GEOTECHNICAL INVESTIGATION REPORT

Proposed Construction Materials Quarry
Lot 2 'Dolwendee Estate', 770 Merriwa Road (Golden Highway), Hollydeen.

Prepared for Upper Hunter Holdings Pty Ltd – Goat Farm Trust

Prepared by RCA Australia

RCA ref 9325-203/1

November 2015

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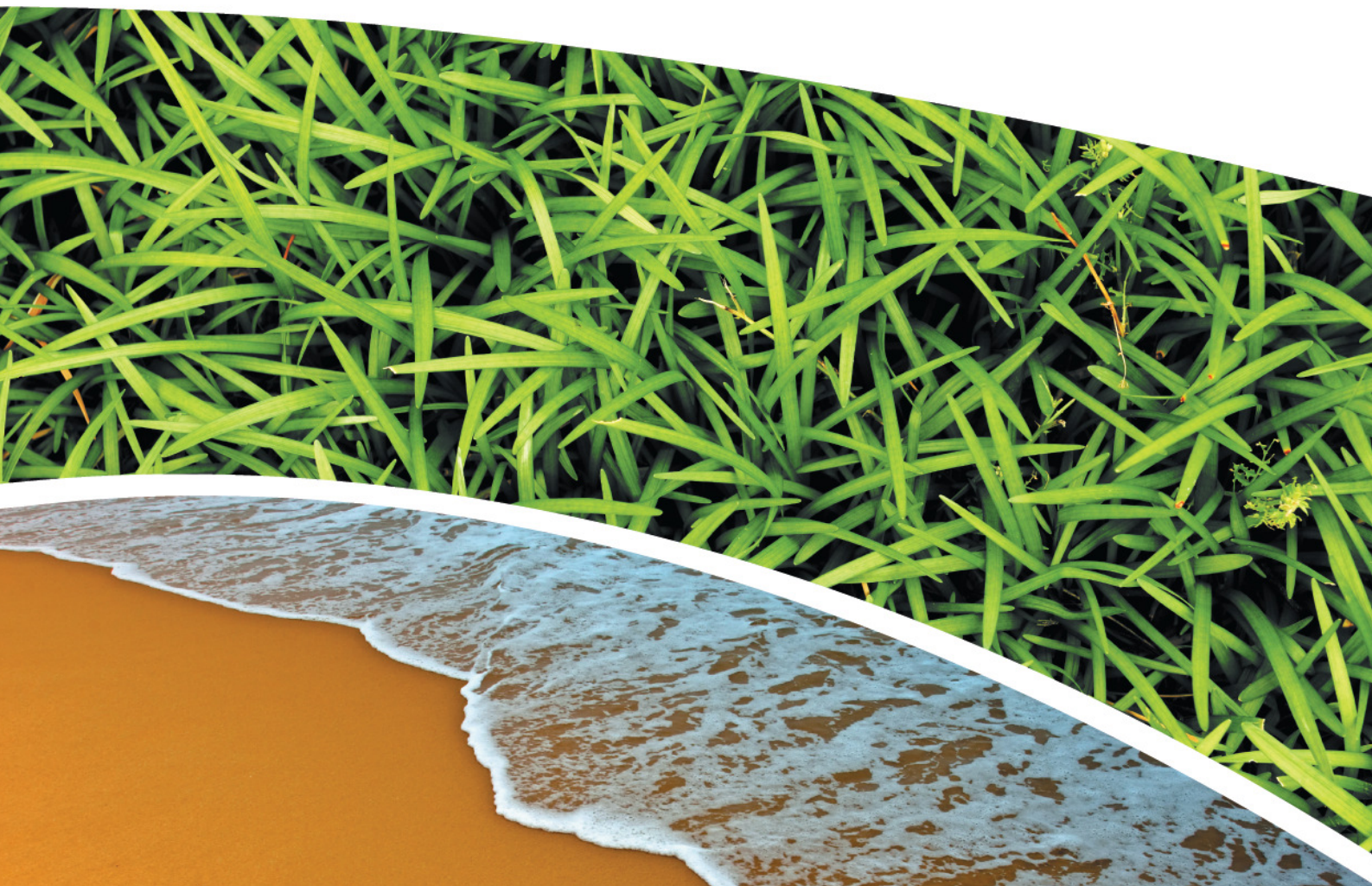

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RCA ref 9325-203/1
Client ref Dolwendee Quarry Project SSD 6519

5 November 2015

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Attention: Adam Bishop

GEOTECHNICAL INVESTIGATION
PROPOSED CONSTRUCTION MATERIALS QUARRY
LOT 2 'DOLWENDEE ESTATE', DP 1160936
770 MERRIWA RD (GOLDEN HIGHWAY) HOLLYDEEN

1 INTRODUCTION

This report describes geotechnical studies carried out for Upper Hunter Holdings Pty Ltd – Goat Farm Trust for a proposed construction material quarry located at Lot 2 DP 1160936 'Dolwendee Estate', 770 Merriwa Road (Golden Highway) Hollydeen.

This work was commissioned by Mr Gary Williams acting on behalf of United Mining & Upper Hunter Holdings Pty Ltd on 22 August 2014 by email.

Based on review of supplied documentation, RCA understands the proposed development is called Dolwendee Quarry Project and has been designated as a state significant development and assigned SSD 6519 by the NSW Department of Planning & Infrastructure.

Discussions with client, project team and review of client supplied Director General Requirements (DGR's) and Secretary's Environmental Assessment Requirements (SEAR's) for the proposed quarry development it is understood that the objectives of the investigation are to satisfy geotechnical and groundwater assessment components of the client supplied DGR's and SEAR's in relation to the proposed Dolwendee Quarry Project-SSD 6519.

Geotechnical requirements stated in the client supplied DGR's and SEAR's comprise:

- Establish long term groundwater monitoring wells for the proposed project area. (No groundwater encountered in previous boreholes to 30m depth.)

- Estimate bedrock permeability and identify if any groundwater table exist within a depth of approximately 20m below the proposed quarry floor (~RL 139m AHD) for determination of aquifer quality protection requirements from proposed quarry activities.
- Confirmation of construction material resource lateral and vertical extent within the proposed quarry area, as shown on **Drawing 1** in **Appendix A**.
- Extensive materials testing to assess potential quarry material uses and;
- Additional investigation and materials testing for stability analysis of the proposed quarry batters.

This report contains descriptions of the surface and subsurface conditions at the site together with a comprehensive schedule of laboratory construction material testing. The factual data on which this report is based is presented in the attached appendices.

2 PREVIOUS INVESTIGATIONS

RCA document ref: 9325-101 July 2012 – presented the results of drilling four cored boreholes in the proposed quarry area drilled to depths ranging from 27.15 to 30m and a preliminary material appraisal based on a visual assessment of the recovered rock core.

RCA document ref: 9325.1 September 2012 - presented the results of laboratory CBR and Atterberg Limits tests on a single sample of crushed core from each of the four boreholes and a preliminary material assessment of the laboratory test results against RMS QA 3051 Specification for Granular Base and Sub-base Materials for Surfaced Road Pavements.

RCA document ref: 9325-201/1 April 2014 - presented a preliminary resource estimate based on Director General Requirements (DGR's), Secretary's Environmental Assessment (SEAR's) restrictions for the proposed quarry development and the results of previously completed cored boreholes BH1 to BH4.

The client arranged for inspection of BH1 to BH4 in June 2013 and found no groundwater in the open section of boreholes BH1 to BH4. The extent of the open section in each borehole varied from 11 to 25m below ground level.

