular aggregates of **fine grained opaque material (coalified plant fragments?** Plate H).

Mineralogy	%(approx)	Grain size
Host		
Quartz	5	0.008 x 0.01-0.018 x 0.024mm
Muscovite	5	0.002 x 0.02-0.012 x 0.06mm
Plagioclase	5	0.002 x 0.018-0.016 x 0.03mm
Biotite	2	0.004 x 0.053mm
Clay	83	
Pod		
Quartz	10	0.02 x 0.1-0.06 x 0.08mm
Lithics	64	0.035 x 0.09-0.1 x 0.14mm
Muscovite	1	0.015 x 0.11mm
Plagioclase	5	0.06 x 0.065-0.095 x 0.1mm
Clay	20	
Sample	30.7	

Classification **Feldspathic litharenite**

Description

This is an **feldspathic litharenite** made up of angular to subangular **quartz, plagioclase, perthitic K-feldspar** and **lithic clasts**. Uncommon degraded, deformed **biotite, muscovite** and semi-euhedral **opaque minerals** are also present. **Apatite** and **zircon** are accessory minerals. In the pore spaces **illitic white mica** rims all detrital grains and partly replaces them (Plate I). The lithic clasts are mainly **felsic volcanics**; less common are **quartzites** (pure and impure), very low grade white mica-rich **metamorphics (slate?)** and grains showing graphic intergrowths (Plate J). Replacement of biotite by **chlorite** is a feature.

Mineralogy	%(approx)	Grain size
Quartz	10	0.08 x 0.1-0.15 x 0.6mm
Plagioclase	15	0.11 x 0.2-0.2 x 0.35mm
Lithics	55	0.08 x 0.3-0.3 x 0.35mm
Biotite	5 ¹	0.03 x 0.13-0.03 x 0.6mm
Opaques	5	0.07 x 0.1-0.12 x 0.16mm
Muscovite		0.035 x 0.1-0.075 x 0.15mm
K feldspar	5	0.1 x 0.12-0.25 x 0.5mm
Illite	5	

¹ includes muscovite

Comment

Examination of the thin sections indicates that white mica (probably illite) rather than zeolites developed in the samples. This is due to high a_{K^+} (high K^+ content) in the pore fluid at the time alteration of the samples took place. Clinoptilolite is well developed in rocks from the fore arc basin sequences of the Tamworth Belt particularly NW of the area from which these samples were obtained (Offler & Diessel 1976) Offler 1997). Further exploration should be concentrated in those areas where this zeolite is reported and vitric tuffs that commonly contain this mineral as an alteration product, sampled.

References

OFFLER, R. & DIESSEL, C. F. K. 1976. The application of reflectance determinations on coalified and graphitized plant fragments to metamorphic studies. *Journal of the Geological Society of Australia* 23, 293-297.

OFFLER, R., ROBERTS, J., LENNOX, P. & GIBSON, J. 1997. Metamorphism in Palaeozoic forearc basin sequences, southern New England Fold Belt, NSW, Australia. *Proceedings of the 30th International Geological Congress*. Beijing, China. 241-250.

CAPTIONS

Plate A. Photomicrograph of dacite showing phenocrysts of plagioclase (Pl), hornblende (Hb) and opaque minerals (Op) set in a turbid, felsic groundmass (Gd). Note altered appearance of sample. PPL. Sample BH4-18.19.

Plate B. Photomicrograph of hornblende replaced by white mica (Wm) and mixed-layer clay (Mc). Chlorite (Ch) occurs in fractures cutting this altered phenocryst. PPL. Opaque minerals (Op). Sample BH4-18.19.

Plate C. Photomicrograph of arenite containing quartz (Q), lithic clasts (Lc) and plagioclase (Pl). Small aggregates of chlorite (Ch) occur in the centre. PPL. Sample BH5-23.65.

Plate D. Photomicrograph of arenite showing quartz (Q), plagioclase (Pl) and lithic clasts many of which are replaced by white mica (Lc-Wm). Note abundance of secondary white mica (arrow) in other parts of the sample. XP. Sample BH5-23.65.

Plate E. Photomicrograph of fine grained arenite consisting of angular to sub-angular quartz (Q) and lithic clasts surrounded by an Fe oxide cement (Fo). Note greater content of Fe oxide to the left. PPL. Sample BH5-24.5.

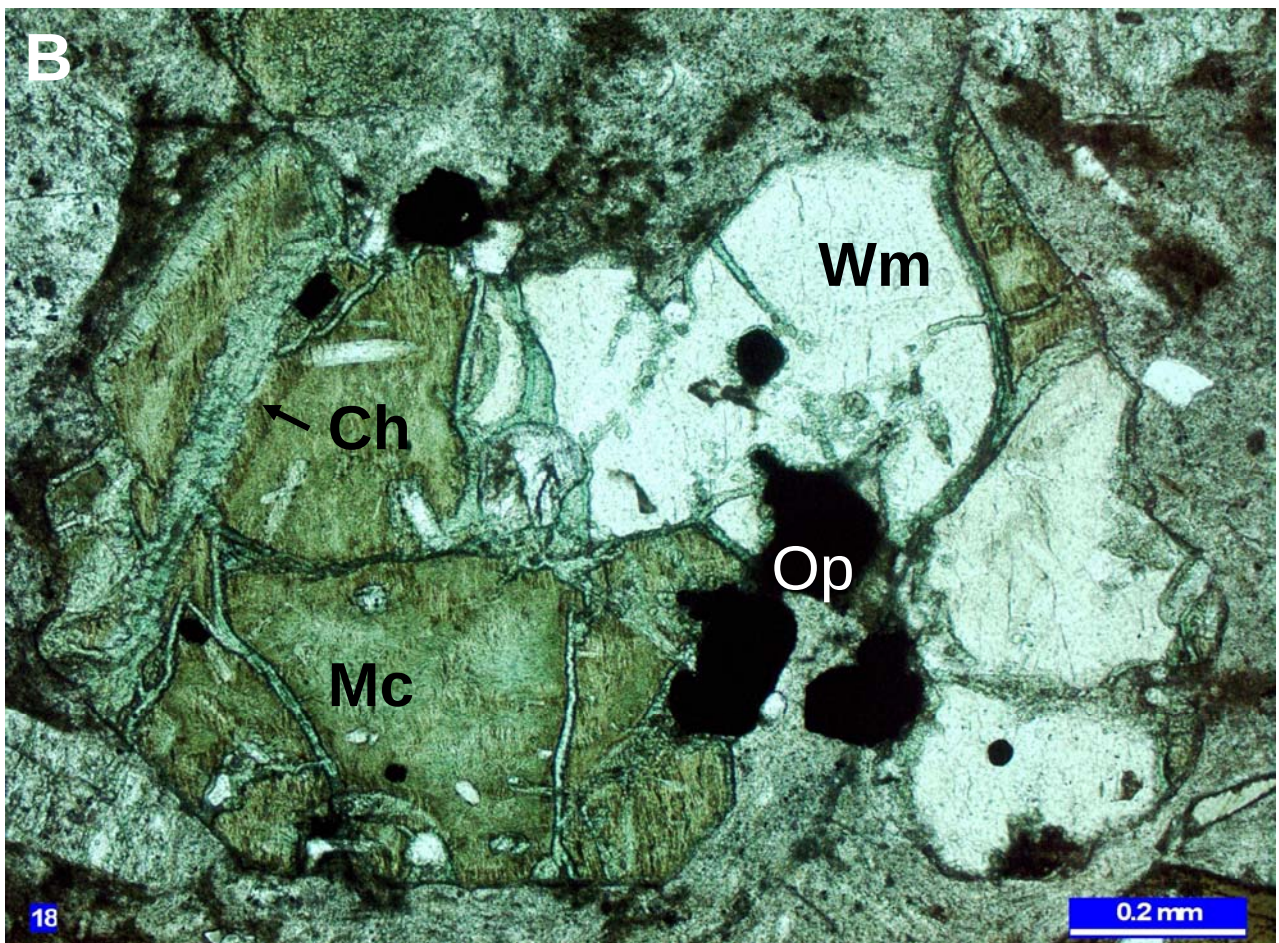
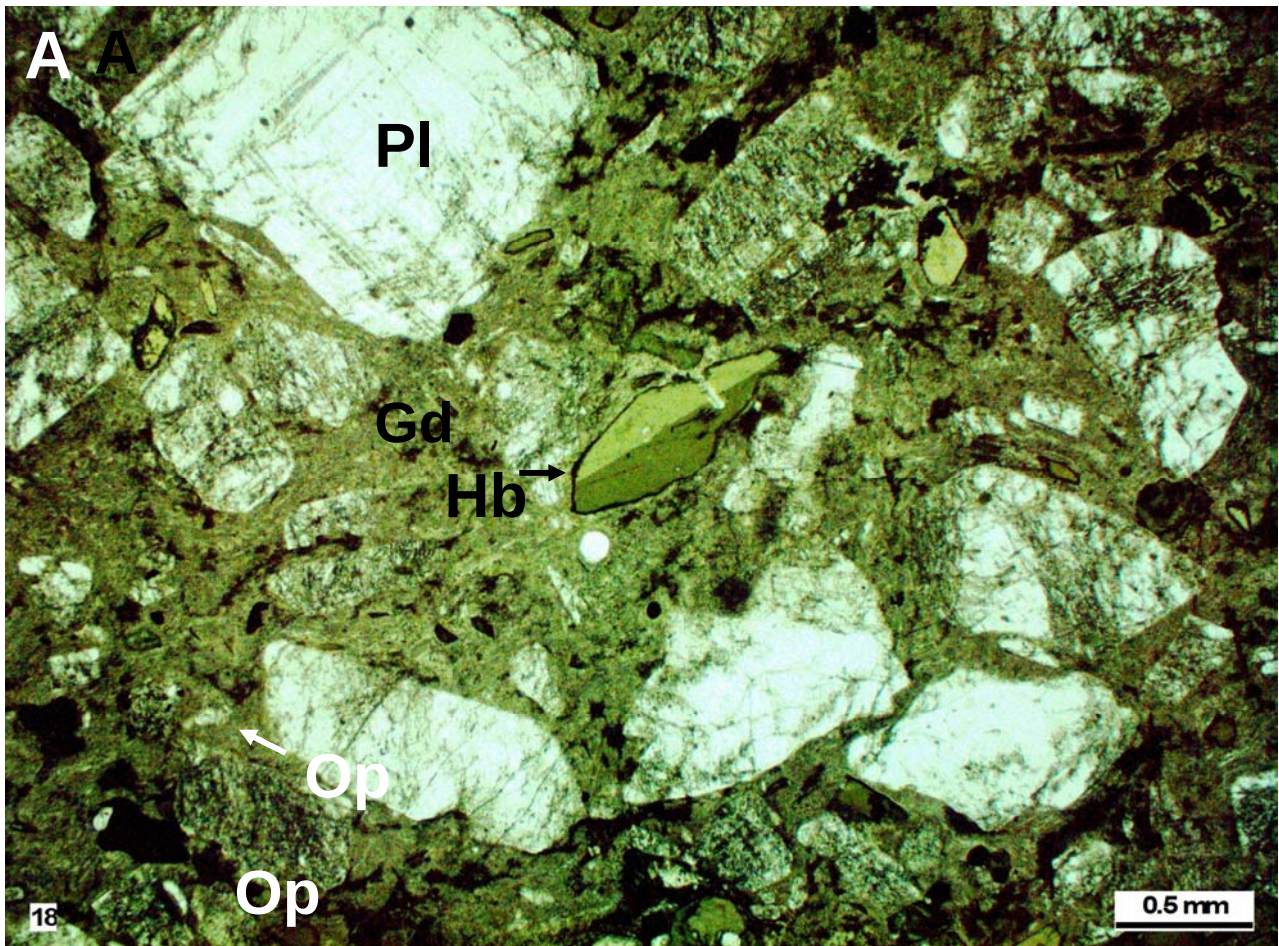
Plate F. Photomicrograph showing presence of very fine grained, turbid aggregates (Tb) of white mica, Fe oxide and clay in arenite. Note Fe oxide (Fo) cement engulfing grains of quartz (Q) and lithic clasts (Lc). PPL. Sample BH5-24.5.

