APPENDIX B

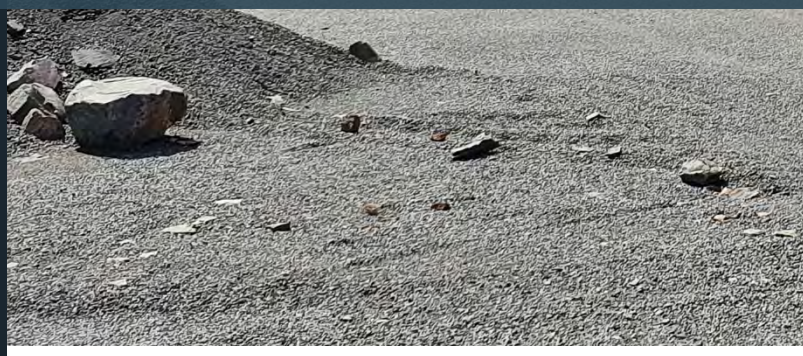
Geological Assessment

vgt environmental compliance solutions and laboratories



March 2021

Amended Geological Assessment for Martins Creek Quarry Buttai Gravel Pty Ltd



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Revision Table

Date	Version	Author	Reviewed	Approved
September 2015	1217	GVT	GT	
July 2018	5897	GVT	LT	
August 2019	5897 D2 & D3	GVT	AK, PW	
October 2019	5897 D4	GVT	Daracon/Umwelt	
September 2020	9714 D0	GVT	Daracon/Umwelt	
November 2020	9714 D2	GVT	Daracon/Umwelt	
December2020/January 2021	9714 D3	GVT	Daracon/Umwelt	
March 2021	9714 F1	GVT	Daracon/Umwelt	

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Acronyms and Terms Used Throughout the Report

Through this document, a number of Acronyms and reference terms are frequently used. To assist the reader, the following lists are provided.

ACRONYMS	
AHD	Australian Height Datum
Ma	Million years
Daracon	Buttai Gravel Pty Ltd

Geology Glossary

Word	Meaning
Agglomerate	Large, coarse, rock fragments associated with lava flow, ejected during explosive volcanic eruptions.
Alluvial Soil	Juvenile soils formed by deposition from still or moving water. Little pedological development beyond some accumulation of organic matter at the surface.
AHD – Australian Height Datum	A height of zero was assigned to the mean sea level determination at 30 tide gauges around the Australian Mainland coastline, measured over a three-year period from 1966 to 1968 Ref 2.
Aquifer	A soil or rock layer or group of layers that is sufficiently saturated and permeable to yield significant quantities of water.
Andesite	A fine grained volcanic igneous rock Ref 3. The term is derived from the series of mountains found along the west coast of South America, known as the “Andes”. These general form along convergent plate margins.
Bed Rock	The unweathered rock that lies below loose surface deposits of soil and alluvium.
Conglomerate	A rock consisting of individual clasts within a finer grained matrix, rounded fragments mostly indicate movement through water.
Earthworks	The process of extracting, moving and depositing earth during construction.
Embankment	A mound or bank of earth or stone formed to support a roadway, serve as a protective barrier, or the like.
Erosion	The natural process where wind or water detaches a soil particle and provides energy to move the particle.
Excavation	The act or process of digging out earth during construction.
Faulting	A fracture in rock along which there has been an observable amount of displacement. Ref 3
Feldspar	Most important rock forming silicate mineral, either Plagioclase or Alkali Feldspar Group. Ref 3.
Hydrology	The study of rainfall and surface water runoff processes.

Ignimbrite	New Zealand geologist Patrick Marshall derived the term 'ignimbrite' from ‘fiery rock dust cloud’ (from the Latin *igni-* (fire) and *imbri-* (rain)), formed as the result of immense explosions of pyroclastic ash, lapilli and blocks flowing down the sides of volcanoes. Or sometimes known as Welded Tuffs. An ignimbrite is the deposit of an extremely hot pyroclastic ash, such that the edges of fragments can be seen to weld together. This term describes how the rock is formed not the chemical composition of the rock. Ignimbrites can only form as a result of sub-aerial volcanic activity [Ref 3]. Ignimbrites can be Rhyolite, Rhyodacite or Dacite in composition. Sometimes the crystals can appear flat to show a flow effect, but this is due to a layering of the material as the material compacts and presses down on the hot beds.
Indicative	When you want to show that something is suggestive or serves as a sign of something. [Ref 4]
Indurated	Heat affected rocks that are harder than normal and maybe even partially melted and recrystallised.
Latite	Or Trachyandesite – Intermediate volcanic rock, between Trachyte and Andesite. [Ref 3].
Lithology	A term usually applied to sediments, referring to their general characteristics. [Ref 3]. Can also be a general term for any rock, found in the field.
pH	A measure of the degree of acidity or alkalinity expressed on a logarithmic scale of 1-14, on which 1 is most acid, 7 is neutral and 14 is most basic.
Plagioclase	A type of sodium and calcium feldspar.
Porphyry	Igneous rock with large crystals set in smaller crystals/
Quartz	Chemically SiO_2 this mineral is very resistant to weathering which allows it to be the most common mineral on the surface of the earth.
Sand	Are categorised as particles that range between 0.0625 mm to 2.00 mm. [Ref 1]. These can be made from quartz, limestone, feldspar, basalts, latites, organic particles and olivine. These deposits are found on beaches, dunes, rivers, glacial outwash and volcanic slopes.
Sediment	Material of varying sizes that has been or is being moved from its site of origin by the action of wind, water or gravity.
Sediments	A generic term used to describe consolidated rocks that have been deposited by water, wind and air. These include sandstone, claystone, conglomerate and coal.
Silt	Are categorised as particles that range between 0.0625 mm to 0.0039 mm. [Ref 1]
Smectite	A group of clays that readily accept (swell) and reject water (shrink).
Soil	That part of the upper weathered layer of the earth’s crust that can support plant growth. Any naturally occurring loose or soft deposit forming part of the earth’s crust and resulting from weathering or breakdown of rock formation or from the decay of vegetation.

Soil Texture Group	An important attribute of soils that affects the effectiveness of sediment retention structures is the proportion of particles finer than 0.02 mm. Particles that are finer than 0.02 mm are relatively difficult to trap in simple sediment retention basins, while those that are coarser are not.
Tuff	A pyroclastic ash, originated from volcanoes [Ref 3].
T – Tonnes	Weight measurement being 1000 kilograms.
Volcano	A vent or fissure in the Earth's crust through which molten magma, hot gases and other fluids escape onto the Earth's surface.
Volcanics	A generic term for the purpose of this document includes Andesite, Rhyolite, Basalt, Ignimbrite, tuff and volcanic breccia. All of which produce, depending on structural integrity, concrete, road and construction aggregates.
Waste	Includes any matter (whether liquid, solid, gaseous or radioactive) that is discharged, emitted or deposited in the environment in such volume, constituency, or manner as to cause an alteration to the environment.
Weathering	The process by which rocks are broken down and decomposed by the action of external agencies such as wind, rain, temperature changes, plants, and bacteria. [Ref 3]

Glossary References

Ref 1. Pettijohn F.J, Potter, P.E. and Siever R. 1972 Sand and Sandstone.
Ref 2. G.C. Luton and G.M Johnson 2001
Ref 3. Penguin Geology Dictionary, Whitten and Brooks 1982
Ref 4. https://www.vocabulary.com/dictionary/indicative

1.1 INTRODUCTION

Martins Creek Quarry is operated by Buttai Gravel Pty Limited (Daracon) under licence and is situated off Station Street, Martins Creek, see *Figure 1.* Martins Creek Quarry is well known in the industry and the community, since the early 1900's in relation to the production of its principal product known as "Andesite". Petrographic assessment completed for the Amended Geological Assessment and presented in *Appendix A* identifies the rock as a Latite Tuff. For the purpose of geological correctness, and comparative analysis with other Quarry resources, the rock will be referred to as Latite for the remainder of the report.

VGT Environmental Compliance Solutions Pty Limited (VGT) was engaged by Umwelt (Australia) Pty Limited on behalf of Daracon to review the Geological Assessment of the Martins Creek Quarry following from the previous geological report prepared by VGT in 2015 (VGT, 2015).

The principal goals for this Amended Geological Assessment are as follows:

- To re-evaluate and describe the geological environment of Martins Creek;
- Describe the methods of resource modelling that make up the volume assessment of all insitu materials for the Martins Creek Quarry based on VGT (2015);
- Confirm the total project area resource and resource required and available for the 25-year project period; and
- Review and analyse the properties of the Martins Creek Quarry resource, along with those of other quarries, and review the strategic relevance and importance of Martins Creek Quarry.

In order to achieve these goals, the Amended Geological Assessment included a review of the drill cores obtained from the 8086 series works provided by Daracon, updates the original resource model to include new data and findings and include details of this new modelling assessment. This Amended Geological Assessment has verified the drill core logs for the 8086 series, provided in the original Geological Assessment (VGT, 2015).

1.2 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS(SEARS)

Table 1. Secretary's Environmental Assessment Requirements (SEARs) dated 4 August 2016

Requirements	Section of report where addressed
DPE	
A full description of the development including: • the resource to be extracted, demonstrating efficient resource recovery within environmental constraints, and having regard to NSW Trade and Investment's requirements (see Attachment 2)	This Report
NSW Trade and Investment	
• A summary of the regional and local geology including information on the stratigraphic unit or units within which the resource is located.	*Section 2*
• The amount of material to be extracted and the method or methods used to determine the size of the resource (e.g. drilling, trenching, geophysical methods). Plans and cross-sections summarising this data, at a standard scale, showing location of drillholes and/or trenches, and the area proposed for extraction, should be included in the EA or EIS. Relevant supporting documentation such as drill logs should be included or appended. Major resource proposals should be subject to extensive drilling programs to identify the nature and extent of the resource.	*Section 4, Figure 4, Figure 9, Figure 10*
• Characteristics of the material or materials to be produced: o For hard rock aggregate proposals, information should be provided on properties such as grainsize and mineralogy, nature and extent of	*Section 5*

weathering or alteration, and amount and type of deleterious minerals, if any.	
• An assessment of the quality of the material and its suitability for the anticipated range of applications should be given.	*Section 5*
• The amount of material anticipated to be produced annually should be indicated. If the proposal includes a staged extraction sequence, details of the staging sequence needs to be provided. The intended life of the operation should be indicated.	*Section*
• If the proposal is an extension to an existing operation, details of history and past production should be provided.	*Section 1.1*

Table 2. Environmental Impact Statement 2016 Submissions

Organisation / Name	Submission Details	Section of report where addressed
DPI - GSNSW	The geological resource volume/quantity has been demonstrated in the EIS, however the resource quality assessments are referenced but not provided. The bolded sections below should be provided to demonstrate the product's suitability to the intended uses, as specified in DRE/GSNSW SEARs. • Appendix B: Business and Extraction Report, Appendix A - Qualtest Material Engineering Properties • Appendix K Part 1: VGT Geological Assessment Sept 2015, Appendix B - Petrographic Assessment GSNSW has no issues regarding resource utilisation or land use compatibility, however the omitted resource quality assessments should be included in the EIS or provided to DRE separately and noted in the EIS.	*Section 5*
Dungog Shire Council	It is worth noting in section 1.2 Previous Geological Assessments the report references the following Exploration Programs 1968, 1984 and 2006. VGT Pty Ltd have either not been provided with the results of the Geological investigations undertaken by C. L. Adamson in December 1979 and which was referenced as Appendix 3 to the EIS prepared by D.P. James in July 1990 for the proposed Railway Ballast Quarry or they have determined not to include them for whatever reason. VGT have plotted the location and outcome of the respective bore holes from each previous investigation	*Section 2.3*

1.3 SCOPE

This document reviews all insitu resources found within the project area at Martins Creek. The quarry industry as a low-cost high-volume industry must keep all available products in mind to achieve an economical operation, from the topsoil for rehabilitation to its premium products, in this case Latite.

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Site Location	***Location:***	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Google Maps 2020	***Our Ref:***	9714_MC_GA2020_C001_V0_F1.cdr
Figure:	ONE	***Council:***	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	SK/JD
Sheet:	1 of 1	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V0 17/09/2020	***Client:***	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

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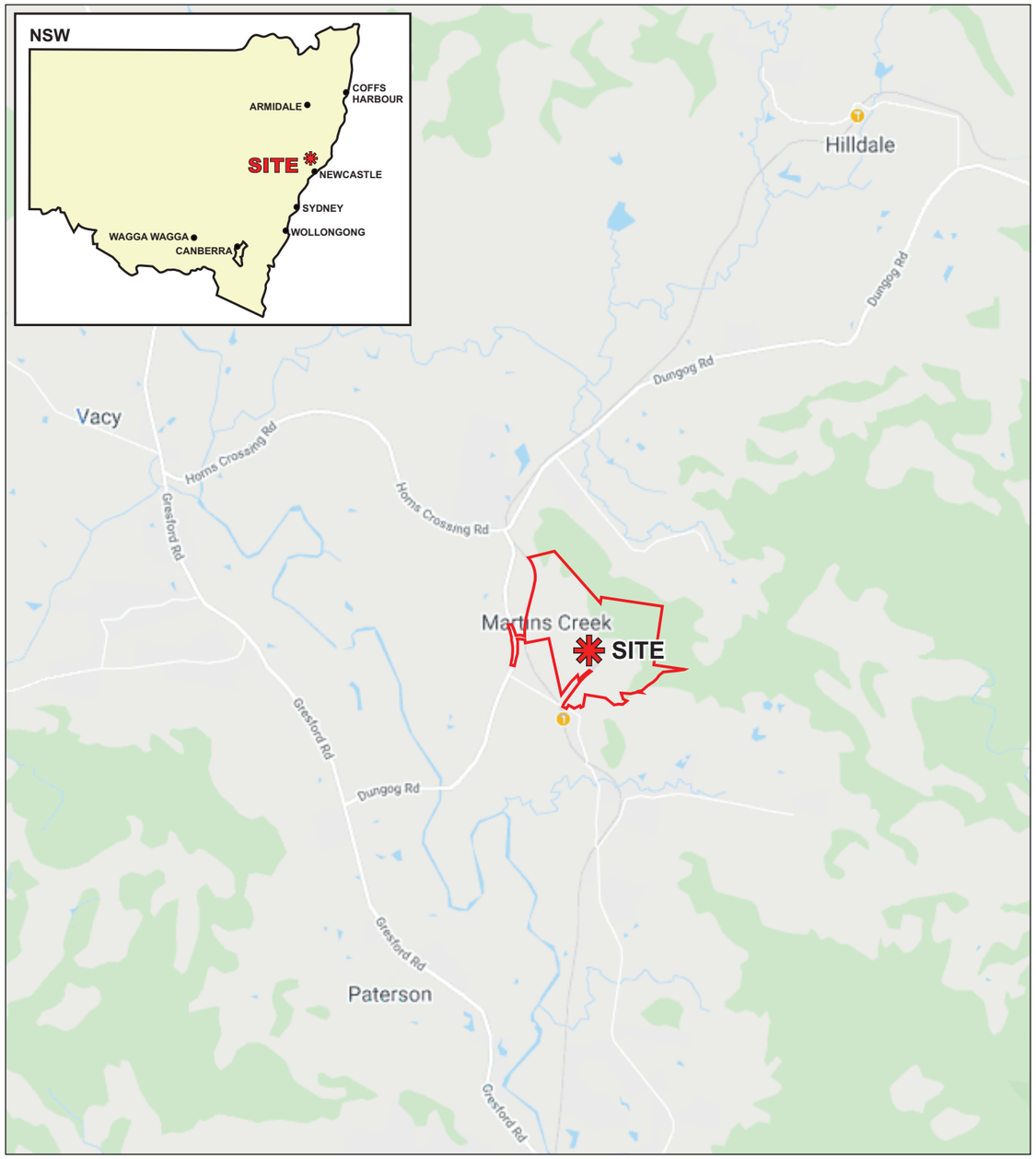

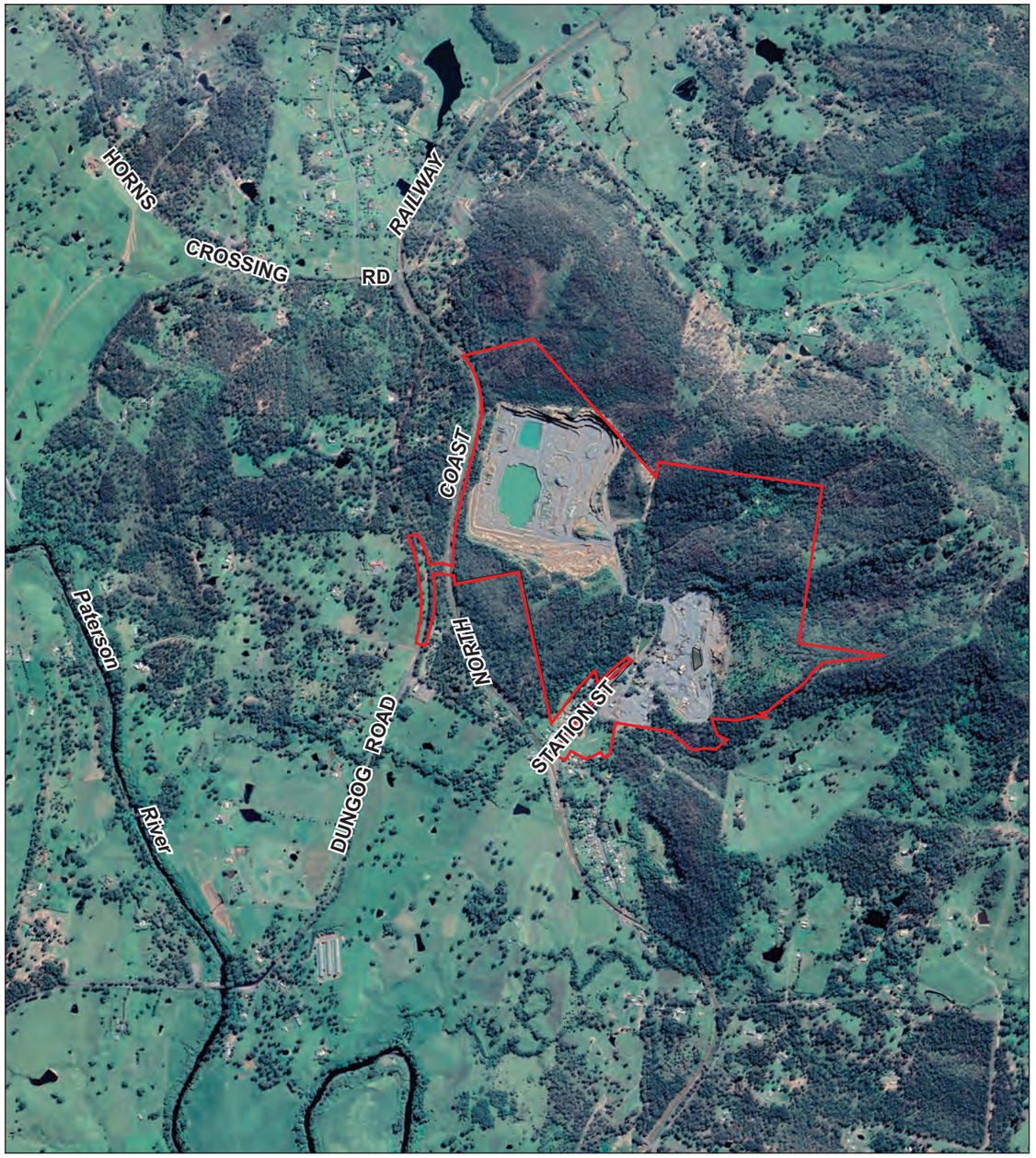

Approx Scale: 0 1km

Approx Scale: 0 500m

Legend

Project Area

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Site Layout
Figure:	TWO
Sheet:	1 of 1
Version/Date:	V1 23/09/2020

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0 150m

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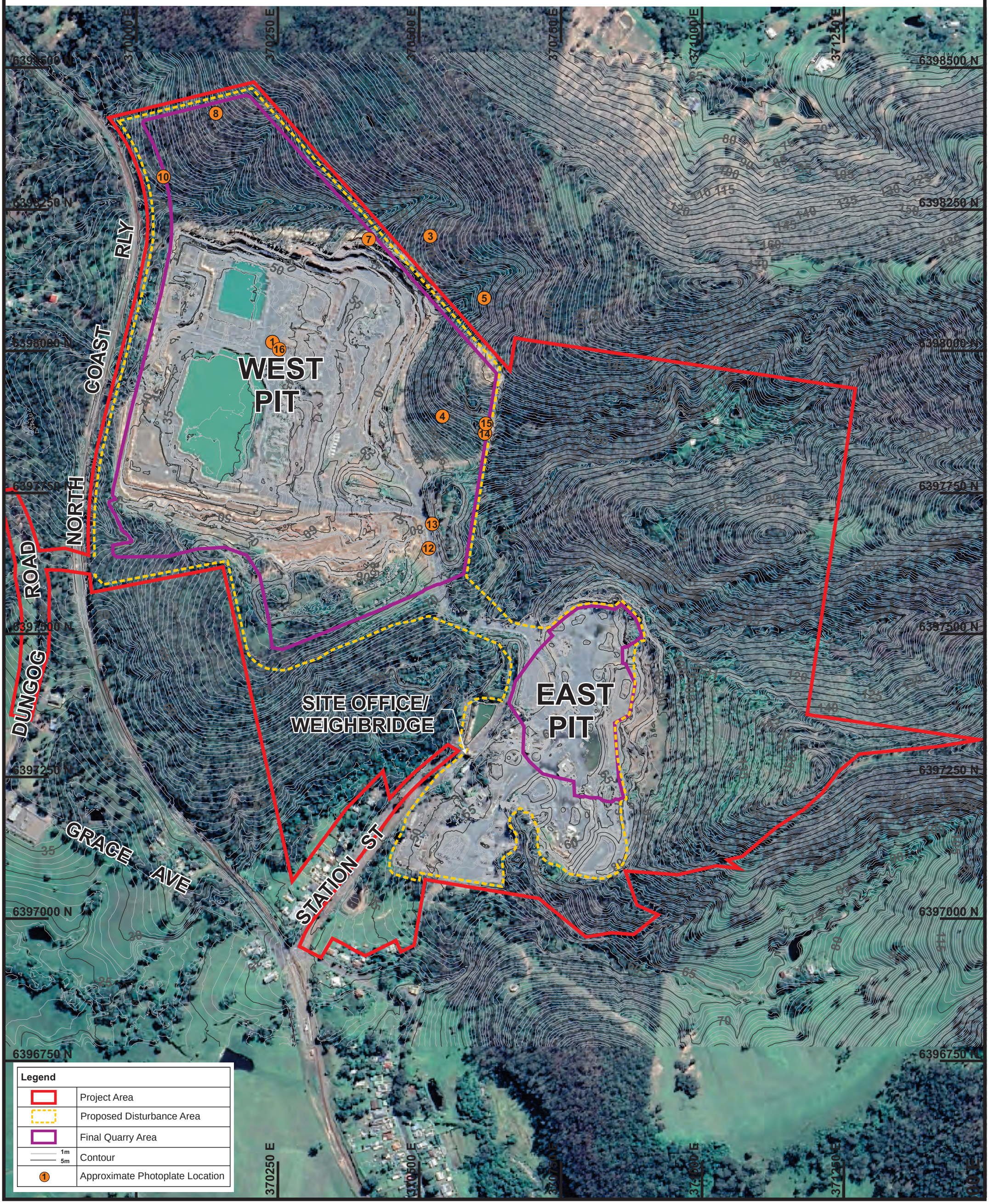
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton



2 Geological Setting

2.1 REGIONAL GEOLOGY

The New England Fold Belt is a very large sequence of rocks, of which the southernmost extent occurs at Raymond Terrace (NSW) and continues northwards to Townsville (QLD) and west to Goondiwindi. These are Carboniferous in Age and are 298 to 354 million years old.

The depositional environment is a complex mix of Volcanics and sediments, not dissimilar to the current circumstances in New Zealand where there are active volcanoes, and on the flanks of the snow-capped mountains, glaciers feed into rivers washing and depositing gravels, sands and clays, which over time would produce conglomerates, sandstone and varve shales. Coupled with this complex depositional environment these rocks, after consolidation, have been uplifted, thrusted and disjointed.

Presented in *Figure 11.A* is the southern portion of the New England Fold Belt which has been coloured to identify two broad rock sequences, volcanic and sediments. The rock units south of these, i.e. not coloured, represent younger Permian sediments, which are rich in coal, the foundation materials for the Newcastle and Hunter coal industry, and even more recent Quaternary unconsolidated sediments found near rivers, beaches and sand dunes.

The purple represents the rock units mostly within the Gilmore Volcanics Group, which include Andesite, Micaceous Ignimbrite, Rhyolite, Dacite tuffs and pyroclastic flows. For reasons demonstrated by the resource sampling and analysis discussed in *Section 5.2*, these units are most sought after to produce the required range of high-quality aggregates.

As seen in *Figure 11.A,* there are six nearby quarries located on similar rock sequences (identified by purple shading). The exception to this is Allandale Quarry which is underlain by the Oldest Permian Formation (i.e. on the contact of the Permian and Carboniferous) known as the Lochinvar Formation, consisting of sediments and Volcanics.

The yellow shading of *Figure 11.A* represents sediments, mostly from an overlying or younger suite of rocks known as the Kings Hill Group. These consist of sandstone, conglomerates and shales. Showing further the complex nature of these rock outcrops there are older sediment units intermixed as well. These are identified in the legend of *Figure 11.A.*

Each solid black line seen in the figure is a contact point between differing units. These could be simply a stratigraphic change as one progresses up a hill from older to younger rocks or in most cases in this sequence, the checker-board pattern of sedimentary and Volcanic units is produced by large faults moving, twisting and turning stratigraphy in many ways.

These major faults not only produce great movements seen on the surface and from the air, they have generated variations in the physical and chemical properties of the rock which are highlighted in the analyses of quarry resources presented in *Section 5.2*.

2.2 QUARRY SITE GEOLOGY

The Martins Creek Quarry is underlain by the Martins Creek Latite, identified as “Clnm” on the geology map see *Figure 11.B*. This unit terminates in the vicinity of the railway line to the north and the northwest where the overlying sequences of Cln (Newtown Volcanics) and Clnv (Vacy Ignimbrite Member) commence.

Figure 11.A shows the regional geological overlay in context with other mines in the area near Martins Creek.

The faces and floor of Martins Creek Quarry (see *Photoplate 1*) are dominated by Latite Tuff, a volcanic rock locally known as Andesite (see sample in *Photoplate 2*). The large white rhombohedra crystal (plagioclase) in the centre of *Photoplate 2* is 3mm in length.

There are some exposures of underlying red sandstone and claystone, known as meta-sediments, in parts of the quarry floor (see *Photoplate 1*). This underlying sequence is most likely to be identified lithologically as Cll (the Wallaringar Formation).

Cross-Sections A through C locations are shown on *Figure 3* through *Figure 5* with geological cross-sections presented in *Figure 9*

2.3 PREVIOUS GEOLOGY REVIEW

A geological report completed by C.L. Adamson 1979, was reviewed and the investigation area for this assessment was for Lot 5 DP 242210 where 5 holes were sunk and identified 12.2 million tonnes of Probable Reserves. The five drill hole locations have been interpolated from the document and appear to be in the extraction area. As such, the data in this document is not required to be used in this assessment.

Photoplate 1. View of Quarry Floor and Faces



Photoplate 2. Microscopic View of Latite Tuff



Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - West Pit with Cross Section & Drill Hole Locations
Figure:	THREE
Sheet:	1 of 1
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0 100m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C003_V0_F3.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

	Project Area
	Proposed Disturbance Area
	Final Quarry Area
A A'	Geological Cross Section *(A-C)*
1968-1	1968 Series *(Cement & Aggregate Consulting Job No.J000077)*
8086-9	8086 Series - (*2007*)
E6	E(2-8) Series - (*Total Drilling 2015*)
PBH15	PBH(1-15) Series - (*Precision Blast Rig 2015*)
1m 5m	Contour

6398500 N
6398250 N
6398000 N
6397750 N
6397500 N
370000 E
370250 E
370500 E

8086-3
8086-4
8086-5
8086-2
8086-11
8086-10
8086-8
E5
E2
E4
E8
1968-1
1968-2
1968-3
1968-4
1968-5
PBH1
PBH2
PBH3
PBH4
PBH5
PBH6
PBH7
PBH8
PBH9
PBH10
PBH11
PBH12
PBH13
PBH14
PBH15
A
A'
B
B'
C
C'
WEST PIT
EAST PIT
RLWY
COAST
NORTH
DUNGOG ROAD

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - East Pit with Cross Section & Drill Hole Locations
Figure:	FOUR
Sheet:	1 of 1
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0 100m

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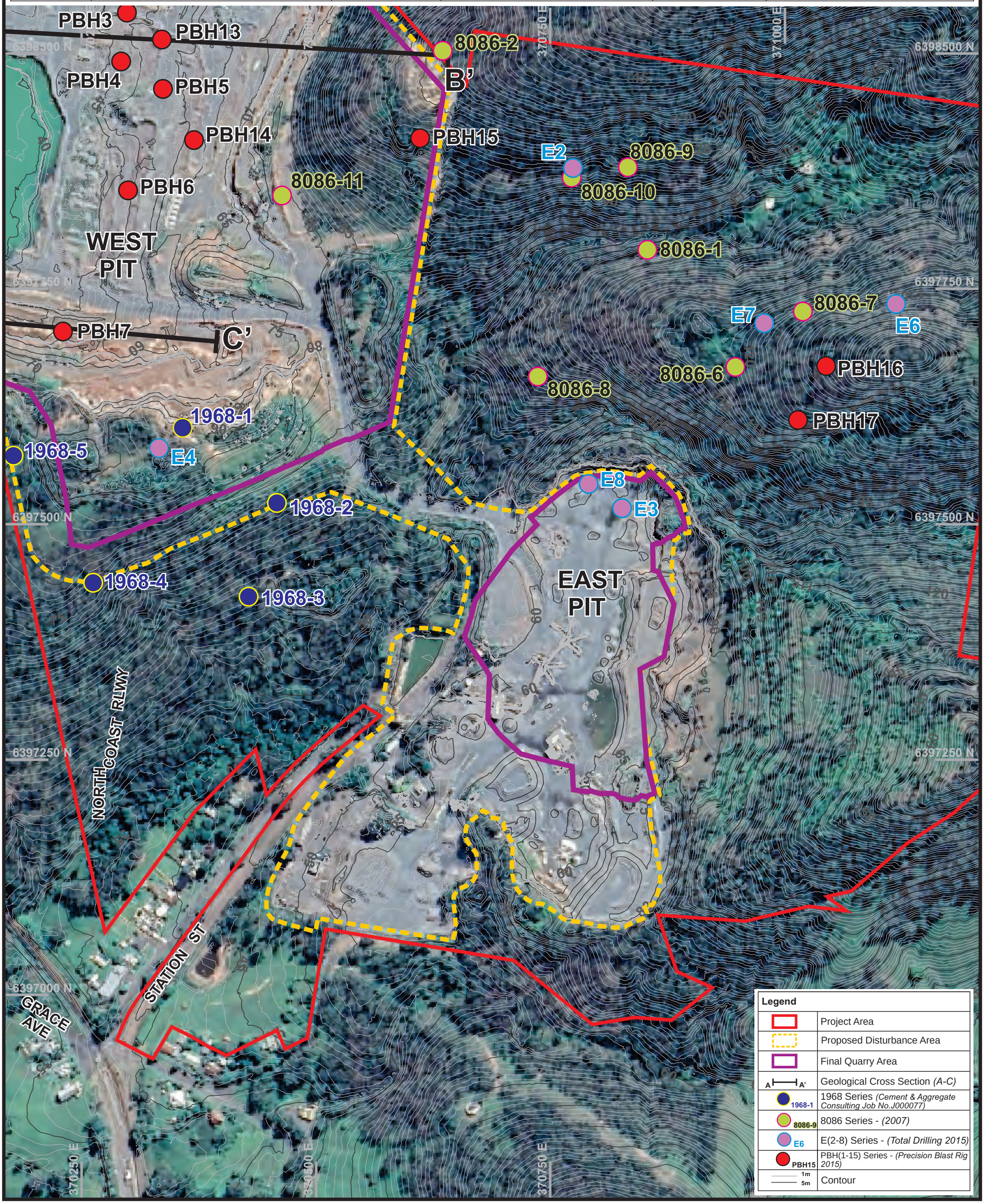
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton



Legend

	Project Area
	Proposed Disturbance Area
	Final Quarry Area
A — A'	Geological Cross Section *(A-C)*
1968-1	1968 Series *(Cement & Aggregate Consulting Job No.J000077)*
8086-9	8086 Series - *(2007)*
E6	E(2-8) Series - *(Total Drilling 2015)*
PBH15	PBH(1-15) Series - *(Precision Blast Rig 2015)*
1m / 5m	Contour

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Drill Hole Locations
Figure:	FIVE
Sheet:	1 of 1
Version/Date:	V0 17/09/2020

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0 50m

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Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

	Project Area
	Proposed Disturbance Area
	Final Quarry Area
A A'	Geological Cross Section *(A-C)*
1968-1	1968 Series *(Cement & Aggregate Consulting Job No.J000077)*
8086-9	8086 Series - *(2007)*
E6	E(2-8) Series - *(Total Drilling 2015)*
PBH15	PBH(1-15) Series - *(Precision Blast Rig 2015)*
1m 5m	Contour

2.3.1 Geological Mapping

A review of the west pit project area was undertaken, which revealed the topography is typically dominated by angular blocks of Latite with vegetation growing around these as seen in *Photoplate 3* and *Photoplate 4*.

Photoplate 3. Latite outcrop



Photoplate 4. Hard Latite Outcrop



The hard angular volcanic Latite rock out crops seen at the surface will have some weathering. The soil profile here is thin as seen at MC 1.