RCA document ref: 9325-202/1 August 2014 - presented the results of laboratory CBR and Atterberg Limits tests on two bulk soil samples from each of the D6 dozer 'costeans' TP1 to TP3. Two bulk soil samples were collected from each test 'costean' pit, for a total of six samples. The results of laboratory CBR and Atterberg Limits tests on these samples were compared to the ARTC Standard ETM-08-01 for Earthworks, Formation and Capping Material.

Results from previous investigations are incorporated into this report.

3 FIELD INVESTIGATIONS

Field work commenced on the 9 September and continued until 6 November 2014 and consisted of:

- Geological measurement of rock mass defects exposed in rock outcrops along ridge lines adjacent to the eastern and southern extents of the proposed quarry.
- Four additional boreholes (BH5 to BH8) drilled to depths of between 41m to 61.5m to:
  - Collect rock core for extensive laboratory material assessment.
  - Determine depth extent of the targeted interbedded conglomerate and sandstone bedrock sequence and floor geology of the proposed 30m deep quarry, with a nominal floor RL of 139m AHD.
  - Determine if there is a groundwater table within the likely zone of influence from a 30m deep quarry.
- Drilling was carried out using down-hole hammer in BH5 to a depth of 61.5m. Rock chips were recovered from BH5 for material identification.
- Boreholes BH6 to BH8 were drilled to depths of between 40.1 and 45m using HQ wireline rock coring methods. Rock core was recovered from bores BH6 to BH8 for laboratory testing. Point load strength testing was undertaken on representative core samples together with photography of the core.
- Down hole double packer testing was undertaken in all four boreholes to assess the in-situ permeability of the rock mass at depth. The packer test interval and/or packer separation was 2.8m.
  - Four tests were conducted in BH5 at depths of 22m, 30m, 42m and 55m, with the deepest test unsuccessful due to packer not being able to seal off test section.
  - Three tests were conducted in each of the cored boreholes at depths of 22m, 30m and between 37 and 40m for the deepest test.
  - The deepest test in BH7 was only partially successful due to loss of packer seal at higher pressures. The deepest test in BH8 was abandoned after several attempts failed to 'seat' packers.
- Installation of 50mm diameter monitoring wells at each borehole location to facilitate long term measurement of groundwater levels / sampling of the groundwater, if present. The installation process included flushing of boreholes to remove drill cuttings and fluids prior to well casing installation.
- Monitoring well construction comprised:
  - A 6m blank sump in BH8 and 9m sumps in BH5 to BH7.
  - A 6m screen in all boreholes, with pea gravel pack to approximately 3m above top of screen, then a bentonite plug a minimum of 1m thick.
  - A cement seal at collar and a lockable monument cover at each borehole.
- To allow time for the groundwater level to equilibrate after drilling, initial groundwater level measurements were taken two months after well installation.

All field work was carried out by and in the presence of RCA Australia (RCA) personnel. Approximate test locations are shown on **Drawing 1** in **Appendix A**.

Borehole collar locations have been surveyed by FYFE Surveyors with results shown on geotechnical logs in **Appendix B**, together with geotechnical log explanation sheets. Groundwater conditions/levels have been noted on the bore logs at the time of fieldwork. Fluctuations in groundwater conditions may be expected due to climatic variations.

4 LABORATORY TEST SCHEDULE

4.1 SOIL TESTING

The principal project consultants KMH Environmental requested testing of soil fertility and soil erodibility are carried out on topsoil and sub-soil from a minimum of three locations within the extent of the proposed Dolwendee Quarry. In consultation with KMH Environmental, RCA Australia utilised the Soil Conservation Service Scone Research Centre Revegetation Test Suite 2 and their Erosion and Sediment Control Test Suite.

Laboratory testing of soil samples consisted of:

- Seven (7) x test suite for soil revegetation suitability (Scone SCS Revegetation Suite 2 – electrical conductivity, pH, texture, Emerson Aggregate Test, Cation exchange capacity and available phosphorus).
- Seven (7) x test suite for erosion and sediment control (Scone SCS Erosion & Sediment Control Suite – Particle size analysis, dispersion percentage, EAT, Organic carbon and soil erodibility factor 'K'.).

The revegetation and erosion testing was undertaken by RCA Australia based on the understanding KMH Environmental would review and arrange for an appropriately qualified consultant to analyse these results.

4.2 TESTING OF INTACT ROCK CORE

Laboratory testing of intact rock core samples consisted of:

- Five (5) Uniaxial Compressive Strength (UCS) tests to assess rock strength.
- Two hundred and twenty nine (229) point load tests on recovered rock core.

4.3 TESTING OF CRUSHED ROCK CORE

The laboratory test schedule of the crushed rock core was designed to take into consideration previous laboratory test results and increase the scope of testing to allow samples of the crushed rock core to be compared to the following specifications:

- RMS QA Specification 3051 Granular Base and Sub-base Materials for Surfaced Road Pavements November 2014.
- AUS-SPEC's C242 and 1141 Flexible Pavement specifications as used by Hunter Region Councils.
- ARTC Standard ETM-08-01 for Earthworks, Formation and Capping Material for rail formation construction.

The test schedule required some 150m of rock core recovered from BH2-4 & BH6-8 to be crushed for testing. Crushing of rock core was carried out by the University of Newcastle Engineering Materials Testing Laboratory using a jaw crusher, with jaw gap set at 19mm. The crushed core samples were distributed to several laboratories depending on their NATA registered testing capabilities.

Laboratory testing of crushed rock core samples consisted of:

- Nine (9) Atterberg Limit tests;
- Nine (9) Particle Size Distribution tests;
- Nine (9) Maximum Dry Compressive Strength tests;
- Nine (9) California Bearing Ratio (CBR) tests;
- Twelve (12) Particle Shape tests;
- One (1) Aggregate Wet Strength and wet/dry strength variation test. Sample pre-treatment for this RMS test (T215) meant all six of the allocated core sample buckets from all six boreholes were required to generate enough sample material for just one test.
- Twelve (12) Fracture Face tests;
- Five (5) Acid Soluble Sulfate tests;
- Five (5) Permeability tests on compacted re-moulded sample;
- Six (6) Modified Texas Triaxial Classification Tests;

Laboratory test reports for all tests listed are attached in **Appendix C** and test results are summarised in **Section 6** and reviewed in **Section 7** of this report.

5 FIELDWORK RESULTS

5.1 SURFACE CONDITIONS

The proposed Dolwendee Quarry Project area is located in the northern portion of the Muswellbrook LGA; which adjoins Singleton Council to the south-east, Mid-Western Regional to the south-west and Upper Hunter Shire Council area to the north. The approximate site location relative to cadastral boundaries, topographic highs, roads, creeks and intermittent watercourses is shown on a locality plan in the top right hand corner of **Drawing 1** in **Appendix A**.

The proposed Dolwendee Quarry is located on the north side of a crescent shaped conglomerate/sandstone plateau remnant, as shown on **Drawing 1** in **Appendix A**. **Drawing 1** presents a site survey surface contour plan supplied by FYFE surveyors that indicates the surface elevation of the plateau remnant rises from 174m AHD up to 225m AHD.

Inspection of the plateau remnant indicated the upper portion is comprised of widely spaced jointed and massively bedded conglomerate/sandstone cliff forming outcrop; whilst the lower portion is comprised of stepped slopes exposing sandy soils with frequent conglomerate/sandstone outcrop, as shown in photographs 1 and 2 below.