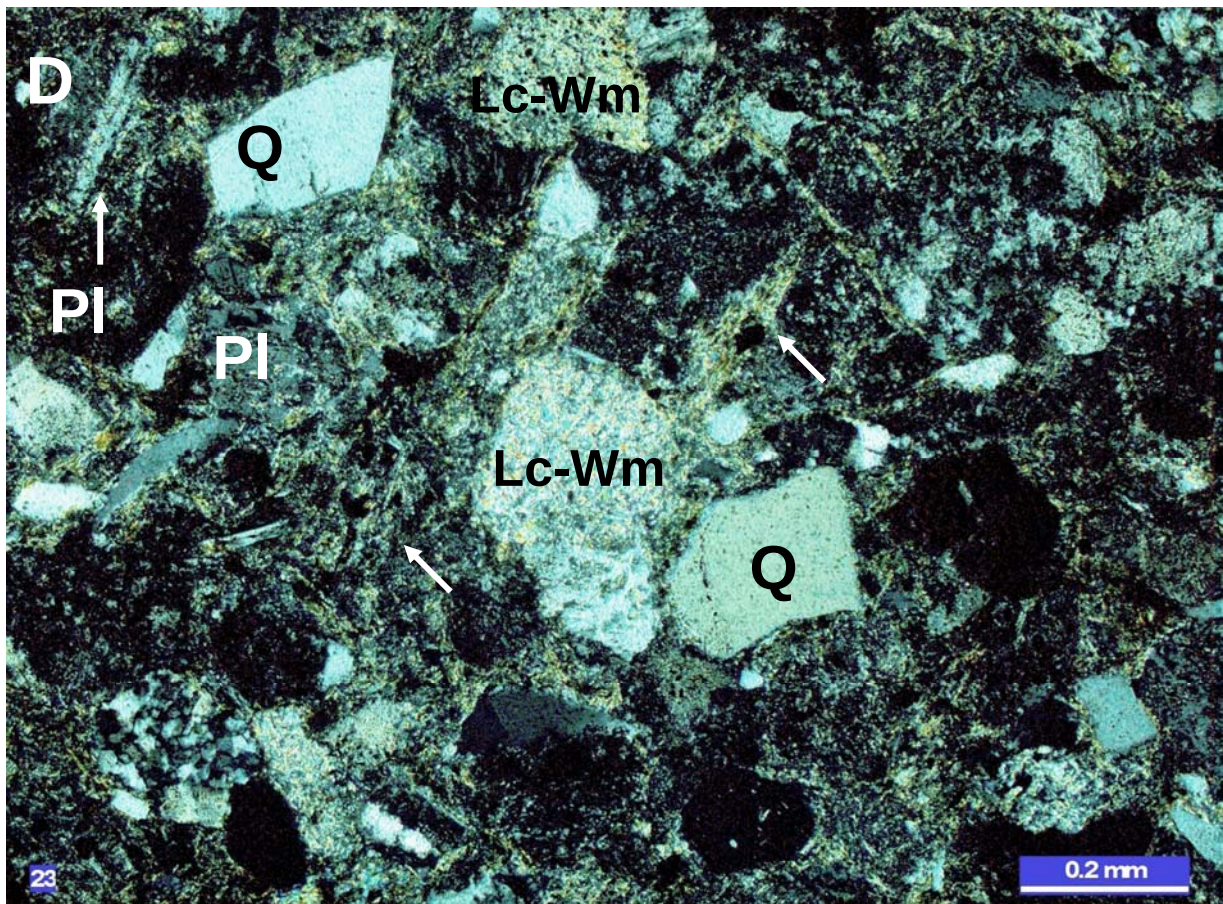
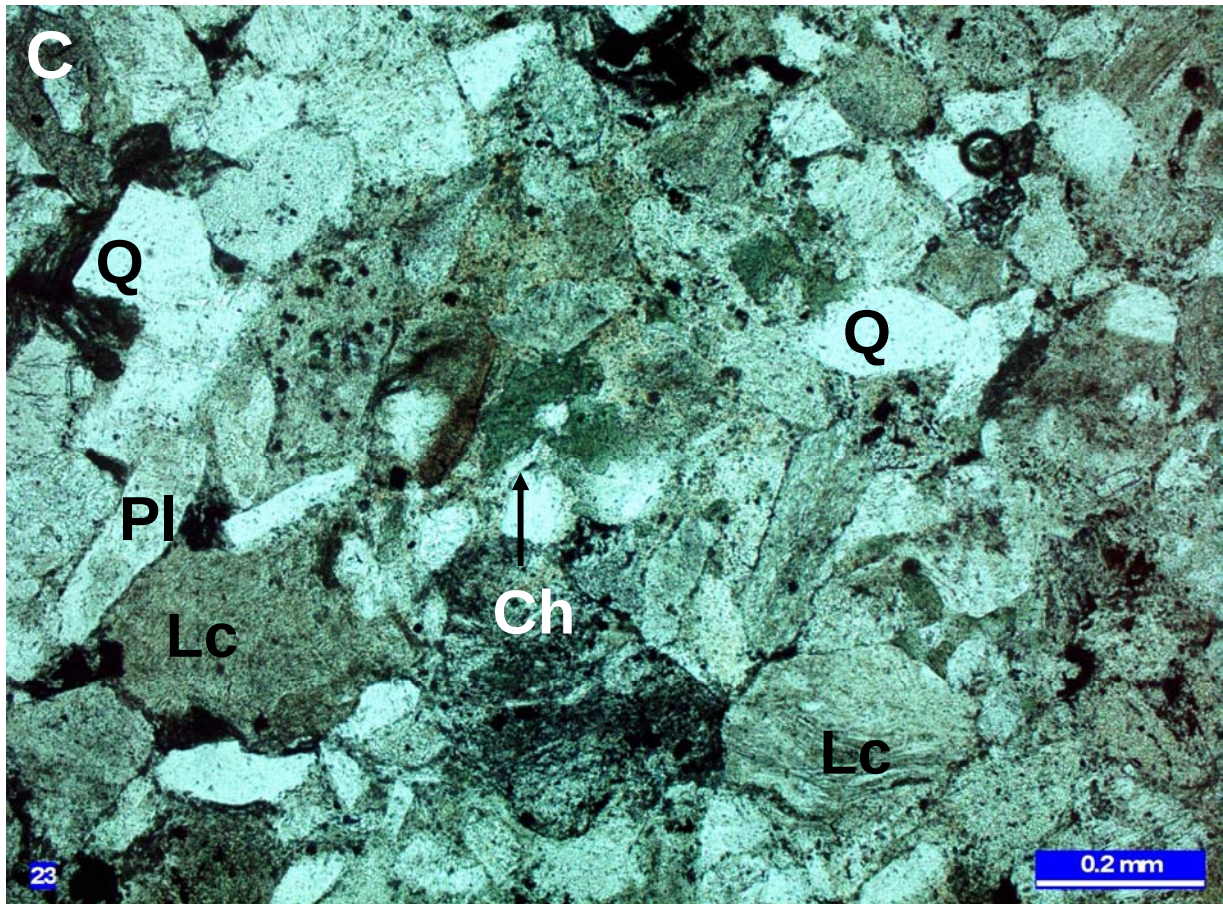
Plate G. Magnified image of very fine grained matrix of sample BH5-5.28. Presence of quartz (Q), muscovite blades (Ms) is apparent. XP. Sample BH5-28.5.