Some Latite samples were collected as seen in *Photoplate 5* to *Photoplate 11*. The approximate locations of these sites are seen in *Figure 2*.

Photoplate 5. Site 3 Latite



Photoplate 6. MC 3 sample



Photoplate 7. Site 4 Latite



Photoplate 8. Site 5 Sample site



Photoplate 9. MC 5 sample



Photoplate 10. Site 6 sample site



Photoplate 11. MC 6 Sample



Other lithologies were encountered such as a conglomerate and sandstone adjacent to the haul road in the eastern portion of the west pit, see *Photoplate 12*. Faulting was also seen in the area which was evidenced by sandy clays with remnant faulting and thrust features, *see Photoplate 13*.

Photoplate 12. Conglomerate



Photoplate 13. Sandy Clays in outcrop



A volcanolithic agglomerate was found on the northern slope of the site, refer to *Photoplate 14* and *15* and *Figure 2* for the location. This shows large angular Latite rocks cemented in an ash flow, refer to *Photoplate 15*. This is typical of this type of pyroclastic event.

Photoplate 14. Mapping Site MC 1



Photoplate 15. Mapping Site MC 2



2.3.2 Structural Geology

Martins Creek quarry resource was deposited 300 to 350 million years ago in the Period known as the Carboniferous, the environment at the time was very active with volcanic eruptions, glaciers, and high energy river systems. This environment produces rapid changes in lithology at the time of formation, and the subsequent faulting can move blocks of rock.

West pit appears to be mostly unaffected by major lithological changes and development to the north and west appears to continue similarly as seen in the drilling as seen in *Photoplate 16*.

The area on the eastern flank of the west pit has some structural changes, with conglomerates described in *Section 2.3.1.*

The east pit has more structural variation as seen in drill holes E8 and E3, with 29 metres and 5 metres of Latite respectively, refer to *Section 2.2.3*.

Photoplate 16. West and north faces



2.3.3 Geological Assessments

Three historical drilling programs for the Martins Creek Quarry 1968, 2006 and 2015 have been reviewed. *Figure 3, Figure 4* and *Figure 5* shows the drill hole locations of each campaign (where data is available).

2.3.3.1 1968 Exploration Program

A five-hole drilling program was undertaken in 1968, with the approximate locations of the drill holes found on *Figure 5.* The logs and photographs of the drill core are located in *Appendix B*, as supplied by Daracon.

Table 3 presents a summary of the drill logs. The rock identification found in *Table 3* is simplistic in nature. BH1968-1 is the only hole within the proposed extraction area and is situated adjacent to E4 (refer to *Figure 3*) and the model adopted relies on E4 being more accurate.

Table 3. 1968 Drill Logs

Hole Number	Collar (mAHD)	"Good Rock" (m)*	"Bad Rock" (m)*	Total Depth (m)
BH1968 – 1	94.0	22.4	19.8	42.2
BH1968 – 2	69.9	7.2	8.5	15.7
BH1968 – 3	54.7	2.8	13.3	16.1
BH1968 – 4	76.2	21.1	6.3	27.4
BH1968 – 5	79.1	1.6	8.1	9.7

*Provided by Client, probable source Railcorp.

2.3.3.2 2006 Exploration Program

Table 4 summarises the eleven core holes which were sunk to evaluate the thickness and extent of the Latite. The locations of each drill hole are presented on *Figure 5*, with all logs found in *Appendix C*. *Appendix E* contains the drill log photographs.

Table 4. 2006 Drill Holes

Hole Name	Eastings	Northings	Collar (mAHD)
8086-1	370854.2	6397789	88.9
8086-2	370636.2	6398001	124.2
8086-3	370204.6	6398448	88.6
8086-4	370030.9	6398271	50.2
8086-5	370452.3	6398203	98.6
8086-6	370947.3	6397664	116.4
8086-7	371018.7	6397723	123.7
8086-8	370736.7	6397654	78.0
8086-9	370833.4	6397877	112.5
8086-10	370772.8	6397867	108.6
8086-11	370465.1	6397847	79.5

A site visit was undertaken on 13 of June 2018 to review the 8086 series of logs core boxes on-site at Martins Creek Quarry to validate the geotechnical core log assessment undertaken by RailCorp during 2006 and 2007 and core trays were inspected and a visual inspection of the core trays found faded numbering. VGT personnel, with permission from Daracon personnel, retraced these numbers and photographed the core tray stack.

The core tray stack was then laid out and cross referenced with start to finish depths with the logs supplied from Rail Corp Geotechnical. The geotechnical data with core breaks, fractures and core loss provided essential data to cross reference drill trays and the core logs. Each core tray was then photographed and once each core tray was verified the relevant number was written in red permanent marker.

Latite thickness data presented in *Table 5* is shown on *Figure 6,* and the base of latite RL plans are shown on *Figure 7.* The base of product contour plan is shown on *Figure 8.*

Table 5. Latite Thickness and Base of RL

Hole Name	RL (m)	Thickness of Latite	Base of Latite (RL m)
PBH1	50	22	22+
PBH2	50	19.5	19.5
PBH3	51.5	7.5	7.5
PBH4	50	8.0	8
PBH5	53.5	4.0	4
PBH6	50	4.0	4
PBH7	50	12.5	12.5
PBH8	50	26.5	26.5
PBH9	50	29.0*	29+
PBH10	49	29.0*	29+
PBH11	50	26.5	26.5
PBH12	61	29.0*	29
PBH13	61.5	11.0	11
PBH14	61	7.5	7.5
PBH15	111	29.0*	29
PBH16	136.6	11.0	10
PBH17	113.2	7.0	8.5**
E2	109	10.0**	10
E3	59	5.0	5
E4	92	42.5	42.5

Hole Name	RL (m)	Thickness of Latite	Base of Latite (RL m)
E5	75	37.0	37
E6	132	0.0	Nil
E7	120	5.0	5.5
E8	59	29.0	29
8086-1	90	30.3	29.6
8086-2	124	31.3	30.9
8086-3	88	38.0	38
8086-4	49.5	40.9	39.7
8086-5	97.5	36.4	34.4
8086-6	115.5	13.3	5.3
8086-7	122	0.0	Nil
8086-8	78	50.35	49
8086-9	95	0.0	Nil
8086-10	107	6.2	1.85
8086-11	79.3	6.9	7

Note *Hole terminated in the Latite

** Weathered Latite, not product.

+ not reached basement

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Latite Thickness Plan
Figure:	SIX
Sheet:	1 of 1
Version/Date:	V0 23/09/2020

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N

0 50m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C006_V0_F6.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

	Project Area
	Proposed Disturbance Area
	Final Quarry Area
A A'	Geological Cross Section *(A-C)*
1968-1	1968 Series *(Cement & Aggregate Consulting Job No.J000077)*
8086-9	8086 Series - *(2007)*
E6	E(2-8) Series - *(Total Drilling 2015)*
PBH15	PBH(1-15) Series - *(Precision Blast Rig 2015)*
29	Latite Thickness *(m)*
1m / 5m	Contour

8086-3 38
8086-4 39.7
8086-5 34.4
8086-2 30.9
8086-1 29.6
8086-7 5.5
8086-6 5.3
8086-8 49
8086-9
8086-10 1.85
8086-11 7
E5 37
E2 10
E7 5.5
E6
E4 42.5
E8 29
E3 5
PBH1 22
PBH12 29
PBH2 19.5
PBH3 7.5
PBH11 26.5
PBH13 11
PBH4 8
PBH5 4
PBH14 7.5
PBH15 29
PBH10 29
PBH6 4
PBH9 29
PBH8 26.5
PBH7 12.5
PBH16 10
PBH17 8.5
1968-1 22.3
1968-5 1.6
1968-2 7.2
1968-4 21.1
1968-3 2.8
A A'
B B'
C C'
WEST PIT
EAST PIT
SITE OFFICE/ WEIGHBRIDGE
COAST RLWY
NORTH
DUNGOG ROAD
GRACE AVE
STATION ST

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Base of Latite Plan
Figure:	SEVEN
Sheet:	1 of 1
Version/Date:	V0 23/09/2020

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N

0 50m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C007_V0_F7.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

	Project Area
	Proposed Disturbance Area
	Final Quarry Area
A A'	Geological Cross Section *(A-C)*
1968-1	1968 Series *(Cement & Aggregate Consulting Job No.J000077)*
8086-9	8086 Series - *(2007)*
E6	E(2-8) Series - *(Total Drilling 2015)*
PBH15	PBH(1-15) Series - *(Precision Blast Rig 2015)*
28	Base of Latite *(mAHD)*
1m 5m	Contour

369750 E 370000 E 370250 E 370500 E 370750 E

6398500 N 6398250 N 6398000 N 6397750 N 6397500 N 6397250 N 6397000 N

8086-3 50.6
8086-4 9.3
8086-5 62.2
8086-2 92.8
8086-1
8086-7
8086-8
8086-6
8086-9
8086-10
8086-11 71
E5 41.7
E2
E7
E6
E4 49
E8 38
E3 50
PBH1 21.9
PBH12 30.1
PBH2 30.3
PBH3 44.1
PBH11 23.2
PBH13 60.2
PBH4 42.3
PBH5 49.4
PBH14 53.8
PBH15 88
PBH10 28
PBH6 45.8
PBH9 12.2
PBH8 23.9
PBH7 37.3
PBH16
PBH17
1968-1 49
1968-5
1968-2
1968-4
1968-3

A A' B B' C C'

WEST PIT
EAST PIT
SITE OFFICE/ WEIGHBRIDGE

COAST RLWY
NORTH
DUNGOG ROAD
GRACE AVE
STATION ST

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Base of Latite Contour Plan & Final Benches
Figure:	EIGHT
Sheet:	1 of 1
Version/Date:	V0 24/09/2020

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N

0 50m

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Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

- Project Area
- Proposed Disturbance Area
- Final Quarry Area
- A — A' Geological Cross Section *(A-C)*
- Base of Latite Contours
- Benches
- 1m / 5m Contour

369750 E · 370000 E · 370250 E · 370500 E · 370750 E · 371000 E

6398500 N · 6398250 N · 6398000 N · 6397750 N · 6397500 N · 6397250 N · 6397000 N

A — A' · B — B' · C — C'

DUNGOG ROAD · COAST RLWY · NORTH · GRACE AVE · STATION ST

SITE OFFICE/ WEIGHBRIDGE

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Cross Section A-A'	***Location:***	Off Station Street, Martins Creek, NSW	***Source:***	Daracon & VGT	***Our Ref:***	9714_MC_GA2020_C010_V0_F9A.cdr
Figure:	NINE - A	***Council:***	Dungog Shire Council	***Survey:***	2014	***Plan By:***	TO/JD
Sheet:	1 of 3	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V0 23/09/2020	***Client:***	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

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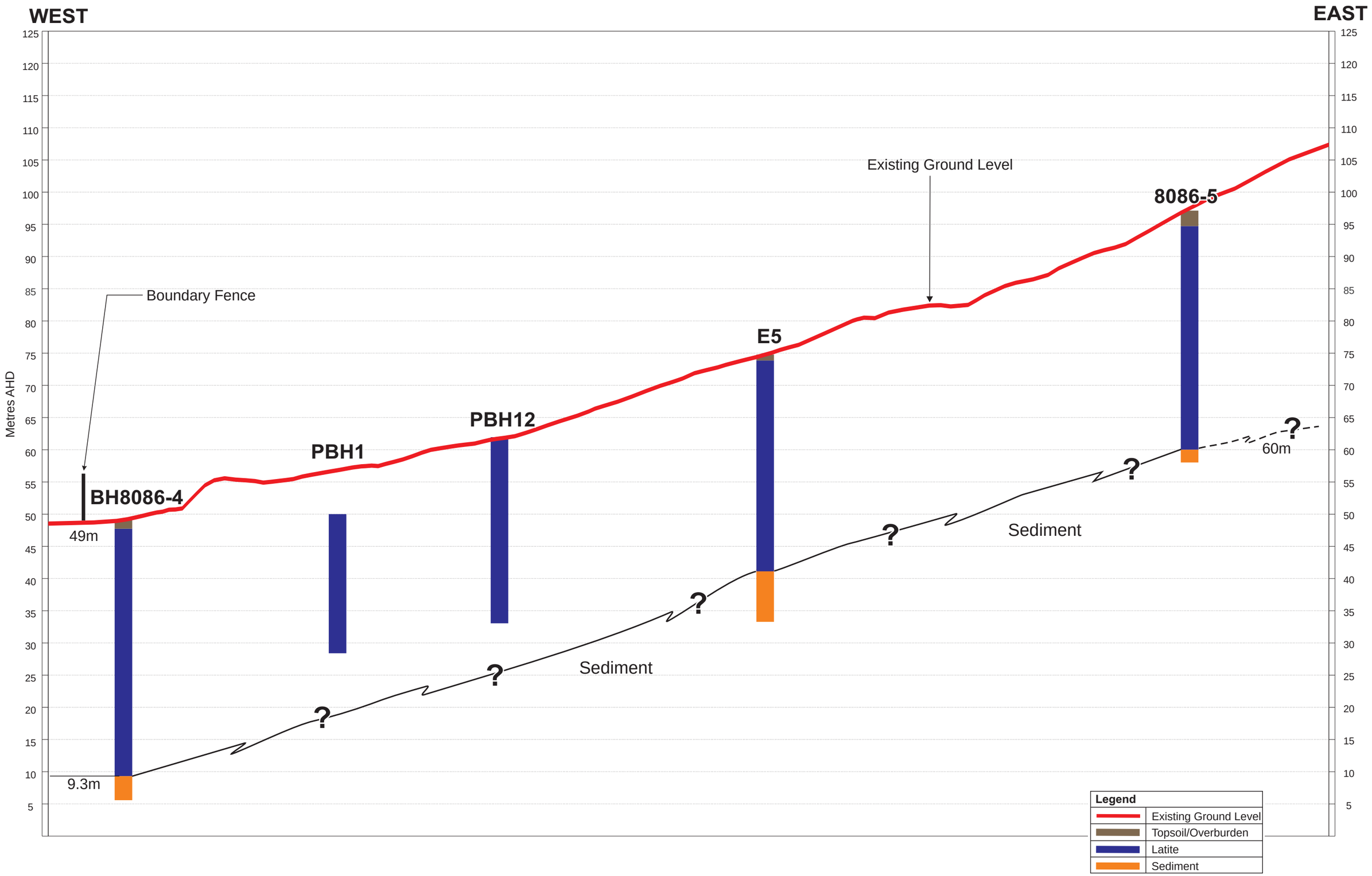

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Cross Section B-B'	***Location:***	Off Station Street, Martins Creek, NSW	***Source:***	Daracon & VGT	***Our Ref:***	9714_MC_GA2020_C011_V0_F9B.cdr
Figure:	NINE - B	***Council:***	Dungog Shire Council	***Survey:***	2014	***Plan By:***	TO/JD
Sheet:	2 of 3	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V0 23/09/2020	***Client:***	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

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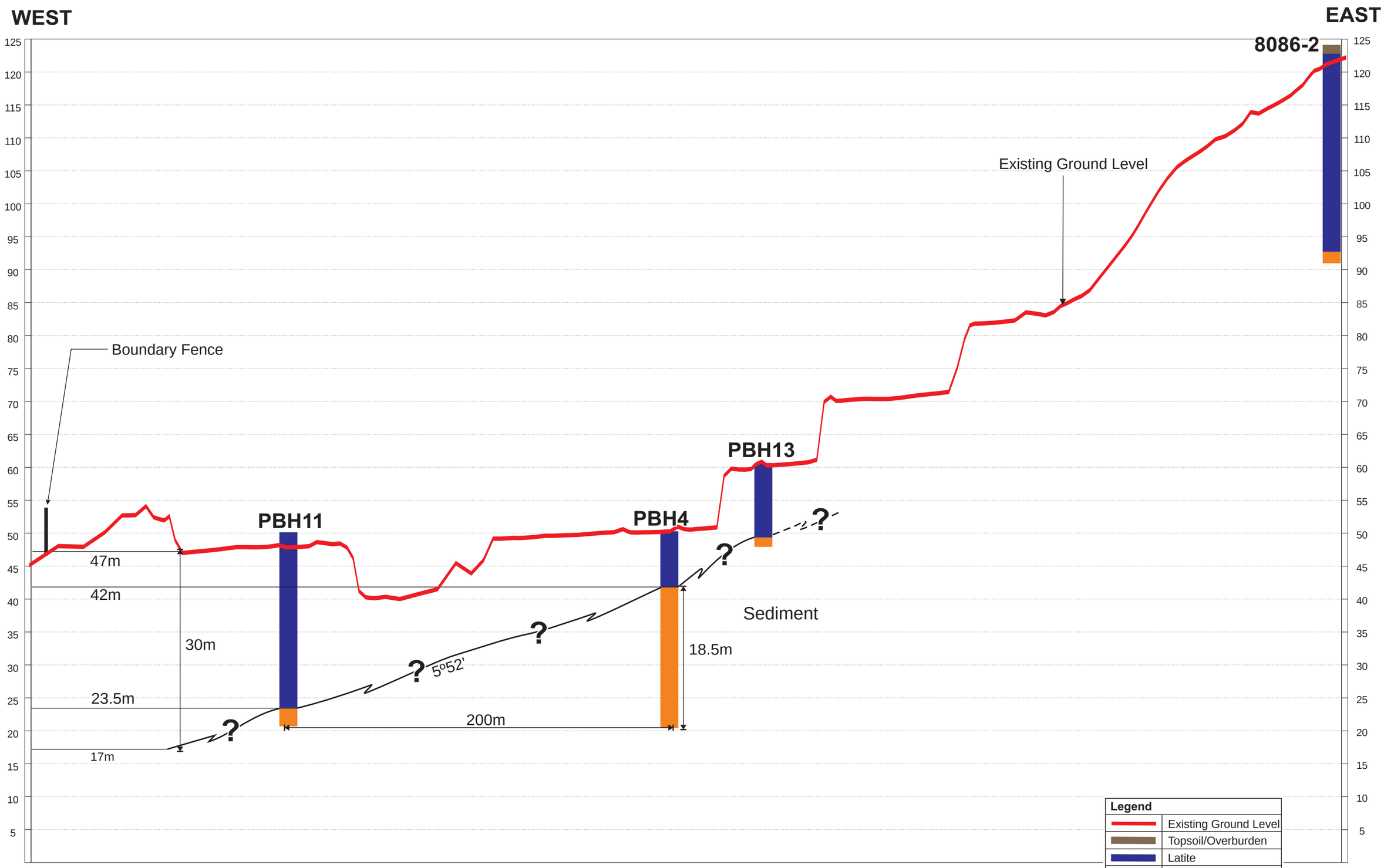

VGT Environmental Compliance Solutions Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 email: mail@vgt.com.au www.vgt.com.au ABN: 26 621 943 888

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Cross Section C-C'	***Location:***	Off Station Street, Martins Creek, NSW	***Source:***	Daracon & VGT	***Our Ref:***	9714_MC_GA2020_C012_V0_F9C.cdr
Figure:	NINE - C	***Council:***	Dungog Shire Council	***Survey:***	2014	***Plan By:***	TO/JD
Sheet:	3 of 3	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V0 23/09/2020	***Client:***	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

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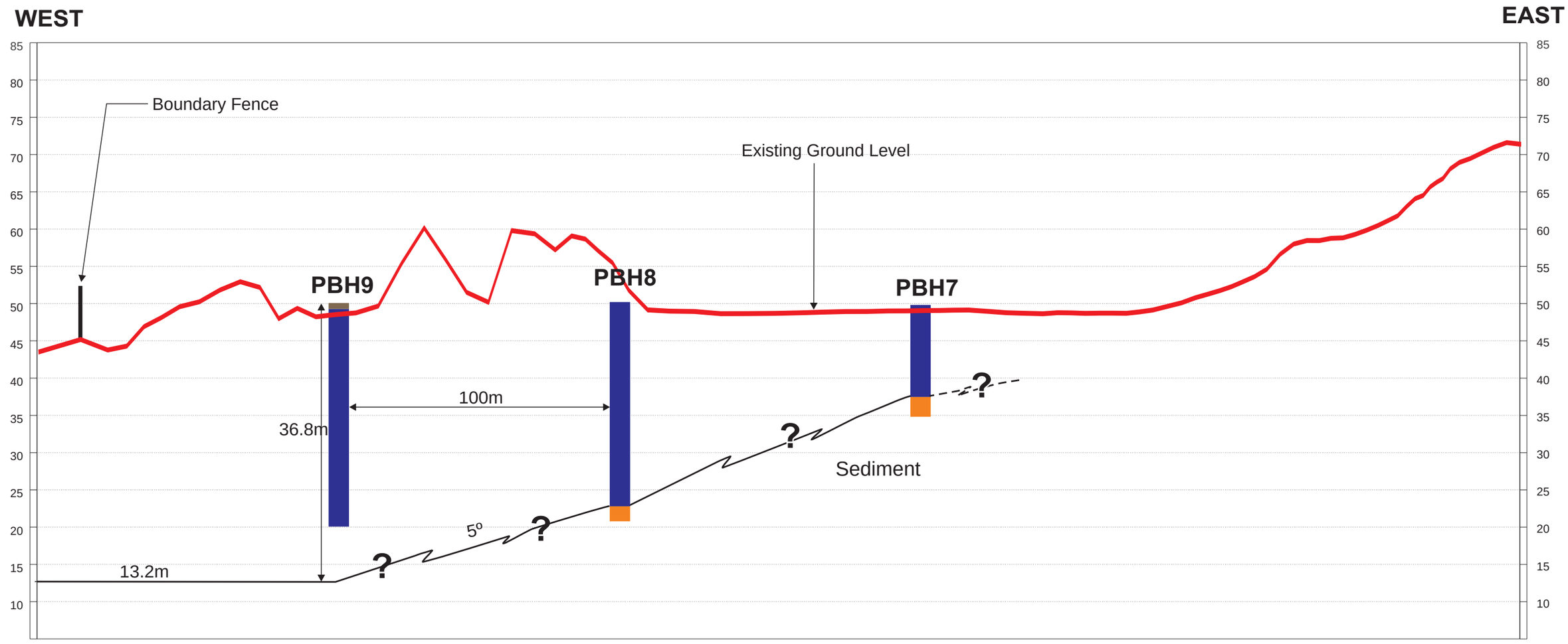

Legend	
	Existing Ground Level
	Topsoil/Overburden
	Latite
	Sediment

Assumed site dip to the west is 6º

2.3.3.3 2015 Exploration Program

The 2015 Exploration Program was specifically undertaken to provide infill geological data to inform quarry planning for the Quarry. Two programs were developed, one which used the on-site blast drill hole rig and the other using Total Drilling exploration hammer drill rig. Drilling occurred in March 2015 and all samples were collected by Daracon representatives. Sample trays were logged and photographed by VGT.

Figure 5 and *Table 6* present the drill hole locations. All logs are found in *Appendix D.*

Table 6. Drill Hole Co-ordinates

Hole Number	Eastings	Northings	Collar (mAHD)
PBH1	370106	6398174	49.4
PBH2	370174	6398119	50
PBH3	370301	6398041	51.5
PBH4	370295	6397989	50
PBH5	370339	6397960	53.5
PBH6	370302	6397852	50
PBH7	370233	6397702	59.5
PBH8	370112	6397734	50.6
PBH9	370013	6397759	50
PBH10	369999	6397851	49
PBH11	370098	6398027	50
PBH12	370172	6398172	61
PBH13	370338	6398013	61.5
PBH14	370372	6397906	61
PBH15	370612	6397908	110.8
PBH16	371044	6397665	137.5
PBH17	371014	6397608	125.9
E2	370775	6397876	111.8
E3	370827	6397514	58.9
E4	370334	6397578	92.8
E5	370272	6398188	78.6
E6	371118	6397731	131.2
E7	370978	6397711	119.7
E8	370791	6397540	58.9
8086-1	370854.2	6397789	88.9
8086-2	370636.2	6398001	124.2
8086-3	370204.6	6398448	88.6
8086-4	370030.9	6398271	50.2
8086-5	370452.3	6398203	98.6
8086-6	370947.3	6397664	116.4
8086-7	371018.7	6397723	123.7
8086-8	370736.7	6397654	78

8086-9	370833.4	6397877	112.5
8086-10	370772.8	6397867	108.6
8086-11	370465.1	6397847	79.5

3 Geology to Quarry Materials

Although the principle rock materials targeted by Daracon is fresh latite, the reader needs to consider that quarries are high volume and low-cost product businesses, which means the utilisation of all products available to them is vital. Listed below are the rock types found on site and their potential uses. The rock uses for quarry products is sourced from Qualtest reports and Daracon.

For the purposes of this document the term “product” encompasses all of the materials listed below excluding meta-sediments and soil.

“Overburden” for this site is broadly defined as material subsoil materials containing vegetation and extremely weathered rock.

Table 7. Quarry Materials Summary

Rock Type	General Description	Products/Use
Fresh Latite	Hard grey	Road base, rail ballast, sealing aggregates, asphalt aggregates, filter aggregates concrete aggregates, gabion and manufactured sand
Weathered Latite	Yellow grey, moderately hard, some clay content	Densely Graded Base for roads, ballast and revetment rock applications, drainage aggregates and fill sands
Agglomerate	Angular Latite rock (bombs) set in ash flow matrix	General Fill, select materials and capping materials
Conglomerate	Pebbles bound in a sandstone matrix	General Fill, select materials and capping materials
Meta-sediments	Mostly Red clays	Not proposed to be extracted, however any removed material will used for rehabilitation
Sandy Clays	Soft yellow orange	Blended with Fresh and weathered Latite to form Densely Graded Base for roads, or for shaping of final landforms
Soils	Orange Brown, clayey, containing seed bank	Used for rehabilitation

4 Indicative Staged Extraction Plans

Establishing a quarry requires careful planning to ensure it is safe, considerate of neighbours and the environment whilst being commercially viable. This section describes the proposed stages of the quarry development up to completion. Each stage is described, and volumes of resource has been estimated.

4.1 RESOURCE CALCULATIONS ASSUMPTIONS AND PARAMETERS

The geological and resource assessment of this deposit was undertaken using the following data:

- Site survey (Daracon);
- Drill site locations provided by Daracon;
- Handheld GPS co-ordinates for final drill hole locations for E and PBH series;
- Some surface mapping was undertaken;
- Total drilling provided samples for E series;
- Precision drilling (blast hole rig) provided samples for PBH series;
- Daracon supplied 8086 series logs;
- Samples were collected by Daracon;
- Drill samples provided samples for E and PBH series were logged by VGT;
- Core samples from the 8086 series were verified by VGT in their core trays against the original drill logs;
- Density of Latite is 2.7 g/cm^3 (Qualtest August 2019 MAT:NEW19W-2685);
- The base of the Latite resource has been determined and interpolated from the drilling data;
- Bench widths 10 metres, provided by client;
- Batter or quarry faces 8 to 12 metres high, provided by client;
- Proposed quarry faces are 0.17H: 1V (or 80 degrees) provided by client and as is in the quarry now, and
- Stages of the quarry development determined by client.

4.2 MINING STAGES CONSIDERED

The following describes the staging of the development of the quarry over the proposed life of operations. References to RLs are indicative and represents the quarry staging based on anticipated production demands. These stages and associated production rates have been used for the purposes of the resource assessment and are consistent with the quarry development and production rates used in other assessments. In reality, there is likely to be some variation in the quarry development and timing from that set out below due to differences in actual annual production demands due to factors such as market demand and weather.

4.2.1 Stage One (To approximately end of Year 2)

Aims for this stage

Commence extraction operations in east pit, to create a floor for the rail loop extension. North development in west pit down to approximately RL 88m, see *Figure 10 - Stage One*.

Considerations

West pit commences north of the main pit and will be developed down to approximately RL 88m. Outcrops on the west pit development show agglomerate, which will provide opportunity for other products to be created, underlying this is Latite as seen in 8086-2 and PBH 15.

Constraints and Issues

All existing plant and stockpiles will remain in place at this stage. The haul trucks will travel from the west pit to the primary over the rail line once constructed. A ramp will be constructed on the eastern portion of the east pit linking the pad areas.

Excess overburden and topsoil will require to be stored until final landform faces have been created.

Table 8. Stage One Outcomes

Item	Thickness (metres)	Area (metres^2)	Volume (metres^3)	Tonnes
Topsoil*	0.2	29,000	6,000	
Overburden*	0.4	29,000	12,000	
Product**			651,000	1,758,000
Total			669,000	

Note: * West pit data is estimated from field mapping and BH 8086-2 and PBH 15

** Product will include some agglomerate

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Stage One Plan
Figure:	TEN - ONE
Sheet:	1 of 6
Version/Date:	V0 24/09/2020

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N

0 50m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C013_V0_F10-1.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

369750 E · 370000 E · 370250 E · 370500 E · 370750 E · 371000 E

6398500 N · 6398250 N · 6398000 N · 6397750 N · 6397500 N · 6397250 N · 6397000 N

Legend

- Project Area
- Proposed Disturbance Area
- Final Quarry Area
- E — E' Stage Cross Sections E-G
- Stage 1 Pit Footprint
- Contour (1m / 5m)

WEST PIT

EAST PIT

88mRL

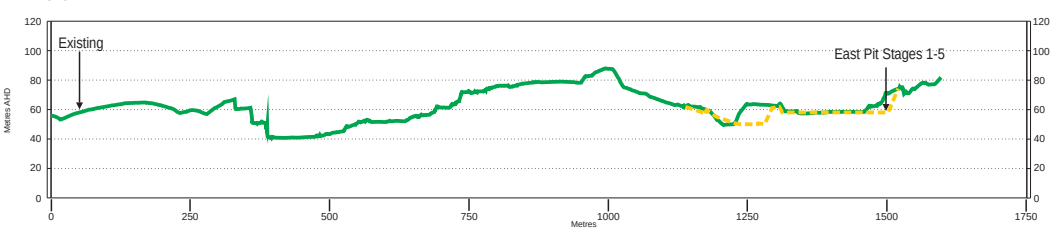
COAST RLWY

NORTH DUNGOG ROAD

E · E' · F · F' · G · G'

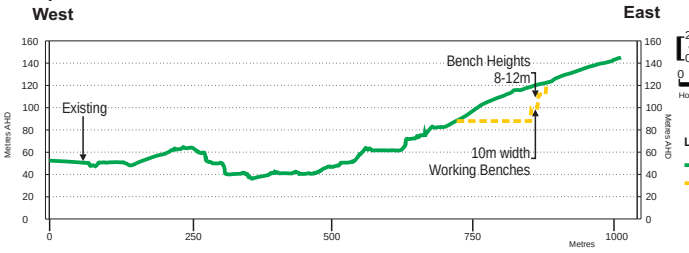
CROSS SECTION E-E'

E North — E' South



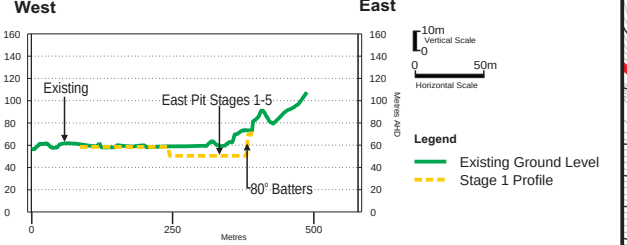
CROSS SECTION F-F'

F West — F' East



CROSS SECTION G-G'

G West — G' East



4.2.2 Stage Two (to approximately end of Year 6)

Aims for this stage

Continue extraction in the west pit down to approximately RL 76m on the north and east and to approximately RL 28m in the south. Latite floor will be reached in some areas. No extraction works proposed in east pit providing all materials are removed in the first 2 years.

Considerations

Extraction could encounter conglomerates in the eastern portion west pit, this will provide other products for development and blending.

Constraints and Issues

The northern portion of west pit will be available during this stage for overburden emplacement and top soiling, refer to *Figure 10 - Stage Two.* As extraction intersects the basal meta sediments rehabilitation can commence.

Table 9. Stage Two Outcomes

Item	Thickness (metres)	Area (metres^2)	Volume (metres^3)	Tonnes
Topsoil*	0.2	12,400	2,000	
Overburden*	0.4	12,400	5,000	
Product			1,474,000	3,980,000
Total			1,481,000	

Note: * West pit data is estimated from field mapping and BH 8086-2 and PBH 15

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Stage Two Plan
Figure:	TEN - TWO
Sheet:	2 of 6
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N

0 50m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C014_V0_F10-2.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

369750 E
370000 E
370250 E
370500 E
370750 E
371000 E

6398500 N
6398250 N
6398000 N
6397750 N
6397500 N
6397250 N
6397000 N

Legend

- Project Area
- Proposed Disturbance Area
- Final Quarry Area
- E — E' Stage Cross Sections E-G
- Stage 3 Pit Footprint
- Contour (1m / 5m)

WEST PIT

EAST PIT

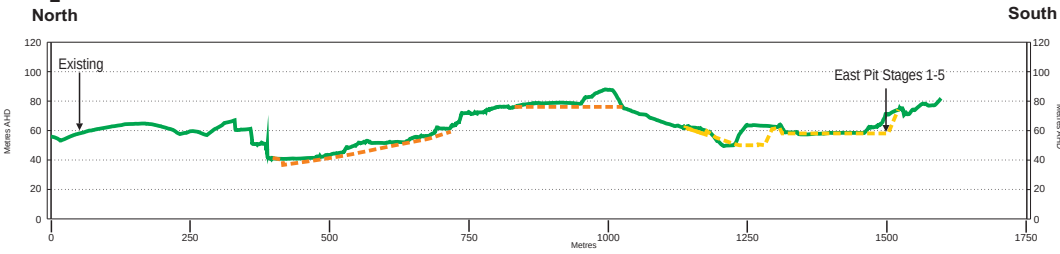
76mRL

COAST RLWY

NORTH DUNGOG ROAD

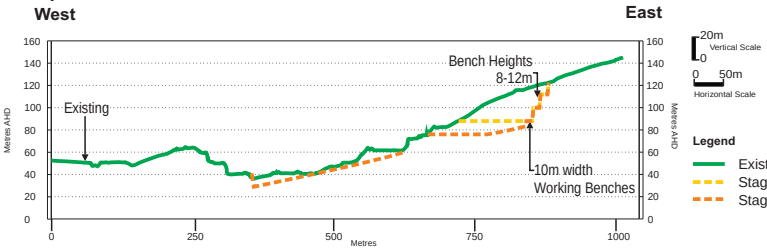
CROSS SECTION E-E'

E North — E' South



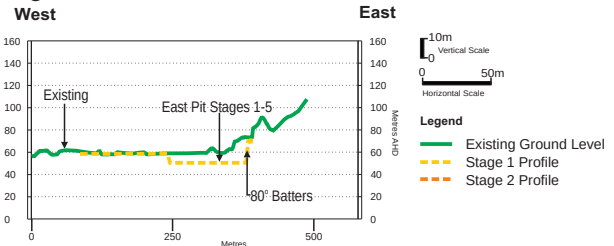
CROSS SECTION F-F'

F West — F' East



CROSS SECTION G-G'

G West — G' East



4.2.3 Stage Three (to approximately end of Year 10)

Aims for this stage

No extraction works proposed in east pit. Continue extraction in the west pit down to approximately RL 76m on the north and commence in the west and the south main pit will be developed to the Latite floor. The east portion will be developed to approximately RL 64m, see *Figure 10 - Stage Three.*

Considerations

Extraction could encounter conglomerates in the eastern portion of west pit, this will provide other products for development and blending.