Photograph 1 - *Typical morphology of upper portion of plateau remnant.*

Photograph 2 - *Typical morphology of lower portion of plateau remnant.*

Geological mapping of the conglomerate/sandstone ridges forming the plateau remnant to the east and south of the proposed quarry area included measurement of forty-five (45) rock mass defects. Typically defect profiles were gently undulating, with rough surfaces in the conglomerate beds and smoother surfaces in sandstone beds.

Stereonet analysis of the forty-five (45) rock mass defect measurements identified two principal bedding partings and five (5) principal joint sets. The geotechnical characteristics of the principal bedding partings and joint sets are summarised in table below.

Table 1 *Summary of Stereonet Analysis of Measured Rock Mass Defects*

Rock Mass Defect	**Fischer Concentration** (1)	**Dip** (degrees)	**Direction** (magnetic)	**Typical Profile** (2)	**Typical Spacing** (m)
Bedding in conglomerate	15%	4° to 8°	197° to 309°	U - R	0.5 to 3 (vertical)
Bedding – sandstone lenses	15%	4° to 6°	126° to 263°	U – S	5 to 6 (vertical)
Joint Set 1	6%	78° to 86°	042° to 044°	U - R	3 to 5
Joint Set 2	5.5%	33° to 51°	299° to 338°	U - R	5 to 7
Joint Set 3	5%	71° to 78°	0° to 18°	U - R	3 to 6
Joint Set 4	4.5%	81° to 88°	153° to 158°	U - R	0.5 to 6
Joint Set 5	4%	84° to 87°	130° to 133°	U - R	0.5 to 6

Notes:

(1) Fischer Concentration – is a statistical measure of defect frequency and indicator of significance.

(2) Defect profile abbreviations:

U – S Defect plane is gently undulating with a smooth surface.

U – R Defect plane is gently undulating with rough surface.

Photograph 3 - *View of quarry area from the north-east*

The site surface elevation within the proposed quarry footprint falls gradually from 186m AHD in the south-east corner down to 153m AHD at the north-west corner. Typically surface morphology for the quarry area is shown in photo above. The gravelly sand exposed on track and slope in foreground of Photograph 3, is typical of the natural soil in the quarry area.

Vegetation cover as seen in photograph above is typical of the proposed quarry site, with frequent exposures of the gravelly sandy soil in between grassy patches and scattered trees.

5.2 SUB-SURFACE CONDITIONS

The subsurface profile encountered on the site is detailed on the borehole and test pit logs attached in **Appendix B** and illustrated on inferred geotechnical sections attached in **Appendix A**.

The depth of soil varies markedly between test locations ranging from 1.1m (TP 2) to 4.75m (BH 2) thick. Typically the soil is comprised of:

- Gravelly Silty SAND 0.2 to 0.4m thick, with abundant rootlets, overlying;
- Silty Sandy GRAVEL to depths ranging from 0.6 to 4.75m, with
- Some Clayey GRAVEL layers/lenses in the lower metre at some test locations.

Using borehole BH6 as the type section for the proposed quarry RCA Australia has assigned geotechnical units, as presented in **Table 2**.

Table 2 *Geotechnical Units for the Dolwendee Quarry Project based on BH6.*

Typical Depth in BH6 (m)		Unit Name	Description/Comment
Top	Base		
0.4	3.8	Soil (1)	Extremely weathered Narrabeen group - sandstone/conglomerate weathered to soil. D6 dozer TP1 to TP3 targeted this unit. Typically a mixture of silt, sand and gravel (well rounded, 60mm minus), with some clayey bands in lower metre of soil profile.
3.8	18.8	N 1 (1)	Highly to moderately (distinctly) weathered, Narrabeen group - conglomerate with minor sandstone bedrock, as observed in outcrop.
18.8	25.3	N 2 (1)	Slightly weathered to fresh, Narrabeen group - conglomerate with minor sandstone bedrock
25.3	26.33	GC (2)	Slightly weathered to fresh interbedded coal/claystone/sandstone (Greigs Creek Coal)
26.33	34.85	RC	Slightly weathered to fresh interbedded conglomerate & sandstone (Redmanvale Creek Formation)
34.85	39.67	HC	Fresh interbedded coal/siltstone/sandstone (Hillsdale Coal)
39.67	43.37	NT	Fresh interbedded Tuff/ Sandy Tuff (Nalleen Tuff)
43.37	45	HG	Fresh interbedded coal/laminated sandstone (Hobden Gully Coal Member)

NOTES:

(1) Proposed quarry resource sequence

(2) Proposed quarry floor sequence

5.3 PACKER TEST RESULTS AND INITIAL GROUNDWATER MEASUREMENTS

At the time of drilling September 2014, groundwater/seepage could only be measured in the percussion drill hole BH5. Separate seepage points were encountered at depths of 30m, 32m, 40.5m and 44.9m in BH5. Frequent seepage points were encountered from depths of 55.5m to 61.5m end of hole in BH5.

Packer test results completed at time of drilling September 2014 indicated high leakage rates based on D.G. Moye's Lugeon evaluation charts for the Snowy Mountains Hydro-electric Authority.

A review of the detailed bore logs of the recovered rock core from BH6 to BH8 indicated the leakage rates recorded in packer tests could be attributed to the rock mass defects observed during detailed logging of core.

Table 3 *Summary of in-situ packer test results*

BH No.	Test depth interval	Description of Test Interval	Peak test pressure (kPa)	Average leakage at peak test pressure (L/min/m)	Leakage Rate after Moye (1)
BH 5	22 ± 1.4m	Non-core bore. Test section in Geotechnical Unit N 1.	293	14.5	High
	30 ± 1.4m	Test section in Geotechnical Unit N 2. Seepage observed during drilling.	300	15.4	High
	42 ± 1.4m	As above, except in Unit R C.	420	21.4	High
	55.2-58m	As above, except in Unit H G?	Test failed	-	-
BH 6	22 ± 1.4m	Conglomerate with Fe-stained defects at 50 to 500mm spacing. Test section in Geotechnical Unit N 2.	220	17.3	High
	30 ± 1.4m	Conglomerate, with two bedding partings. Test section in Geotechnical Unit R C.	400	15.0	High
BH 6	40 ± 1.4m	Coal/Tuff with numerous bedding partings at 30 to 100mm spacing. Test section in across boundary of Geotechnical Units H C & N T.	400	8.6	Moderate
BH 7	22 ± 1.4m	Conglomerate with Fe-stained defects at 200 to 900mm spacing. Test section in Geotechnical Unit N 2.	220	17.0	High
	30 ± 1.4m	Conglomerate, with bedding partings at 1m spacing. Test section in Geotechnical Unit R C.	300	12.4	High
	37 ± 1.4m	Coal with numerous open defects. Test section in Geotechnical Unit H C.	246	18.8	High
BH 8	22 ± 1.4m	Pebbly Sandstone, with Fe-stained joints at 200 to 700mm spacing. Test section in Geotechnical Unit N 2.	293	11.2	High
	30 ± 1.4m	Conglomerate/Shale/Siltstone with numerous Fe-stained bedding partings. Test section in across boundary of Geotechnical Units G C & R C	400	31	High
	37 ± 1.4m	Pebble Conglomerate, no obvious defects in test section. Test section in Geotechnical Unit R C.	Test failed	-	-

NOTES:

(1) D.G. Moye produced Lugeon evaluation charts for the Snowy Mountains Hydro-electric Authority.

The packer test results indicated that the rock mass defects typically had high leakage rates.

The water level in each borehole was allowed to equilibrate for a period of two months after well installation; before the initial groundwater measurements were taken. The results of the initial groundwater level measurements are presented in table below.