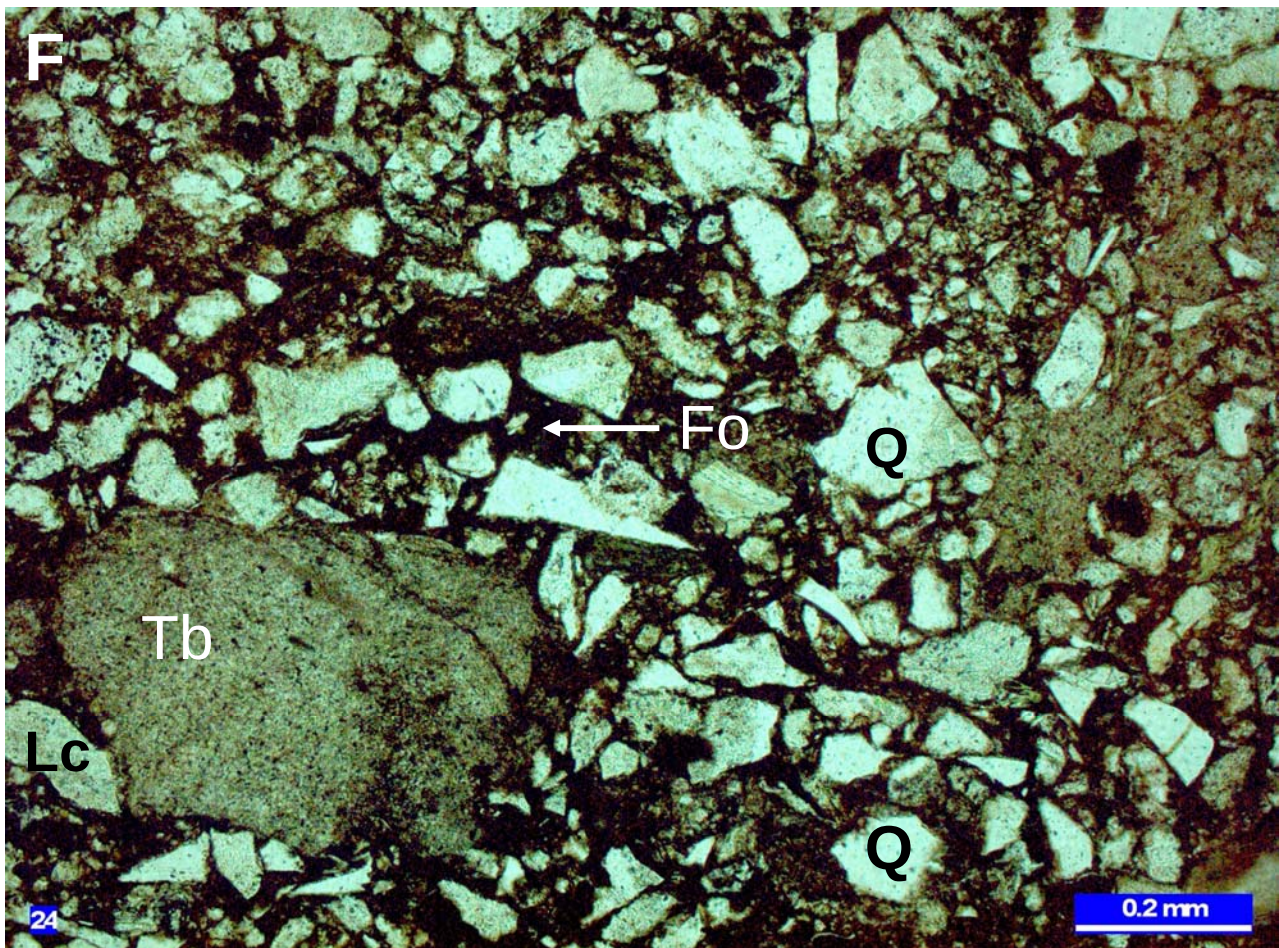
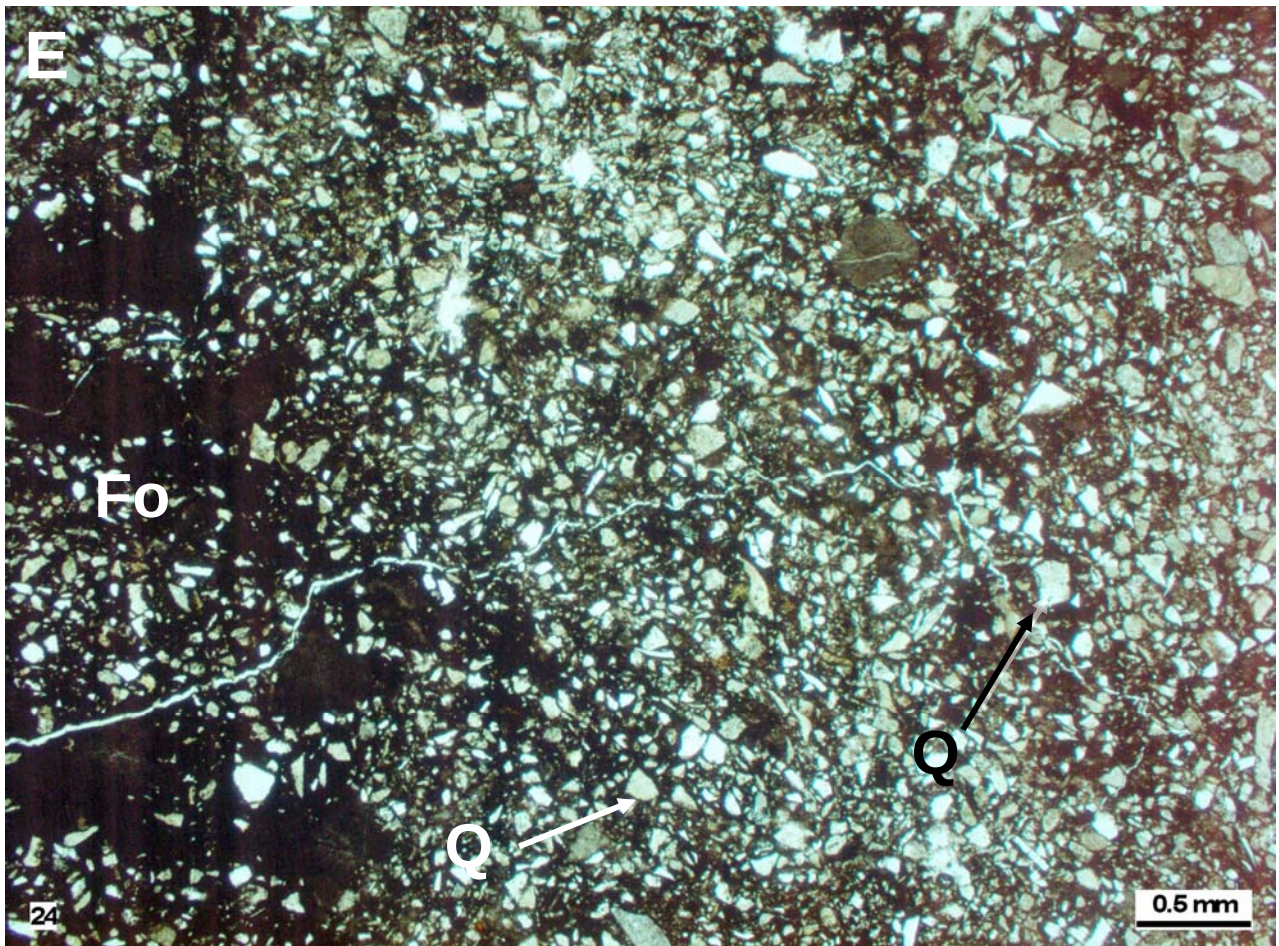
Plate H. Photomicrograph of mudstone showing irregular aggregates of opaque mineral or coalified plant material (Cp). Note presence of larger quartz grains in NW corner. PPL. Sample BH5-28.5.