The west pit development is based upon field mapping.

Constraints and Issues

The underlying meta sediments will form the quarry floor, evaluation of the plastic clays within some of the sediments should be considered. Overburden materials can be placed in the western floor of the quarry or eastern benched area.

Table 10. Stage Three Outcomes

Item	Thickness (metres)	Area (metres^2) **	Volume (metres^3)	Tonnes
Topsoil*	0.2	56,500	11,000	
Overburden*	0.8	56,500	45,000	
Product***			1,167,000	3,151,000
Total			1,223,000	

Note: * West pit data is estimated from BH 8086-3 and BH 8086-5 (average 1 metre auger, i.e. soft material)

**estimated from supplied survey and models from client

***Product will include some conglomerate materials for other products

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Stage Three Plan
Figure:	TEN - THREE
Sheet:	3 of 6
Version/Date:	V0 23/09/2020

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N

0 50m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C015_V0_F10-3.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

369750 E 370000 E 370250 E 370500 E 370750 E

6398500 N 6398250 N 6398000 N 6397750 N 6397500 N 6397250 N 6397000 N

371000 E

Legend

- Project Area
- Proposed Disturbance Area
- Final Quarry Area
- E — E' Stage Cross Sections E-G
- Stage 3 Pit Footprint
- Contour (1m / 5m)

WEST PIT

EAST PIT

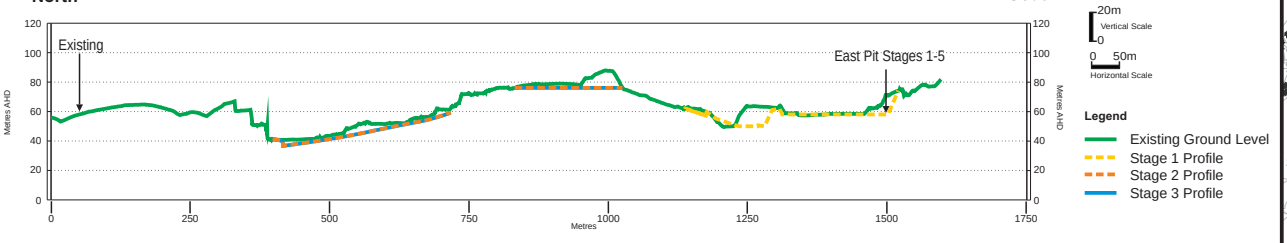
COAST RLWY

NORTH DUNGOG ROAD

E E' F F' G G'

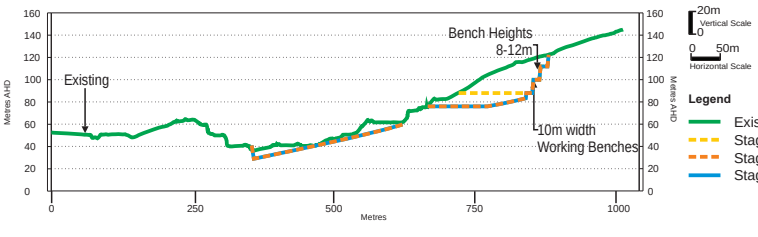
CROSS SECTION E-E'

E North — E' South



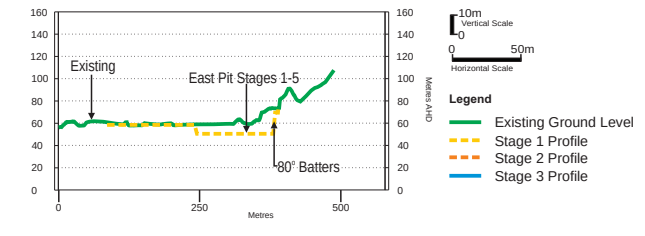
CROSS SECTION F-F'

F West — F' East



CROSS SECTION G-G'

G West — G' East



4.2.4 Stage Four (to approximately end of Year 15)

Aims for this stage

No extraction works proposed in east pit. Continue extraction in the west pit down to approximately RL 76m on the north and commence in the west and the south main pit will be developed to the Latite floor. The east portion will be developed to RL 64m, see *Figure 10 - Stage Four*. The southern portion of west pit will commence down to approximately RL 65 m.

Considerations

Extraction could encounter conglomerates in the eastern portion of west pit, this will provide other products for development and blending.

The west pit development is based upon BH 8086-3 and BH 8086-5 and field mapping. The southern extent has little quality drill data but the current extraction face shows a weathered Latite.

Constraints and Issues

The underlying meta sediments will form the quarry floor, evaluation of the plastic clays within some of the sediments should be considered.

Table 11. Stage Four Outcomes

Item	Thickness (metres)	Area (metres^2) **	Volume (metres^3)	Tonnes
Topsoil*	0.2	58,260	12,000	
Overburden*	0.8	58,260	47,000	
Product			1,696,000	4,579,000
Total			1,755,000	

Note: * West pit data is estimated from BH 8086-3 and BH 8086-5 (average 1 metre auger, i.e. soft material)

**estimated from supplied survey and models from client

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Stage Four Plan
Figure:	TEN - FOUR
Sheet:	4 of 6
Version/Date:	V0 23/09/2020

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Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C016_V0_F10-4.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

- Project Area
- Proposed Disturbance Area
- Final Quarry Area
- E E' Stage Cross Sections E-G
- Stage 3 Pit Footprint
- 1m / 5m Contour

369750 E · 370000 E · 370250 E · 370500 E · 370750 E · 371000 E

6398500 N · 6398250 N · 6398000 N · 6397750 N · 6397500 N · 6397250 N · 6397000 N

WEST PIT

EAST PIT

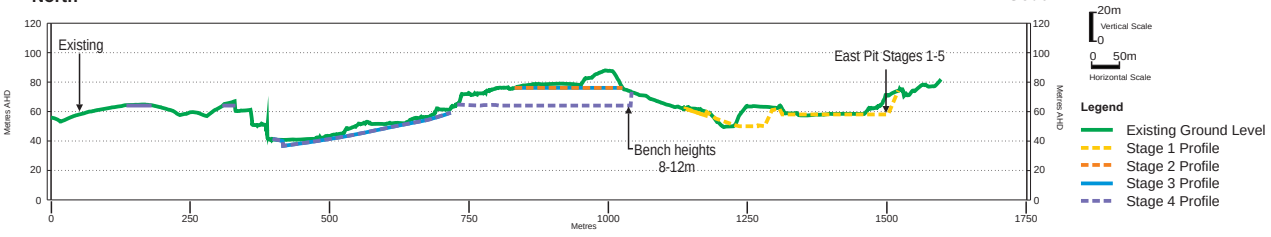
COAST RLWY

NORTH DUNGOG ROAD

E E' F F' G G'

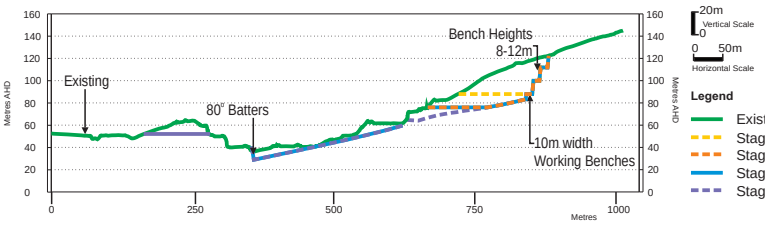
CROSS SECTION E-E'

E North — E' South



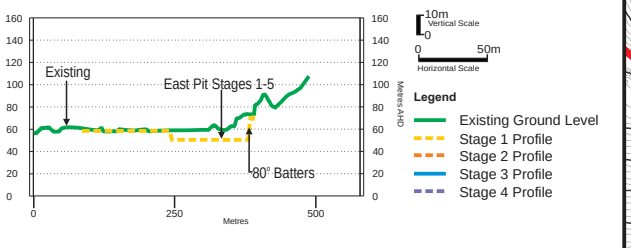
CROSS SECTION F-F'

F West — F' East



CROSS SECTION G-G'

G West — G' East



4.2.5 Stage Five (to approximately end of Year 20)

Aims for this stage

Complete clearing in the north western corner of west pit and extract down to approximately RL 40 m. No extraction activities will occur in east pit. North eastern portion will be extracted to base of Latite, see *Figure 10 - Stage Five.*

Constraints and Issues

The buffer off the railway line along the western boundary will be adopted.

Table 12. Stage Five Outcomes

Item	Thickness (metres)	Area (metres^2) **	Volume (metres^3)	Tonnes
Topsoil*	0.2	20,100	4,000	
Overburden*	1.0	20,100	20,000	
Product			1,508,000	4,072,000
Total			1,532,000	

Note: * this stage data is based from BH 8086-4

**estimated from supplied survey and models from client

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Stage Five Plan
Figure:	TEN - FIVE
Sheet:	5 of 6
Version/Date:	V0 24/09/2020

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Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C017_V0_F10-5.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

N

0 50m

369750 E 370000 E 370250 E 370500 E 370750 E

6398500 N 6398250 N 6398000 N 6397750 N 6397500 N 6397250 N 6397000 N

371000 E

Legend

- Project Area
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- Final Quarry Area
- E — E' Stage Cross Sections E-G
- Stage 3 Pit Footprint
- 1m / 5m Contour

WEST PIT

EAST PIT

COAST RLWY

NORTH DUNGOG ROAD

E F F' G G' E'

CROSS SECTION E-E'

E North — E' South

Existing; 10m width Benches; 80° Batters; Bench Heights 8-12m; East Pit Stages 1-5

Metres AHD; Metres

20m Vertical Scale; 0 50m Horizontal Scale

Legend: Existing Ground Level; Stage 1 Profile; Stage 2 Profile; Stage 3 Profile; Stage 4 Profile; Stage 5 Profile

CROSS SECTION F-F'

F West — F' East

Existing; Bench Heights 8-12m; 10m width Working Benches

Metres AHD; Metres

20m Vertical Scale; 0 50m Horizontal Scale

Legend: Existing Ground Level; Stage 1 Profile; Stage 2 Profile; Stage 3 Profile; Stage 4 Profile; Stage 5 Profile

CROSS SECTION G-G'

G West — G' East

Existing; East Pit Stages 1-5; 80° Batters

Metres AHD; Metres

10m Vertical Scale; 0 50m Horizontal Scale

Legend: Existing Ground Level; Stage 1 Profile; Stage 2 Profile; Stage 3 Profile; Stage 4 Profile; Stage 5 Profile

VGT Environmental Compliance Solutions Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 email: mail@vgt.com.au www.vgt.com.au ABN: 26 621 943 888

4.2.6 Stage Six (to approximately end of Year 25)

Aims for this stage

This final stage creates the final landform in west and east pits, see *Figure 10 - Stage Six.*

Considerations

The east pit will require a switch back haul road to obtain material down to RL 30. The fixed plant crushing and screening will be removed and mobile plant will be utilised.

Constraints and Issues

The east pit quarry development has a steep floor due the geological data obtained from E3, E8 and 8086-8.

Table 13. Stage Six Outcomes

Item	Thickness (metres)	Area (metres^2)	Volume (metres^3)	Tonnes
Topsoil*	No Clearing	0	0	
Overburden*	None	0	0	
Product			1,807,000	4,879,000
			1,807,000	

Note: * West pit data is estimated from BH 8086-4 and east pit data E3, E8 and 8086-8

These works are anticipated to take around 5 years to complete.

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Stage Six Plan
Figure:	TEN - SIX
Sheet:	6 of 6
Version/Date:	V0 23/09/2020

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N

0 50m

Location:	Off Station Street, Martins Creek, NSW	***Source:***	Google Earth Pro - Image Date 10/04/2020 & Client *(Umwelt)*	***Our Ref:***	9714_MC_GA2020_C018_V0_F10-6.cdr
Council:	Dungog Shire Council	***Survey:***	Client *(Umwelt)*	***Plan By:***	JD/SK
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	1m	***Office:***	Thornton

Legend

- Project Area
- Proposed Disturbance Area
- Final Quarry Area
- E — E' Stage Cross Sections E-G
- Stage 3 Pit Footprint
- Contour (1m / 5m)

369750 E · 370000 E · 370250 E · 370500 E · 370750 E

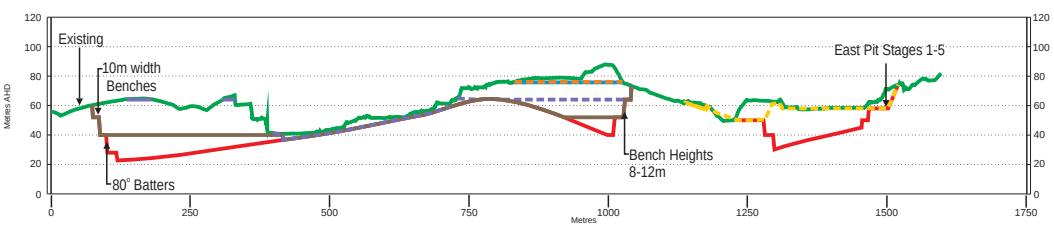
6398500 N · 6398250 N · 6398000 N · 6397750 N · 6397500 N · 6397250 N · 6397000 N

371000 E

COAST RLWY · NORTH · DUNGOG ROAD

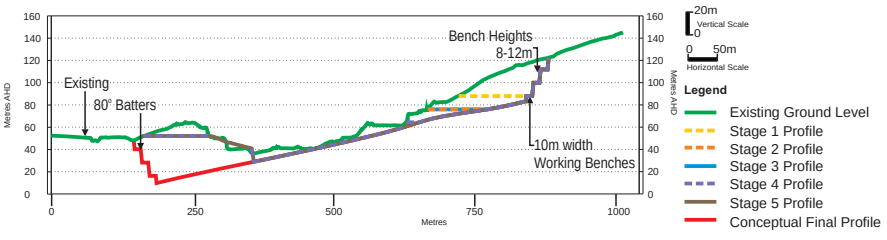
CROSS SECTION E-E'

E North — E' South



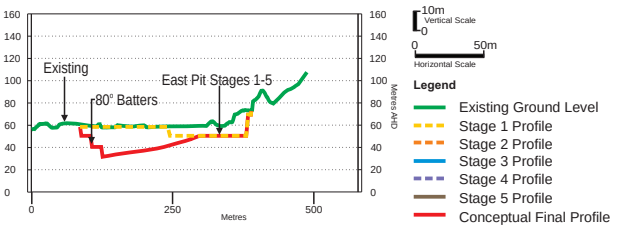
CROSS SECTION F-F'

F West — F' East



CROSS SECTION G-G'

G West — G' East



4.3 RESOURCE SUMMARY

The Martins Creek Quarry is principally dominated by Fresh Latite, with some Weathered Latite and pockets of Conglomerate, Agglomerate and sandy clays. All Fresh and weathered Latite was seen in the drill logs and quarry faces, the other materials were identified in the field mapping.

As discussed in *Section 2.3.3* all the materials found on site, excluding the basal meta-sediments, are suitable to create a variety of products in the construction industry. Summarised below in *Table 14* is the staged volumes.

Table 14. Staged Volumes Summary

Stage	Topsoil (metres^3)	Overburden (metres^3)	Product (metres^3)	Product (tonnes)
One	6,000	12,000	651,000	1,758,000
Two	2,000	5,000	1,474,000	3,980,000
Three	11,000	45,000	1,167,000	3,151,000
Four	12,000	47,000	1,696,000	4,579,000
Five	4,000	20,000	1,508,000	4,072,000
Final	0	0	1,807,000	4,879,000
Total	35,000	129,000	8,303,000	22,419,000

Note some rounding up and down was undertaken.

Over the 25-year proposed life of the quarry the calculated resource within the proposed quarry area would enable an average annual production of around 900,000 tonnes of quarry materials.

It is noted that the above assessment relates only to the resource in the quarry area proposed as part of the Revised Project and does not cover the broader resource present in the area which extends beyond the revised quarry footprint.

5 Unique Properties of the Martins Creek Quarry Resource

This assessment investigates the comparison of the fresh Latite found at Martins Creek and its principal hard rock uses against similar materials found in the local quarries.

In response to the Community Response Document 16 December 2016, Appendix 3 *"Hunter Region Quarried Material Supply Capacity"*, eight other Quarry sites were identified:

- Karuah East Quarry (Hunter Quarries Pty Ltd)
- Martins Creek Quarry (Daracon)
- Seaham Quarry (Boral Quarries Pty Ltd)
- Allandale Quarry (Quarry Products Newcastle Pty Ltd)
- Karuah (Hunter Quarries Pty Ltd)
- Brandy Hill (Hanson Pty Ltd)
- Teralba (Metromix Pty Ltd)
- Eagleton Quarry (Eagleton Rock Syndicate Pty Ltd)

With the exception of Eagleton Quarry, which is currently being assessed by the Department of Planning, Industry and Environment (DPIE) prior to recommendation to and determination by the NSW Independent Planning Commission, all of the quarries are currently operating. In addition to the above quarries, the Karuah South Quarry (Wedgerock Pty Ltd) is currently being assessed by the DPIE. Secretary's environmental assessment requirements have been issued for the Hillview Hard Rock Quarry (Coastwide Materials Pty Ltd) but a development application has not yet been lodged.

Table 15 provides a summary of the regionally significant quarries operating, or proposed to operate, within the Hunter region.

Table 15. Regional Quarries – Production and Resources

Quarry	Lithology	Maximum Production (tpa)	Resource [#3](Mt)
Approved			
Martins Creek	Latite	449,000	<5
Karuah	Andesite / Ignimbrite	500,000	<1
Karuah East	Andesite	1,500,000	29
Seaham	Ignimbrite	800,000	3
Allandale	Andesite	Undefined[#1]	undefined
Brandy Hill	Ignimbrite	700,000 – 1,500,000	78.1
Teralba	Conglomerate	1,200,000	22
	Sub-total	**>4,700,000**	**>138**
Proposed			
Martins Creek	Latite	1,100,000	22.4
Eagleton	Rhyolite	600,000	10
Karuah South	Ignimbrite	600,000	11.3
Hillview[#2]	Rhyolite	1,500,000	35
	Sub-total (proposed + additional)	**3,800,000**	**78.7**
	Total (approved + proposed)	**8,500,000**	**216.7**

Note #1: Environment Protection Licence limit of 2,000,000 tpa

Note #2: Details based on Preliminary Environmental Assessment information only.

Note #3: Resource is indicative of what is identified, not approved.

With the exception of Teralba Quarry (which is located within conglomerate), all are identified lithologically as Volcanics. As discussed further below, based on this key difference in geology, Teralba Quarry has been excluded from comparative analyses of the quarries both in relation to local lithology and resource properties.

As part of this assessment a macro and microscopic review of the quarries and their resources has been undertaken. The macro review (*Section 5.1*) provides an overall assessment as to the strategic importance of these resources, including those of Martins Creek Quarry, considering both the regional geological context, as well as local lithological settings.

The microscopic review (*Section 5.2*) interrogates the individual properties of the resources of the operating quarries in order to illustrate the suitability of these resources to the provision of various quarry products to the region. This review also includes an analysis of specific quarry products produced by Martins Creek Quarry and their importance in the marketplace.

A review of the strategic need for these products and estimates of future use are provided in other reports but summarised for contextual purposes in *Section 5.3*.

5.1 MACRO – REGIONAL QUARRY CONTEXT

As seen in *Figure 11.A* five of the six quarries (Karuah and Karuah East Quarries are grouped together – refer to *Figure 11.E*) are found underlain by the Carboniferous Volcanics. Allandale Quarry occurs over Permian aged Volcanics. The yellow sedimentary geological formations comprise approximately 60 - 70% of the mapped area and dominate over the purple Volcanics within the Carboniferous. It is within the Volcanics (both Carboniferous and Permian aged) that the hard rock resources suitable for concrete aggregates and other construction materials are available for extraction (quarrying).

As illustrated by *Figure 11.B* to *Figure 11.F*, there is a more detailed checker-board of the differing rock suites contained within the broader Volcanics geology. This checker-board of different lithologies is a result of the post consolidation movements, i.e. faulting, folding and uplift (identified by the solid and broken black lines on *Figure 11.A* to *Figure 11.F*. These strains on all of the rocks can alter the mineral structures and the microscopic faults lead to failures in the rock which affects its performance in concrete. As a result, the lithological formations suitable for the production of high-quality quarry products may be constrained by surrounding lithology which is less conducive to the production of hard rock products suitable for concrete manufacture, construction or other specialised requirements.

The review of regional geology, as well as an analysis of the local lithology of the various quarries of the region, illustrate that the geology in this region is not homogenous. The checker-board nature of regional and local geology illustrates that identifying sequences of rock units of the type and quality, conducive to the production of aggregate products of sufficient quantity to secure economic resources, will continue to be a challenge. Due to the competing interests of residential, agricultural, scenic and conservation land uses, the availability of land for the development of quarrying operations to satisfy the growing demand for these products is limited. This increases the strategic value of existing quarry sites which are located over suitable geology/lithology, or which have been identified through detailed geological, economic and environmental analysis as suitable for quarry development, to the regional and NSW economy.

As an established quarry site, with an identified resource of in excess of 22.4 million tonnes (not yet approved) (refer to *Section 2.3)* Martins Creek Quarry is one of a limited number of locations where significant quantities of high-quality hard rock resources are accessible for economic extraction.

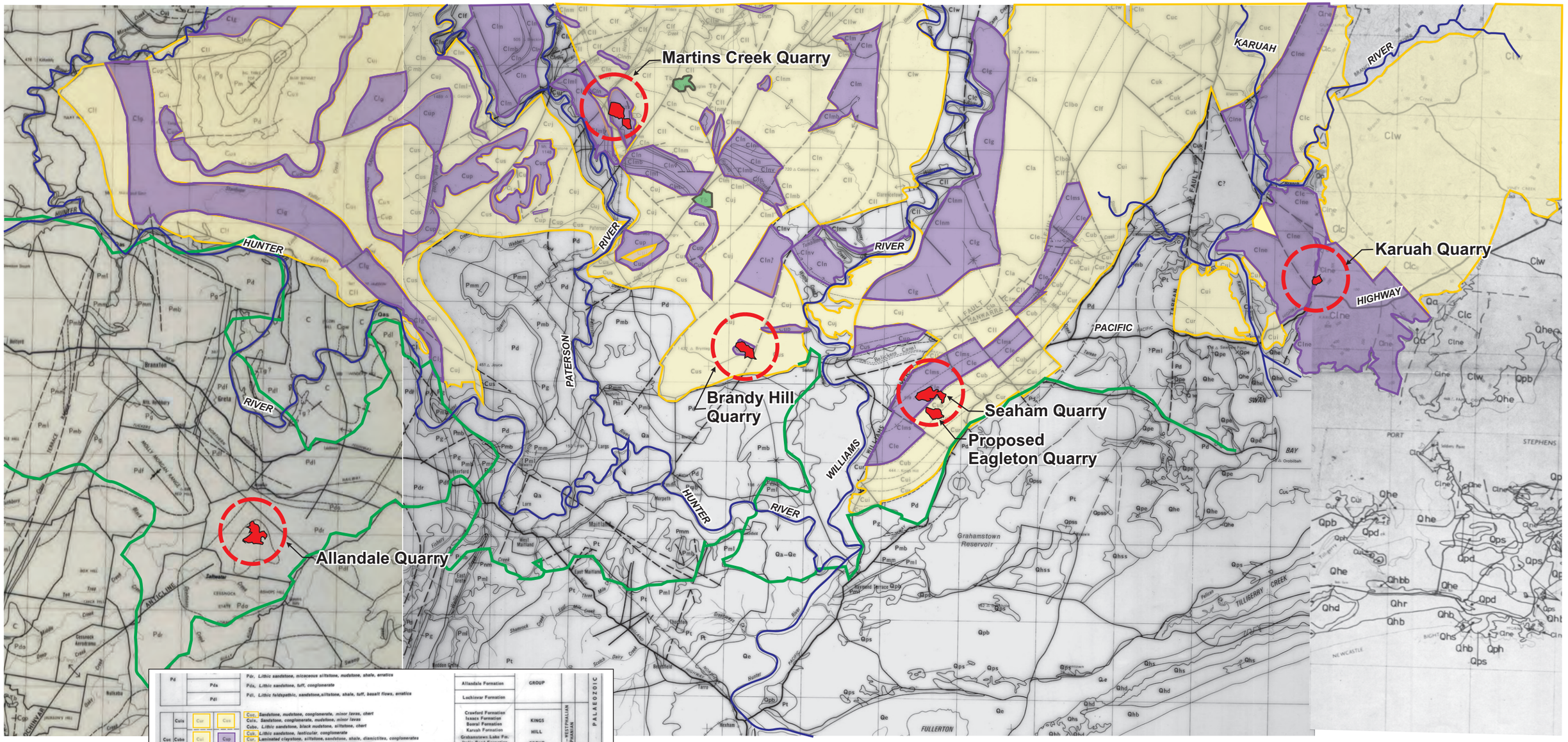
Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Overlay of Hunter Valley Region including Allandale, Brandy Hill, Karuah & Martins Creek Quarries	***Location:***	Cessnock, Newcastle & Port Stephens	***Source:***	Google Maps Image Date 12/14/2015 & 1:100000 DEP Geological Map Port Stephens, Cessnock & Newcastle	***Our Ref:***	9714_MC_GA2020_C022_V0_F11A.cdr
Figure:	ELEVEN - A	***Council:***	Cessnock, Newcastle & Port Stephens City Councils	***Survey:***	N/A	***Plan By:***	GT/SC/JD
Sheet:	1 of 6	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V0 23/09/2020	***Client:***	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt environmental compliance solutions and laboratories

N

0 1 2 3 4km



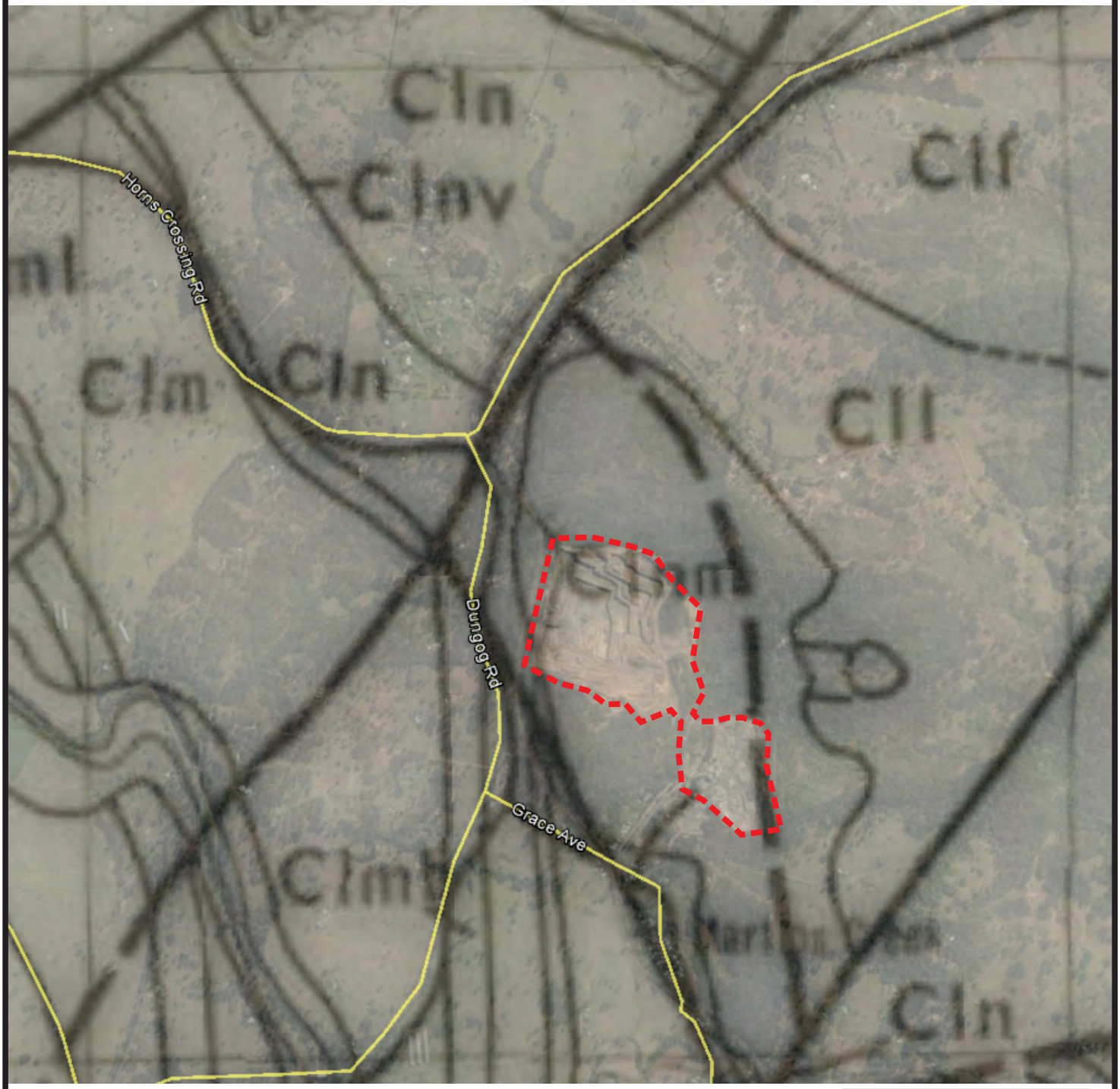
Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Overlay of Martins Creek Quarry
Figure:	ELEVEN - B
Sheet:	2 of 6
Version/Date:	V0 23/09/2020

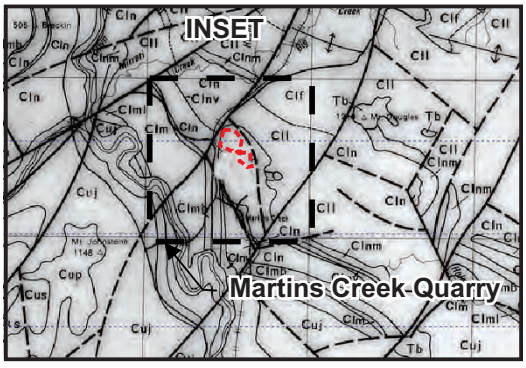
This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

N

0 500m

Location:	Martins Creek, NSW	***Source:***	Google Maps Image Date 12/14/2015 & 1:100000 DEP Geological Map Port Stephens, Cessnock & Newcastle	***Our Ref:***	9714_MC_GA2020_C024_V0_F11B.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton





Legend

- Martins Creek Quarry
- Roads

Lithology

Clf	Coarse Tuffaceous, Lithic Sandstone, Minor Interbeds of Siltstone
Cll	Andesitic Ignimbrite
Clmb	Coarse to Conglomerate Lithic Sandstone
Clmv	Micaceous Ignimbrite
Cln	Lithic Sandstone

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Overlay of Brandy Hill Quarry	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	ELEVEN - C				
Sheet:	3 of 6				
Version/Date:	V0 23/09/2020				
Location:	Brandy Hill, Seaham	***Source:***	Google Maps Image Date 12/14/2015 & 1:100000 DEP Geological Map Port Stephens, Cessnock & Newcastle	***Our Ref:***	9714_MC_GA2020_C021_V0_F11C .cdr
Council:	Port Stephens Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