Table 4 *Initial Groundwater Level (GWL) measurements taken on 6/11/14*

BH No.	Depth to GWL from top of well casing (m)	Date & Time of GWL measurement	Inferred GWL RL (m AHD) (1)	Comments
5	45.51	6/11/14 10:15am	131.5	Isolated seepage points were encountered during percussion drilling from a depth of 30m. Frequent seepage points were encountered during percussion drilling from depth of 55.5 to 61.5m.
6	30.83	6/11/14 11:45am	131.7	No groundwater seepage observed prior to HQ coring commencing.
7	34.91	6/11/14 11:10am	132.8	As above.
8	36.13	6/11/14 12:25pm	123.2	As above. Potentially a localised 'depressed' groundwater table not connected to principal joint sets.

NOTES:

(1) RL listed are based on supplied FYFE survey data

6 SUMMARY OF LABORATORY TEST RESULTS

6.1 SOIL FERTILITY & EROSION CONTROL TEST RESULTS

Soil fertility and erosion control testing was arranged by RCA Australia for review by others. Full copies of the Scone Soil Conservation Service Test Laboratory Reports are attached in **Appendix C** and summarised below.

The test results for Scone SCS Revegetation Suite 2 – electrical conductivity (EC), pH, Particle size analysis (PSD), Emerson Aggregate Test (EAT), Cation exchange capacity (CEC) and available phosphorus are summarised in table below.

Table 5 *Summary of Scone SCS Soil Revegetation Suite Test Results*

BH	Depth (m)	Soil Type	EC (dS/m)	pH	Soil Class based on PSD	EAT	CEC	Avail P (mg/kg)
BH5	0.1-0.5	Gravelly Silty Sand	<0.01	5.7	SW	8	5.4	2
BH6	0.1-0.3	Gravelly Sand	0.01	6.2	SW	2(1)	5.1	2
BH6	1-1.3	Gravelly Sand	0.13	6	SW	2(1)	5.7	<1
BH7	0.1-0.3	Sandy Gravel	0.01	5.8	GP	n/a	2.9	3
BH7	0.9-1.0	Gravelly Sand	<0.01	6.4	SW	3(2)	4.8	2
BH8	0.1-0.3	Silty Sand	0.02	6.3	SW	3(1)	8.7	1
BH8	0.7-1.0	Clayey Gravelly Sand	0.1	7.1	GC	2(2)	7	1

The test results for Scone SCS Erosion & Sediment Control suite – Particle size analysis (PSD), Dispersion percentage (D %), Emerson Aggregate Test (EAT), Organic carbon and soil erodibility factor 'K' are summarised in table below.

Table 6 *Summary of Scone SCS Erosion & Sediment Control Suite Test Results*

BH	Depth (m)	Soil Type	Soil Class based on PSD	D %	EAT	Organic Carbon %	K
BH5	0.1-0.5	Gravelly Silty Sand	SW	75	8	0.57	0.026
BH6	0.1-0.3	Gravelly Sand	SW	75	2(1)	0.32	0.042
BH6	1-1.3	Gravelly Sand	SW	75	2(1)	0.08	0.031
BH7	0.1-0.3	Sandy Gravel	GP	42	n/a	0.79	0.030
BH7	0.9-1.0	Gravelly Sand	SW	65	3(2)	0.13	0.027
BH8	0.1-0.3	Silty Sand	SW	68	3(1)	1.62	0.027
BH8	0.7-1.0	Clayey Gravelly Sand	GC	83	2(2)	0.26	0.031

6.2 TEST RESULTS ON INTACT ROCK

6.2.1 UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS

Laboratory test reports for Uniaxial Compressive Strength tests on five representative samples of intact rock core are attached in **Appendix C** and test results are summarised in table below.

Table 7 *Summary of Uniaxial Compressive Strength Test Results on Intact Rock Core Samples from Geotechnical Resource Units N1 and N2*

Bore No.	Depth (m)	Sample Description	Geot. Unit	MC (%)	MDD (t/m^3)	UCS (MPa)
BH 2	27.07-27.49	Fresh Pebble Conglomerate	N 2 (1)	2.4	2.35	23.9
BH 3	8.27-8.65	DW Pebbly Sandstone	N 1 (1)	2.1	2.30	21.7
BH 4	18.2-18.48	DW Pebble Conglomerate	N 1 (1)	2.4	2.31	26.3
BH 6	7.55-7.80	As above	N 1 (1)	3.8	2.31	21.3
BH 7	15.4-15.75	As above	N 1 (1)	3.7	2.28	26.8

NOTES:

- MC –moisture content
- MDD – maximum dry density
- UCS – uniaxial compressive strength
- DW – Distinctly weathered includes highly and moderately weathering categories

(1) Proposed quarry resource sequence.

The core densities listed above are similar to previous test result of 2.318 t/m^3 presented in RCA report ref: 9325-201/1 and used to estimate preliminary resource tonnage. Referencing the UCS tests results to AS1726-1996 Rock Strength classifications indicates the selected intact core samples are typically of high rock strength.

6.2.2 POINT LOAD INDEX TEST RESULTS

The test results of Point Load Index tests on representative samples of intact rock core recovered from the quarry type section in borehole BH6 are summarised in table below.

Table 8 *Summary of Point Load Index Test Results from BH 6*

Geotechnical Unit	Rock Unit Description	Unit Depth interval from BH6 log (m)	Point Load Index Is(50) (MPa)			AS1726-1996 Rock Strength Class
			Min	Max	Average	
N 1 (1)	Highly to moderately (distinctly) weathered, Narrabeen group - sandstone/conglomerate bedrock	3.8-18.8	0.13	2.7	1.35	Low to High. Average is High.

Geotechnical Unit	Rock Unit Description	Unit Depth interval from BH6 log (m)	Point Load Index Is(50) (MPa)			AS1726-1996 Rock Strength Class
			Min	Max	Average	
N 2 (1)	Slightly weathered to fresh, Narrabeen group - sandstone/conglomerate bedrock	18.8-25.3	0.48	2.05	1.35	Medium to High. Average is High.
GC (2)	Slightly weathered to fresh, interbedded coal/claystone/sandstone (Greigs Creek Coal)	25.3-26.33	0.06	1.46	0.74	Very Low to Medium. Average is Medium.
RC	Slightly weathered to fresh, interbedded conglomerate & sandstone (Redmanvale Creek Formation)	26.33-34.85	0.19	1.58	0.75	Low to High. Average is Medium.
HC	Fresh interbedded coal/siltstone/sandstone (Hillsdale Coal)	34.85-39.67	0.60	3.17	1.91	Medium to Very High. Average is High.
NT	Fresh interbedded Tuff/ Sandy Tuff (Nalleen Tuff)	39.67-43.37	0.03	0.44	0.22	Very Low to Medium. Average is Medium.
HG	Fresh interbedded coal/laminated sandstone (Hobden Gully Coal Member)	43.37-45	0.24	1.54	1.05	Low to High. Average is High.

NOTES:

(1) Proposed quarry resource sequence

(2) Proposed quarry floor sequence

Referencing Point Load Index tests results to AS1726-1996 Rock Strength classifications indicates the proposed quarry resource sequence defined by geotechnical units N1 and N2 is typically comprised of high strength rock.

6.3 CONSTRUCTION MATERIAL TEST RESULTS ON CRUSHED ROCK CORE & SOIL

Laboratory test reports for all tests listed are attached in **Appendix C** and test results are summarised in tables below. The implications of these lab test results for the proposed Dolwendee Quarry Project development SSD 6519 are discussed in **Section 7** of this report.