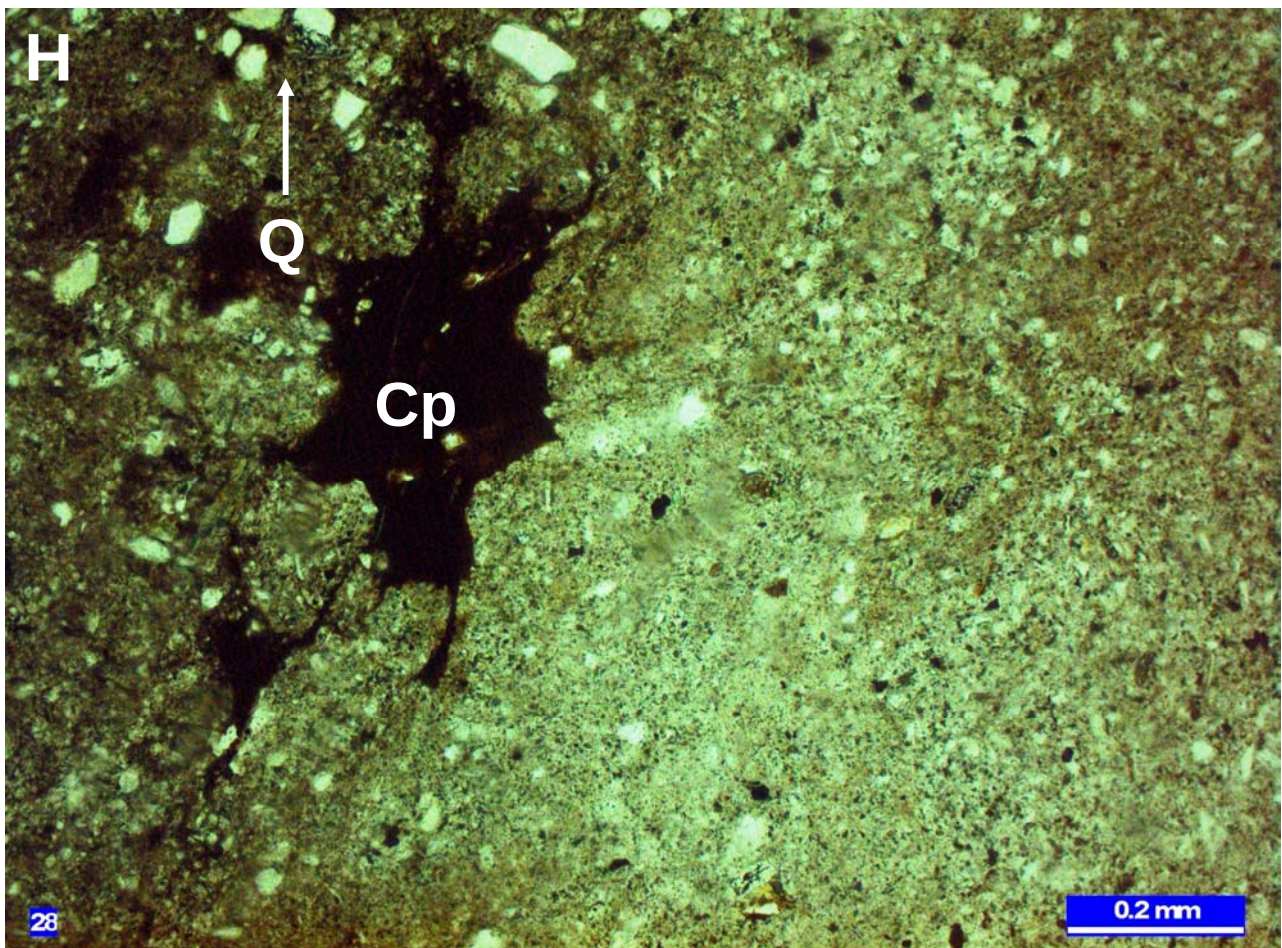
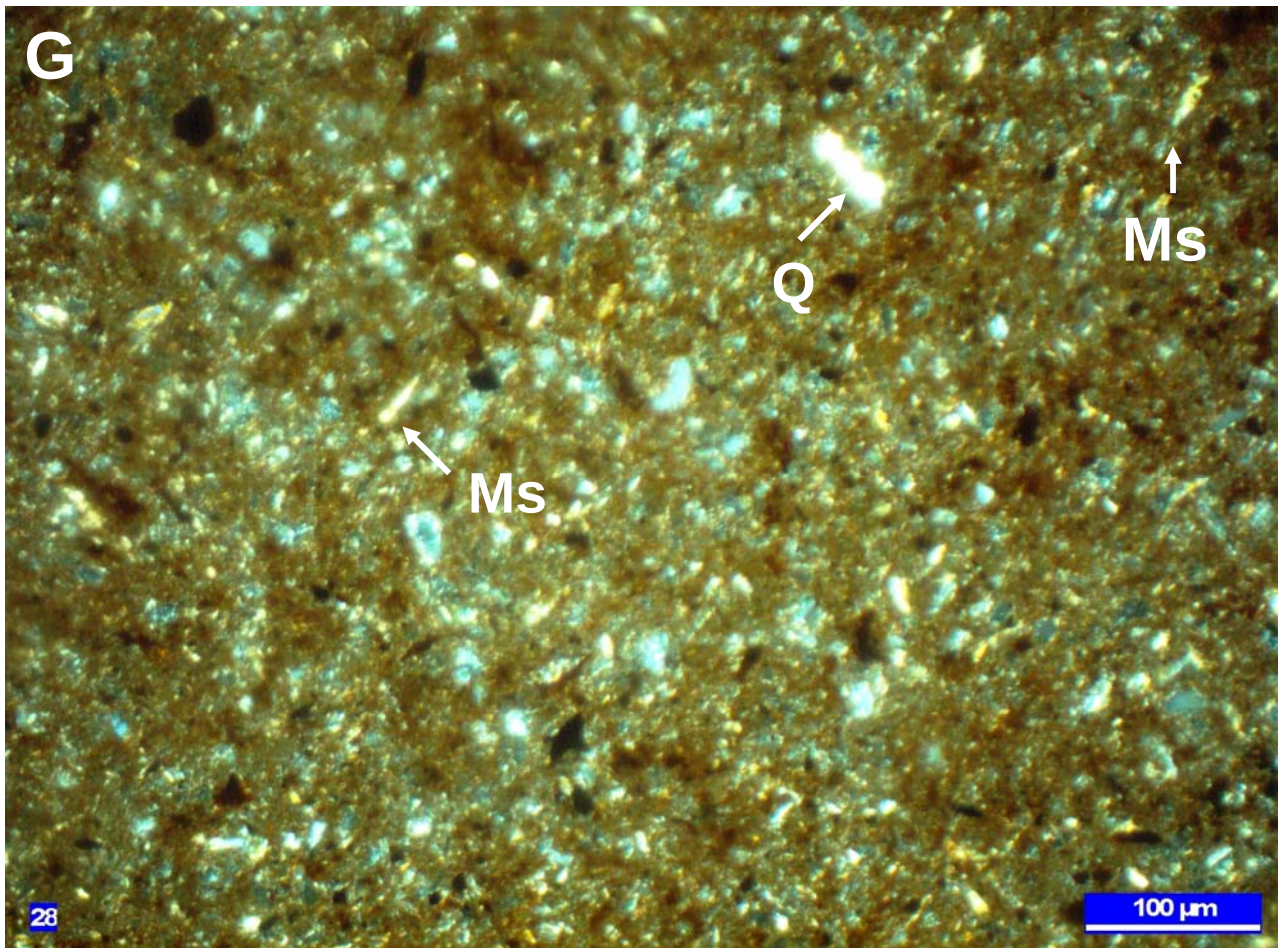
Plate I. Photomicrograph of arenite showing white mica (Wm-illite?) in pore spaces between quartz (Q), plagioclase (Pl) and lithic clasts (Lc). XP. Sample BH5-30.7.