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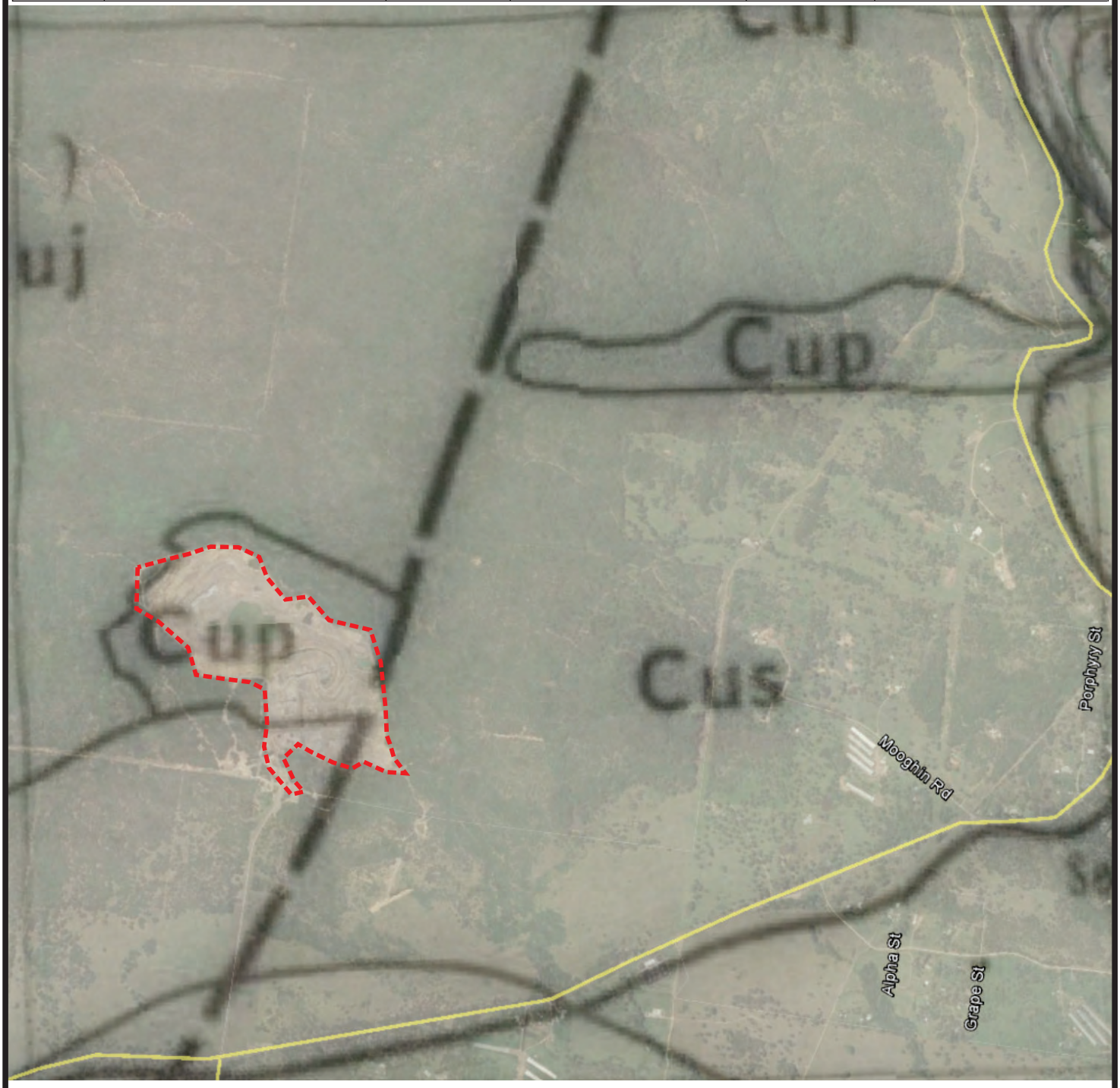
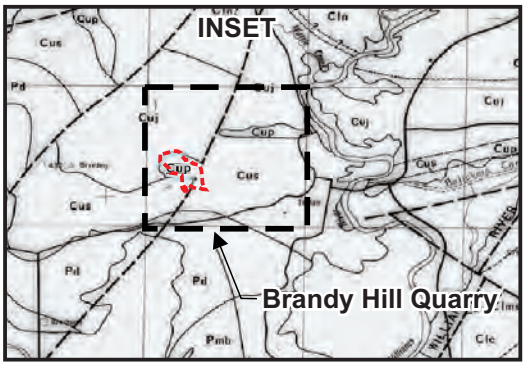
0 500m





Legend

- Brandy Hill Quarry
- Road

Lithology

- **Cuj** Conglomerate, Tuff, Sandstone, Shale
- **Cup** Acid Lava Flows, Crystal Tuff, Interbedded Conglomerate, Ignimbrite
- **Cus** Tillite, Varved Shale, Conglomerate Tuff, Sandstone, Mudstone, Minor Lava

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Overlay of Allandale Quarry	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	ELEVEN - D				
Sheet:	4 of 6				
Version/Date:	V0 17/09/2020				
Location:	Allandale, Cessnock	***Source:***	Google Maps - Image Date 12/14/2015 & 1:100000 DEP Geological Map Port Stephens, Cessnock & Newcastle	***Our Ref:***	9714_MC_GA2020_C020_V0_F11D .cdr
Council:	Cessnock City Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

N

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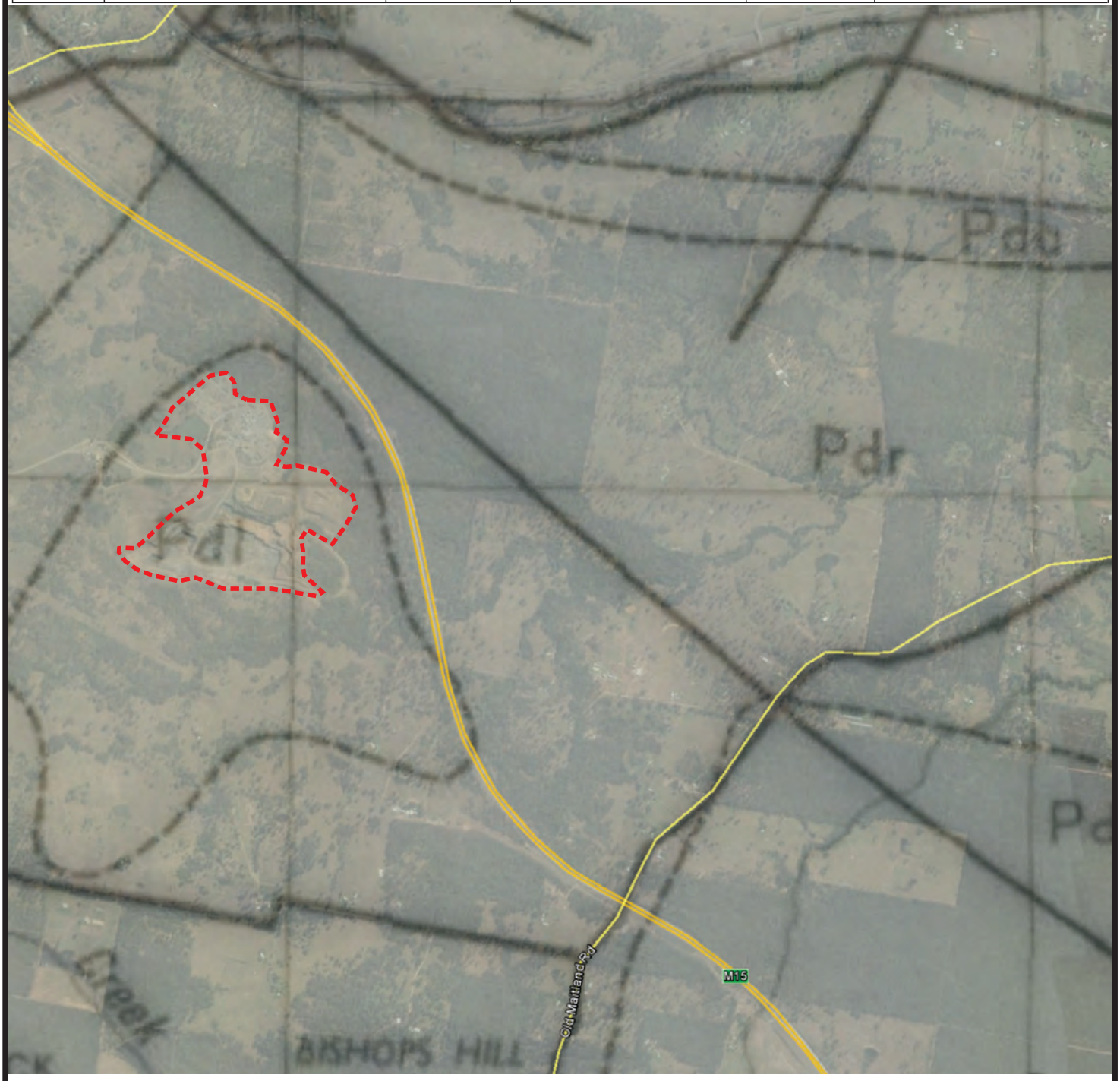

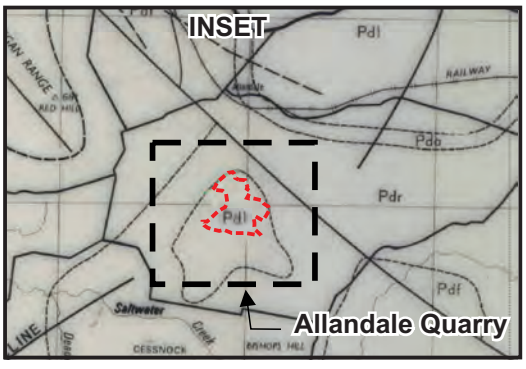

Legend

- Allandale Quarry
- Road

Lithology

Pdr	Conglomerate, Tuff, Sandstone, Shale
Pdl	Acid Lava Flows, Crystal Tuff, Interbedded Conglomerate, Ignimbrite
Pdo	Tillite, Varved Shale, Conglomerate Tuff, Sandstone, Mudstone, Minor Lava

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Overlay of Karuah & Karuah East Quarry	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	ELEVEN - E				
Sheet:	5 of 6				
Version/Date:	V0 23/09/20				
Location:	Karuah, Port Stephens	***Source:***	Google Maps Image Date 12/14/2015 & 1:100000 DEP Geological Map Port Stephens, Cessnock & Newcastle	***Our Ref:***	9714_MC_GA2020_C023_V0_F11E.cdr
Council:	Port Stephens Council	***Survey:***	N/A	***Plan By:***	GT/SC/JD
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

N

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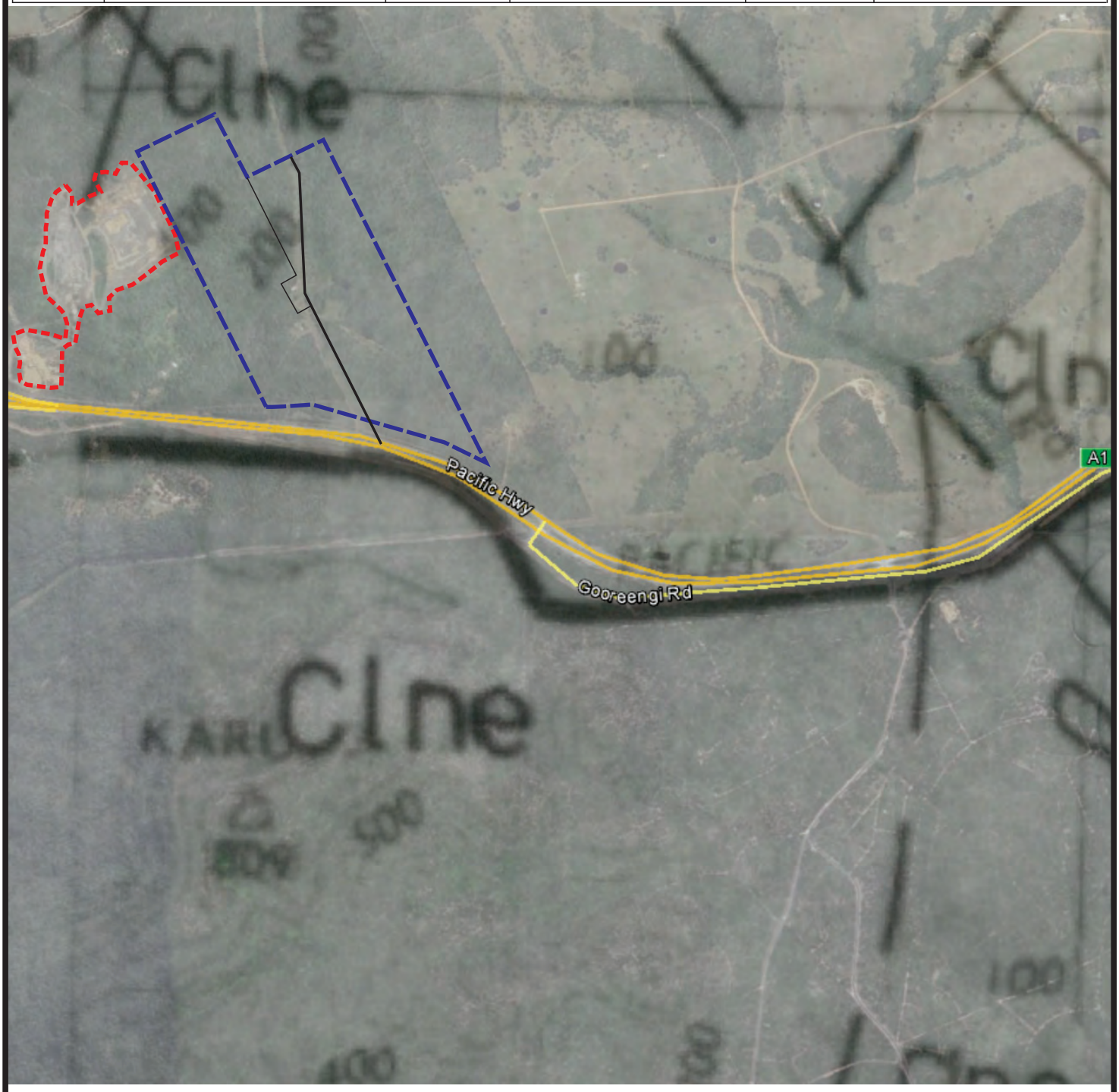

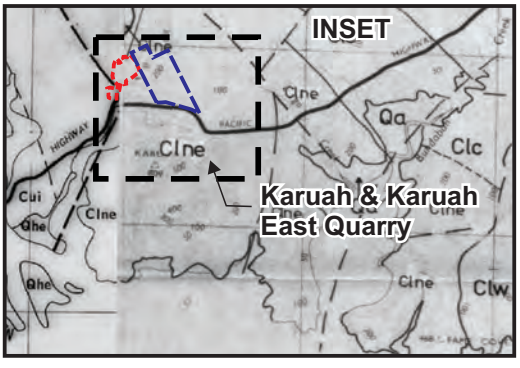

Legend

- Karuah Quarry
- Karuah East Quarry
- Road

Lithology

Clne = Clg, Toscanite, Dacite Andesite, Ignimbrite, Agglomerate, Conglomerate, Sandstone & Siltstone

Plan of:	Amended Geological Assessment for Martins Creek Quarry 2020 - Geological Overlay of Seaham Quarry & Proposed Eagleton Quarry	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	ELEVEN - F				
Sheet:	6 of 6				
Version/Date:	V0 23/09/2020				
Location:	Seaham, Newcastle	***Source:***	Google Maps - Image Date 12/14/2015 & 1:100000 DEP Geological Map Port Stephens, Cessnock & Newcastle	***Our Ref:***	9714_MC_GA2020_C025_V0_F11F.cdr
Council:	Port Stephens Council	***Survey:***	N/A	***Plan By:***	GT/SC/JD
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Limited	***Contour Interval:***	N/A	***Office:***	Thornton

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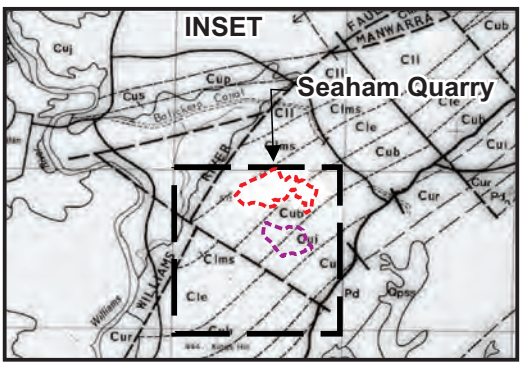
0 500m





Legend

- Seaham Quarry
- Proposed Eagleton Quarry
- Road

Lithology

Cle	Toscanite, Dellenitic & Ryholitic, Volcanic & Pyroclastic rocks
Clms	Andestic Pitchstone, Ignimbrite, Tuffs, Diacitic Ignimbrite
Cub	Coarse, Polymictic, Boulder Conglomerate
Cui	Litchic Sandstone, Shale, Coal, Chert, Ignimbrites, Tuffs

5.2 MICRO – AGGREGATE REVIEW

In order to further assess the key properties of the various operating quarries, and identify key similarities and differences between these, a review of key physical and chemical properties (relevant to product quality) of the deposit has been undertaken.

The results of the analysis of resource properties, along with the identification and assessment of unique or important products currently produced, are used to further assess the strategic and economic importance to the regional (and NSW) economy.

5.2.1 Methodology

Samples of both crusher dust and 20mm aggregate were collected from the seven operating quarries identified by the Community Response Document of 16 December 2016, Appendix 3 *"Hunter Region Quarried Material Supply Capacity"* and listed earlier. The original sample locations were collated by VGT Environmental Compliance Solutions Pty Ltd and renamed as anonymous sample identifications A through F (see *Table 16*) to ensure external laboratories conducting the testing were not biased by quarry names, see photography in *Appendix F.*

Table 16. Sample Identifications

VGT Sample ID	Quarry	Operator	20mm Delivered Date	Crusher Dust Delivered Date
A	Karuah East	Hunter Quarries Pty Ltd	02/08/2019	02/08/2019
B	Martins Creek	Buttai Gravel Pty Ltd	05/08/2019	05/08/2019
C	Seaham	Boral Quarries	05/08/2019	05/08/2019
D	Allandale	Quarry Products (Newcastle) Pty Ltd	02/08/2019	02/08/2019
E	Karuah	Hunter Quarries Pty Ltd	05/08/2019	02/08/2019
F	Brandy Hill	Hanson Pty Ltd	02/08/2019	02/08/2019

The following tests were undertaken:

- Petrographics;
- Bulk Density;
- Particle Density;
- pH; and
- Conductivity.

All tests were undertaken by Qualtest Pty Ltd.

5.2.2 Results

Table 17 shows the results from the pH and Conductivity testing for the sites.

pH is a critical factor in the chemistry of concrete and in order for the cement to hold together the other components, it is important for it to remain at or near a pH of 11. While the principal determinant of pH in concrete is cement (which has a pH at or near 11), a low pH of the aggregate used could reduce the final pH of the concrete and as a result reduce its strength (as a consequence of micro-cracking resultant from infiltration of acidic moisture within the small pores of the curing concrete). High conductivity can show high salt content and this in concrete can cause "salt attack" and potential failure in the concrete.

Table 17. Conductivity and pH Results

VGT Sample ID	Quarry	Operator	pH	Conductivity (µS/cm)
A – Dust	Karuah East	Hunter Quarries Pty Ltd	8.5	75
B - Dust	Martins Creek	Buttai Gravel Pty Ltd	9.3	80
C - Dust	Seaham	Boral Quarries	9.2	45
D - Dust	Allandale	Quarry Products (Newcastle) Pty Ltd	9.2	280
E - Dust	Karuah	Hunter Quarries Pty Ltd	9.2	45
F - Dust	Brandy Hill	Hanson Pty Ltd	9.6	90

The results show Karuah East has the lowest pH at 8.5 and Brandy Hill the highest at 9.6. Allandale had the highest conductivity of 280 µS/cm. Overall, the results are very similar and none of the samples present properties which would prevent these from use in concrete manufacture or other construction uses.

Table 18 shows the dry density ranges from 2.48 t/m^3 for Allandale to 2.66 t/m^3 for Karuah, with Martins Creek 2.57 t/m^3 and in general there is very little difference between the resources, except that Karuah and Martins Creek has the lowest water absorption.

Table 18. Density Results

VGT Sample ID	Quarry	Uncompacted Bulk Density (t/m^3)	Compacted Bulk Density (t/m^3)	Aggregate Moisture Conditions	Nominal Size of Sample (mm)	Apparent Particle Density (t/m^3)	Particle Density Dry (t/m^3)	Particle Density SSD (t/m^3)	Water Absorption (%)
A - Dust	Karuah East	1.29	1.55	As received	6	2.71	2.53	2.59	2.6
B - Dust	Martins Creek	1.22	1.42	" "	6	2.67	2.50	2.57	2.5
C - Dust	Seaham	1.17	1.41	" "	6	2.63	2.45	2.52	2.8
D - Dust	Allandale	Insufficient sample to test	Insufficient sample to test	Insufficient sample to test	Insufficient sample to test	2.73	2.43	2.54	4.6
E - Dust	Karuah	1.20	1.44	As received	6	2.72	2.60	2.64	1.6
F - Dust	Brandy Hill	1.15	1.35	" "	6	2.65	2.46	2.53	3.0
A - Aggregate	Karuah East	1.41	1.54	As received	20	2.72	2.64	2.67	1.1
B - Aggregate	Martins Creek	1.38	1.52	" "	20	2.67	2.57	2.61	1.5
C - Aggregate	Seaham	1.37	1.52	" "	20	2.64	2.54	2.58	1.6
D - Aggregate	Allandale	1.33	1.50	" "	20	2.73	2.48	2.57	3.7
E - Aggregate	Karuah	1.42	1.58	" "	20	2.74	2.66	2.69	1.2
F - Aggregate	Brandy Hill	1.33	1.47	" "	20	2.65	2.52	2.57	1.9

With particular reference to water absorption, while no limits are specified in AS 2758.11, Technical Note 73 Concrete aggregates: The requirements of AS 2758.1 – 2009 (CCAA, 2014) the preferred average absorption of normal weight aggregate is about 2%. With low water absorption, this identifies aggregate from Martins Creek Quarry as having preferred characteristics for concrete manufacture over some of the other quarries with higher water absorption ratios (notably Allandale Quarry (3.7%)). It is unusual for structural concrete to have a water absorption over 2% (Source: Daracon).

Table 19 presents the results of petrographic analyses of the various samples and provides an assessment as to suitability for various uses, see *Appendix H* for full reports. The petrographic analysis presented in the EIS for Eagleton Quarry is also presented, however, the author cannot validate the tests completed for this material and as such the results are provided for contextual purposes only.

Table 19. Petrographic Results

VGT Sample ID	Quarry	Rock Name	Smectite %	Free Silica %	Suitable for Road Base	Suitable for Concrete	Suitable for sealing Aggregate	Rail Ballast
A - Aggregate	Karuah East	Latite Tuff	15	3 to 4	Yes	Yes	Yes	Yes
B - Aggregate	Martins Creek	Latite Tuff	5	8 to 9	Yes	Yes*	Yes	Yes
C - Aggregate	Seaham	Rhyodacite Tuff	2	27	Yes	Yes*	Yes	Yes
D - Aggregate	Allandale	Porphyritic Latite - Andesite	15	0	Yes	Yes	Yes***	Yes****
E - Aggregate	Karuah	Latite Tuff and minor Dolerite	14	2 to 3	Yes	Yes	Yes	Yes
F - Aggregate	Brandy Hill	Rhyodacite Tuff	0	27	Yes	Yes*	Yes	Yes
EIS Petrographic	Eagleton	Hematized rhyolitic tuff	0	28	Yes	Yes**	Yes	Yes

Note: *Mild or slow potential for alkali-silica reactivity in concrete

**Substantial potential for deleterious alkali-silica reactivity

***Subject to bitumen stripping and polishing tests

****Subject to compliance with Durability Criteria of CT147/AS 2758.7

With the exception of Allandale Quarry (which requires further analysis prior to confirmation of suitability for concrete manufacture, sealing aggregates or rail ballast), all materials presented in *Table 17* would be suitable for road base, sealing aggregate and rail ballast. Uses for concrete vary depending on the alkali silica reactivity with the higher the occurrence of free silica, in particular if combined with a higher water absorption ratios, increasing the risk of this swelling reaction between the highly alkaline cement paste and the reactive non-crystalline (amorphous) silica. Smectite, a combined term for various hydrous aluminium phyllosilicate clay minerals (montmorillonite, beidellite, nontronite, saponite and hectorite), can be particularly deleterious to curing concrete due to swelling on exposure to water.

While overall, the values for free silica and smectite are within ranges allowing for used in the manufacture of concrete (subject to further testing in some cases), the low values of Smectite and free silica in the Martins Creek Quarry sample confirm this as suitable for all purposes (with only mild potential for alkali-silica reactivity in concrete).

[1] AS 2758.1:2014 Aggregates and rock for engineering purposes Part 1: Concrete aggregates (Standards Australia Limited, 2014)

Table 20 shows the results of point loads testing for Martin Creek Quarry and Seaham Quarry. The average strength classification for Seaham and Martins Creek being 5.8 and 10.6 Mpa respectively. Martins Creek material has significantly higher strength relative to the Seaham Quarry material.

Table 20. Point Load

Site	$I_{s(50)}$ (Mpa)	Strength Classification
Martins Creek	8.92	Very High Strength
	11.83	Extremely High Strength
	11.18	Extremely High Strength
	10.98	Extremely High Strength
	10.28	Extremely High Strength
Seaham	8.22	
	7.66	
	4.98	
	5.81	
	7.10	
	3.53	
	5.26	
	8.24	
	4.22	
	3.87	

Material with higher Polished Aggregate Friction value (PAFV) is better material for use in sealing aggregate and asphaltic concrete production application. *Table 21* shows a comparison of PAFV between Martins Creek Quarry and Brandy Hill. As can be seen from *Table 21*, Martins Creek material has higher PAFV than Brandy Hill material in the samples tested.

Table 21. Polished Aggregate Friction Value

Site	Polished Aggregate Friction value (PAFV)
Martins Creek	53
	51
Brandy Hill	50

5.2.3 Discussion

The analysis of the various properties of aggregates from quarries supplying the Hunter region demonstrates that the aggregates of the Martins Creek Quarry display properties which are suitable (and in many cases preferential to aggregates from other quarries) for a range of uses where physical and chemical properties are an important consideration.

On further analysis of Martins Creek Quarry products, it has been established that not only does it produce aggregates suitable for a diverse range of end uses, it is unique to the industry (based on the analysis completed for this review) in three broad areas as discussed below.

Unbound Road Base - RMS 3051 Edition 7

"Martins Creek Quarry produces an unbound road base product (Stabilbase) that is "unique" in the Hunter. The product is compliant in all aspects of the RMS 3051 Edition 7 specification (latest and current spec) for Unbound Base and is approved by the Roads and Maritime Services (RMS) (also known as Transport for NSW (TfNSW)) for use in all road categories including the maximum traffic loading category "A" for highway use.

There is a limited source of material meeting this current RMS Category "A" requirement in regions from the Central Coast to the Upper Hunter. RMS utilises this product directly in their own construction projects and confirm there are very limited compliant sources available to the Hunter, Central Coast and New England markets.

The product is registered with the RMS under their unique materials category (see *Appendix G*). The product has been specifically developed to meet the highest performance standards of RMS/TfNSW whilst utilising product that was historically a by-product of quarrying operations. Specific amounts of Fly-ash and other additives are added to this product to provide a very high specification product at a low price point. This delivers a high value for money for local infrastructure and project developments." (Source Daracon 12/9/2019)

Heavily Bound Base - RMS R 73 Ed. 3

Martins Creek Quarry produces a Heavily Bound Base product (Stabilstone) that is also unique in the Hunter.

The product is compliant in all aspects of the RMS R73 Ed. 3 Rev 0 – Hunter Region Heavily Bound Base specification (latest and current spec). It provides particularly long working times (in excess of 72 hrs) relative to other heavily bound materials available. It utilises binders which minimise the heat of hydration[2] generating a bound product without the excessive shrinkage cracking of other products available. This enables the covering asphalt layer to be much thinner as reflective cracking from the pavement is minimised. Any hairline cracking is identifiable and easily sealed. Reductions from the standard of 180mm asphalt thickness down to 90mm and less are typical. The product is also uniquely suitable to accept a surfacing of spray seal where surfacing requirements allow.

As for the above, the product being specifically developed to meet the highest performance standards whilst utilising input product that was historically a poor-quality quarry by-product blended with power station by-product to provide a product of the highest product standards whilst minimising product cost for infrastructure and project developments. (Source Daracon 12/9/2019)

Washed Manufactured Sand for the Concrete Industry

Background

Since the Egyptians built the pyramids in 3,000 BC, concrete has been a vital part of human endeavour, as it still is, today. Concrete now is a carefully blended product of cement, water coarse and fine aggregates, each element as important as the other.

Around 75% of the mix are coarse and fine aggregates. Previously, in the Hunter and Sydney region the fine aggregate portion has been met mostly by extracting sands from rivers or near river deposits as unconsolidated sand

[2] The heat of hydration is the heat generated when water and cement react. In large mass concrete structures hydration heat can create high temperatures in the center of large concrete masses that, in turn, may cause undesirable stresses as the concrete cools to ambient temperature (Portland Cement Association (PCA), 1988. Design and Control of Concrete Mixtures).

and gravel. Exhausted resources, regulatory and residential pressures have all but eliminated this type of resource being extracted.

The hard rock quarry industry, which are extracting consolidated Volcanics (i.e. andesite, basalts, etc) produce large amounts of manufactured sand, which typically has around 10% portion, known as silt (i.e. less than 75 micron). The concrete manufacturers cannot take too much of this silt as it absorbs water and creates numerous problems.

As such some quarries wash their Volcanic manufactured sand using a sand screw system (refer to *Photoplate 17*) which removes to finer fractions; Martins Creek is the only one known to the author, at the time of this report, in Newcastle / Hunter region to do this.



Photoplate 17. Sand Screw System

Context of Martins Creek Quarry

"Martins Creek Quarry produces high quality manufactured sand suitable for use in high quality concrete and asphalt products compliant to all applicable contemporary standards. MCK is unique in that it is the only hard rock quarry in the Hunter offering washed manufactured sand to meet the requirements of high strength concrete specifications and coarse drainage sand for biofiltration and filter sand.

This enables utilisation of what is otherwise quarry by-product in applications complying with the highest industry standards." (Source Daracon 12/9/2019)

It is noted that previous analysis and testing of manufactured sands by Cement Concrete & Aggregates Australia (CCAA, 2007, 2008) provided recommendations for testing methods and the specification limits for manufactured sand. AS 2758.1:2014 was subsequently updated to provide a full specification for manufactured fine aggregate. The ability to meet the requirements of AS 2758.1:2014 increases the importance of the Martins Creek Quarry noting the increasing pressure on supply of sand to the Hunter, Sydney and other NSW markets (see below).

Other Potential Suppliers of Sand

The concrete and asphalt industries require sand to meet a specific grading, that is, a careful blend of small and medium grain sizes. The washing of Martins Creek produces this. Other sand suppliers found on the Newcastle sand dunes only provides a mid-size sand grain, as these sources have been carefully sorted and sized by the wind for thousands of years.

The other independent supplier, known to the author at the time of preparing this document, of the sand mix to the concrete batching plants in the Newcastle and Hunter region is a river gravel quarry known as Dalswinton Quarry. Dalswinton Quarry's consent was due to lapse on November 13th, 2019, however, approval is being sought to quarry up to 500,000tpa (from a resource of 5 million tonnes). An application to extend the life of this operation is yet to be lodged however SEARs have been issued.

Teralba Quarry (Metromix) does provide a washed concrete sand but quality and volumes available to independent concrete manufacturers at the time of preparing this report are unknown to the author.

If Martins Creek and Dalswinton Quarries cease to operate then the next nearest known independent supplier to the author is Maroota, north west of Sydney and obtaining access to the Hunter region trucks will be going through North Western Sydney and Pennant Hills Road.

The current Daracon Concrete Batching plant has been used as a reference point for distance comparisons to feed into the Hunter / Newcastle market.

Table 22. Distance from Sources to Daracon Concrete Plant at Cameron Park

Sand suppliers	Distance to Cameron Park (kilometres)
Martins Creek	51
Dalswinton	117
Maroota	157

5.3 CONCLUSION

The Martins Creek Quarry resource is a Latite Tuff, which is mostly free of structural strains, such as faults, thrusts and folding. Within a regional context, the resource is significant as the availability of other hard rock resources, with properties suitable for concrete, asphalt and sealing aggregates, road and rail construction, are limited both by the regional and local lithological settings as well as competing land uses.

The resource modelling undertaken identifies that the revised proposed quarry area contains up to 22Mt of high quality saleable latite resource, with some minor amounts of other lower value products. This amount of resource equates to an average annual production rate of approximately 900,000tpa over the proposed 25-year life of operations.

When key physical and chemical properties of the Martins Creek Quarry resource was analysed and compared to those of other quarries within the region, it compares favourably with equivalent or better properties associated with pH, electrical conductivity, water absorption, free silica and smectite. The analysis confirms that unlike several of the other regional quarries, which require further testing prior to confirmation of suitability for some purposes, the properties of the Martins Creek Quarry products allow it to be used in all aspects of road, concrete and rail construction industries. This conclusion is also supported by the uses of the quarry materials in their relevant markets.

Further to the suitability of the Martins Creek Quarry products for concrete, road and rail construction, it is demonstrated as producing and supplying several product types which are unique and sought after for specific purposes. Notably, the Roads and Maritime Services (TfNSW) have and still rely on this resource for unbound and heavily bound base

The ability of Martins Creek Quarry to produce a manufactured sand which complies with the specifications of AS 2758.1:2014 (aggregates for concrete manufacture) further sets it apart from other quarries. With supply of sand likely to reduce over the coming decades, greater utilisation of manufactured sands not only ensures greater utilisation of the quarry resource but will assist in easing supply pressure on sand resources.

Appendix A
Martins Creek Petrographic Assessment 2014

GEOCHEMPET SERVICES BRISBANE

Geochempet Services

ABN 980 6945 3445
PETROLOGICAL and GEOCHEMICAL CONSULTANTS
Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.