Table 9 *Summary of Particle Size Distribution tests in Proposed Quarry Resource Sequence*

Unit	Grading				Approx. Stemming fraction (12-24mm) %
	Clay/silt (<0.075m) %	Sand (0.075-2.36mm) %	Fine gravel (2.36-6mm) %	Med-coarse gravel (6-37.5mm) %	
Soil	7 to 66, av. 22	25 to 67, av. 44.5	2 to 23, av. 13	0 to 42, av. 20.5	0 to 21, av.11
N 1	1 to 8 av.5	13 to 27 av.21	14 to 19 av.17	51 to 68 av.57	17 to 37 av.30
N 2	1 to 2 median 2	19 to 26 av.21	19 to 23 av.21	50 to 59 av.57	25 to 37 av.31

Table 10 *Summary of CBR and Atterberg Limits Test Results in Proposed Quarry Resource Sequence*

Unit	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	MDD (%)	CBR (%)
Soil	15 to 35, av.22	13 to 19, av.16	1 to 16, av.6	1 to 8, av.3	1.95 to 2.2, av.2.12	4 to 110, av.71. [median.85 (1)]
N 1	23 to 27, av.25	15 to 21, av.18	2 to 11, av.7	-	1.82 to 1.92, av. 1.89	50 to 60, av.56 [median.60 (1)]
N 2	22 to 25, av.23	17 to 22, av.19	3 to 7, av.5	-	1.79 to 1.91, av. 1.84	40 to 90, av.65 [median.60 (1)]

NOTES:

- Blank cells indicate test not conducted.

(1) Calculation of median value weighted towards most frequent results.

Table 11 *Summary of RMS QA 3051 Specification Test Results in Proposed Quarry Resource Sequence*

Unit	AS1289.6.7.2 Permeability	T114 MDCS	T171 Mod. Texas Triaxial Class No.	T213 Misshaped Particles %	T215 (1)		T219 SO_3	T239 FF
					Agg. Wet str.	Wet/ dry var.		
N 1	$2.46x10^{-5}$ to $6.69x10^{-7}$	4.3	2.5 to 3.4	9 to 18	19 (1)	80 (1)	0.09 to 0.11	7 to 23
N 2	$2.46x10^{-5}$ to $6.21x10^{-6}$	3.1 to 4.5	2.9 to 3	12 to 21			0.1	5 to 12

NOTES:

- Soil not specifically tested for compliance with RMS QA 3051 Specification
- No T116 – remoulded UCS tests conducted

(1) Sample pre-treatment for T215 meant the allocated core samples from all six boreholes were required to generate enough sample material for one test.

The implications of these test results for the proposed Dolwendee Quarry Project development SSD 6519 are discussed below.

7 DISCUSSION AND COMMENTS

The proposed quarry is located in the northern portion of the Muswellbrook Shire Council (MSC) LGA; which adjoins Singleton Shire Council (SSC) to the SE, Mid-Western Regional (MWRC) to the SW and Upper Hunter Shire Council (UHSC) area to the north.

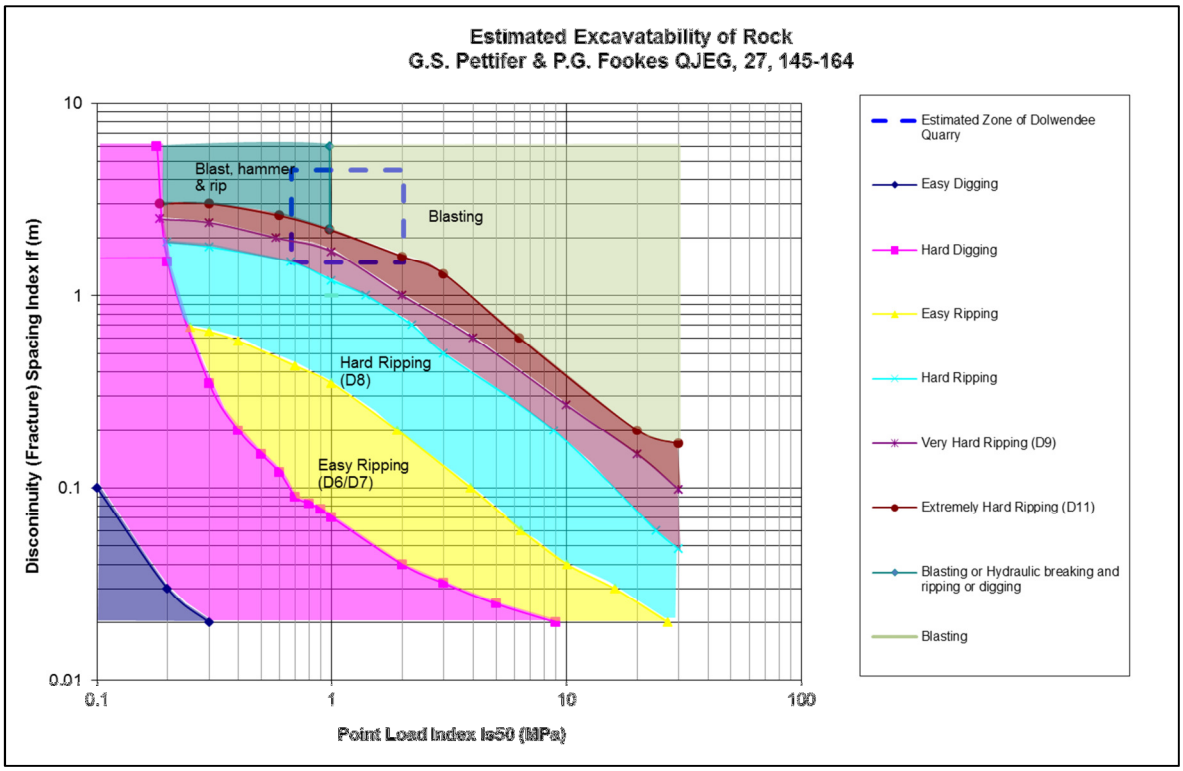
A review of council specifications indicates MSC uses AUS-SPEC 1141 Flexible Pavement material specification, SSC still uses AUS-SPEC C242 and it was unclear from RCA review of MWRC & UHSC web sites which pavement material specification these Councils use.

7.1 EXCAVATABILITY ASSESSMENT

The D6 dozer used to excavate test pits TP1 to TP3, encountered blade/ ripper tyne refusal at depths ranging from 1.1m (TP2) to 3.5m (TP3), as reported in 9325-202/1 August 2014. These D6 dozer refusal depths are considered to be the top of geotechnical unit N1.

Based on the performance of the D6 dozer, the results of intact rock strength tests and defect spacing from field mapping an assessment of excavatability of the proposed Dolwendee Quarry resource units N1 and N2 was carried out using Pettifer & Fookes methodology. A copy of Pettifer & Fookes chart for the Dolwendee Quarry is presented below.

According to the Pettifer & Fookes chart for the Dolwendee Quarry presented below, approximately one third of the proposed Dolwendee Quarry resource units N1 and N2 could be excavated by very hard ripping using a D9 or equivalent dozer to extremely hard ripping using a D11 or equivalent dozer; whilst the remainder will require drill and blast.



7.2 POTENTIAL BATTER STABILITY HAZARDS

Based on the supplied copies of VGT proposed quarry development plans, RCA analysed defect orientation from field mapping to assess potential batter stability hazards affecting the VGT proposed quarry batter angles and orientations in both soil and rock.