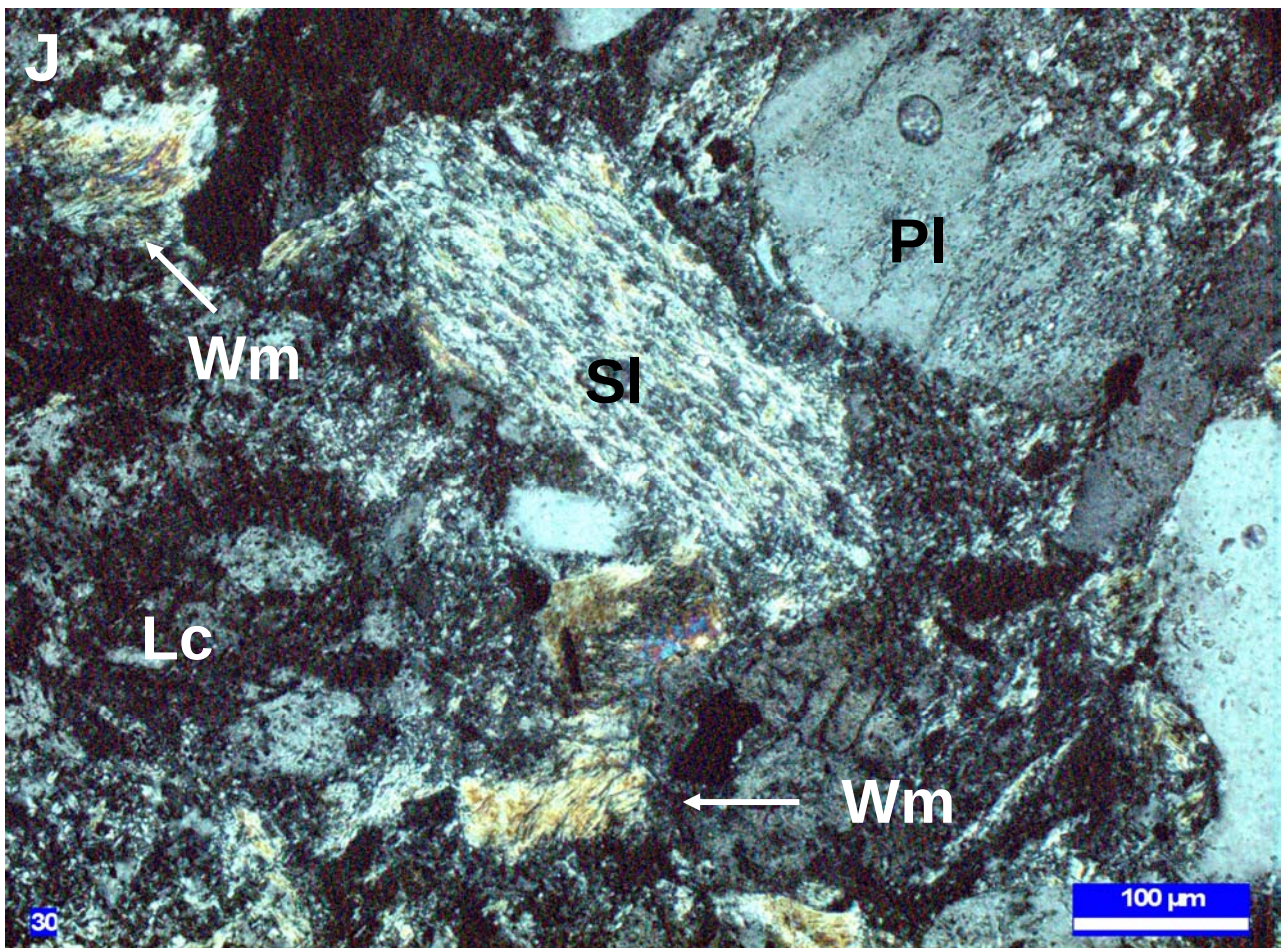
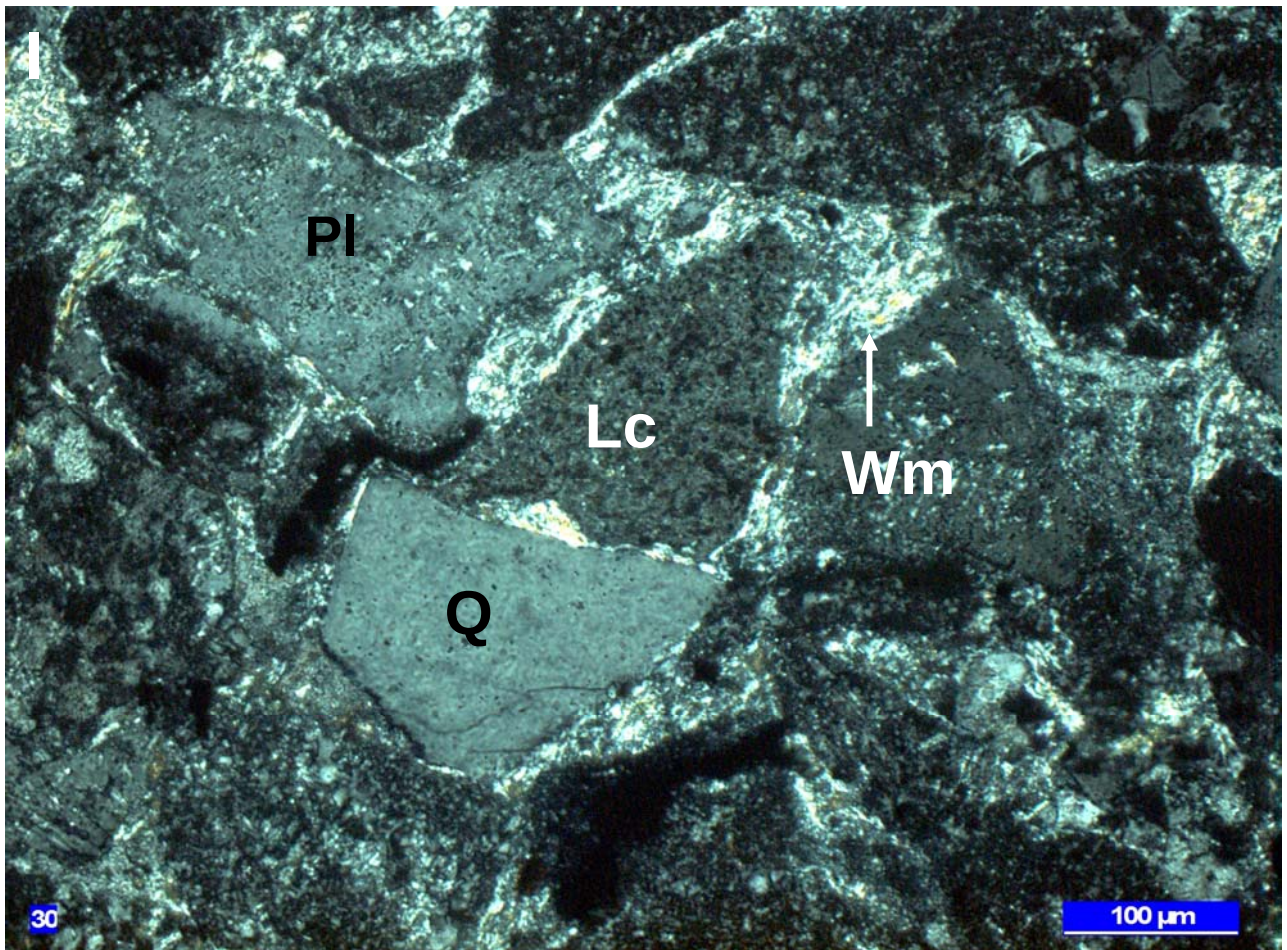
Plate J. Image of low grade metamorphic (Sl-slate?), lithic clast and plagioclase (Pl). Note presence of white mica (Wm). XP. Sample BH5-30.7.