5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019

Telephone: (07) 32840020
Fax: (07) 32840018

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT ON A 20 mm BLENDED AGGREGATE (149789) FROM CARDNO GEOTECH SOLUTIONS

prepared for

BORAL RESOURCES (NSW) PTY LTD
MATERIALS TECHNICAL SERVICES

Purchase Order: 5208821

Invoice Number: 00005648

Client Ref: George Calvar

Issued by:

L. P. Evans, B.Sc
14 February, 2014

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Sample Number:	149789	**Date Sampled**:	08/01/14
Product Type:	20 mm Blended Aggregate	**Date Despatched**:	21/01/14
Sample Loc'n:	Cardno Geotech Solutions		

Work Requested Petrographic analysis in relation to suitability for use as concrete aggregate; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of ASTM C 295 Standard Guide for *Petrographic Assessment of Aggregates for Concrete,* the AS2758.1 – 1998 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B),* the AS1141 Standard Guide for the *Method for sampling and testing aggregates*, of the content of the 1996 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-1996) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*

Identification Latite tuff

Description

The sample consisted of about 2.0 kg of hard, robust, angular fragments of medium grey, largely unweathered to less common slightly weathered (pale yellowish red), finely crystalline rock speckled with small phenoclasts of lighter grey feldspar and darker grey hornblende. The weathering is displayed by light brown and reddish colouration in some rock fragments and on a few flat joint surfaces. The aggregate fragments are coated by an easily removed fine dust.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 random fragments. An approximate mineralogical composition of the rock, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

20%	microcrystalline feldspars and very minor quartz (products of devitrification; 2% microcrystalline quartz)
7%	spherulitic feldspar and very minor quartz (<1% quartz)
33%	plagioclase feldspar phenoclasts
5%	hornblende phenoclasts
<1%	quartz phenoclasts
<1%	coarser groundmass quartz
19%	coarser groundmass feldspar
3%	leucoxene
1%	opaque oxide (magnetite and/or ilmenite)
<1%	pyroxene
4%	haematite/limonite/goethite

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

<1%	apatite and zircon

Weak or Otherwise Non-durable Minerals

6%	chlorite-smectite
2%	sericite
<1%	limonite
trace	calcite

In thin section the rock displays textures of tuffaceous style, involving many smoothly corroded, subhedral and less commonly broken phenoclasts (mainly about 0.1 to 3.5 mm in size) along with a few lithic clasts of similar size dispersed through a now devitrified and clouded matrix with obvious ghosts of former moderately welded vitric shards (mainly about 0.2 to 0.3 mm long).

The most abundant phenoclasts are twinned, strongly zoned, prismatic plagioclase with variable alteration to sericite. Other phenoclasts are brownish-green hornblende (thinly rimmed by haematite), opaque oxide (slightly haematized), remnant pyroxene (now largely pseudomorphed by chlorite-smectite accompanied by variable sericite and hematite, sparse flakes of biotite (completely altered to chlorite and hematite) and a very few broken quartz. The formerly vitroclastic matrix, strongly flow-banded in discreet portions of the rock, now consists of variably clouded (apparently a dusting of fine brown clay) and, microcrystalline to microspherulitic feldspars, accompanied by leucoxene, very minor anhedral quartz (about 0.05 to 0.3 mm size), chlorite and very fine haematite specks and dust. A few small grains of apatite and zircon are present. Calcite is seen along the edge of a few fragments.

Comments and Interpretations

The rock represented in the supplied 20 mm blended aggregate sample (labelled 149789) from Cardno Geotech Solutions is considered to be latite tuff which is in a partly oxidized (haematitic) condition. It seem that the oxidation may be of diagenetic or alteration origin, rather than necessarily an expression of weathering. In more detail, the rock appears to have originated as moderately welded crystal-vitric tuff generated by ash flow (or ignimbrite) processes. Its composition seems to be equivalent to latite, an intermediate volcanic rock, similar to andesite but more potassic. The rock initially consisted of abundant phenoclasts of plagioclase, hornblende, pyroxene, biotite, opaque oxide and a trace amount of quartz dispersed through a moderately welded mass of glass shards. Subsequently the rock experienced devitrification resulting in conversion of all of the glass to microcrystalline and microspherulitic feldspars, leucoxene, chlorite and to minor amounts of fine clay, sericite and secondary iron oxide. Phenoclasts suffered minor, probably related alteration.

For engineering purposes, the rock in the supplied aggregate sample may be summarised as:

- **latite tuff** (equivalent in composition to intermediate volcanic igneous rock)
- devitrified and now finely crystalline
- mainly unweathered (less commonly slightly weathered)

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- lightly altered
- carrying about 8% of weak minerals (6% chlorite, 2% sericite, <1% limonite and trace calcite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

Thus, aggregate equivalent to the supplied sample is predicted to be **suitable for use as concrete aggregate**.

Free Silica Content

Apparently 2% of finely microcrystalline quartz and coarser quartz, all locked in crystalline rock.

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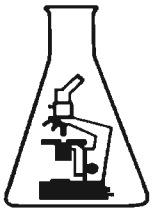
GEOCHEMPET SERVICES BRISBANE

Geochempet Services

ABN 980 6945 3445
PETROLOGICAL and GEOCHEMICAL CONSULTANTS
Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.



5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019

Telephone: (07) 3284 0020
Fax: (07) 3284 0018

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT ON A ROCK SPALL (NEW14W-0091-S01)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARRABROOK

Purchase Order:	QTPO14-1321
Invoice Number:	00005653
Client Ref:	Adam Dwyer Dane Cullen

Issued by:

L. P. Evans, B.Sc
17 February, 2014

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Sample Ref No.:	NEW14W-0091-S01	**Date Sampled**:	21/01/14
Lab Ref No.:	NEW13W-0091	**Project No.**:	12/00005

Sample Description: Martins Creek Revetment-Rockfill

Project: Material Testing

Work Requested Petrographic analysis in relation to suitability for use as revetment – rockfill for erosion control

Methods Account taken of ASTM D4992-07 Standard Practice for *Evaluation of Rock to be used for Erosional Control*

Identification Latite tuff

Description

The sample consisted of a rock spall, being medium grey, essentially unweathered, finely crystalline rock speckled with small phenoclasts of lighter grey feldspar and darker bluish black hornblende. The rock is bound by fracture faces, with no apparent fabric observed in hand specimen. The rock can be scratched lightly by a metal implement.

A thin section was prepared to permit microscopic examination in transmitted polarised light of the rock. An approximate mineralogical composition of the rock, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

12%	microcrystalline feldspars and very minor quartz (products of devitrification; 1% microcrystalline quartz)
6%	spherulitic feldspar and very minor quartz (<1% quartz)
35%	plagioclase feldspar phenoclasts
1%	hornblende phenoclasts
2%	quartz phenoclasts
1%	coarser groundmass quartz
26%	coarser groundmass feldspar
2%	leucoxene
<1%	opaque oxide (magnetite and/or ilmenite)
1%	clinopyroxene
1%	haematite/limonite/goethite
<1%	apatite and zircon

Weak or Otherwise Non-durable Minerals

10%	chlorite-smectite
3%	sericite
<1%	limonite

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

trace calcite

In thin section the rock displays textures of tuffaceous style, involving many smoothly corroded, subhedral and less commonly broken phenoclasts (mainly about 0.1 to 3.5 mm in size) along with a few lithic clasts of similar size dispersed through a now devitrified and clouded matrix with obvious ghosts of former moderately welded vitric shards (mainly about 0.2 to 0.3 mm long).

The most abundant phenoclasts are twinned, strongly zoned, prismatic plagioclase with variable alteration to sericite. Other phenoclasts are brownish-green hornblende (thinly rimmed by opacite), opaque oxide (slightly haematized), clinopyroxene, sparse flakes of biotite (completely altered to chlorite and haematite) and a very few broken quartz. The formerly vitroclastic matrix, strongly flow-banded in discreet portions of the rock, now consists of variably clouded (apparently a dusting of fine brown clay) and, microcrystalline to microspherulitic feldspars, accompanied by leucoxene, very minor anhedral quartz (about 0.05 to 0.3 mm size), chlorite and very fine haematite specks and dust. A few small grains of apatite and zircon are present.

Comments and Interpretations

The rock represented in the supplied rock spall (labelled NEW14W-0091-S01) is considered to be latite tuff. In more detail, the rock appears to have originated as moderately welded crystal-vitric tuff generated by ash flow (or ignimbrite) processes. Its composition seems to be equivalent to latite, an intermediate volcanic rock, similar to andesite but more potassic. The rock initially consisted of abundant phenoclasts of plagioclase, hornblende, pyroxene, biotite, opaque oxide and a trace amount of quartz dispersed through a moderately welded mass of glass shards. Subsequently the rock experienced devitrification resulting in conversion of all of the glass to microcrystalline and microspherulitic feldspars, leucoxene, chlorite and to minor amounts of fine clay, sericite and secondary iron oxide. Phenoclasts suffered minor, probably related alteration.

For engineering purposes, the rock in the rock spall sample may be summarised as:

- **latite tuff** (equivalent in composition to intermediate volcanic igneous rock)
- devitrified and now finely crystalline
- essentially unweathered
- lightly altered
- carrying about 13% of weak minerals (10% chlorite, 3% sericite, <1% limonite and trace calcite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

Thus, rock equivalent to the supplied sample is predicted to be **suitable for use as a source of marine armour rock, rip rap, revetment or rockfill**, with the caveat the quarry is examined for boulders that can be liberated from the face which are free of jointing, fractures or other weaknesses.

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Free Silica Content

Apparently 4% (1% of finely microcrystalline quartz and 3% coarser quartz) all locked in crystalline rock.

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Appendix B
1968 Bore Hole Logs and Core Photographs

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH1
Figure:	Appendix C
Sheet:	1 of 3
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_68BH1_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

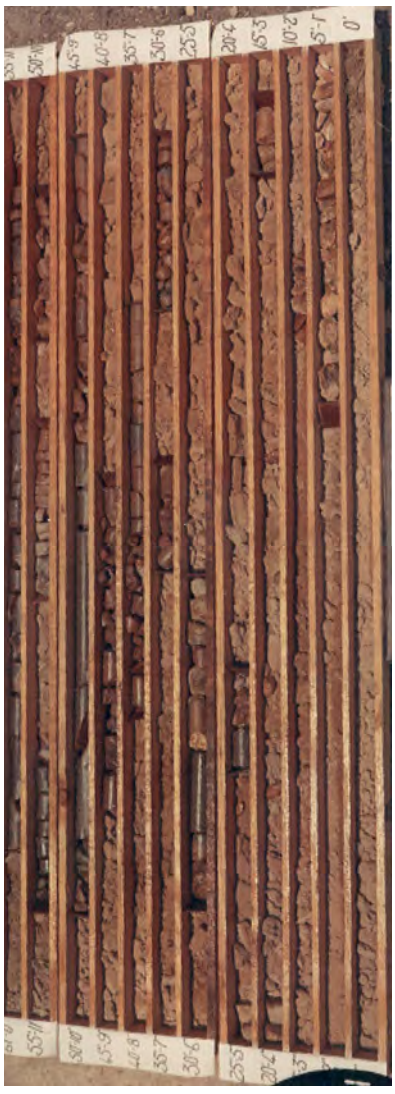
Drill Hole Number: Martins Creek 1968 BH1

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 42.2
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Bad, some rare good	1				Collar 99 m RL
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
Good, some rare bad	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH1
Figure:	Appendix C
Sheet:	2 of 3
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_68BH1_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 1968 BH1

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 42.2
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
Good, some rare bad	21–26				
Bad	26–29				
Good, some rare bad	29–40				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH1
Figure:	Appendix C
Sheet:	3 of 3
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

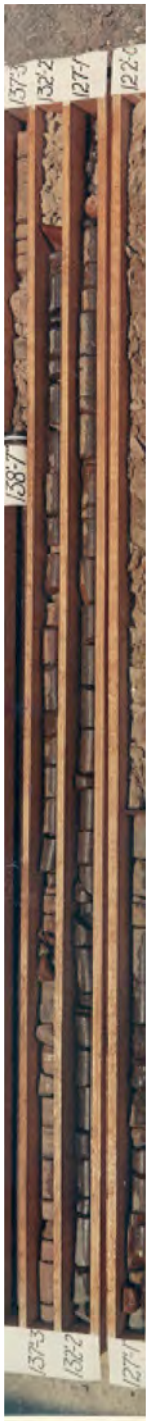
Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_68BH1_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 1968 BH1

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 42.2
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41–60				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH2
Figure:	Appendix C
Sheet:	1 of 1
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_68BH2_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 1968 BH2

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 15.7m
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Bad, some rare good	1				
	2				
	3				
	4				
	5				
	6				
	7				
Good, to medium, some bad	8				
	9				
	10				
	11				
	12				
	13				
	14				
Bad	15				
	16				
	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH3
Figure:	Appendix C
Sheet:	1 of 1
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_68BH3_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 1968 BH3

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 16.1
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Bad, some rare good	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
Good, some rare bad	14				
	15				
	16				
	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH4
Figure:	Appendix C
Sheet:	1 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_68BH4_V1.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO/JD
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 1968 BH4

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 27.4
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
Bad, some rare good	0–6				
Good, some rare bad	6–20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH4
Figure:	Appendix C
Sheet:	2 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_68BH4_V1.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO/JD
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 1968 BH4

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 27.4
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole 1968 BH5
Figure:	Appendix C
Sheet:	1 of 1
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_68BH5_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 1968 BH5

Project: Martins Creek
Drilling Co: Unknown
Date: 1968

Job Number: 1217
Logged By: Unknown

Hole Depth: 9.7 m
Hole Dia: Unknown

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Bad, some rare good	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
Good, some rare bad	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				



Appendix C
2006 8086 Bore Hole Logs

Drill Hole Number: 2006 BH 8086-1

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 33.5m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				GR 6397788.650, 370854.181 RL 90m
Silty Sand - Grey brown					
Latite - Grey	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

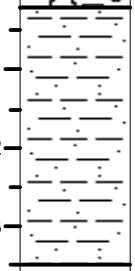
VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-1

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 33.5m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
Sandstone / Shale -Grey Fine to medium grained.	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-1

Project: Martins Creek
Job Number: 1217
Hole Depth: 33.5m
Drilling Co: Intertech
Logged By: Rail Corp
Hole Dia: 110mm
Date: 2006

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-2

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 33.77m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Silty Sand - Brown grey Trace clay, some gravels.					GR 6398000.558, 370636.245 RL 124m
Latite - Grey	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-2

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 33.77m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
Silty Clay - Brown/red - brown/grey	32				
Sandstone - Red-brown	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-2

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 33.77m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-3

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 40m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey	1				GR 6398448.194, 370204.574
	2				RL 88m
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-3

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 40m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
Shale/Sandstone - Dark grey/brown	39				
	40				

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Drill Hole Number: 2006 BH 8086-3

Project: Martins Creek
Job Number: 1217
Hole Depth: 40m
Drilling Co: Intertech
Logged By: Rail Corp
Hole Dia: 110mm
Date: 2006

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-4

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 44.93m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				GR 6398270.972, 370030.885 49.5m
Silty Clay - Light grey Trace sand.	1				
Latite - Grey/brown	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-4

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 44.93m
Hole Dia: 110mm

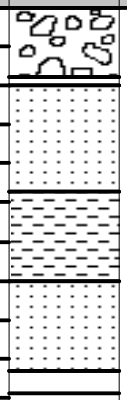
Description	Depth	Graphic Log	Sample	Strength	Remarks
Latite - Grey/brown	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40				

Drill Hole Number: 2006 BH 8086-4

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 44.93m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Silty Clay - Grey	41				
Sandstone - Brown Fine to medium grained.	42				
Shale - Dark grey	43				
Sandstone - Brown Fine to medium grained.	44				
Shale - Dark grey	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-5

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 39.10m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
Soil	0				GR 6398202.695, 370452.250
	1				RL 60.600m
Latite - Brown/grey/reddish-brown	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

VGT
PO Box 2335
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-5

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 39.10m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
Sandstone/Siltstone - Grey-brown Fine to medium grained, medium to coarse grained	37				
	38				
	39				
	40				

Drill Hole Number: 2006 BH 8086-5

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 39.10m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

VGT
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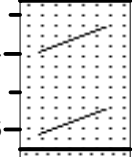
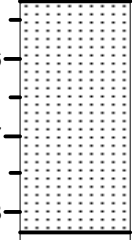
GREENHILLS NSW 2323

Drill Hole Number: 2006 BH 8086-6

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 18.25m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
No Recovery	0–8				GR 6397663.987, 370947.323 RL 103m
Latite - Brown/grey-brown	8–13				
Shale/Sandstone/Siltstone - Grey/brown Fine to medium grained.	13–15				
Sandstone - Brown Fine to medium grained.	15–18				
	18–20				

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Drill Hole Number: 2006 BH 8086-6

Project: Martins Creek
Job Number: 1217
Hole Depth: 18.25m
Drilling Co: Intertech
Logged By: Rail Corp
Hole Dia: 110mm
Date: 2006

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

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Drill Hole Number: 2006 BH 8086-6

Project: Martins Creek
Job Number: 1217
Hole Depth: 18.25m
Drilling Co: Intertech
Logged By: Rail Corp
Hole Dia: 110mm
Date: 2006

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

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Drill Hole Number: 2006 BH 8086-7

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 18.19m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Coreloss	1				GR, 6397722.605, 371018.685 RL 122m
	2				
Siltstone/Sandstone - Brown/grey Medium to coarse grained, fine grained.	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

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Drill Hole Number: 2006 BH 8086-8

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 54.25m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				GR 6397654.294, 370736.745 RL 78m
Soil	1				
Latite - Grey/Reddish-brown	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

VGT
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Drill Hole Number: 2006 BH 8086-8

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 54.25m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Latite - Grey/Reddish-brown	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40				

Drill Hole Number: 2006 BH 8086-8

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 54.25m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
Shale - Dark grey					
Sandstone - Grey/Brown Fine to medium grained, medium to coarse grained.	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

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PO Box 2335
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Drill Hole Number: 2006 BH 8086-9

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 7.065m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
Silty Sand - Brown	0				GR 6397877.234, 370833.382
	1				RL 95m
	2				
	3				
	4				
Sandstone - Brown Fine to medium grained	5				
	6				
Siltstone - Brown					
Sandstone - Brown Fine to medium grained.	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

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Drill Hole Number: 2006 BH 8086-9

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 7.065m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

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Drill Hole Number: 2006 BH 8086-9

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 7.065m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

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Drill Hole Number: 2006 BH 8086-10

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 10.5m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
Silty Sand - Brown	0				GR 6397866.988, 370772.757
	1				107m
Latite - Grey					
	2				
Silty Sand - Brown					
Latite - Grey	3				
Silty Sand - Brown					
Latite - Grey-brown	4				
Silty Sand - Brown					
	5				
Latite - Grey					
Sandstone /Silty Sand - Brown	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

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Drill Hole Number: 2006 BH 8086-10

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 10.5m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

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Drill Hole Number: 2006 BH 8086-10

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 10.5m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

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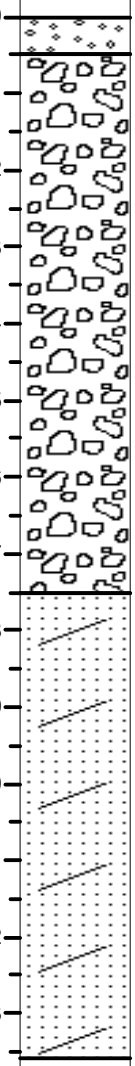
Drill Hole Number: 2006 BH 8086-11

Project: Martins Creek
Drilling Co: Intertech
Date: 2006

Job Number: 1217
Logged By: Rail Corp

Hole Depth: 13.58m
Hole Dia: 110mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
Soil					GR 6397846.791, 370465.085
Latite - Grey					RL 79.3m
Sandstone/Siltstone - Brown/Grey Fine to medium grained.					



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Appendix D
2015 Bore Hole Logs

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E2
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E2_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E2

Project: Martins Creek
Drilling Co: Total Drilling
Date: 2015

Job Number: 1217
Logged By: G Thomson

Hole Depth: 30 Metres
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Weathered Latite?- brown Few fragments, soft clayey,	1			3	GR 6397876, 370775 RL 109
Weathered Latite-orange brown Soft, clayey, few fragments	2			3	
	3			3	
	4			3	
	5			3	
	6			3	
	7			3	
	8			3	
	9			3	
Weathered Claystone - brown soft	10			3	
	11			3	
	12			3	
	13			3	
	14			3	
Weathered Sandstone - brown, medium to coarse grained.	15			3	
	16			3	
	17			3	
	18			3	
	19			3	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E2
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E2_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E2

Project: Martins Creek
Drilling Co: Total Drilling
Date: 2015

Job Number: 1217
Logged By: G Thomson

Hole Depth: 30 Metres
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			3	
	22			3	
	23			3	
Sandstone-Grey brown medium coarse, volcano lithic	24			2	
	25			2	
	26			2	
	27			2	
	28			2	
Siltstone - grey,	29			2	
	30			2	
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E3
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E3_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E3

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite -Grey red brown	1			2	GR 6397514, 370827 RL 59m
	2			1	
	3			1	
	4			1	
	5			2	
Sandstone - Brown Medium to coarse grained mod hard, can break fragments in fingers, volcano-lithic origin, angular fragments, becomming grey toward base	6			2	
	7			2	
	8			2	
	9			2	
	10			2	
	11			2	
	12			2	
	13			2	
Sandstone- Grey brown Medium to fine grained, can break fragments in fingers.	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E3
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V1 02/08/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E3_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E3

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			1	
Sandstone-grey, Medium coarse, very clayey and soft,	22			1	
	23			1	
	24			1	
Sandstone - Grey brown Fine to medium grained, silty in part	25			1	
	26			2	
	27			2	
	28			2	
	29			2	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E4
Figure:	Appendix E
Sheet:	1 of 3
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E4_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E4

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015
Job Number: 1217
Logged By: Greg Thomson
Hole Depth: 48 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Slightly Weathered Latite - Grey brown	1			3	GR 6397578, 370334 RL 92m
	2			3	
	3			3	
	4			3	
	5			1	
	6			1	
Latite- Grey with red brown (15%)	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20			1	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E4
Figure:	Appendix E
Sheet:	2 of 3
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E4_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E4

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 48 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Latite- Grey with red brown (15%)	21			1	
	22			1	
	23			1	
	24			1	
	25			1	
	26			1	
	27			1	
	28			1	
	29			1	
	30			1	
	31			2	
	32			1	
	33			1	
	34			2	
	35			2	
	36			2	
	37			1	
	38			1	
	39			1	
	40			1	

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E4
Figure:	Appendix E
Sheet:	3 of 3
Version/Date:	V1 0209/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E4_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E4

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 48 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	41			1	
	42			2	
Sandstone - Red brown Fine to medium grained, soft and clayey at top.	43			3	
	44			3	
	45			3	
Sandstone- Grey Fine grained	46			3	
	47			3	
	48			3	
	49				
	50				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
	60				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E5
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E5_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E5

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015
Job Number: 1217
Logged By: Greg Thomson
Hole Depth: 42m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Extremely Weathered Latite - Cream Very soft	1			3	GR 6398188, 370272 RL 75m
Slightly Weathered Latite - Grey brown Moderately hard to hard	2			3	
	3			3	
	4			3	
	5			2	
	6			2	
	7			2	
	8			3	
	9			1	
Latite - Grey, red brown	10			1	
	11			2	
	12			2	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E5
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E5_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E5

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015
Job Number: 1217
Logged By: Greg Thomson
Hole Depth: 42m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Latite - Grey, red brown	21–40			1, 1, 2, 2, 2, 3, 3, 3, 2, 2, 1, 1, 2, 2, 1, 1, 3, 2, 3, 3	
Latite / Sandstone - Grey	37–39				
Sandstone - Grey brown, Medium to coarse grained.	39–40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E6
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V1 02/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E6_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E6

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				GR 6397731, 371118, RL 132m
No sample	1				
Weathered Sandstone- brown Very few sample return, soft, clayey, extremely weathered.	2			3	
	3			3	
	4			3	
	5			3	
	6			3	
	7			3	
Weathered Claystone- red brown	8			2	
	9			2	
Weathered Sandstone - grey brown fine to medium	10			2	
	11			2	
Weathered Sandstone- grey brown Coarse, mod soft, can break in fingers, volcano-lithic source. Occassional claystone bands, soft,	12			2	
	13			2	
	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			2	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E6
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V1 02/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E6_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E6

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Weathered Sandstone- grey brown Coarse, mod soft, can break in fingers, volcano-lithic source. Occassional claystone bands, soft,	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			2 2 2 2 2 2 2 2 2	

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E7
Figure:	Appendix E
Sheet:	1 of 1
Version/Date:	V1 02/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E7_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

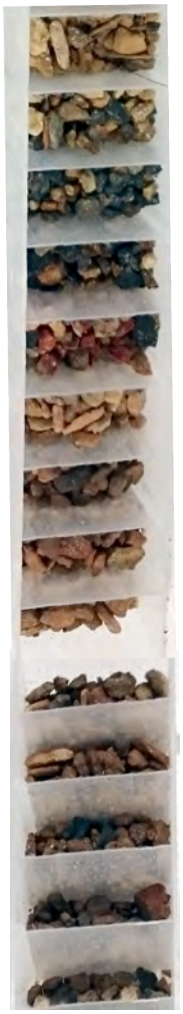
Drill Hole Number: Martins Creek 2015 E7

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 14 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Soil and roots - brown					
Slightly Weathered Latite - Grey brown Mod hard to hard, phorphryitc texture	1			3	GR 6397711, 370978 RL 120m
	2			3	
	3			2	
	4			2	
	5			2	
Very Weathered Latite - brown Soft, friable, clayey	6			2	
Weathered sandstone- Orange brown Fine to coarse grained, volcano-lithic source, welded in part, mod hard, can break in fingers,	7			2	
	8			2	
	9			2	
	10			2	
	11			2	
	12			2	
	13			2	
	14				
	15				
	16				
	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E8
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V1 02/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E8_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E8

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, hard, minor red fleck Cannot break in fingers	1			2	GR 6397540,370791 RL 59m
	2			2	
	3			2	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			2	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole E8
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V1 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

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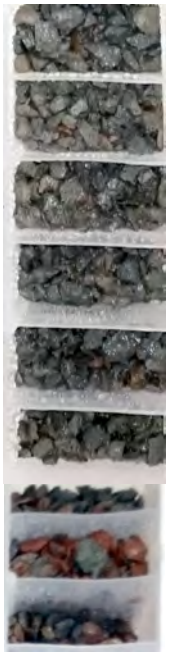
Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_E8_V1.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 E8

Project: Martins Creek
Drilling Co: Total Drilling
Date: March 2015

Job Number: 1217
Logged By: Greg Thomson

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			2	
	22			2	
	23			2	
	24			2	
	25			1	
	26			1	
	27			2	
	28			2	
	29			2	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH1
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH1_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

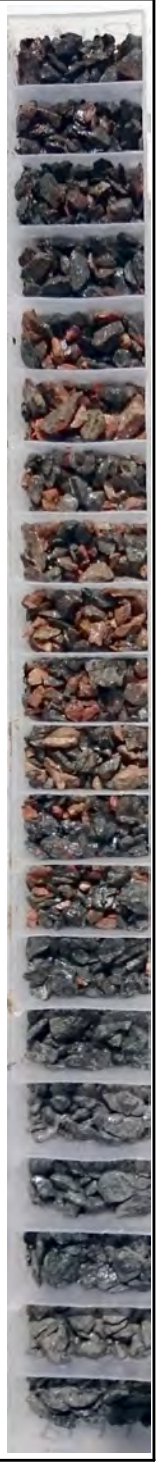
Drill Hole Number: Martins Creek 2015 PBH1

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 22 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, red brown, hard	1			1	GR, 6398174,370106 RL 50m
	2			1	
	3			1	
	4			1	
	5			1	
	6			2	
	7			2	
	8			2	
	9			2	
	10			2	
	11			2	
	12			2	
	13			2	
Latite - Grey, hard	14			2/1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH1
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V0 02/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH1_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH1

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 22 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			1	Hole terminated By Daracon
	22			1	
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH2
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 02/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH2_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH2

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 21 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, hard	1			1	GR, 6398119, 370174 RL 50m
	2			1	
	3			1	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			2/3	
	19			2	
Sandstone - Grey brown Fine to medium grained	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH2
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	11/03/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_PBH2_V0.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 2015 PBH2

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 21 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Sandstone - Grey brown Fine to medium grained	21			2	
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH3
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 02/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH3_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

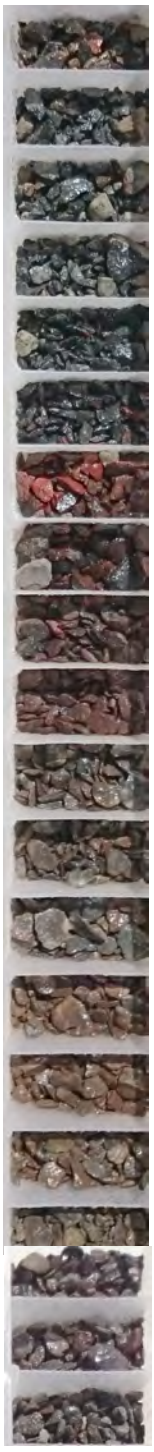
Drill Hole Number: Martins Creek 2015 PBH3

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey	1			1	GR 6398041, 370301 RL 51.5m
	2			1	
	3			1	
	4			1	
	5			1	
	6			1	
Latite - red brown	7			1/2	
Sandstone - Red brown Medium coarse	8			2	
	9			2	
	10			2	
Sandstone-Grey, light brown Fine grained, silty in part, becomming medium garined toward base.	11			2	
	12			2	
	13			2	
	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			2	
	20			2	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH3
Figure:	Appendix E
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This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_PBH3_V0.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO/JD
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 2015 PBH3

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29 m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			2	
	22			2	
	23			2	
	24			2	
	25			2/1	
	26			2/1	
	27			1	
	28			2	
	29			2/1	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH4
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This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH4_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH4

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, hard	1			1	GR 6397989, 370295 RL 50m
	2			1	
	3			1	
	4			1	
	5			1	
	6			1	
Latite - Red brown	7			2	
	8			2	
Sandstone- Grey, light brown Medium grained	9			2	
	10			2	
	11			2	
	12			2	
	13			2	
	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			2	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH4
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Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_PBH4_V0.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO/JD
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 2015 PBH4

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			2	
	22			2	
	23			1	
	24			1	
	25			1	
	26			1	
	27			1	
	28			1	
	29			2	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH5
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Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_PBH5_V0.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO/JD
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 2015 PBH5

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, hard Minor sandstone (contamination?)	1			1	GR 6397960, 370339 RL 53.5m
	2			1	
	3			1	
Latite - Red brown	4			1/3	
Sandstone - Brown, medium grained	5			2	
	6			2	
	7			2	
	8			2	
	9			2	
	10			2	
	11			2	
	12			2	
	13			2	
Sandstone- Grey medium grained	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			2	
	20			2	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH5
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Location:	Off Station Street, Martins Creek, New South Wales	***Source:***	VGT Pty Ltd	***Our Ref:***	1217_MCGA_Bore Hole_PBH5_V0.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	TO/JD
Tenures:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	***Contour Interval:***	N/A	***Office:***	Thornton

Drill Hole Number: Martins Creek 2015 PBH5

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Sandstone- Grey medium grained	21			2	
	22			2	
	23			2	
	24			2	
	25			2	
	26			2/1	
	27			2	
	28			1	
	29			1	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH6
Figure:	Appendix E
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH6_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH6

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 7m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey	1			BG	GR 6397852, 370302 RL 50m
	2			BG	
	3			1	
Latite - Red Brown	4			2	
Sandstone- Brown, medium grained	5			2	
	6			2	
	7			2	
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH7
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH7_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH7

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 15m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite- Grey, Minor broken and brown at surface. Pink veining at 4-5 metres	1			BG	GR 6397702, 370233 RL 50m
	2			2	
	3			2	
	4			2	
	5			2	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
Latite - Red brown	12			2	
Sandstone - Brown, medium grained	13			2	
	14			2	
	15			2	
	16				
	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH8
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH8_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH8

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, minor brown	1			1	GR 6397734, 370112 RL 50m
	2			2	
	3			1	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH8
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH8_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

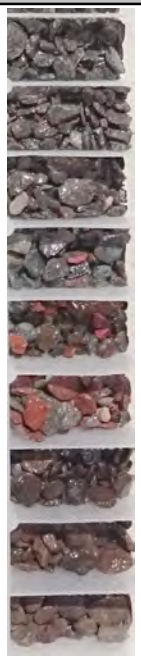
Drill Hole Number: Martins Creek 2015 PBH8

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			1	
	22			1	
	23			1	
	24			1	
	25			1	
Latite - Red brown	26			2	
	27			2	
Sandstone - Brown, medium grained	28			2	
	29			2	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH9
Figure:	Appendix E
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Version/Date:	V0 03/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH9_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH9

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite/Sandstone - Brown Mix of stratum	1			2	GR 6397759, 370013 RL 50m
Latite - Brown, minor grey	2			2	
Latite - Grey, minor brown banding	3			1	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			2	
	10			2	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20			1	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH9
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH9_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH9

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			2	
	22			2	
	23			2	
	24			2	
	25			2	
	26			2	
	27			2	
	28			2	
	29			2	Hole terminated, maximum limit of blast rig reached
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH10
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH10_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH10

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey, minor brown	1			1	GR 6397851, 369999 RL 49m
	2			1	
	3			1	
	4			2	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
Latite - Grey, with orange veining	13			2	
	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			2	
Latite - Grey with minor green alteration	20			2	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH10
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH10_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH10

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Latite - Grey, hard	21			1	
	22			1	
	23			1	
	24			1	
	25			1	
	26			1	
	27			1	
	28			1	
	29			1	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH11
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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH11_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH11

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015
Job Number: 1217
Logged By: G THOMSON
Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0			BG	
Latite - Grey, very minor red brown	1			1	GR 6398027, 370098 RL 50m
	2			1	
	3			1	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH11
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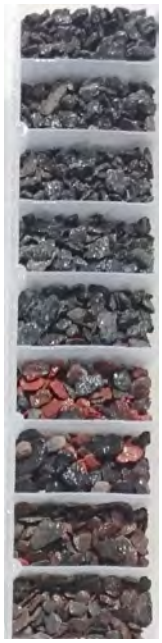
Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH11_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH11

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21–29			1 1 1 1 1 1/2 2 2 2	
Latite - Red brown					
Sandstone - Grey brown medium to fine grained					

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH12
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 03/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH12_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH12

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey minor red brown	1			2	GR 6398172, 370172 RL 61m
	2			1	
	3			1	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
Latite - Grey, hard	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH12
Figure:	Appendix E
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Version/Date:	V0 03/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH12_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH12

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Latite - Grey, hard	21–29			1	
	29–40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH13
Figure:	Appendix E
Sheet:	1 of 1
Version/Date:	V0 03/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MCGA_Bore Hole_PBH13_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH13