Table 12 *Summary of Potential Batter Stability Hazards*

	VGT Proposed Batters					
	Angle	**2H: 1V in soil**	**0.5H: 1V in N 1 & N 2**			
	Quarry face	**All**	**N**	**E**	**S**	**W**
Potential Failure Modes	**Slip**	Possible if inundated	No	Yes	Yes	No
	Wedge	n/a	Yes	Yes	Yes	Yes
	Topple	n/a	Yes	No	No	Yes

The proposed VGT quarry design incorporates 2H: 1V batters in soil and 5m benches in 0.5H: 1V batters in geotechnical units N 1 & N 2 in consideration of these potential batter stability hazards.

Quarry operators should be made aware of these potential hazards during excavation of the VGT proposed 15m high 0.5H: 1V batters in quarry bedrock.

7.3 SUITABILITY AS STEMMING MATERIAL FOR MINE BLAST HOLES

The client supplied specification for stemming material in mine blast holes indicated the criteria is that the material particle size distribution range from 22/24mm down to 12/14mm, with no fines.

Based on the client supplied specification for stemming material in mine blast holes it is anticipated the in-situ sandstone and conglomerate bedrock could be crushed, screened and washed to satisfy the client supplied specification.

A review of cored borehole logs indicates the proposed Dolwendee Quarry resource units N1 and N2 are predominantly comprised of conglomerate beds with well-rounded gravel up to 60mm, but more typically 40mm minus in a sandy matrix.

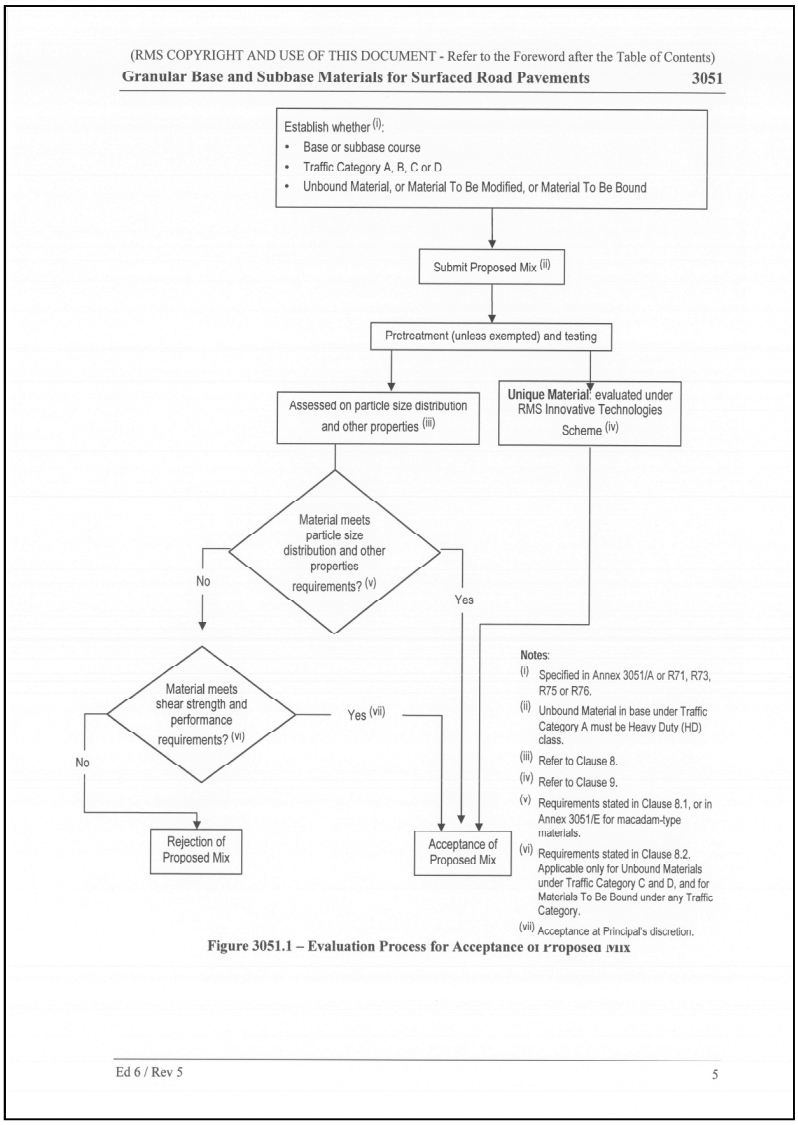
Based on grading tests the soil profile could yield up to 21%, but typically 11% by mass of stemming gravel.

Based on grading tests the crushed rock is likely to yield 17%-37%, average 31% by mass of stemming gravel.

7.4 COMPARISON OF LAB TEST RESULTS TO RMS QA 3051

RCA Australia compared the relevant lab test results to the latest version of the RMS QA Specification 3051 for granular base and sub-base materials for surfaced road pavements Edition 6 Revision 5 November 2014.

A copy of the RMS QA Specification 3051 material evaluation process is presented below.



RMS definition of traffic categories are presented in table below.

Table 13 *RMS QA 3051 – Annexure 3051/A – A1 – Traffic Category*

Traffic Category	Road Type	Traffic Classification	Design Traffic 'N' (DESA)
A	Freeways or major highways	Very Heavy	$N \geq 10^7$
B	Rural highways	Heavy	$10^7 > N \geq 4x10^6$
C	Arterial and collector roads	Medium	$4x10^6 > N \geq 10^6$
D	Lower trafficked rural or urban local roads	Light	$N < 10^6$

A review of lab test results compared to RMS QA 3051 Clause 8.1 Criteria is presented in table below.

Table 14 *Percentage of test results meeting the RMS QA 3051 Clause 8.1 Criteria*

		Unbound Base Materials / Materials to be modified		Unbound Sub-Base Materials / Materials to be modified		Materials to be bound	
Test Type	**Traffic Category**	**DGB20 (HD)**	**DGB20**	**DGS20**	**DGS40 (1)**	**MB20**	**MB40 (1)**
PSD (1) (2)	**All**	37.5%		50%	75%	50%	75%
Plasticity	**A**	5.5%	- (3)	44%		8% (4)	
	B	-	44%			67% (4)	
	C						
	D					92% (4)	
Permeability	**A only**	None	-	-		-	
Max. Dry Compressive Strength	**All**	100%				-	
Particle Shape	**All**	100%					
Two or more fractured faces	**A**	None	-	None		None	
	B,C & D	-	None	None		None	
Aggregate Wet Strength	**A**	None (5)	-	None (5)		None (5)	
	B	-	None (5)				
	C						
	D						
Wet/Dry strength variation	**A**	None (5)	-	None (5)		None (5)	
	B	-	None (5)				
	C & D	-					
Acid soluble sulfate	**All**	100%					

Notes -

(1) Jaw crusher gap set at 19mm to crush rock core samples. So criteria for PSD fractions > 20mm could not be assessed.
(2) PSD – Particle size distribution determined using RMS T106/T107
(3) Blank cells are not used to assess materials for that category.
(4) These categories have no LL or PL specification.
(5) Sample pre-treatment for T215 meant the allocated core samples from all six boreholes were required to generate enough sample material for one test.

Reference to RMS QA 3051 evaluation procedure indicated test results from crushed core samples fail to meet most of Clause 8.1 criteria as shown in table above and must be checked against clause 8.2 criteria, as presented on table below.