APPENDIX C | JORC TABLE 1

Appendix C – Karuah Table 1 in accordance with JORC Code 2012

Criteria	Explanation
Section 1	
Sampling techniques	9 Holes were drilled on the southern segment of Lot 11 DP1024564. Visual assessment and geological mapping faces within the Karuah Quarry Pit. Each of the drill holes were logged by a competent person with samples photographed and kept onsite.
Drilling techniques	Varying drilling techniques were used based on the material encountered onsite. Auger flights were used in the clay/soil overburden material. Percussion and core drilling were used in weather sedimentary material and andesite.
Drill sample recovery	Clay/Soil samples were recovered and logged however were not kept with the core tray samples. Percussion drilling samples were returned to the surface in the form of chips. Core drilling returned samples, which were logged and stored in the core trays.
Logging	Each of the core drill holes were logged by a qualified geologist (Bert Brink and Larry Cook) with full logs provided in Appendix A. The samples were photographed and stored in core trays. Percussion drill holes were logged at a later date by reviewing chip samples.
Sub-sampling techniques and sample preparation	A number of samples were selected during an initial report called “North Karuah Hard Rock Deposit, Stage 2 Due Diligence Report for National Maritime Services.” Samples were split into upper and lower zones from BH4A which 8 sub-samples split into 2 bags for each zone that was sent for material testing report and polished aggregate friction value.
Quality of assay data and laboratory tests	Material Testing was completed by Coffey Testing Pty Ltd which are a NATA accredited laboratory. Test Results for the Polished Aggregate Friction Value was completed by Boral Construction Materials who are accredited a NATA accredited laboratory. Densities have not been completed on overburden material as it was not deemed necessary as this product provides little value.
Verification of sampling and assaying	No independent review or audit was necessary for the laboratory test results. The nature of the deposit does not require large scale analytical laboratory testing.
Location of data points	The drill hole sample point locations (X & Y) were determined by hand held GPS unit in GDA94 datum. Surface RL of the drill hole sample points were determined by LiDAR flight data that was undertaken by Atlss Aerometrex in 2017.
Data spacing and distribution	A total of 9 bore holes were completed, mainly in the southern region of Lot 11/DP1024564 each spaced from 50-100m apart. Geological mapping was completed on exposed walls of the Karuah Quarry with which is approximately 250m to the north west of the drill holes. Representative target unit samples were obtained from each bore hole.
Orientation of data in relation to geological structure.	The target geological unit is flat lying with a dip of 5 to 10 degrees and a bearing of 155 degrees. The drillholes were vertical and therefore intersect the body close to perpendicular. The exposure in the Karuah Pit is extensive with vast expanses of exposed resource on all sides. The target unit is part of the same body in terms of rock type, hardness and colour and is readily determined in data points.
Sample security	Chain of custody was managed by Quarry Mining Systems Pty Ltd, All samples were removed from site to safe storage on completion work field work. The source rock sample was delivered to the laboratory by registered courier or by hand. Sampling was conducted prior to the author's involvement in the project.

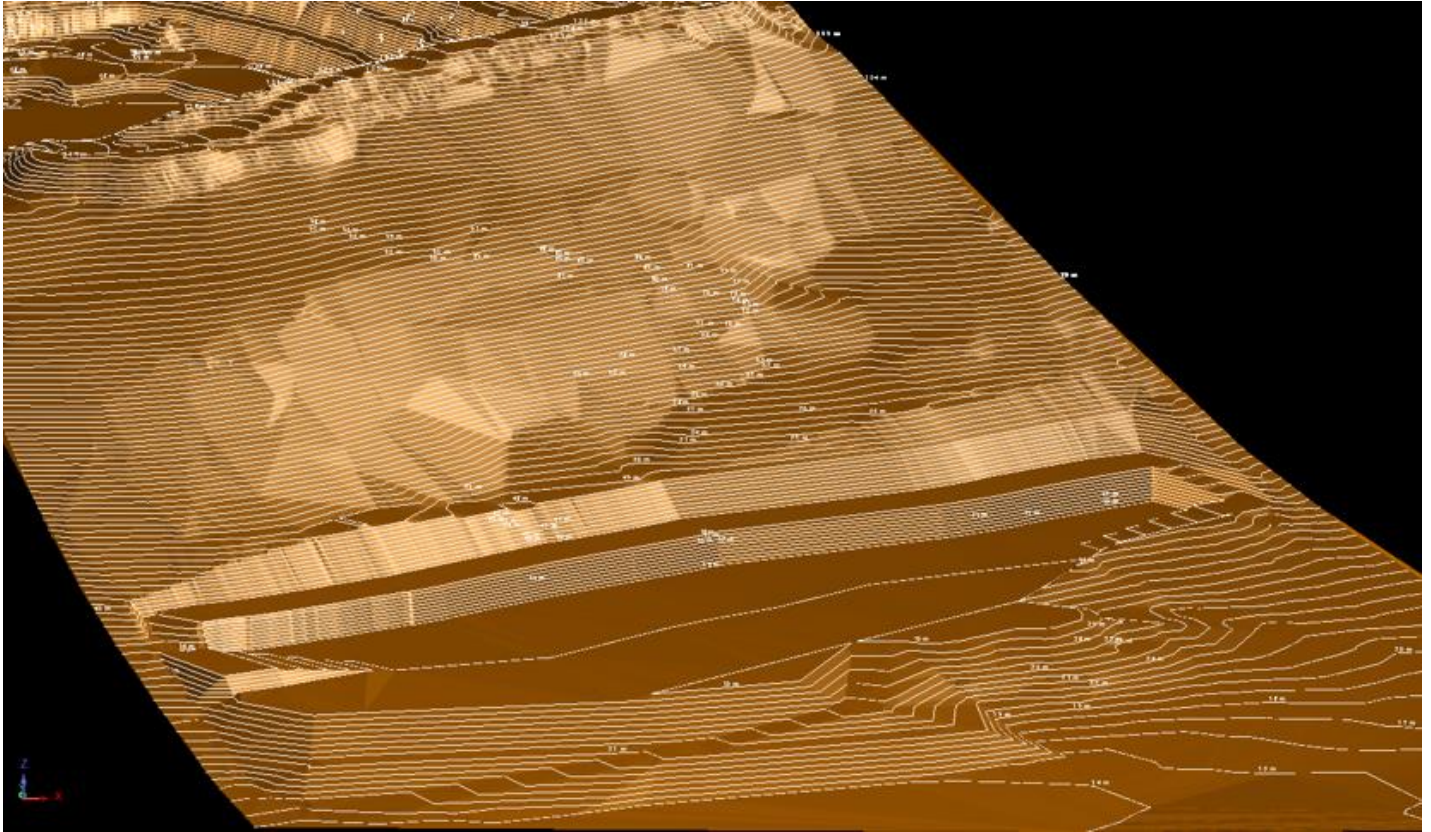
Audits or reviews	Peer review of logs were carried out. No audit of logs has been carried out by third party.
Section 2	
Mineral tenement and land tenure status	The site is known as the Kiely's Quarry and the site is currently non-operational. There is an existing Quarry to the North on the same property (Lot 11 DP1024564) known as "Karuah Quarry" and an approved quarry located to the east of Lot 11 known as "Karuah East Quarry". The freehold land of the proposed Kiely's Quarry is owned by Michael Kiely. It is proposed to apply for permits for the quarry in the near future.
Exploration done by other parties	See Section 3 – Site Investigation and Fieldwork of Kiely's Karuah Quarry - Resource Assessment
Geology	See Section 2 of Kiely's Karuah Quarry – Resource Assessment
Drill hole information	All drill hole were recorded with a handheld GPS, and logged by a qualified geologist. Photos were taken of the logs. Part of the core from the most recent drilling campaign is still stored onsite less the material that was used for testing.
Data aggregation methods	No data aggregation methods were carried out.
Relationship between mineralisation width and intercept lengths	N/A
Diagrams	Borehole locations are shown Figure 3.1 within the report.
Balanced reporting	All borehole data is summarised in Table 3.2. All laboratory test result sheets are attached in Appendix B.
Other substantive exploration data	No other exploration data is available on the deposit at the date of report writing.
Further work	At this stage it has been deemed that there is sufficient geological information between the 9 logged drill holes and the exposed face that has been surveyed within the wall at Karuah Quarry to the north to proceed with applying for an environmental approval.
Section 3	
Database integrity	Estimated target unit thicknesses from the drill holes were used in Surpac 3D software version 6.6.1 to analyse volume of rock mass. Data entry was checked visually for inconsistencies.
Site visit	The drilling was overseen by a competent geologist with photographs and logs taken. Prior to the modelling a competent mining engineer along with the geologist looked at the exposed faces at Karuah Quarry and the drill holes prior to modelling.
Geological interpretation	The geology of the site is relatively simple. A simple geological model, consistent with the existing geological mapping, is sufficient for the resource confidence stated. Local anomalies in thickness have occurred (from past mining) but haven't significantly impacted the mining of panels. Continuity of the target unit to the east and west is valid, but needs testing and quantifying. The southern target unit boundary is not clearly defined but a cut off boundary has been applied based on drill holes with and without the target unit present. The lower boundary of the unit has been determined using visual inspection in the Karuah Quarry pit (underlying conglomerate observed) and the base of some of the drill holes.
Dimensions	The target unit is known over 700m length on the longest side and ranges in width from 300-350m. The body has a relatively consistent thickness (30-60m). To the north material has been historically extracted by Hunter Quarries at their Karuah Quarry resource. The footprint of this previously mined area covered approximately 7.6 Hectares. The calculated area of the interpreted unmined target unit is 10.89 Hectares.