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 13m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey	1			1	GR 6398013, 370338 RL 61.5m
	2			1	
	3			1	
	4			1	
	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
Latite - Grey, red brown	11			2	
Sandstone - Grey brown	12			2	
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH14
Figure:	Appendix E
Sheet:	1 of 1
Version/Date:	V0 03/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH14_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

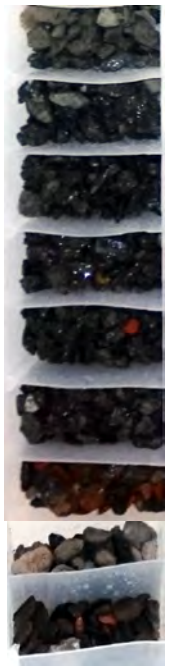
Drill Hole Number: Martins Creek 2015 PBH14

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 9m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface					
Latite - Grey	0–6.5			1, 1, 1, 1, 1, 1	GR 6397906, 370372 RL 61m
Latite - Red brown	6.5–7.5			2	
Sandstone - Grey brown	7.5–9			2, 2	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH15
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 03/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH15_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH15

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey brown, Slightly weathered.	1			2	GR 6397908, 370612 RL 111m hole not surveyed Daniel H located on plan
	2			2	
	3			1	
	4			2	
Latite -Grey with minor red brown stain and veining.	5			1	
	6			1	
	7			1	
	8			1	
	9			1	
	10			1	
	11			1	
	12			1	
	13			1	
	14			1	
	15			1	
	16			1	
	17			1	
	18			1	
	19			1	
	20			1	



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH15
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V0 03/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH15_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH15

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			1	
	22			1	
	23			1	
	24			1	
	25			1	
	26			1	
	27			1	
	28			1	
	29			1	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH16
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 03/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH16_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH16

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
No sample	1			na	
Weathered Latite - brown				2	GR 6397675, 371044 RL 136.6m
	2			2	
	3			2	
	4			2	
	5			2	
	6			2	
	7			2	
	8			1	
	9			2	
Latite - Red brown	10			2	
Weathered Sandstone -brown Occassional Latite frag (contamination?)	11			2	
	12			2	
	13			2	
	14			2	
	15			2	
	16			2	
	17			2	
	18			2	
	19			2	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH16
Figure:	Appendix E
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Version/Date:	V0 03/09/2015

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vgt Environmental Compliance Solutions

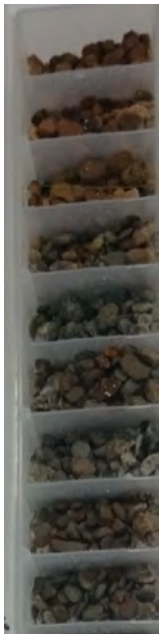
Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH16_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH16

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
	21			2	
	22			2	
	23			2	
Sandstone - grey, medium Grained clayey	24			1	
	25			1	
	26			2	
	27			1	
	28			2	
	29			1	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH17
Figure:	Appendix E
Sheet:	1 of 2
Version/Date:	V0 03/09/2015

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Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH17_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH17

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
Latite - Grey brown, slightly weathered minor sandstone	1			2	
Latite - Grey brown Slighty weathered	2			2	GR 6397608, 371014 RL 113.2m
	3			1	
	4			1	
	5			1	
	6			2	
Latite - Red brown Clay band brown 7-8m	7			2	
	8			3	
Sandstone - Brown, coarse medium Welded vdcano source	9			2	
	10			2	
	11			2	
	12			2	
Sandstone/Latite - mix (contamination)	13			2	
Clay - Brown, soft	14			2	
Weathered Sandstone-brown, Medium coarse, mod soft, poor returns	15			2	occasional latite (fall in?)
	16			2	
	17			2	
Weathered Sandstone - grey brown Mod soft occassional latite fragments large, fall in from top of hole. Fine to medium grained clayey soft when wet.	18			1	
	19			1	
	20				



Plan of:	Martins Creek Andesite Quarry Geology Assessment - Drill Hole PBH17
Figure:	Appendix E
Sheet:	2 of 2
Version/Date:	V0 03/09/2015

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

vgt Environmental Compliance Solutions

Location:	Off Station Street, Martins Creek, New South Wales	**Source:**	VGT Pty Ltd	**Our Ref:**	1217_MC_Bore Hole_PBH17_V0.cdr
Council:	Dungog Shire Council	**Survey:**	N/A	**Plan By:**	TO/JD
Tenures:	N/A	**Projection:**	N/A	**Project Manager:**	GVT
Client:	Buttai Gravel Pty Ltd (Daracon Group)	**Contour Interval:**	N/A	**Office:**	Thornton

Drill Hole Number: Martins Creek 2015 PBH17

Project: Martins Creek
Drilling Co: Precision Drilling
Date: March 2015

Job Number: 1217
Logged By: G THOMSON

Hole Depth: 29m
Hole Dia: 100mm

Description	Depth	Graphic Log	Sample	Strength	Remarks
Weathered Sandstone - grey brown Mod soft occassional latite fragments large, fall in from top of hole. Fine to medium grained clayey soft when wet.	21–29			1 2 2 2	

Appendix E
2006 8086 Core Photographs

Plan of:	Field Figure 1 - Photograph of Borehole 8606-4 by Rail Corp Geotechnical Services				
Figure:	FF - ONE				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS001_FF1_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 2 - Photograph of Borehole 8606-5 by Rail Corp Geotechnical Services				
Figure:	FF - TWO				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS002_FF2_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



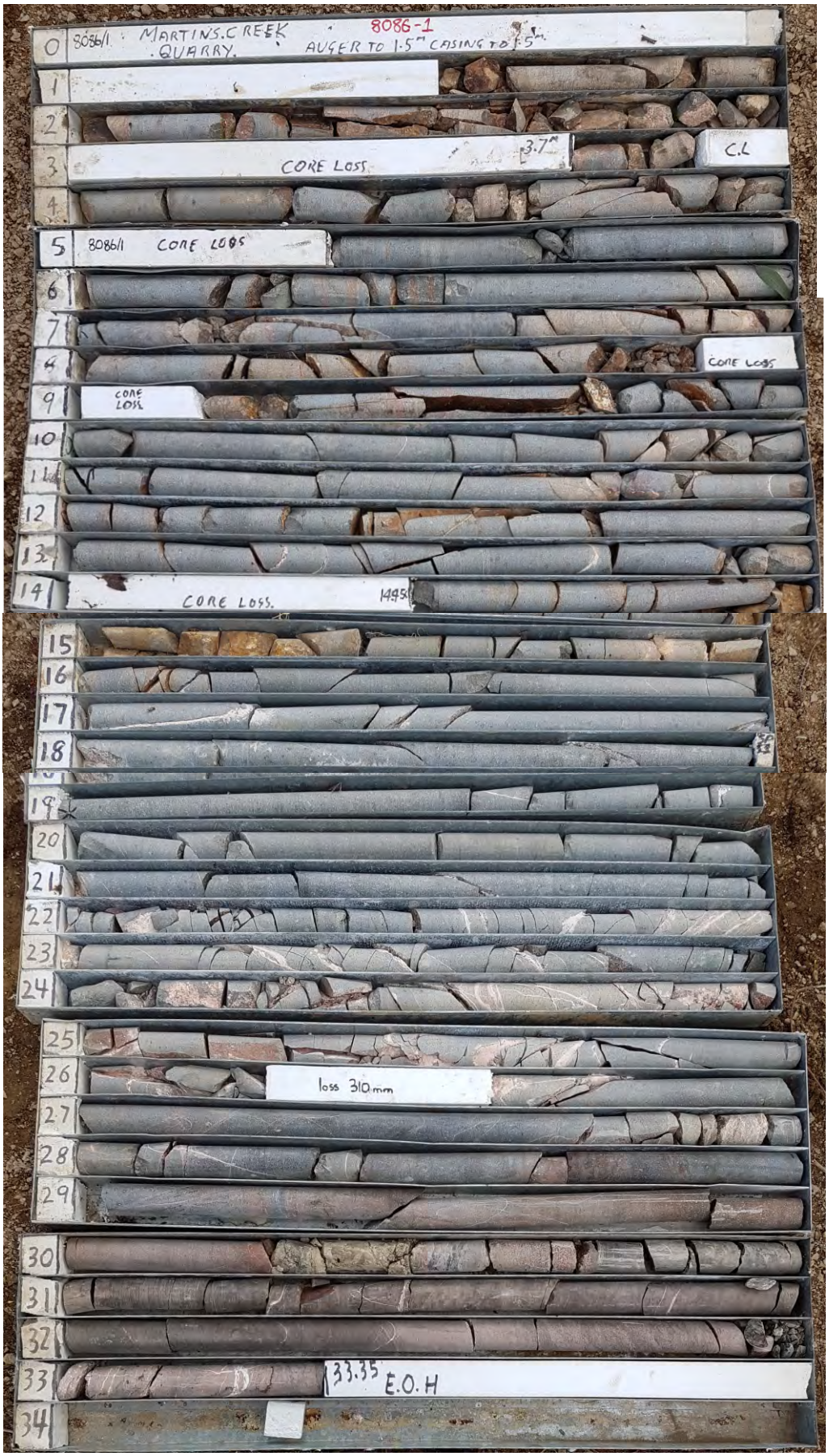
Plan of:	Field Figure 3 - Photograph of Borehole 8606-8 by Rail Corp Geotechnical Services				
Figure:	FF - THREE				
Sheet:	2 of 2				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS003_FF3_pg2_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 3 - Photograph of Borehole 8606-8 by Rail Corp Geotechnical Services				
Figure:	FF - THREE				
Sheet:	1 of 2				
Version/Date:	V2 08/08/2016				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS003_FF3_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 4 - Photograph of Borehole 8606- 1 by Rail Corp Geotechnical Services				
Figure:	FF - FOUR				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS004_FF4_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 5 - Photograph of Borehole 8606-2 by Rail Corp Geotechnical Services				
Figure:	FF - FIVE				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS005_FF5_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 6 - Photograph of Borehole 8606-11 by Rail Corp Geotechnical Services				
Figure:	FF - SIX				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS006_FF6_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 7 - Photograph of Borehole 8606- 6 by Rail Corp Geotechnical Services				
Figure:	FF - SEVEN				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS007_FF7_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 8 - Photograph of Borehole 8606- 3 by Rail Corp Geotechnical Services				
Figure:	FF - EIGHT				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS008_FF8_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 9 - Photograph of Borehole 8606-10 by Rail Corp Geotechnical Services				
Figure:	FF - NINE				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS009_FF9_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Field Figure 10 - Photograph of Borehole 8606- 7 by Rail Corp Geotechnical Services				
Figure:	FF - TEN				
Sheet:	1 of 1				
Version/Date:	V2 08/08/2018				
Location:	Off Station Street, Martins Creek, NSW	***Source:***	VGT Environmental Compliance Solutions Pty Ltd & Daracon Group Pty Ltd	***Our Ref:***	5898_MC_HR2018_FS010_FF1_V2.cdr
Council:	Dungog Shire Council	***Survey:***	N/A	***Plan By:***	GT/SC
Tenure:	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Client:	Daracon Group Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Appendix F
2019 Sample Information

Table 10 Original Sample Photography

VGT Sample ID	Photography 20mm Gravel	Photography Crusher Dust	Photography Dry Crusher Dust and 20mm Sample	Photography Wet Crusher Dust and 20mm Sample
A				
B				

VGT Sample ID	Photography 20mm Gravel	Photography Crusher Dust	Photography Dry Crusher Dust and 20mm Sample	Photography Wet Crusher Dust and 20mm Sample
C				
D				
E				

VGT Sample ID	Photography 20mm Gravel	Photography Crusher Dust	Photography Dry Crusher Dust and 20mm Sample	Photography Wet Crusher Dust and 20mm Sample
F				
G				

Appendix G
NSW RMS Unique Granular Materials Excerpt

A SERICITIC LIMESTONE

Material Name:	Sericitic limestone
Source:	Excelsior quarry, Capertee, NSW.
Material Description:	Sericitic limestone is a carbonate rich limestone breccia containing approximately 85% calcite/limestone. Other minerals include dolomitic carbonate (1-2%), quartz (1-2%) and sericite (12-15%).
Approval Status:	Approved 12 April 2000

Overall application details:

Application:	The principal use is in sealed unbound rural pavements. The material has special application to overlays in pavement rehabilitation. Where it is used in an unbound state the pavement should be well drained. Bound material can be produced with a slow setting binder to improve the wet strength of the material. Mix design in accordance with R75 or R73 is required.
Applicable Traffic Category: (3051 Cl. 6.2.1)	B, C & D
Applicable specifications:	3051, R71, R73, R75, M290
Surfacing treatment:	Sprayed seal - Design in accordance with Roads & Maritime practices.
Material type: (3051 Cl. 6.2.5)	Unbound and bound
Particle size distribution: (3051 Cl 8.1)	Refer to Table 1A
Maximum aggregate size:	26.5 mm.
Maximum plasticity	Refer to Table 1A
Maximum permeability	Not applicable for traffic category B, C & D.
Other tests	Table 3051.3 requirements must also be satisfied.

Construction

Production:	The sericitic limestone is won by blasting. Roadbase is produced by crushing the material through primary and secondary crushers in a single pass with no further processing.
Maximum moisture content:	5.5% at time of placement (unbound). 6.0% at time of placement (bound).
Quality System	Supplier must meet the requirements in 3051 Clause 4.
Construction Specification:	The construction process and end product must meet the relevant construction specification R71, R73, R75 or M290.
Testing	Conformance testing frequency is to be in accordance with Table 3051/L.1, any tests not identified in Table 3051/L.1 are to be undertaken at the same frequency as specified in 3051 for test method T106.

Material information for pavement design and construction

1. Sericitic limestone roadbase is a carbonate rich limestone breccia containing approximately 85% calcite/limestone. Other minerals include dolomitic carbonate (1-2%), quartz (1-2%) and clay sericite (12-15%). The sericite is a talcose mineral produced during the metamorphic phase of the limestone's genesis. The sericite occurs as veinlets within the limestone. Crushed aggregate contains fine grained sericite which lubricates rock particles and promotes compaction at lower moisture content.
2. The clay sericite provides a solid and stable support to the limestone aggregates under dry conditions however, compacted laboratory specimens of sericitic limestone become unstable when soaked. The material may be stabilised to improve its wet strength. When sericitic limestone is used in an unbound state the pavement should be well drained.
3. The clay sericite acts as a compaction aid reducing the moisture content requirement for compaction to a maximum of 5.5%. Compaction may also be achieved at lower moisture contents with appropriate compaction equipment.
4. Not all limestones meet these guidelines and advice should be sought from Pavement and Geotechnical Section in this matter.
5. These requirements apply to the applications of Sericitic Limestone on Traffic Category B, C and D roads (traffic volumes less than 10^7 ESA).
6. The construction procedures for handling this material are as follows:
    a. A minimum thickness of 300 mm of select material is to be placed under the subbase.
    b. The moisture content should not exceed 5.5% for unbound material and 6% for bound material. These upper limits on moisture content are appropriate in hot weather. For cooler periods a lower moisture content should be used.
    c. The material may appear too dry for compaction but the sericite acts as a compaction aid that allows it to be compacted at a lower moisture content. Optimum moisture content is around 7.5% for unbound material and 8% for bound material. The material must not be placed at optimum. Over wetting of the roadbase during compaction will cause it to become unstable and will require a long period of 'dry back' before adequate strength is obtained.
    d. The interface between multiple layers may not fully bond so stabilised construction is to be limited to a single layer.
    e. For bound material under specification R73, compaction should be carried out in a single lift of around 200 mm.
    f. For bound applications 5% by mass of a slow setting binder has generally been incorporated into the roadbase to maintain its retained strength in a wet environment and to minimise the effects of erosion, this proportion of binder is to be confirmed for the relevant binder in accordance with R73 mix design requirements.
    g. The characteristic relative compaction should be the same as that specified for other unbound or heavily bound pavements as specified in R71, R73 or R75 as appropriate.
    h. The surface can be slurried to waterproof the surface and this should be done if it is to be left unsealed for a time. The slurry must be removed by grading or heavy steel brooming prior to priming or primer sealing.
    i. A 10 mm primer seal should be applied as soon as possible after compaction to assist in curing when the layer has been stabilised. (This may avoid the slurrying operation.)

7. Where stabilised sericitic limestone is used as a:
    a. Base - The wearing surface can consist of either a rubber bitumen seal, a geotextile seal or a thin polymer asphalt (maximum 50 mm).
    b. Subbase - The base course above should have a minimum thickness of 150 mm. If a granular base is used, an 'upside-down' pavement can result, the base needs to be relatively moisture insensitive with positive drainage by daylighting at the edge of formation and have a full width seal.

Table 1A Particle size distribution and plasticity for Sericitic Limestone.

Property	Base	Subbase
RTA T106 & T107: Particle Size Distribution Passing AS Sieve (% by mass)		
26.5 mm	100	100
19 mm	95-100	70-100
13.2 mm	70-95	
9.5 mm	60-85	
4.75 mm	41-68	
2.36 mm	30-55	
425 µm	11-30	
75 µm	5-20	4-23
13.5 µm	2-15	2-17
RTA T106 & T107: Particle Size Distribution Retained between AS Sieve (% by mass)		
26.5 mm		
	0-5	0-5
19 mm		
	7-18	12-23
13.2 mm		
	8-16	
9.5 mm		
	14-24	
4.75 mm		
	8-21	
2.36 mm		
	14-28	
425 µm		
	7-14	6-14
75 µm		
	3 -12	3-8
13.5 µm		
RTA T109: Plasticity Index	Max 8	Max 12

Notes:

1. Replaces Table 3051.1 requirements for particle size distribution and Table 3051.2 a) requirement for plasticity index.

B DENDROBIUM MATRIX BASE

Material Name:	Dendrobium Matrix Base
Source:	Coal washery reject – Dendrobium Coal Mine, Mount Kembla, NSW Fly ash – (for current assessment Eraring Power Station, Eraring, NSW).
Material Description:	A blend of coal wash reject from Dendrobium Coal Washery located within the BlueScope Steel Complex at Port Kembla, NSW and run-of-station fly ash from Origin Energy's Eraring Power Station blended at the West Cliff Colliery.
Approval Status:	Conditional – Expires 30 June 2016

Overall application details:

Application:	Sealed overlay base layer (unbound) to a minimum and maximum thickness of 150 mm and 300 mm respectively. Patching - Seek advice from Pavements Section, Engineering Services Branch. Use in unsealed roads needs consideration of how dust will be managed. Further consideration required when material is placed adjacent to kerb and gutter to ensure compaction, prevent water ingress and maintain adequate shear strength.
Applicable Traffic Category: (3051 Cl. 6.2.1)	D (Trials may be conducted on roads at Traffic Category C)
Min. width of sealed shoulders:	500 mm
Applicable specifications:	R71 (not modified), M250 (not modified or bound) and M290 (not modified or bound).
Surfacing treatment:	Sprayed seal – No advice at this stage.
Material type: (3051 Cl. 6.2.5)	Unbound.
Particle size distribution: (3051 Cl 8.1)	Refer to Table 1B
Maximum aggregate size:	53 mm.
Maximum plasticity	Refer to Table 2B
Maximum permeability	Refer to Table 2B
Other tests	Table 3051.3 - T116 and T219 requirements must also be satisfied.
EPA Exemptions:	Component materials must meet relevant EPA exemptions. As at June 2014 both 'The coal washery rejects general exemption 2009' and 'The coal ash exemption 2013' material requirements and reporting requirements must be satisfied.

Construction

Layer thickness limits:	150 to 300 mm (Limits specified by StabilCo)
Production:	Blended by stationary pug-mill.
Stockpiles:	Maximum size 4,000 t (blended material).
Maximum moisture content:	8% at time of placement. (Limit specified by StabilCo)
Quality System	Supplier must meet the requirements in 3051 Clause 4.
Project Quality Plan:	Supplier must provide inspection test plans and procedures for the placement of the material, including details for sprayed sealing and compaction of outer edges of the layer.
R71 Specification:	Must meet the end product requirements in Clause 8. Place, compact and trim in accordance with the supplier's recommendations.
Testing	Conformance testing frequency is to be in accordance with Table 3051/L.1, any tests not identified in Table 3051/L.1 are to be undertaken at the same frequency as specified in 3051 for test method T106.

Material information for pavement design and construction:

1. The coarse aggregates have low wet strength (too low to be determined by standard testing) and further work is required to determine the durability of the material.
2. A construction trial carried out by RMS indicates that potential distress of the material will occur if the moisture content exceeds 8%.
3. Material has low permeability (approximately 10^{-9} m/s).
4. Material has higher fines content than traditional DGB materials achieved by the addition of fly ash. The high fly ash content results in a cohesive material with low plasticity properties. It also requires specific consideration for sealing as the high fines creates adhesion and binder penetration issues for the initial seal treatment.
5. Material assessment is based on coal wash reject from the Dendrobium mine and is not applicable to aggregates from other mines.
6. The elastic modulus of the materials is unknown and further work is required to provide design guidance. A maximum vertical modulus of 250 MPa is to be assumed for pavement structural design.
7. The material relies on a lower relative moisture regime to provide shear resistance than DGB material, requiring particular attention to compaction moisture content and compaction technique.
8. The material has a pozzolanic content and will become bound with the addition of lime. The degree of strength gain will be influenced by the fineness and source of fly ash used and designers need to consider flexible versus bound material design properties where future maintenance work may involve the incorporation of lime as part of a rehabilitation process.

Table 1B Particle size distribution and tolerances for Dendrobium Matrix Base.

AS Sieve	% Passing by mass
75.0 mm	–
53.0 mm	100
37.5 mm	98 - 100
26.5 mm	85 - 98
19.0 mm	
13.2 mm	
9.5 mm	
4.75 mm	
2.36 mm	30 – 50
425 µm	
75 µm	13 - 19

Notes:

1. Limits specified by StabilCo.
2. Particle size distribution determined using test methods T106 and T107.
3. Grading limits apply to non pretreated material.
4. Replaces Table 3051.1 requirements.

Table 2B Particle size distribution and tolerances for Dendrobium Matrix Base.

Property	Limit	Test Method
Liquid Limit	Max. 28	T108
Plastic Limit	Max 20	T109
Plastic index	Max 8	T109
Linear shrinkage	Max 4%	T113
Permeability (m/s)	Max $5x10^{-8}$	1289.6.7.2

Notes:

1. Limits apply to non pretreated material.
2. Permeability limit applies to material compacted to 100% MDD (standard compaction) in accordance with T112.
3. Replaces Table 3051.2 a) requirements.

C STABILBASE

Material Name:	Stabilbase
Source:	Andesite aggregate – Martin's Creek Quarry, Martin's Creek, NSW 2420 (located approximately 28 km north of Maitland). Martin's Creek Quarry is an andesite deposit quarry which was previously operated and established under RailCorp. Fly ash - Bayswater Power Station, 250 km north-west of Sydney.
Material Description:	The Stabilbase material comprises an andesite derived base with up to 10 % fly ash by mass which is incorporated into the material via mechanical pug-mill. Stabilbase is typically non-plastic and currently fails to meet particle size distribution and particle shape requirements under RMS QA Specification 3051 Ed7 Rev0.
Approval Status:	Traffic Categories B, C, D - Approved for Use Traffic Category A - Conditional Use - Subject to Roads and Maritime acceptance for trial use

Overall application details:

Application:	The principal use of this material is for sealed unbound rural road pavements. The material may also be used as a sealed unbound overlay base layer. Placement of material is to be in accordance with RMS R71.
Applicable Traffic Category: (3051 Cl. 6.2.1)	B, C and D (Traffic Volumes < 10^7 ESA) Category A applications (Traffic Volumes > 10^7 ESA) may be accepted on a trial basis and requires prior approval from Roads and Maritime Pavements Unit, Engineering Services Branch.
Applicable specifications:	R71 (not modified), M250 (not modified or bound) and M290 (not modified or bound).
Surfacing treatment:	Sprayed Seal - Design in accordance with Roads and Maritime current practises.
Material type: (3051 Cl. 6.2.5)	Unbound
Particle size distribution: (3051 Cl. 8.1)	Table 1C requirements must be satisfied.

Other Tests	Table 3051.2 and 3051.3 requirements must also be satisfied. (with the exception of particle shape)

Construction:

Layer thickness:	As per RMS R71
Production:	Fly ash incorporated by the use of a mechanical pug-mill in producing a moisture controlled base material.
Stockpiles:	Maximum size 4000 t
Maximum Moisture Content:	70 % - 80 % of OMC for placement.
Quality System:	Supplier must meet the requirements in 3051 Clause 4.
Project Quality Plan:	Supplier must provide inspection and test plans, and procedures for the placement of the material, compaction and sealing.
R71 Specification:	Must meet end product requirements specified in Clause 8.
Testing	Testing frequency to be carried out in accordance with Table 3051/L.1

Material information for pavement design and construction:

1. The material has a higher fines content than typical conforming base materials. This is due to the addition of fly-ash (up to 10 %) to assist in mix workability in the absence of plasticity. Special consideration is to be given to sealing the surface to ensure adhesion during an initial seal treatment. Past successful treatments have included:

   a) Two coat seal, generally consisting of 14 mm and 7 mm aggregate and conventional binders

   b) Primer seal with final polymer modified seal after 12 months

   c) Primer seal followed by asphalt at later stage.

   Note that cutter content for 7 mm or 10 mm primer seals was generally applied at 5 % and is not to exceed 7 %.

2. Material assessment is based on Stabilbase Material from Martin's Creek Quarry only and this approval does not apply to any other materials from any other quarry sources.

3. For the purposes of pavement structural design, a maximum vertical modulus of 350 MPa should be assigned.

4. The characteristic relative compaction requirement is the same as that for other unbound pavements as specified in R71.

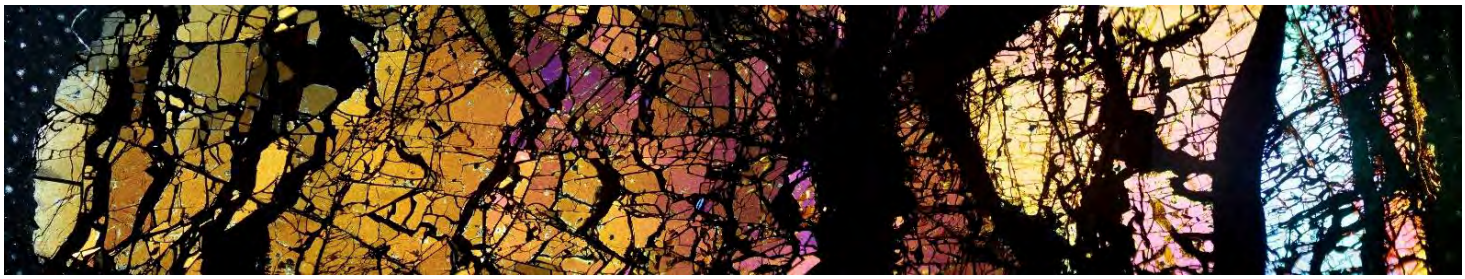
5. The material contains supplementary cementing materials and may become bound with the addition of lime through pozzolanic activity. The degree of strength gain will be influenced by both the source of the fly ash and its fineness.The designer is to consider both flexible and bound material properties for the full life cycle of the pavement where it is expected that future maintenance work may involve the incorporation of lime as part of the rehabilitation process.

Table 1C- Particle Size Distribution Requirements for Stabilbase

Property	Base and Subbase
RMS T106 and T107: Particle Size Distribution Passing AS Sieve (% by mass)[1]	
26.5 mm	100
19.0 mm	100
13.2 mm	97-100
9.5 mm	84-95
4.75 mm	54-65
2.36 mm	42-50
425 um	22-27
75 um	13-17

Notes: 1. *Replaces RMS QA Specification 3051, Table 3051.1 requirement*

Appendix H Petrographic Reports 2019



Geochempet Services

ABN 980 6945 3445
PETROLOGICAL and GEOCHEMICAL CONSULTANTS
Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.

5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019
Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT
ON AN AGGREGATE SAMPLE (NEW19W-2685-S01)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARABROOK

Purchase Order: QTPO19-0253
Invoice Number: 00008914
Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
29 August 2019

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Sample No.:	NEW19W-2685-S01	**Date Sampled**:	05/08/2019
Description:	Sample A	**Date Received**:	08/08/2018
Material:	Source Aggregate	**Client**:	VGT Pty Ltd
Word Order No.:	NEW19W-2685	**Project No.**:	NEW15P-0045
Project Name:	Material Testing		
Sample Source:	Various, NSW		

Work Requested Petrographic analysis in relation to use as road base, concrete aggregate, sealing/asphaltic aggregate, rail ballast, rip rap, dimension stone and marine armour rock; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of *ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the *AS1141 Standard Guide for the Method for sampling and testing aggregates,* of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-2015) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*, and in accordance with *ASTM C 294 Standard Guide for Petrographic Assessment of Railway Ballast* and to the content of the 2015 publication of Standards Australia (AS 2758.7 – Appendix B), entitled Aggregates and Rock for Engineering Purposes- Part 7: Railway Ballast, and in accordance with ASTM C1721-09 *Standard Guide for Petrographic Assessment of Dimension Stone*, and in accordance with ASTM D4992-07 *Standard Guide for Evaluation of Rock to be used for Erosion Control*

Identification Latite tuff

Description

The supplied sample consisted of robust, hard, and angular to sub-angular fragments of intermediate tuffaceous rock. When washed, the fine dust coatings on fragments were easily removed and are seen to consist of medium dark grey, essentially unweathered, apparently robust, latite tuff displaying numerous phenoclasts of mainly light grey plagioclase and black hornblende dispersed through a now very finely crystalline feldspathic matrix.

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.



Plate 1: Image of supplied aggregate sample.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 randomly-selected fragments. An approximate mineralogical composition of the aggregate, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

29%	microcrystalline feldspars and very minor quartz (products of devitrification; 2-3% microcrystalline quartz)
31%	plagioclase feldspar phenoclasts
7%	hornblende phenoclasts
3%	opaque oxide phenoclasts
<1%	quartz phenoclasts
1%	coarser quartz
11%	coarser feldspar
1%	leucoxene
<1%	epidote
1%	opaque oxide (magnetite and/or ilmenite) in matrix
<1%	hematite
trace	apatite and zircon

Weak, Deleterious or Otherwise Non-durable Minerals

15%	chlorite-smectite
1%	sericite

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<1% limonite
<1% pyrite
trace calcite

In thin section, the rock displays textures of tuffaceous style, involving many smoothly corroded, subhedral and less commonly broken phenoclasts (mainly about 0.1 to 1.5 mm in size) dispersed through a now devitrified and clouded matrix with a few discrete patches of ghosted former moderately welded vitric shards (mainly about 0.2 to 0.3 mm long).

The most abundant phenoclasts are twinned, strongly zoned, prismatic plagioclase with variable alteration to sericite. Other phenoclasts are brownish-green hornblende (thinly rimmed by opacite), opaque oxide (with slight hematized auras), former pyroxene and biotite are now completely altered to chlorite-smectite, epidote and leucoxene) along with a few broken quartz crystals. The formerly vitroclastic matrix, flow-banded in discreet portions of the rock, now consists of variably clouded (apparently a dusting of fine brown clay) microcrystalline feldspars (occasionally micro-spherulitic in a few places), accompanied by leucoxene, minor anhedral quartz (about 0.05 to 0.2 mm size), patches of green to brown chlorite-smectite and very fine hematite specks and dust. A few small grains of apatite and zircon are present. There are a few fine discontinuous feldspar veins.

Comments and Interpretations

The rock represented in the supplied aggregate sample (labelled NEW19W-2685-S01 Sample A is considered to be latite tuff. In more detail, the rock appears to have originated as moderately welded crystal-vitric tuff generated by ash flow (or ignimbrite) processes. Its composition seems to be equivalent to latite, an intermediate volcanic rock, similar to andesite but more potassic. The rock initially consisted of abundant phenoclasts of plagioclase, hornblende, opaque oxide and minor pyroxene, biotite and quartz dispersed through a moderately welded mass of glass shards. Subsequently the rock experienced devitrification resulting in conversion of all of the glass to microcrystalline feldspars, leucoxene, chlorite-smectite and to minor amounts of fine clay, sericite and secondary iron oxide. Phenoclasts suffered minor, probably related alteration.

For engineering purposes, the rock in the aggregate sample may be summarised as:

- **latite tuff** (equivalent in composition to intermediate volcanic igneous rock)
- devitrified and now finely crystalline
- essentially unweathered
- moderately altered
- carrying about 16% of weak minerals (15% chloritic-smectite, 1% sericite, <1% limonite and a trace of calcite)
- carrying <1% deleterious sulphides (pyrite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

The latite tuff is predicted to be **innocuous in relation to alkali-aggregate reactivity in concrete**. It apparently contains 3-4% quartz which is interpreted to be insufficient to impart a deleterious degree of reactivity to the rock as a whole.

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Latite tuff of the type represented by the supplied sample is predicted to be **a suitable for use as road base, concrete aggregate, sealing/asphaltic aggregate** (subject to bitumen stripping and polishing tests) **and rail ballast** (subject to compliance with the Durability Criteria of CT147 / AS2758.7). The wet/dry strength of the aggregate should be tested to determine the effect of the content of secondary minerals (swelling smectite) versus the fine-grained tougher texture.

The rock is predicted to be **suitable for use as rip rap.** It is predicted to have potential for use as a source of marine armour rock or dimension stone, provided that a quarry inspection can indicate that blocks of sufficient size can be obtained free of weak or permeable joints or other penetrative defects. Additionally, the chlorite-smectite in the matrix may prove difficult to polish.

Free Silica Content

Apparently 3-4%, all locked in crystalline rock. An XRD analysis may be useful to accurately determine the fine quartz content as some may be obscured in the clouded matrix.



Plate 2: Photo-micrograph taken at low magnification in cross polarised light of part of a latite tuff fragment. Cloudy areas are microcrystalline quartz and feldspar devitrification products. Phenoclasts are mostly feldspar with a couple of brighter hornblendes to the left and a broken quartz phenoclast in middle of bottom of image. Note the chloritic-smectite alteration of a former pyroxene phenoclasts in middle of upper part of image.