Table 15 *Percentage of test results meeting the RMS QA 3051 Clause 8.2 Criteria*

<table>
<tr><th rowspan="2">Test Type</th><th rowspan="2">Traffic Category</th><th colspan="2">Unbound Base Materials / Materials to be modified</th><th colspan="2">Unbound Sub-Base Materials / Materials to be modified</th><th colspan="2">Materials to be bound</th></tr>
<tr><th>DGB20 (HD)</th><th>DGB20</th><th>DGS20</th><th>DGS40</th><th>MB20</th><th>MB40</th></tr>
<tr><td rowspan="4">Modified Texas Tri-axial Test Class No.</td><td>A</td><td rowspan="3">Note (1)</td><td rowspan="2">Note (1)</td><td colspan="2" rowspan="2">Note (1)</td><td colspan="2">None</td></tr>
<tr><td>B</td><td colspan="2">20%</td></tr>
<tr><td>C</td><td>None</td><td colspan="4" rowspan="2">80%</td></tr>
<tr><td>D</td><td>20%</td></tr>
<tr><td>PSD [2] ≤ max. dev.</td><td>All</td><td colspan="2">37.5%</td><td>50%</td><td>75%</td><td>50%</td><td>75%</td></tr>
</table>

Notes -

(1) Blank cells are not used to assess materials for that category.
(2) PSD – Particle Size Distribution determined using RMS T106/T107

Based on this comparison of quarry sample test results to RMS QA 3051 specifications it would appear that:

- None (0%) of quarry samples tested are suitable for use as DGB20 in Category A to C roads.
- None (0%) of quarry samples tested are suitable for use as MB20/40 in Category A roads.
- Approximately 20% of quarry samples tested are likely to be suitable for use as MB20/40 in Category B roads.
- Approximately 20% - 37.5% of quarry samples tested are likely to be suitable for use as DGB20 in Category D roads.
- Approximately 50% - 80% of quarry samples tested are likely to be suitable for use as DGS20/40 or MB20/40 in Category C & D roads.

7.5 COMPARISON OF LAB TEST RESULTS TO AUS-SPEC C242 AND 1141 FLEXIBLE PAVEMENT SPECIFICATIONS

A review of AUS-SPEC C242 and 1141 Flexible Pavement Specifications indicates any pavement material derived from processing the on-site gravelly soils would be classified as natural gravels and assessed against NGB and NGS specifications. Natural gravel (NG) products are typically used for unsealed pavements.

Reference to AUS-SPEC C242 and 1141 Flexible Pavement specifications indicates any pavement materials derived from crushing in-situ bedrock would be classified as crushed rock and assessed against DGB and DGS specifications. Dense graded (DG) products are typically used for sealed pavements.

A review of AUS-SPEC C242/ 1141 Flexible Pavement specification indicates traffic categories and appropriate pavement material types are assigned as presented in table below.

Table 16 *Copy of AUS-SPEC C242/ 1141 Acceptable Pavement Material Types*

Traffic Category	Acceptable Base Material Types	Acceptable Sub-base Material Types	Applicable Road Type
A (1, 2a & 2b)	DGB20, GMB20	DGS20, DGS40 & GMS40	Urban sub-arterial, Collector, Local 1 & 2. Rural sub-arterial & Collector.
B (2c & 2d)	DGB20, GMB20 & NGB20	DGS20, DGS40, GMS40, NGS20 & NGS40	Rural Local 1, 2, 3 & lanes.

A review of lab test results compared to the AUS-SPEC C242/ 1141 Flexible Pavement specification as used by Hunter Region Councils is presented in table below.

Table 17 *Percentage of test results meeting the AUS-SPEC C242/ 1141 Criteria*

		Unbound Base Materials Types		Unbound Sub-Base Material Types			
Test Type	**Traffic Category**	**DGB20/ GMB20**	**NGB 20 (2c-2d)**	**DGS 20**	**DGS40 GMS40 (1)**	**NGS 20**	**NGS 40**
PSD (1) (2)	**All**	11-77%	33%	11%	~55%	33%	
Fine PSD Ratio A	**All**	0%	50%	0%		50%	
Fine PSD Ratio B		22-33%		33%	33-55%		
Fine PSD Ratio C		55%	- (3)	55%	67%	- (3)	
CBR	**A**	None	- (3)	89%		- (2)	
	B		67%			83%	
LL	**A**	50%	-	42%		-	
	B		33%			83%	
PL	**A**	75%	-	75%		-	
	B		83%			100%	

		Unbound Base Materials Types		Unbound Sub-Base Material Types			
Test Type	**Traffic Category**	**DGB20/ GMB20**	**NGB 20 (2c-2d)**	**DGS 20**	**DGS40 GMS40 (1)**	**NGS 20**	**NGS 40**
PI	**A**	67%	- (3)	100%		- (3)	
	B		67%			83%	
Max. Dry Compressive Strength	**A & B**	MDCS only applies if PI < 1% (4)					
Particle Shape	**A & B**	100%	-	100%		-	
Aggregate Wet Strength	**A & B**	None (5)		None (5)			
Wet/ Dry strength variation	**A & B**						

Notes -

(1) Jaw crusher gap set at 19mm to crush rock core samples. So criteria for PSD fractions > 20mm could not be assessed.

(2) PSD – Particle Size Distribution determined using RMS T106/T107

(3) Blank cells are not used to assess materials for that category.

(4) No test results with PI < 1%

(5) Sample pre-treatment for T215 meant the allocated core samples from all six boreholes were required to generate enough sample material for one test.

Based on this comparison of quarry sample test results to AUS-SPEC specifications it would appear that:

- None (0%) of crushed core samples tested are suitable for use as DGB20/ GMB20; due to grading gaps, inadequate CBR value, inadequate aggregate wet strength and excessive wet/ dry strength variation.
- Approximately 33% - 83% of gravelly soil samples tested are likely to be suitable for use as NGB20 in Category B (2c-2d) roads. Limitations due to gaps in grading specification and excess plasticity.
- Approximately 33% - 89% of crushed core samples tested are likely to be suitable for use as DGS20/40 for all traffic categories. Limitations due to grading gaps, inadequate aggregate wet strength, excessive plasticity and excessive wet/ dry strength variation.
- None (0%) of crushed core samples tested are likely to be suitable for use as GMS40; due to grading gaps, inadequate aggregate wet strength and excessive wet/ dry strength variation.
- Approximately 33% - 83% of gravelly soil samples tested are likely to be suitable for use as NGS20/40 in Category B (2c-2d) roads. Limitations due to gaps in grading specification and excess plasticity.

7.6 COMPARISON OF LAB TEST RESULTS TO ARTC ETM-08-01

A comparison of bulk soil sample test results from June 2014 test pits to the ARTC Standard ETM-08-01 for Earthworks, Formation and Capping Material has already been presented in RCA Report ref: 9325-202/1 August 2014.

A review of lab test results on crushed core samples collected from the April 2012 and September 2014 boreholes compared to the ARTC Standard ETM-08-01 for Earthworks, Formation and Capping Material is presented in the tables below.

Table 18 *Percentage of test results meeting the ARTC ETM-08-01 Structural Fill Criteria*

Specification description	ARTC values for Structural Fill	Geotechnical Unit	
		N 1	N 2
PSD % passing 53mm sieve (1)	80-100	Note (1)	Note (1)
PSD % passing 2.36mm sieve	15-100	80%	100%
PSD % passing 425um sieve	0-70	100%	100%
PSD % passing 75um sieve	0-30	100%	100%
Liquid Limit (%)	Max. 40	100%	100%
Plastic Limit (%)	-		
Plasticity Index (%)	Max. 20	100%	100%
Linear Shrinkage (%)	-		
Maximum Dry Density (t/cu.m)	Min 1.8	100%	87.5%
Soaked California Bearing Ratio (%) (2.5 / 5.0mm penetration)	Min. 8	100%	100%

Notes -

(1) Jaw crusher gap set at 19mm to crush rock core samples. So criteria for PSD fractions > 20mm could not be assessed.