Estimation and modelling techniques	The mineral resource identified is based on defined target unit boundaries (which have been a 10m offset from the property boundary) and interpreted continuity or projection between these boundaries. The base of the resource has been assumed at the base of the holes that have been drilled, or unless encountered within the hole. A computer generated wireframe model was used to interpolate the resource, using an inverse distance interpolation method.
Moisture	The target rock is a non-porous material so moisture has a limited affect on the target material.
Cut-off parameters	The whole of the target unit rock mass is considered as the mineral resource suitable for various uses.
Mining factors or assumptions	Assumed that open pit mining operations will be implemented onsite.
Metallurgical factors or assumptions	Not applicable for quarry resources
Environmental factors and assumptions	Environmental factors have been considered using surrounding operations as a precedent. Detailed studies will be conducted as part of the upcoming EIS.
Bulk density	Material has been reported in volumes at this point in time, awaiting further bulk density testing.
Classification	The identified resources are considered an "Indicated Mineral Resource"
Audits or reviews	No audits or reviews have been carried out at this stage of the project.
Discussion of relative accuracy/confidence	The resource estimate comprised a model using Surpac Software and was cross checked with a relatively simple volume estimate of a rock mass with various degree of thickness of the target unit applied.

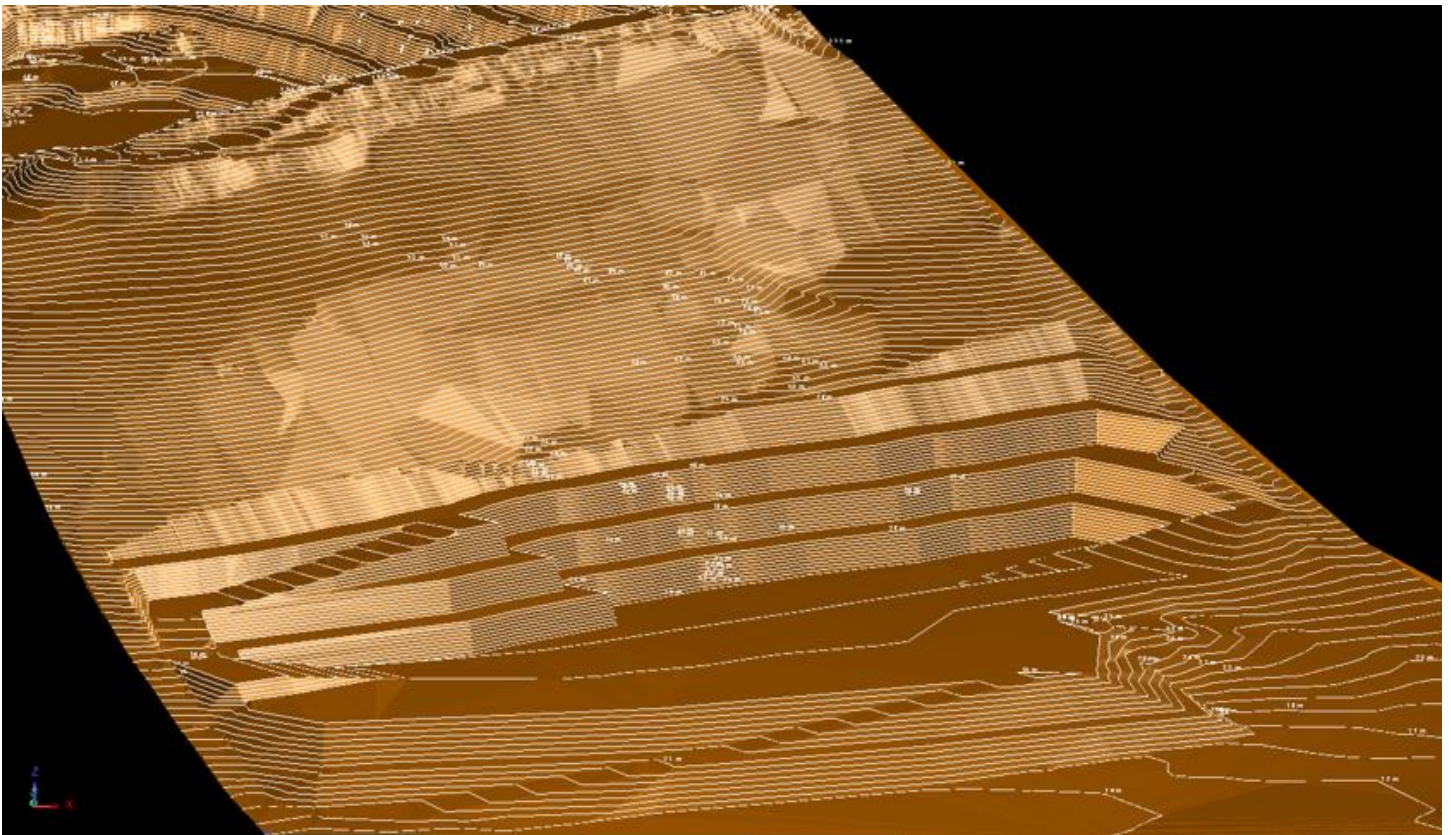
APPENDIX D | STAGED 3D EXTRACTION VIEWS

Appendix D – Staged Extraction 3-D Views

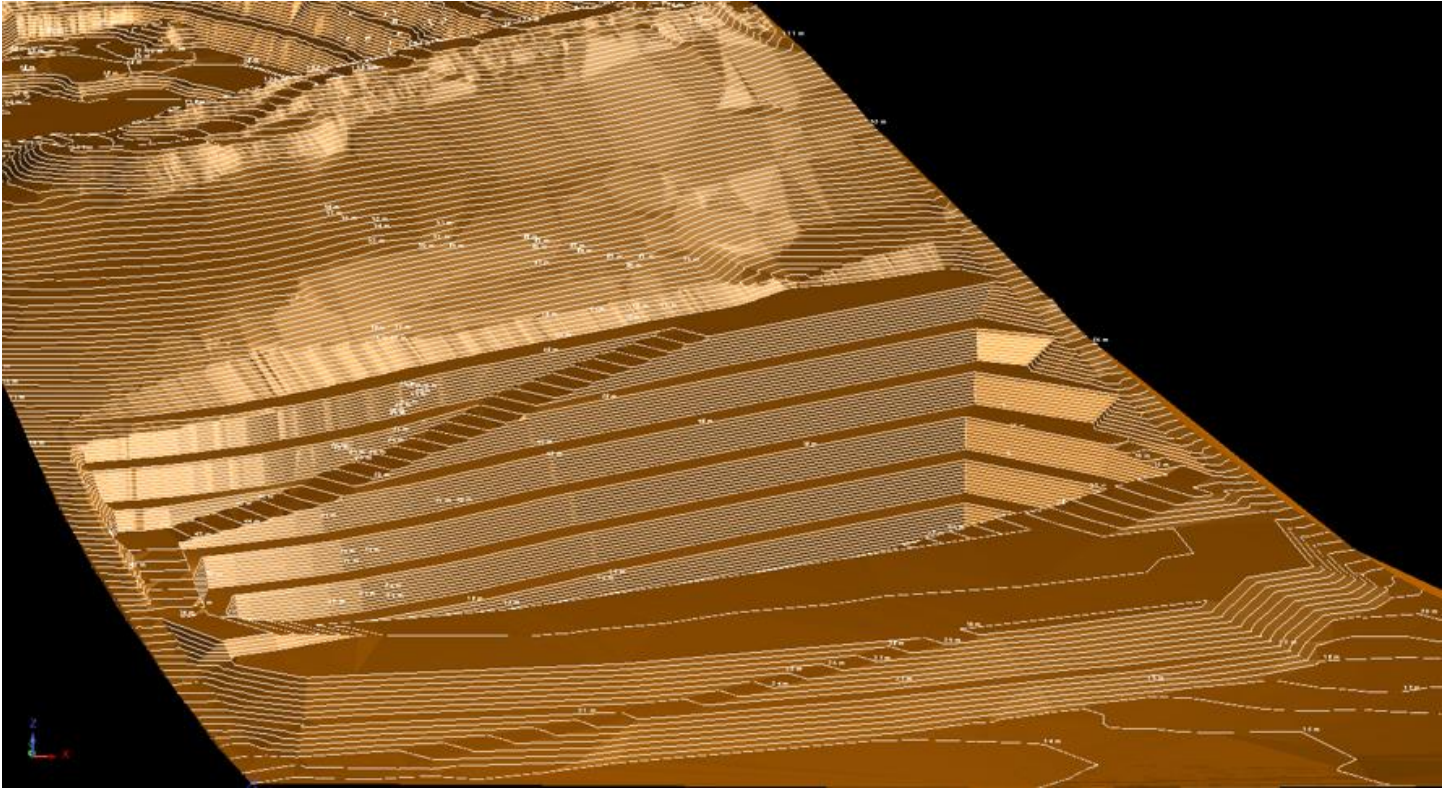
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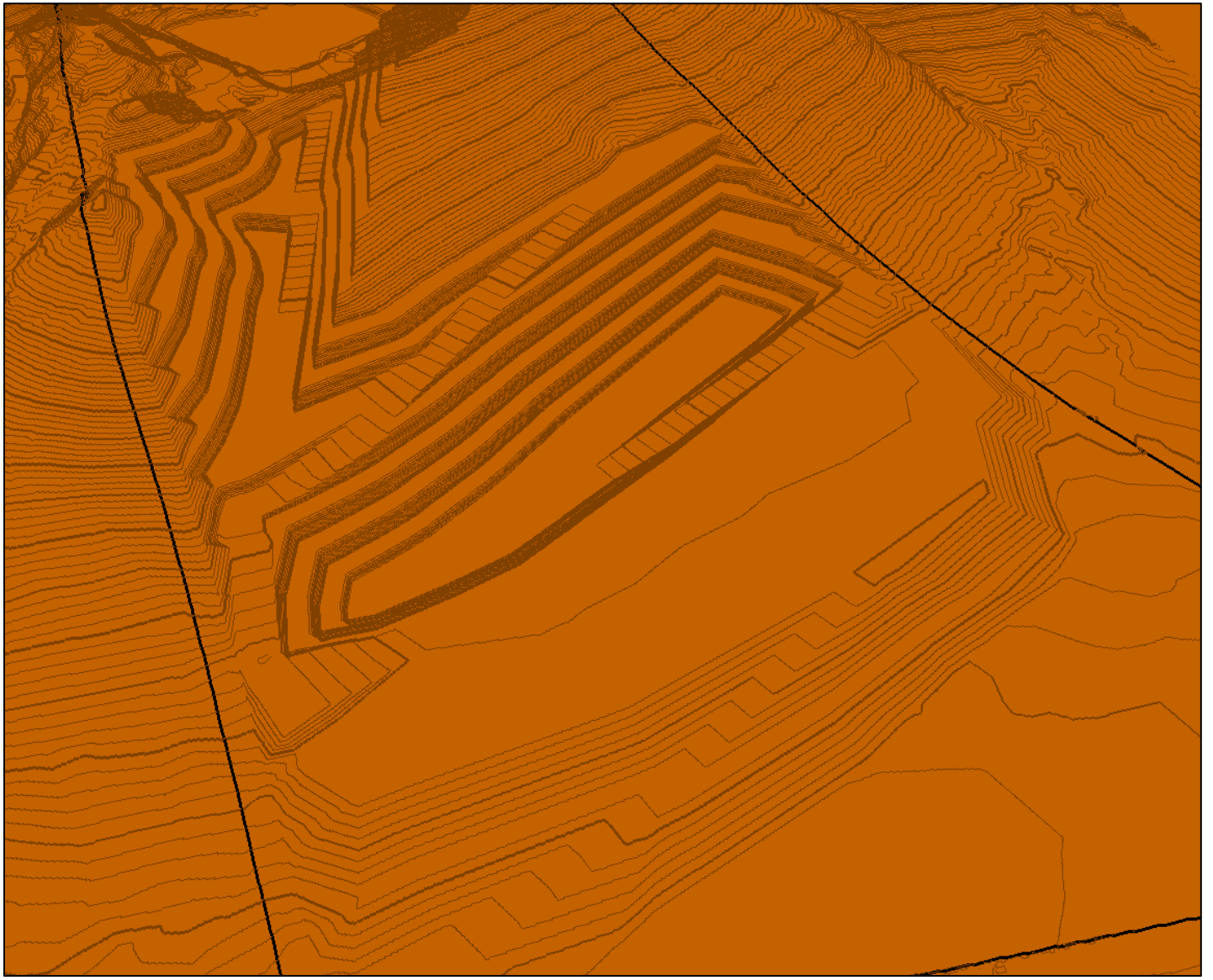
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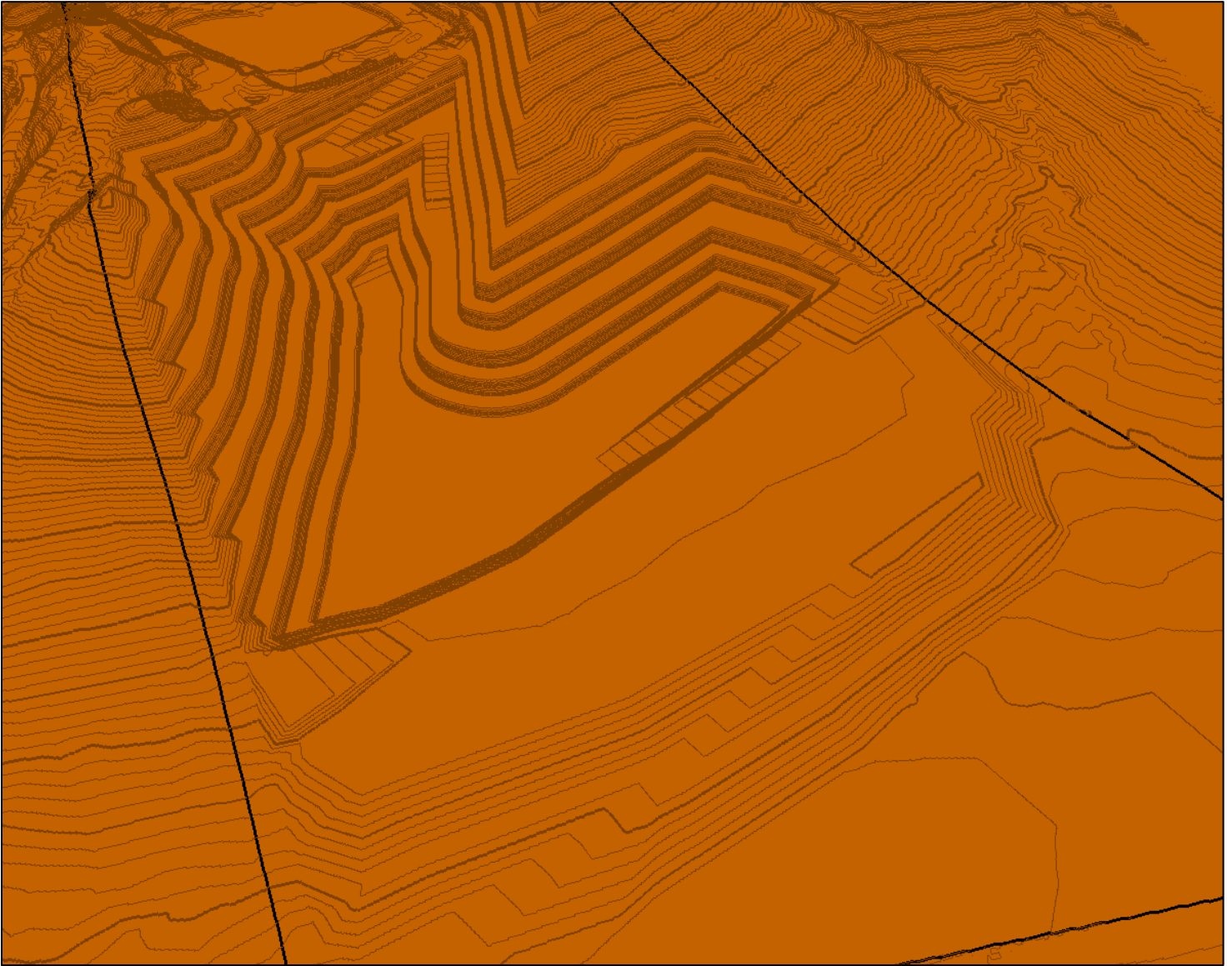
Stage 1c



Stage 2a



Stage 2b



Stage 2c