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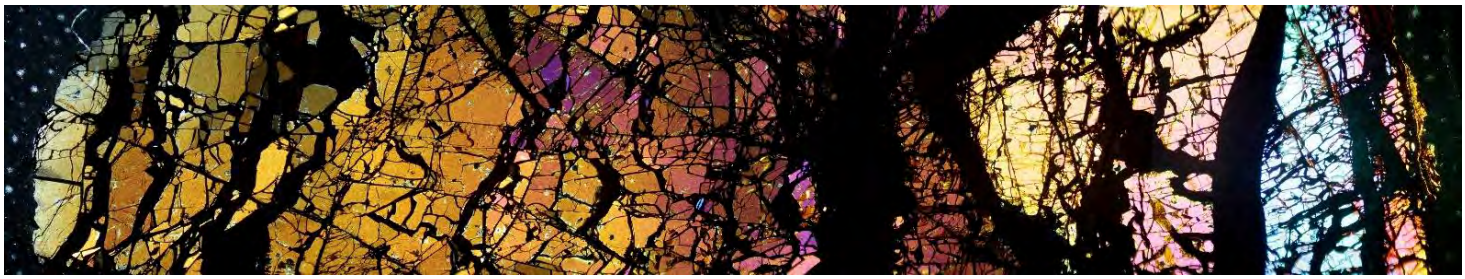
Plate 3: Photo-micrograph taken at medium magnification in plane polarised light of part of a latite tuff fragment. It highlights a discrete patch of flow-banding in centre of image with an obvious opacite-rimmed hornblende phenoclast.

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.



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ABN 980 6945 3445
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Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.

5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019
Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT
ON AN AGGREGATE SAMPLE (NEW19W-2685-S02)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARABROOK

Purchase Order: QTPO19-0253
Invoice Number: 00008914
Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
29 August 2019

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Sample No.:	NEW19W-2685-S02	**Date Sampled**:	05/08/2019
Description:	Sample B	**Date Received**:	08/08/2018
Material:	Source Aggregate	**Client**:	VGT Pty Ltd
Word Order No.:	NEW19W-2685	**Project No.**:	NEW15P-0045
Project Name:	Material Testing		
Sample Source:	Various, NSW		

Work Requested Petrographic analysis in relation to use as road base, concrete aggregate, sealing/asphaltic aggregate, rail ballast, rip rap, dimension stone and marine armour rock; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of *ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the *AS1141 Standard Guide for the Method for sampling and testing aggregates,* of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-2015) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*, and in accordance with *ASTM C 294 Standard Guide for Petrographic Assessment of Railway Ballast* and to the content of the 2015 publication of Standards Australia (AS 2758.7 – Appendix B), entitled Aggregates and Rock for Engineering Purposes- Part 7: Railway Ballast, and in accordance with ASTM C1721-09 *Standard Guide for Petrographic Assessment of Dimension Stone*, and in accordance with ASTM D4992-07 *Standard Guide for Evaluation of Rock to be used for Erosion Control*

Identification Latite tuff

Description

The aggregate sample consisted of medium dark-grey, essentially unweathered, finely crystalline intermediate tuffaceous fragments speckled with small phenoclasts of lighter grey feldspar and black hornblende. When washed, the fine dust coatings on fragments were easily removed.

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.



Plate 1: Image of supplied aggregate sample.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 randomly-selected fragments. An approximate mineralogical composition of the aggregate, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

37%	finely microcrystalline feldspars and minor quartz (products of devitrification; 5-6% quartz)
31%	plagioclase feldspar phenoclasts
3%	hornblende phenoclasts
1%	opaque oxide phenoclasts
<1%	remnant pyroxene phenoclasts
1%	quartz phenoclasts
2%	coarser quartz
14%	coarser feldspar
<1%	leucoxene
<1%	epidote
<1%	opaque oxide (magnetite and/or ilmenite) in matrix
trace	apatite and zircon

Weak, Deleterious or Otherwise Non-durable Minerals

5%	chlorite-smectite
3%	sericite
3%	biotite phenoclasts

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

In thin section, the rock displays textures of tuffaceous style, involving many smoothly corroded, subhedral and less commonly broken phenoclasts (mainly about 0.1 to 2 mm in size) dispersed through a now devitrified and clouded, strongly flow-banded matrix with obvious ghosted former moderately welded vitric shards (mainly about 0.2 to 0.3 mm long).

The most abundant phenoclasts are twinned, strongly zoned, prismatic plagioclase with variable alteration to sericite and chlorite-smectite. Other phenoclasts are fresh brownish-green hornblende, opaque oxide, slim biotite flakes, and remnant pyroxene which are now almost completely altered to chlorite-smectite, epidote and leucoxene along with scattered small, equant, corroded and broken quartz crystals. The formerly vitroclastic matrix is strongly flow-banded and now consists of variably clouded (apparently a dusting of fine brown clay) finely microcrystalline feldspars, accompanied by leucoxene, minor anhedral quartz (about 0.05 to 0.2 mm size), small patches of green to brown chlorite-smectite. A few small grains of apatite and zircon are present.

Comments and Interpretations

The rock represented in the supplied aggregate sample (labelled NEW19W-2685-S02 Sample B) is considered to be latite tuff. In more detail, the rock appears to have originated as moderately welded crystal-vitric tuff generated by ash flow (or ignimbrite) processes. Its composition seems to be equivalent to latite, an intermediate volcanic rock, similar to andesite but more potassic. The rock initially consisted of abundant phenoclasts of plagioclase, hornblende, opaque oxide and minor pyroxene, biotite and quartz dispersed through a moderately welded mass of strongly flow-banded glass shards. Subsequently the rock experienced devitrification resulting in conversion of all of the glass to microcrystalline feldspars, leucoxene, chlorite-smectite and to minor amounts of fine clay, sericite and epidote. Phenoclasts suffered minor, probably related alteration.

For engineering purposes, the rock in the aggregate sample may be summarised as:

- **latite tuff** (equivalent in composition to intermediate volcanic igneous rock)
- devitrified and now finely crystalline
- essentially unweathered
- moderately altered
- carrying about 11% of weak minerals (5% chloritic-smectite, 3% biotite and 3% sericite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

In relation to potential for alkali-silica reactivity the rock is seen to contain about 5-6% finely microcrystalline quartz which is regarded as sufficient to be deleterious, thus the rock is predicted to have **mild or slow potential for alkali-silica reactivity in concrete**.

Thus, rock equivalent to the supplied sample is predicted to be **suitable for use as concrete aggregate** subject to a caution about its perceived potential for mild or slow deleterious alkali-silica reactivity. Appropriate precautions in mix and engineering design are recommended to suppress or eliminate the perceived potential for mild or slow deleterious reaction.

Guidance on appropriate precautions can be obtained from the 2015 joint publication of the *Cement and Concrete Association of Australia* and *Standards Australia,* entitled *Alkali*

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia.

Latite tuff of the type represented by the supplied sample is predicted to be **a suitable for use as road base, sealing/asphaltic aggregate** (subject to bitumen stripping and polishing tests) **and rail ballast** (subject to compliance with the Durability Criteria of CT147 / AS2758.7).

The rock is predicted to be **suitable for use as rip rap.** It is predicted to have good potential for use as a source of marine armour rock or dimension stone, provided that a quarry inspection can indicate that blocks of sufficient size can be obtained free of weak or permeable joints or other penetrative defects.

Free Silica Content

Apparently 8-9%, all locked in crystalline rock. An XRD analysis may be useful to accurately determine the fine quartz content as some may be obscured in the clouded matrix.



Plate 2: Photo-micrograph taken at low magnification in cross polarised light of part of a latite tuff fragment. Cloudy areas are strongly flow-banded microcrystalline quartz and feldspar devitrification products. Phenoclasts are mostly feldspar with a couple of brighter hornblendes at top of image and two small quartz phenoclasts in middle of image.

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Plate 3: Photo-micrograph taken at medium magnification in cross polarised light of part of a latite tuff fragment. It highlights the flow-banded texture in the matrix with devitrified vitric shards in centre of image. Note the biotite flake and hornblende prisms in left of image.

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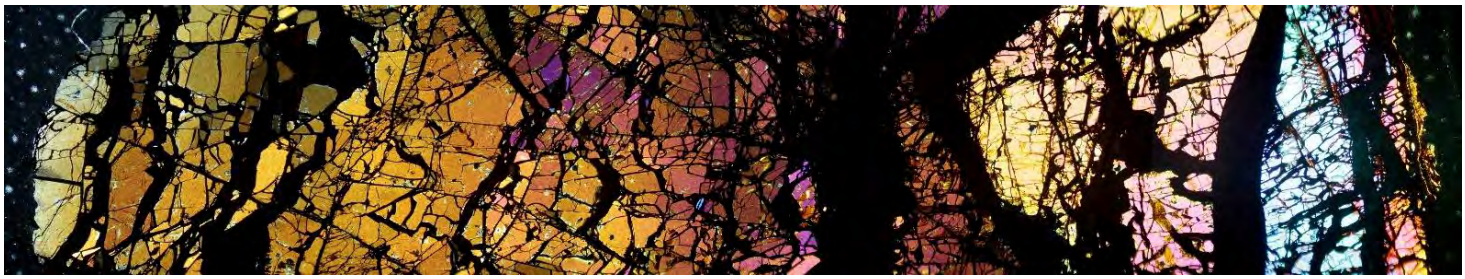

Geochempet Services

ABN 980 6945 3445
PETROLOGICAL and GEOCHEMICAL CONSULTANTS
Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.

5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019
Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT
ON AN AGGREGATE SAMPLE (NEW19W-2685-S03)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARABROOK

Purchase Order: QTPO19-0253
Invoice Number: 00008914
Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
29 August 2019

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

Sample No.:	NEW19W-2685-S03	**Date Sampled**:	05/08/2019
Description:	Sample C	**Date Received**:	08/08/2018
Material:	Source Aggregate	**Client**:	VGT Pty Ltd
Word Order No.:	NEW19W-2685	**Project No.**:	NEW15P-0045
Project Name:	Material Testing		
Sample Source:	Various, NSW		

Work Requested Petrographic analysis in relation to use as road base, concrete aggregate, sealing/asphaltic aggregate, rail ballast, rip rap, dimension stone and marine armour rock; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of *ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the *AS1141 Standard Guide for the Method for sampling and testing aggregates,* of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-2015) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*, and in accordance with *ASTM C 294 Standard Guide for Petrographic Assessment of Railway Ballast* and to the content of the 2015 publication of Standards Australia (AS 2758.7 – Appendix B), entitled Aggregates and Rock for Engineering Purposes- Part 7: Railway Ballast, and in accordance with ASTM C1721-09 *Standard Guide for Petrographic Assessment of Dimension Stone*, and in accordance with ASTM D4992-07 *Standard Guide for Evaluation of Rock to be used for Erosion Control*

Identification Rhyodacite tuff

Description

The aggregate sample consisted of medium dark-grey with some iron-stained on a few fragments, unweathered to less commonly slightly weathered, apparently robust, finely crystalline, acid tuffaceous fragments speckled with phenoclasts of whitish feldspar and pale grey quartz. When washed, the fine dust coatings on fragments were easily removed.

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Plate 1: Image of supplied aggregate sample.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 randomly-selected fragments. An approximate mineralogical composition of the aggregate, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

40%	finely microcrystalline feldspars and minor quartz (products of devitrification; about 13% quartz)
21%	feldspar phenoclasts (plagioclase and orthoclase)
<1%	hornblende phenoclasts
1%	opaque oxide phenoclasts
8%	quartz phenoclasts
6%	coarser quartz
12%	coarser feldspar
<1%	leucoxene
1%	opaque oxide (magnetite and/or ilmenite) in matrix
1%	calcite
trace	apatite and zircon

Weak, Deleterious or Otherwise Non-durable Minerals

2%	chlorite-smectite
7%	sericite
<1%	biotite phenoclasts
1%	limonite/goethite

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Microscopically, the sectioned fragments are seen to be essentially similar (but varying slightly in composition) and to display internal textures of tuffaceous style, involving many smoothly corroded, subhedral and commonly broken phenoclasts (about 0.1 to 4.5 mm in size) dispersed through a now mosaic devitrified matrix (<0.01 mm to less commonly 0.05 mm grainsize) with recognisable ghost textures after former moderately welded vitric shards. There are a few larger lithic clasts of acid volcanic style.

The most abundant phenoclasts are twinned, zoned, prismatic plagioclase and less commonly stubby orthoclase, some with slight alteration to calcite or sericite. Other phenoclasts are cracked, corroded and embayed quartz of beta-form, small brown hornblende, opaque oxide (magnetite and/or ilmenite) and flakes of brown biotite. The strongly flow-banded, formerly vitroclastic matrix now consists of a finely microcrystalline and less commonly micro-spherulitic mosaic of mainly feldspars and quartz, but with minor opaque oxide, biotite, chlorite-smectite and leucoxene. In a single fragment, the devitrified matrix is pigmented by limonite/goethite.

Comments and Interpretations

The rock represented in the supplied aggregate sample (labelled NEW19W-2685-S03) consists of fragments which are considered to qualify for identification as rhyodacite tuff, a pyroclastic rock with a bulk composition equivalent to that of acid volcanic rock.

For engineering purposes, the rock represented by the supplied aggregate sample may be summarised as:

- **rhyodacite tuff** (composition equivalent to acid volcanic rock, but in this case somewhat gradational towards a quartzose intermediate volcanic composition)
- devitrified and now finely and densely crystalline
- unweathered and less commonly slightly weathered
- lightly altered
- carrying about 10% of weak minerals (7% sericite, 2% chloritic-smectite, 1% limonite/goethite and <1% biotite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

In relation to potential for alkali-silica reactivity the rock is seen to contain about 13% finely microcrystalline quartz which is regarded as sufficient to be deleterious, thus the rock is predicted to have **mild or slow potential for alkali-silica reactivity in concrete**.

Thus, rock equivalent to the supplied sample is predicted to be **suitable for use as concrete aggregate** subject to a caution about its perceived potential for mild or slow deleterious alkali-silica reactivity. Appropriate precautions in mix and engineering design are recommended to suppress or eliminate the perceived potential for mild or slow deleterious reaction.

Guidance on appropriate precautions can be obtained from the 2015 joint publication of the *Cement and Concrete Association of Australia* and *Standards Australia,* entitled *Alkali*

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Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia.

Latite tuff of the type represented by the supplied sample is predicted to be **a suitable for use as road base, sealing/asphaltic aggregate** (subject to bitumen stripping and polishing tests) **and rail ballast** (subject to compliance with the Durability Criteria of CT147 / AS2758.7).

The rock is predicted to be **suitable for use as rip rap.** It is predicted to have good potential for use as a source of marine armour rock or dimension stone, provided that a quarry inspection can indicate that blocks of sufficient size can be obtained free of weak or permeable joints or other penetrative defects.

Free Silica Content

Estimated to be 27%, all locked in crystalline rock.

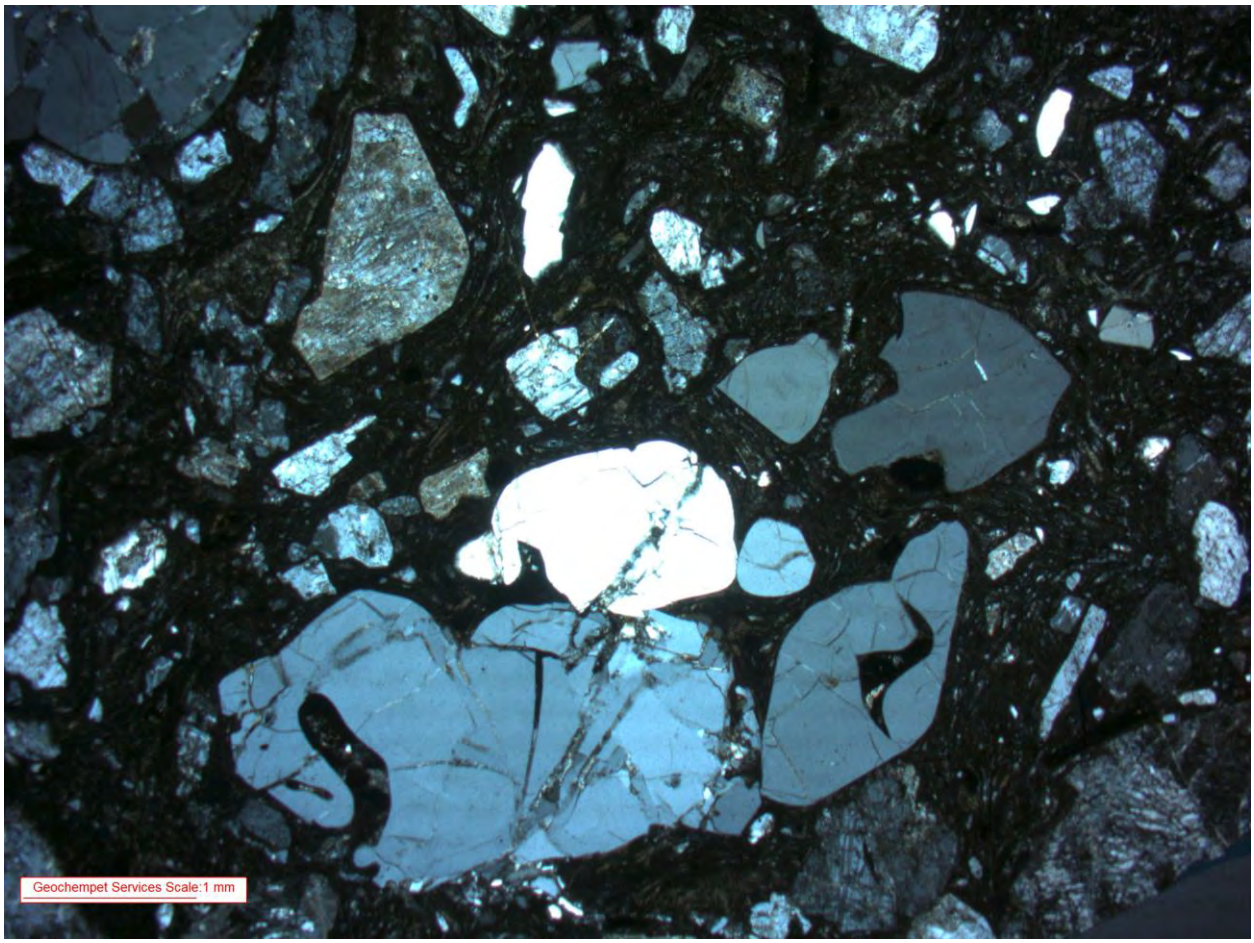

Plate 2: Photo-micrograph taken at low magnification in cross polarised light of part of a rhyodacite tuff fragment. Cloudy areas are strongly flow-banded microcrystalline quartz and feldspar devitrification products. Phenoclasts are mostly feldspar and cracked, beta-form quartz phenoclasts.

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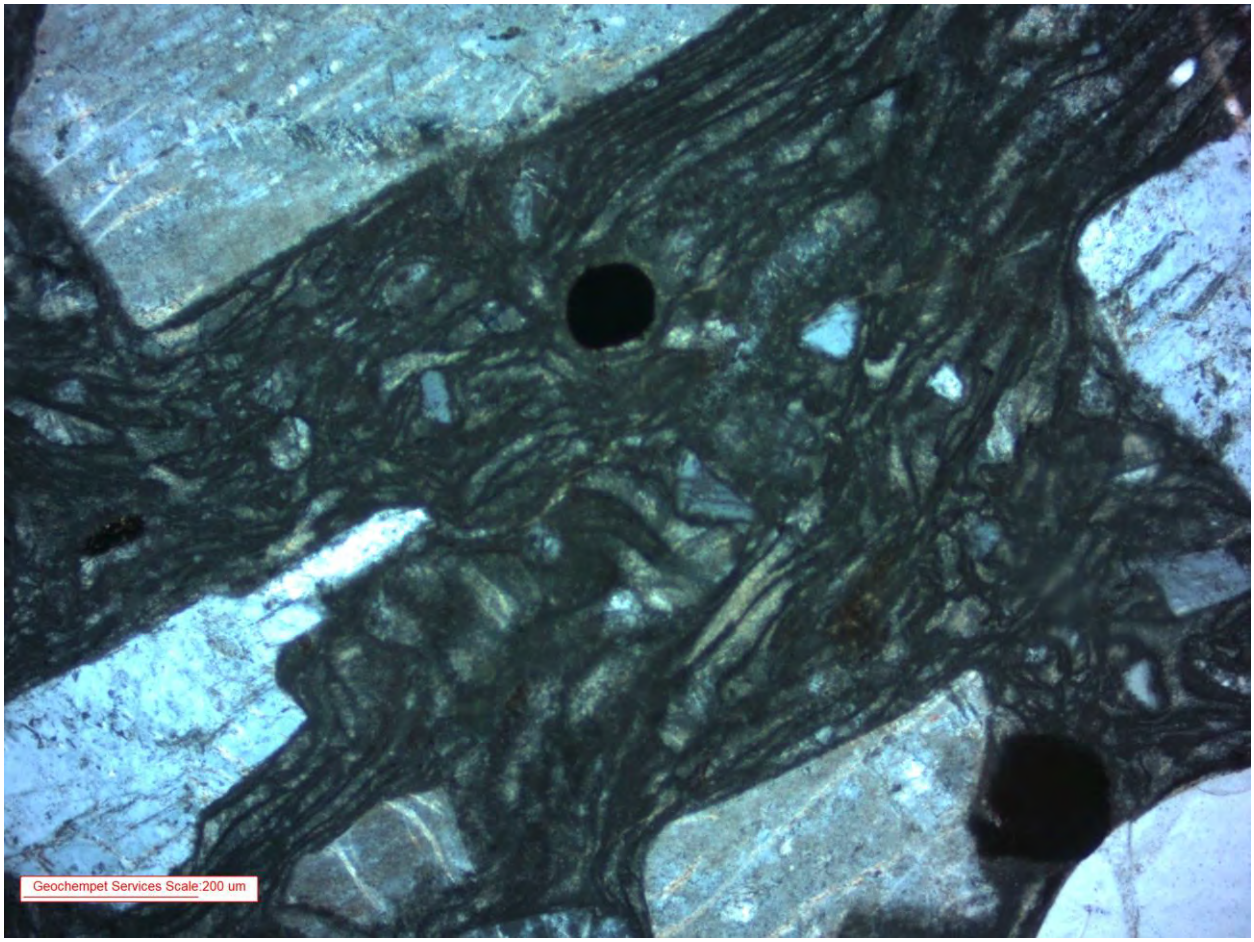

Plate 3: Photo-micrograph taken at medium magnification in cross polarised light of part of a rhyodacite tuff fragment. It highlights the strong flow-banded texture in the matrix with devitrified vitric shards. Note the small opaque oxide phenocrysts and quartz chips in the matrix.

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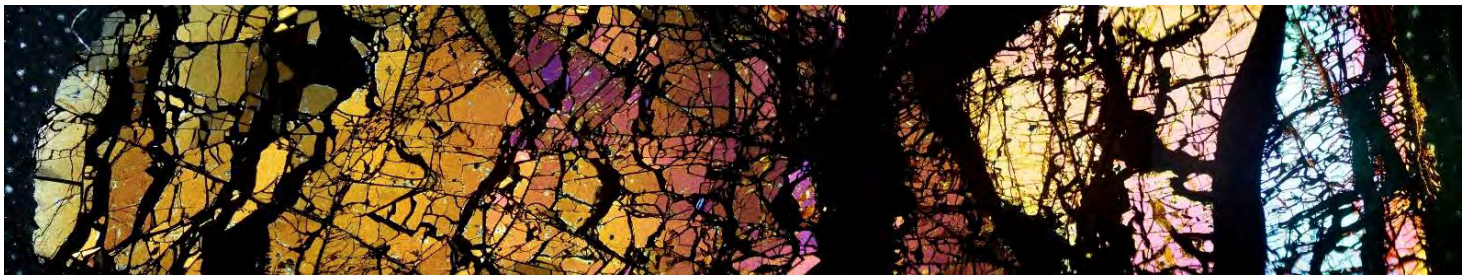

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Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.

5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019
Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT
ON AN AGGREGATE SAMPLE (NEW19W-2685-S04)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARABROOK

Purchase Order: QTPO19-0253
Invoice Number: 00008914
Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
29 August 2019

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Sample No.:	NEW19W-2685-S04	**Date Sampled**:	05/08/2019
Description:	Sample D	**Date Received**:	08/08/2018
Material:	Source Aggregate	**Client**:	VGT Pty Ltd
Word Order No.:	NEW19W-2685	**Project No.**:	NEW15P-0045
Project Name:	Material Testing		
Sample Source:	Various, NSW		

Work Requested Petrographic analysis in relation to use as road base, concrete aggregate, sealing/asphaltic aggregate, rail ballast, rip rap, dimension stone and marine armour rock; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of *ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the *AS1141 Standard Guide for the Method for sampling and testing aggregates,* of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-2015) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*, and in accordance with *ASTM C 294 Standard Guide for Petrographic Assessment of Railway Ballast* and to the content of the 2015 publication of Standards Australia (AS 2758.7 – Appendix B), entitled Aggregates and Rock for Engineering Purposes- Part 7: Railway Ballast, and in accordance with ASTM C1721-09 *Standard Guide for Petrographic Assessment of Dimension Stone*, and in accordance with ASTM D4992-07 *Standard Guide for Evaluation of Rock to be used for Erosion Control*

Identification Porphyritic latite-andesite

Description

The supplied sample consisted of robust, hard, and angular to sub-angular fragments of medium dark grey, essentially unweathered, apparently robust, abundantly porphyritic, finely crystalline, intermediate igneous rock. A few fragments appeared to be altered by selective argillization and/or carbonation of mafic crystals and infilled amygdules.

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Plate 1: Image of supplied aggregate sample.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 randomly-selected fragments. An approximate mineralogical composition of the aggregate, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Primary Minerals

44%	groundmass feldspar (plagioclase and orthoclase)
23%	plagioclase phenocrysts
1%	hornblende phenocrysts
3%	biotite phenocrysts
4%	pyroxene
1%	opaque oxide (magnetite and/or ilmenite)

Secondary Minerals

15%	brown smectite
2%	sericite
1%	leucoxene
6%	epidote

In thin section, the rock displays textures of volcanic style involving an intact framework of subhedral phenocrysts (mainly around 0.2 to 1 mm size) in very finely crystalline groundmass of finer grains and laths (about 0.01 to 0.05 mm). Amygdules range up to 4 mm in diameter in some fragments and are absent in others.

The phenocrysts are dominated by finely sericite-speckled, euhedral to subhedral, twinned laths of plagioclase. Other phenocrysts are fresh to strongly altered brownish-green biotite and green

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hornblende prisms which vary from totally fresh, with rim alteration to totally chloritized/smectitized.

The groundmass is dominated by randomly orientated laths of plagioclase and finely epidote clouded K-feldspar. The groundmass contains very fine patches of finely cloudy epidote. Other groundmass components are grains of partly leucoxenized greenish-brown biotite and hornblende prisms, pyroxene grains, opaque oxide (equant grains of magnetite) along with more abundant patches of interstitial brown smectite which is also occurring along grain boundaries.

Two fragments are quite smectite-altered with common rip outs and are amygdaloidal which are probably from margins of the flow. Amygdules are filled by colourless to brown smectite clay. In a third fragment, carbonate alteration occurs additionally as short discontinuous veins and as infill in amygdules.

Comments and Interpretations

The rock represented in the supplied aggregate sample (labelled NEW19W-2685-S04 sample D) is considered to be porphyritic latite-andesite, its mineralogy and texture is consistent with compositional gradation between latite and andesite, intermediate igneous rock. Its textures are consistent with crystallization within a lava flow. The rock shows a varying degree of alteration of probable deuteric style (i.e. alteration developed during final crystallization and cooling) or hydrothermal alteration.

For engineering purposes, the rock represented in the supplied aggregate sample may be summarised as:

- **porphyritic latite-andesite** (an intermediate igneous rock)
- porphyritic
- essentially unweathered
- moderately altered
- secondary mineral content of about 24% including 7% robust minerals composed mainly epidote and leucoxene
- contains 17% soft weak minerals including 15% smectite and 2% sericite
- **moderately hard to hard**
- **moderately strong to strong**

The rock is predicted to be **moderately durable to durable**. About half of the examined fragments are quite smectitized and amygdaloidal and are considered to be of moderate durability.

The rock is predicted to be **innocuous in relation to alkali-aggregate reactivity in concrete**. It appears to lack free silica.

Less altered rock of the type represented by the supplied sample is predicted to be **a suitable for use as road base, concrete aggregate, sealing/asphaltic aggregate** (subject to bitumen stripping and polishing tests) **and rail ballast** (subject to compliance with the Durability Criteria of CT147 / AS2758.7). The wet/dry strength of the aggregate should be tested to determine the effect of the variations in content of secondary minerals (swelling smectite) noted across the examined fragments.

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The less altered rock is predicted to be **suitable for use as rip rap.** It is not recommended for use as a source of marine armour rock or dimension stone because of an elevated soft, weak mineral content in some of the fragments.

Free Silica Content

Apparently nil.

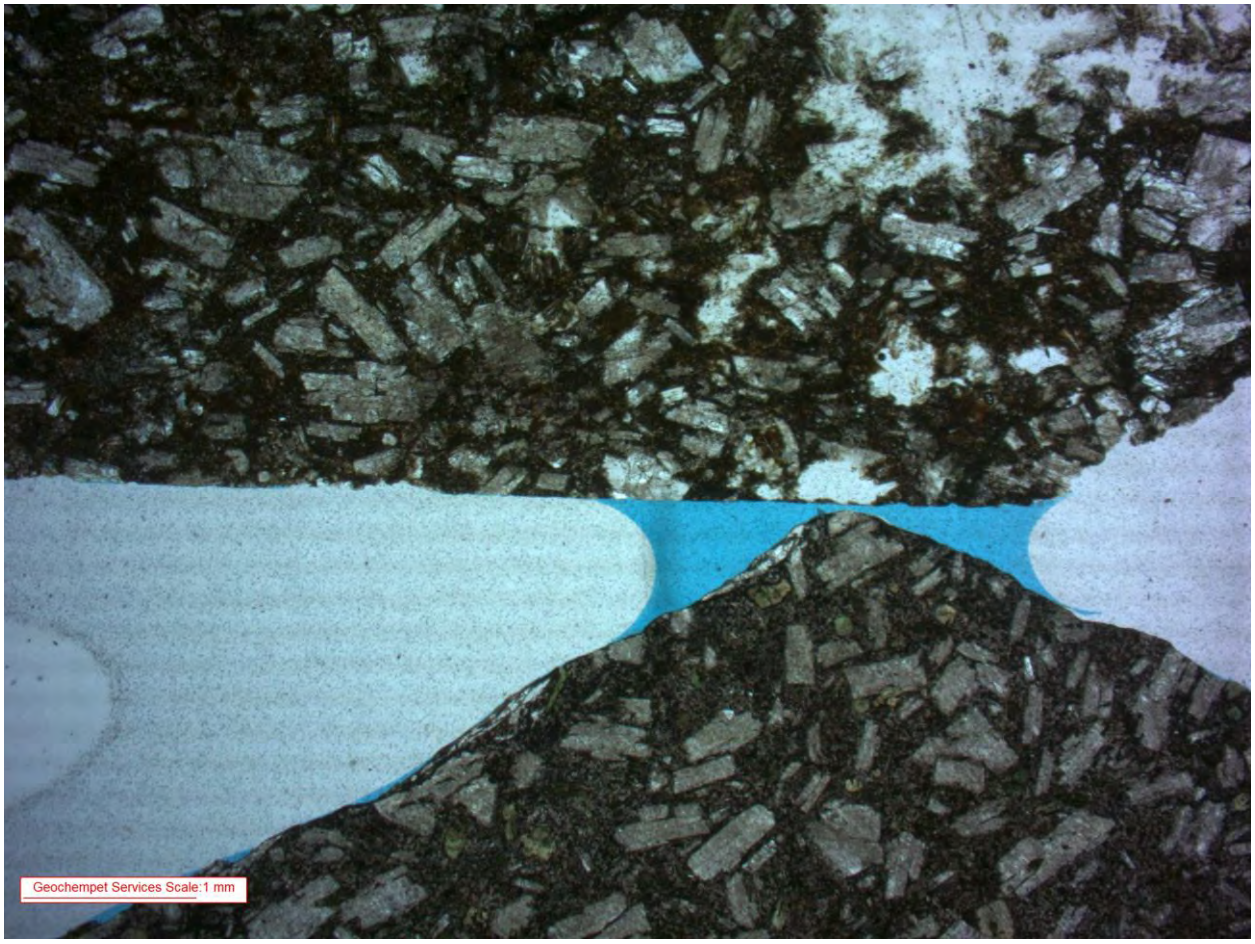

Plate 2: Photo-micrograph taken at low magnification in cross polarised light of part of two latite-andesite fragments. The fragment in the upper part of image is darkened by smectite-alteration of mafic silicates in the groundmass. The fragment in bottom of image is less altered and fresh. Note the abundance of plagioclase phenocrysts.

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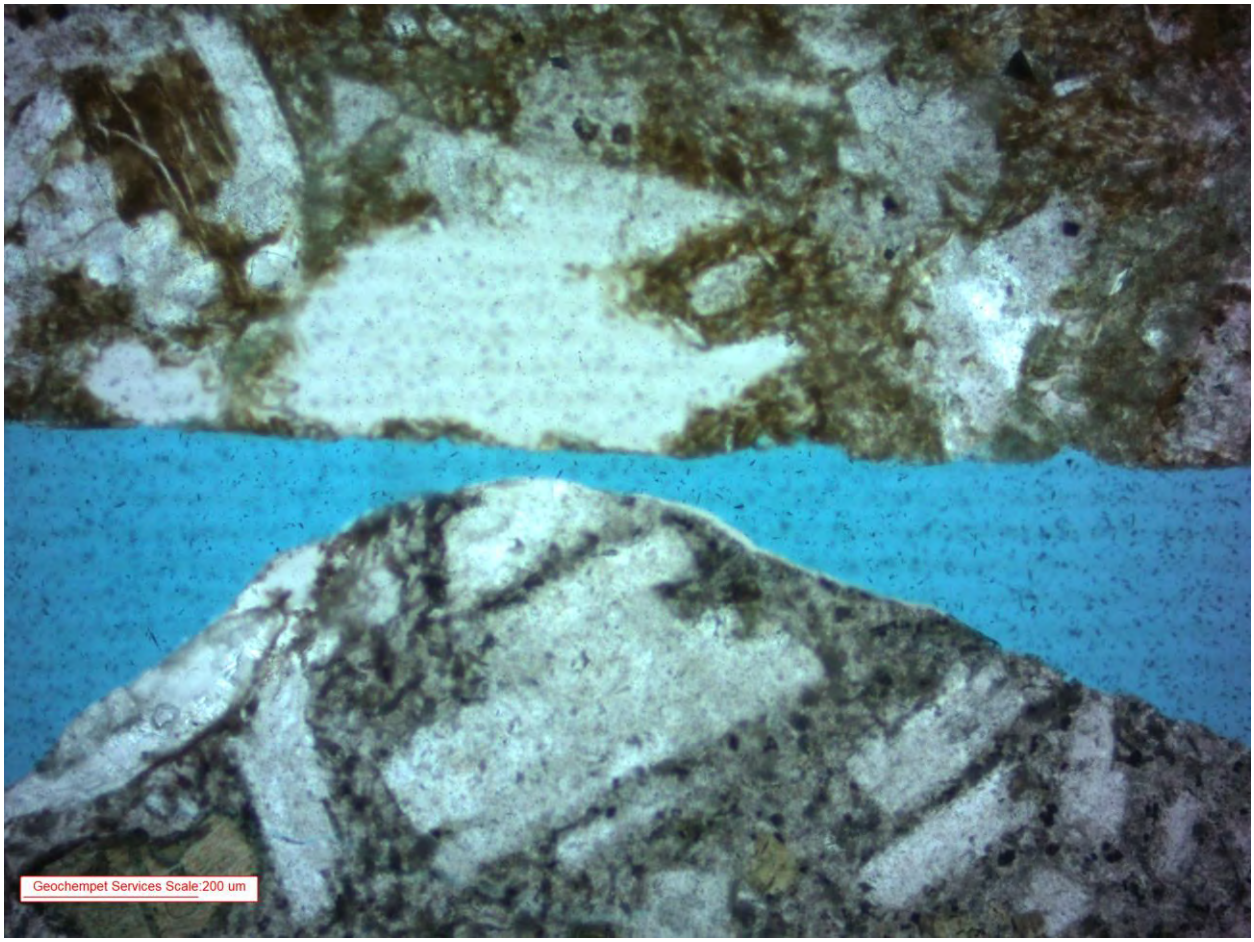

Plate 3: Photo-micrograph taken at medium magnification in plane polarised light of part of two latite-andesite fragments. The fragment in the upper part of image is darkened by smectite-alteration of mafic silicates in the groundmass. The fragment in bottom of image is less altered and fresh. Note the smectitized phenocryst in upper fragment while lower fragment retains biotite phenocrysts.

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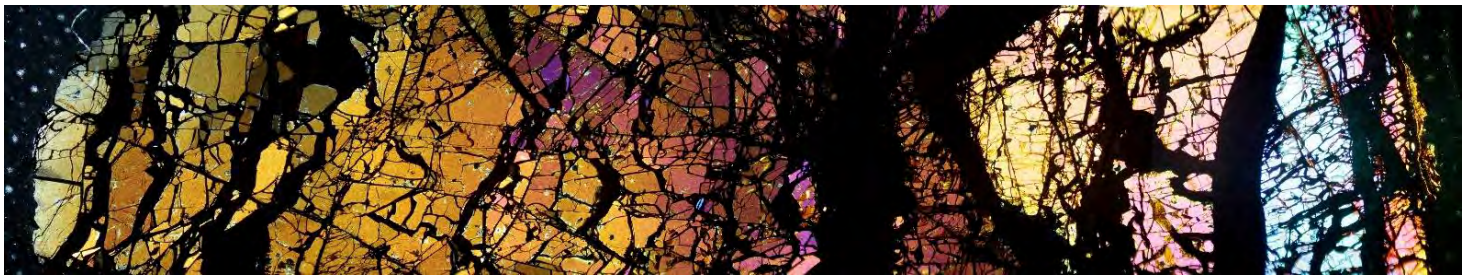

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Clontarf, QLD 4019
Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT
ON AN AGGREGATE SAMPLE (NEW19W-2685-S05)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARABROOK

Purchase Order: QTPO19-0253
Invoice Number: 00008914
Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
29 August 2019

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Sample No.:	NEW19W-2685-S05	**Date Sampled**:	05/08/2019
Description:	Sample E	**Date Received**:	08/08/2018
Material:	Source Aggregate	**Client**:	VGT Pty Ltd
Word Order No.:	NEW19W-2685	**Project No.**:	NEW15P-0045
Project Name:	Material Testing		
Sample Source:	Various, NSW		

Work Requested Petrographic analysis in relation to use as road base, concrete aggregate, sealing/asphaltic aggregate, rail ballast, rip rap, dimension stone and marine armour rock; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of *ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the *AS1141 Standard Guide for the Method for sampling and testing aggregates,* of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-2015) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*, and in accordance with *ASTM C 294 Standard Guide for Petrographic Assessment of Railway Ballast* and to the content of the 2015 publication of Standards Australia (AS 2758.7 – Appendix B), entitled Aggregates and Rock for Engineering Purposes- Part 7: Railway Ballast, and in accordance with ASTM C1721-09 *Standard Guide for Petrographic Assessment of Dimension Stone*, and in accordance with ASTM D4992-07 *Standard Guide for Evaluation of Rock to be used for Erosion Control*

Identification Latite tuff and minor dolerite

Description

The supplied sample consisted of robust, hard, and angular to sub-angular fragments of intermediate tuffaceous rock. When washed, the fine dust coatings on fragments were easily removed and are seen to consist of medium dark grey, essentially unweathered, apparently robust, latite tuff displaying numerous phenoclasts of mainly light grey plagioclase and black hornblende dispersed through a now very finely crystalline feldspathic matrix.

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Plate 1: Image of supplied aggregate sample.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 randomly-selected fragments (one fragments is a dolerite). An approximate mineralogical composition of the aggregate, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

24%	microcrystalline feldspars and very minor quartz (products of devitrification; 1-2% microcrystalline quartz)
29%	plagioclase feldspar phenoclasts
5%	hornblende phenoclasts
2%	opaque oxide phenoclasts
<1%	quartz phenoclasts
1%	coarser quartz
15%	coarser feldspar
2%	leucoxene
5%	clinopyroxene
trace	apatite and zircon

Weak, Deleterious or Otherwise Non-durable Minerals

6%	chlorite-smectite
5%	colourless smectite
3%	brown smectite
3%	sericite

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The five sectioned latite tuff fragments display textures of mildly flow-banded, tuffaceous style, involving many smoothly corroded, subhedral and broken phenoclasts (about 0.1 to 2.5 mm in size) dispersed through a now mosaic devitrified matrix (<0.01 mm to about 0.1 in grainsize).

The most abundant phenoclasts are poorly twinned, zoned, prismatic plagioclase, with slight to moderate alteration to chlorite-smectite and sericite. Prismatic phenocrysts of green to brown hornblende have thin opacite rims and other mafic silicates are heavily altered to colourless and green chlorite-smectite and leucoxene. Other phenocrysts include sparse biotite flakes, corroded and broken quartz and opaque oxide (magnetite and/or ilmenite). The formerly vitroclastic matrix between the phenoclasts now consists of a microcrystalline mosaic of mainly feldspars, but possibly with some hidden quartz which is impregnated by fine opaque oxide and chlorite-smectite along with traces of zircon and apatite crystals. There is a series of thin discontinuous quartz veins in one latite tuff fragment.

The single sectioned fragment of dolerite displays primary textures of subtly ophitic, non-porphyritic, hypidiomorphic, finely crystalline, igneous style. The main framework is formed by randomly orientated prisms and stumpy laths of twinned and zoned plagioclase about 0.2 to commonly 1 mm long: the plagioclase is essentially fresh, but a few microfractures are healed by brown smectite and leucoxene to quite altered (rip outs are common in altered areas). Numerous pyroxene grains have been partly altered to brown smectite clay. Some leucoxene and smectite-altered mesostasis occurs as interstices between the primary minerals. Opaque oxide forms many equant, fresh grains (probably magnetite). Apatite forms numerous, but small and slim, acicular grains.

Comments and Interpretations

The rock represented in the supplied aggregate sample (labelled NEW19W-2685-S05 sample E) is considered to be latite tuff (intermediate tuffaceous rock) with minor dolerite (a basic igneous dyke rock). The tuff formed initially by a pyroclastic, ash flow mechanism, rather than as simple lava. Subsequent diagenesis (i.e. modifications induced by burial and the passage of time) and/or hydrothermal action (i.e. modifications by passage of hot fluids) has devitrified and moderately altered the rock.

For engineering purposes, the rock in the aggregate sample may be summarised as:

- **latite tuff** (equivalent in composition to intermediate volcanic igneous rock)
- devitrified and now finely crystalline
- essentially unweathered
- moderately altered
- carrying about 17% of weak minerals (14% chloritic-smectite and 3% sericite)
- **hard**
- **strong**

The rock is predicted to be **durable**. The altered dolerite is probable less desirable in the product as its secondary mineral content is elevated.

The rock is predicted to be **innocuous in relation to alkali-aggregate reactivity in concrete**. It apparently contains 2-3% quartz which is interpreted to be insufficient to impart a deleterious degree of reactivity to the rock as a whole.

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Rock of the type represented by the supplied sample is predicted to be **a suitable for use as road base, concrete aggregate, sealing/asphaltic aggregate** (subject to bitumen stripping and polishing tests) **and rail ballast** (subject to compliance with the Durability Criteria of CT147 / AS2758.7). The wet/dry strength of the aggregate should be tested to determine the effect of the content of secondary minerals (swelling smectite) versus the fine-grained tougher texture.

The rock is predicted to be **suitable for use as rip rap.** It is predicted to have potential for use as a source of marine armour rock or dimension stone, provided that a quarry inspection can indicate that blocks of sufficient size can be obtained free of weak or permeable joints or other penetrative defects. Additionally, the chlorite-smectite in the matrix may prove difficult to polish.

Free Silica Content

Apparently 2-3%, all locked in crystalline rock. An XRD analysis may be useful to accurately determine the fine quartz content as some may be obscured in the clouded matrix.

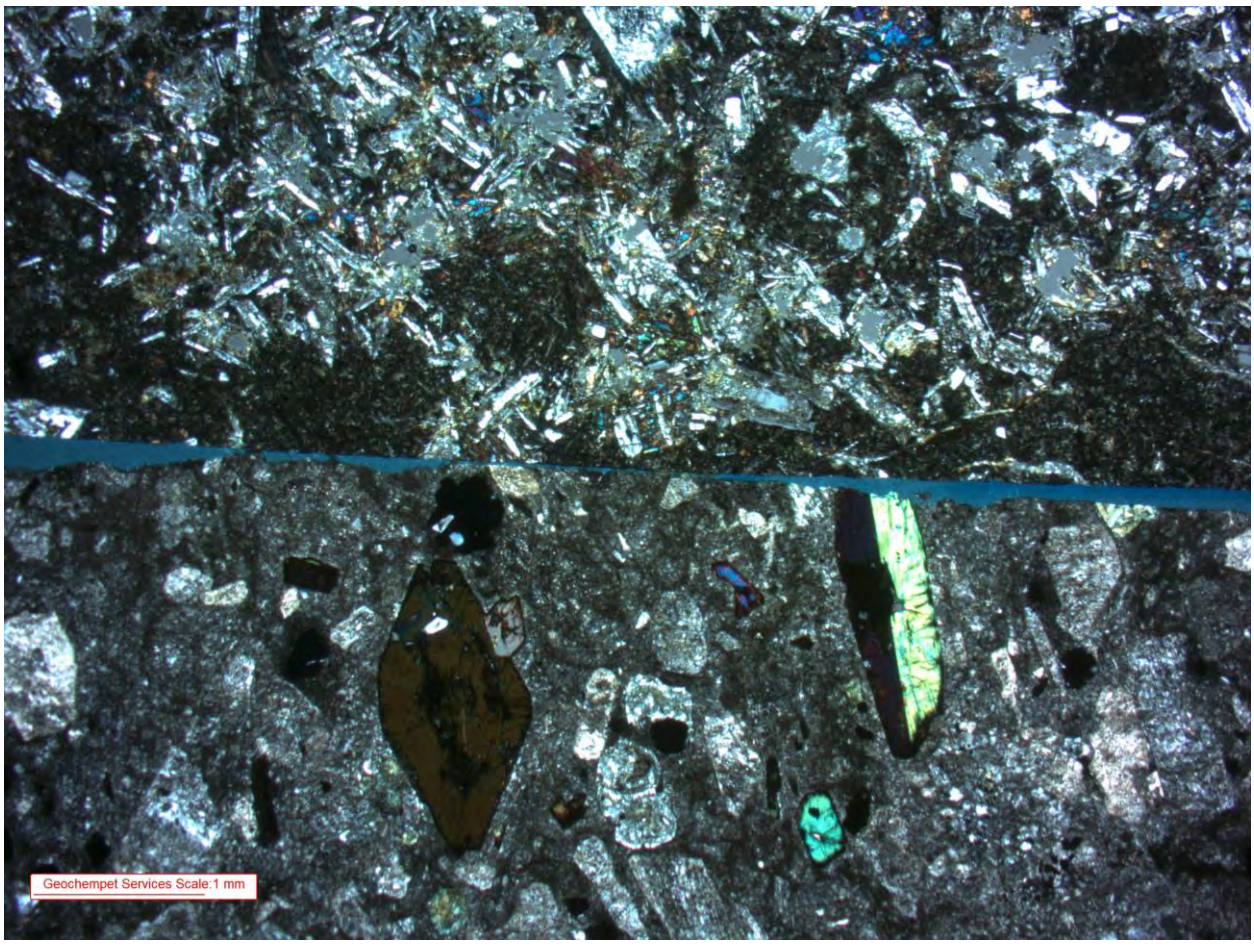

Plate 2: Photo-micrograph taken at low magnification in cross polarised light of part of latite tuff and dolerite fragments. The dolerite in the upper part of image is quite smectite and leucoxene-altered containing plagioclase laths intergrown with pyroxene grains in a sub-ophitic texture. The latite tuff in the lower part of image contains abundant feldspar phenoclasts along with conspicuous hornblende prisms in a largely feldspathic matrix.

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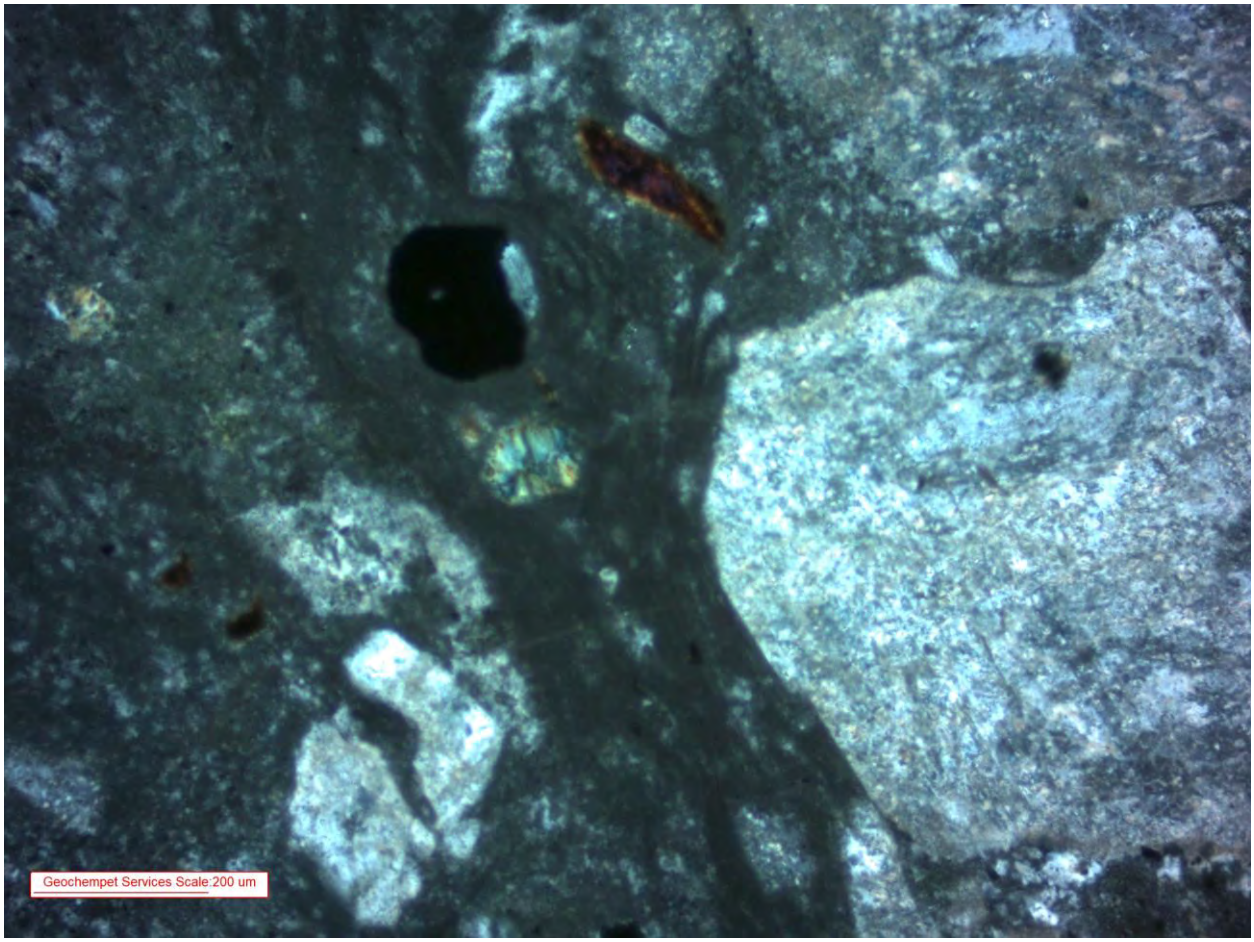

Plate 3: Photo-micrograph taken at medium magnification in cross polarised light of part of a latite tuff fragment. It highlights a discrete patch of flow-banding in centre of image.

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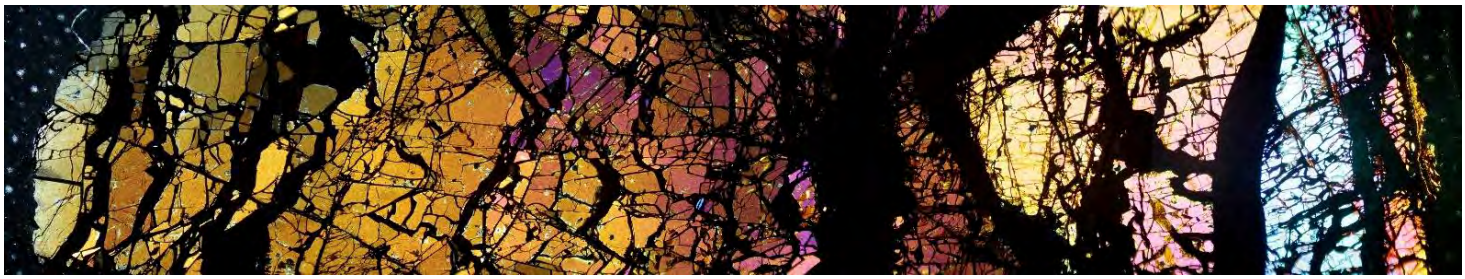

Geochempet Services

ABN 980 6945 3445
PETROLOGICAL and GEOCHEMICAL CONSULTANTS
Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.

5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019
Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT
ON AN AGGREGATE SAMPLE (NEW19W-2685-S06)

prepared for

QUALTEST LABORATORY (NSW) PTY LTD
WARABROOK

Purchase Order: QTPO19-0253
Invoice Number: 00008914
Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
29 August 2019

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Sample No.:	NEW19W-2685-S06	**Date Sampled**:	05/08/2019
Description:	Sample F	**Date Received**:	08/08/2018
Material:	Source Aggregate	**Client**:	VGT Pty Ltd
Word Order No.:	NEW19W-2685	**Project No.**:	NEW15P-0045
Project Name:	Material Testing		
Sample Source:	Various, NSW		

Work Requested Petrographic analysis in relation to use as road base, concrete aggregate, sealing/asphaltic aggregate, rail ballast, rip rap, dimension stone and marine armour rock; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of *ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the *AS1141 Standard Guide for the Method for sampling and testing aggregates,* of the content of the 2015 joint publication of the Cement and Concrete Association of Australia and Standards Australia, (HB 79-2015) entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*, and in accordance with *ASTM C 294 Standard Guide for Petrographic Assessment of Railway Ballast* and to the content of the 2015 publication of Standards Australia (AS 2758.7 – Appendix B), entitled Aggregates and Rock for Engineering Purposes- Part 7: Railway Ballast, and in accordance with ASTM C1721-09 *Standard Guide for Petrographic Assessment of Dimension Stone*, and in accordance with ASTM D4992-07 *Standard Guide for Evaluation of Rock to be used for Erosion Control*

Identification Rhyodacite tuff

Description

The aggregate sample consisted of medium dark-grey and greyish-red fragments, unweathered to slightly weathered, still robust, finely crystalline, acid tuffaceous fragments speckled with phenoclasts of whitish feldspar and pale grey quartz. When washed, the fine dust coatings on fragments were easily removed.

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Plate 1: Image of supplied aggregate sample.

A thin section was prepared to permit microscopic examination in transmitted polarised light of 6 randomly-selected fragments. An approximate mineralogical composition of the aggregate, expressed in volume percent and based on a brief count of 100 widely spaced observation points in thin section, is:

Durable Minerals

47%	finely microcrystalline feldspars and minor quartz (products of devitrification; about 15% quartz)
19%	feldspar phenoclasts (plagioclase and orthoclase)
1%	opaque oxide phenoclasts
9%	quartz phenoclasts
3%	coarser quartz
7%	coarser feldspar
<1%	leucoxene
1%	epidote
<1%	opaque oxide (magnetite and/or ilmenite) in matrix
2%	calcite and siderite
1%	hematite
trace	apatite and zircon

Weak, Deleterious or Otherwise Non-durable Minerals

5%	chlorite
3%	sericite
2%	biotite phenoclasts

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Microscopically, the sectioned fragments are seen to be essentially similar (but varying slightly in composition) and to display internal textures of tuffaceous style, involving many smoothly corroded, subhedral and commonly broken phenoclasts (about 0.1 to 4 mm in size) dispersed through a now mosaic devitrified matrix (<0.01 mm to less commonly 0.05 mm grainsize) with recognisable ghost textures after former moderately welded vitric shards.

The most abundant phenoclasts are twinned, zoned, prismatic plagioclase and less commonly stubby orthoclase, some with slight alteration to calcite/siderite, chlorite or sericite/illite. Other phenoclasts are broken, corroded and embayed quartz of beta-form, opaque oxide (magnetite and/or ilmenite) and flakes of brown biotite (partly altered to epidote and opacite) with auras of fine hematite. There are a few former mafic silicate phenoclasts which are totally carbonated or chlorite-altered. The strongly flow-banded, formerly vitroclastic matrix now consists of a finely microcrystalline and micro-spherulitic mosaic of mainly feldspars and quartz, but with minor opaque oxide (some are hematitized), biotite, chlorite, sericite/illite, hematite and leucoxene. Minor irregular fine veins are filed by feldspar and sericite/illite.

Comments and Interpretations

The rock represented in the supplied aggregate sample (labelled NEW19W-2685-S06 sample F) consists of fragments which are considered to qualify for identification as rhyodacite tuff, a pyroclastic rock with a bulk composition equivalent to that of acid volcanic rock.

For engineering purposes, the rock represented by the supplied aggregate sample may be summarised as:

- **rhyodacite tuff** (composition equivalent to acid volcanic rock, but in this case somewhat gradational towards a quartzose intermediate volcanic composition)
- devitrified and now finely and densely crystalline
- unweathered and slightly weathered
- moderately altered
- carrying about 10% of weak minerals (3% sericite, 5% chlorite and 2% biotite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

In relation to potential for alkali-silica reactivity the rock is seen to contain about 15% finely microcrystalline quartz which is regarded as sufficient to be deleterious, thus the rock is predicted to be borderline between having **mild or slow and substantial potential for alkali-silica reactivity in concrete**.

Thus, rock equivalent to the supplied sample is predicted to be **suitable for use as concrete aggregate** subject to a caution about its perceived potential for deleterious alkali-silica reactivity. Appropriate precautions in mix and engineering design are recommended to suppress or eliminate the perceived potential for deleterious reaction.

Guidance on appropriate precautions can be obtained from the 2015 joint publication of the *Cement and Concrete Association of Australia* and *Standards Australia,* entitled *Alkali*

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Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia.

Latite tuff of the type represented by the supplied sample is predicted to be **a suitable for use as road base, sealing/asphaltic aggregate** (subject to bitumen stripping and polishing tests) **and rail ballast** (subject to compliance with the Durability Criteria of CT147 / AS2758.7).

The rock is predicted to be **suitable for use as rip rap.** It is predicted to have good potential for use as a source of marine armour rock or dimension stone, provided that a quarry inspection can indicate that blocks of sufficient size can be obtained free of weak or permeable joints or other penetrative defects.

Free Silica Content

Estimated to be 27%, all locked in crystalline rock.

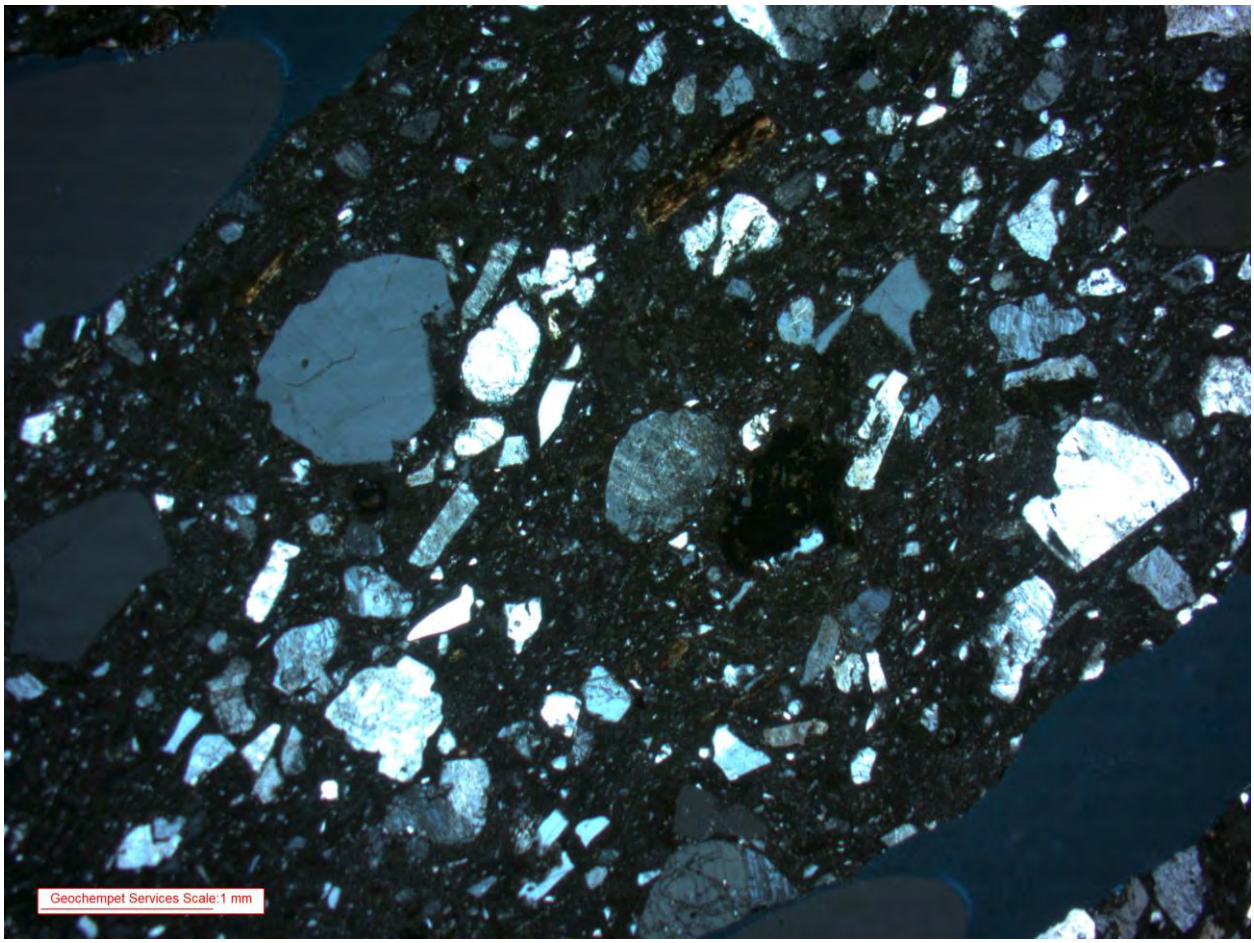

Plate 2: Photo-micrograph taken at low magnification in cross polarised light of part of a rhyodacite tuff fragment. Darker areas are strongly flow-banded microcrystalline quartz and feldspar devitrification products. Phenoclasts are mostly feldspar and broken quartz phenoclasts.

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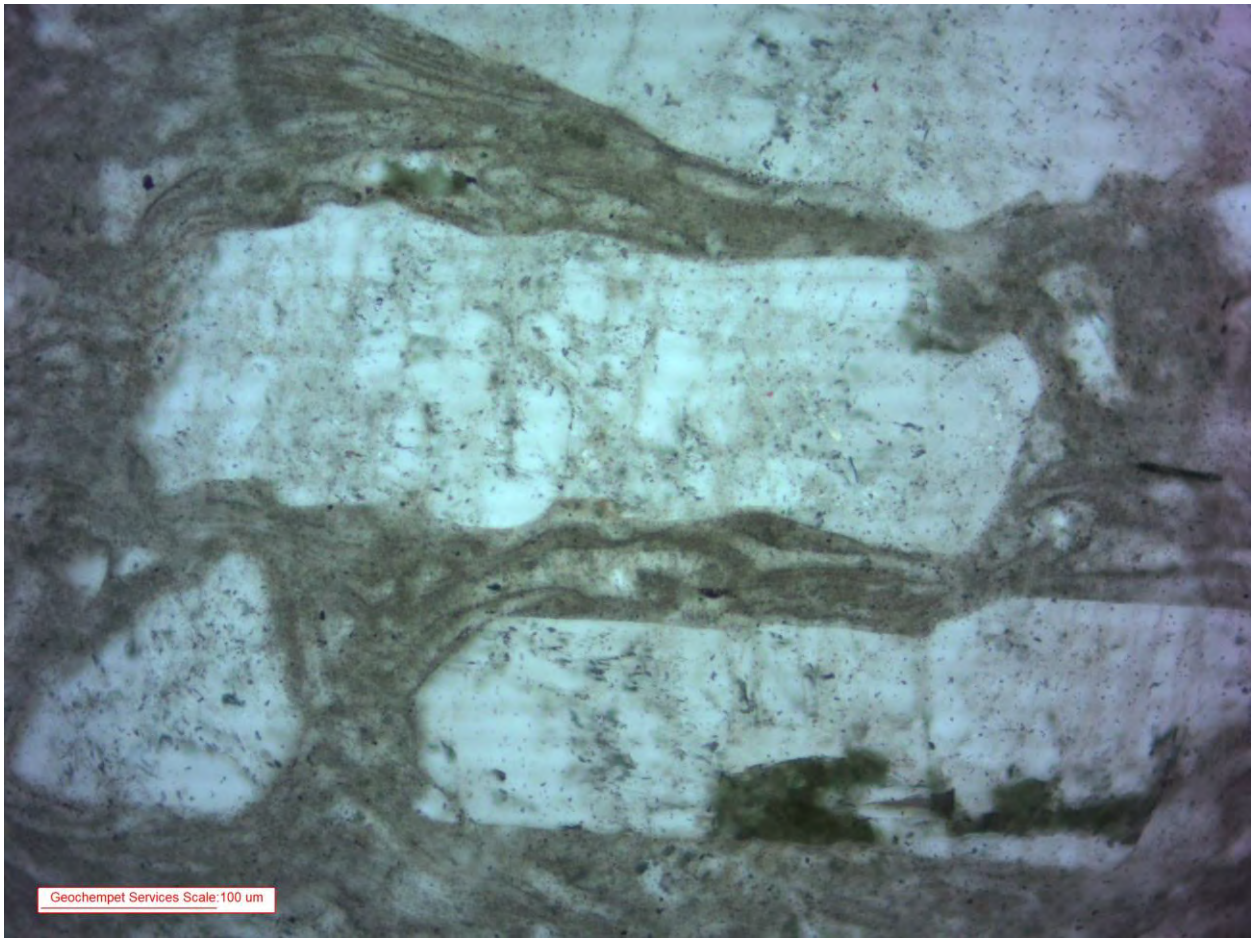

Plate 3: Photo-micrograph taken at medium high magnification in plane polarised light of part of a rhyodacite tuff fragment. It highlights the strong flow-banded texture in the matrix with ghosted devitrified vitric shards. Note the dark green chlorite alteration on feldspar phenoclast.

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VGT Environmental Compliance Solutions Pty Ltd
ABN 26 621 943 888

Unit 4, 30 Glenwood Drive Thornton NSW 2322
PO Box 2335, Greenhills NSW 2323

Ph: (02) 4028 6412
E: mail@vgt.com.au

www.vgt.com.au