(2) PSD – Particle Size Distribution determined using RMS T106/T107

(3) Blank cells are not used to assess materials for that category.

Table 19 *Percentage of test results meeting the ARTC ETM-08-01 Capping Criteria*

Specification description	ARTC values for Capping	Geotechnical Unit	
		N 1	**N 2**
PSD % passing 53mm sieve	**100**	Note (1)	Note (1)
PSD % passing 2.36mm sieve	**30-80**	40%	0%
PSD % passing 75um sieve	**6-10**	40%	0%
Liquid Limit (%)	**Max. 30-35**	100%	100%
Plastic Limit (%)	**Max. 20**	80%	87.5%
Plasticity Index (%)	**Max. 2-10**	80%	100%
Linear Shrinkage (%)	**Max 3**	Note (2)	Note (2)
Maximum Dry Density (t/cu.m)	**Min 1.8**	100%	87.5%
Soaked California Bearing Ratio (%) (2.5 / 5.0mm penetration)	**Min. 50**	100%	75%

Notes -

(1) Jaw crusher gap set at 19mm to crush rock core samples. So criteria for PSD fractions > 20mm could not be assessed.

(2) Not tested

(3) PSD – Particle Size Distribution determined using RMS T106/T107

(4) Blank cells are not used to assess materials for that category.

Based on comparison of test results to the ARTC Standard ETM-08-01 for Earthworks, Formation and Capping Material shown in tables above the resource geotechnical units are likely to yield a high percentage of material suitable for use as structural fill and capping material in accordance with ARTC specifications.

7.7 COMPARISON OF LAB TEST RESULTS TO AS3798-2007

A review of lab test results compared to the Australian Standard *AS 3798-2007* - Guidelines on earthworks for commercial and residential developments indicated:

> "Most naturally occurring soils, with the exceptions specified in Clause 4.3 are capable of being compacted to form structural fill. Similarly, weathered rock that can be ripped and broken down will be generally suitable for use as structural fill."

Based on the laboratory test results completed to date, RCA Australia considers it is likely that materials produced from geotechnical units: Soil, N1 and N2 would be suitable for use as engineered fill; providing they are free from any organic matter, rootlets, roots and/or any deleterious materials as defined in *AS 3798-2007 Clause 4.3 - definition of unsuitable materials*.

8 LIMITATIONS

This report has been prepared for Upper Hunter Holdings Pty Ltd – Goat Farm Trust in accordance with the agreement with RCA. The services performed by RCA have been conducted in a manner consistent with that generally exercised by members of its profession and consulting practice.

This report has been prepared for the sole use of Upper Hunter Holdings Pty Ltd – Goat Farm Trust for the specific purpose and the specific development described in the report. The report may not contain sufficient information for purposes or developments other than that described in the report or for parties other than Upper Hunter Holdings Pty Ltd – Goat Farm Trust. This report shall only be presented in full and may not be used to support objectives other than those stated in the report without permission.

The information in this report is considered accurate at the date of issue with regard to the current conditions of the site. The conclusions drawn in the report are based on interpolation between boreholes or test pits. Conditions can vary between test locations that cannot be explicitly defined or inferred by investigation.

Yours faithfully
RCA AUSTRALIA

Jeremy Everitt
Principal Engineering Geologist

Robert Carr
Principal Geotechnical Engineer

REFERENCES

[1] RCA Australia Report "Preliminary Review of Hollydeen Core and Recommendations for Laboratory Testing, RCA ref: 9325-101/0 July 2012.

[2] RCA Australia Letter "Hollydeen Laboratory Test Results and Material Recommendations, RCA ref: JN-9325.1 September 2012.

[3] RCA Australia Report "Preliminary Resource Estimate for Proposed Stage 1 Construction Materials Quarry, 'Dolwendee', Golden Highway, Hollydeen, RCA ref: 9325-201/1 April 2014.

[4] RCA Australia Report "Preliminary Geotechnical Materials Assessment, Proposed Construction Materials Quarry, Lot 2 'Dolwendee Estate', Golden Highway, Hollydeen, RCA ref: 9325-202/1 August 2014.

[5] Field Geologists' Manual, compiled by D.A. Berkman, 3rd edition, Monograph series No.9, The Australasian Institute of Mining and Metallurgy, 1989.

[6] Standards Association of Australia. AS1726-1993, "Geotechnical site investigations", Standards Association of Australia.

[7] Quarterly Journal of Engineering Geology and Hydrogeology, G.S. Pettifer & P.G. Fookes, “A revision of the graphical method for assessing excavatability of rock”, pp.154-164, Vol. 27, 1994.

[8] Roads and Maritime Services NSW, QA Specification 3051 “Granular Base and Sub-base Materials for Surfaced Road Pavements”, Edition 6 Rev 5 2014.

[9] Singleton Shire Council Development Construction Specification C242 Revision 3 - Flexible Pavement Specifications, September 2001. (Still current on SSC web site)

[10] Muswellbrook Shire Council Construction Specification AUS-SPEC 1141 Flexible Pavements Version 01 June 2012.

[11] ARTC Standard, Earthworks, Formation and Capping Material, ETM-08-01, Version 1.1, 18 June 2010.

[12] Standards Association of Australia. AS 3798-2007: Guidelines on Earthworks for Commercial and Residential Structures. Standards Association of Australia, 2007.

Appendix A

Drawings

LEGEND

- Borehole location BH1 to BH4 drilled April 2012
- Borehole location BH5 to BH8 drilled September 2014
- Approximate bulk sample test pit location
- Boardman Peasley plot of ESA
- Boardman Peasley plot of RUL
- RCA quarry concept, December 2014
- VGT project area, July 2015
- VGT extraction area, July 2015
- Geotechnical cross section location (A A)

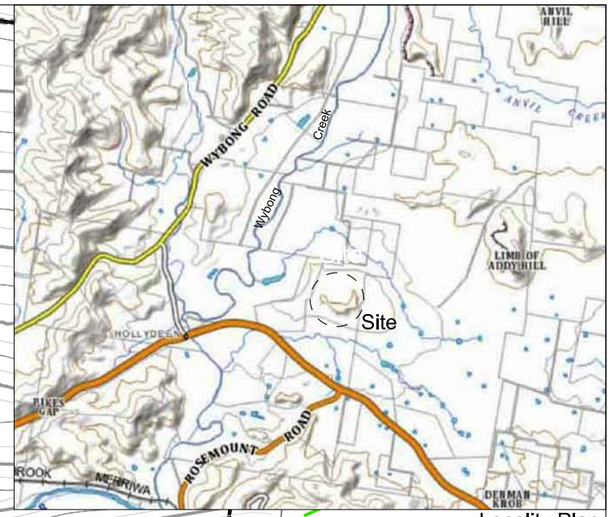
Pt. 1
(8.003ha)

5
45.89 ha

2
40 ha

4
40.55 ha

BH1 BH2 BH3 BH4 BH5 BH6 BH7 BH8
TP1 TP2 TP3



Locality Plan
N.T.S.

NOTE: Drawing adapted from plan supplied by Boardman Peasley Pty Ltd
Job No. S4953, Plan No. 001, Rev A
Dated February 2013

Project Area and Extraction Area locations supplied by VGT
Dwg Ref. 1257_DQ_PP_C011_V1_F6.cdr
Version/Date V1 22/07/2015

0 25 50 75 100
metres

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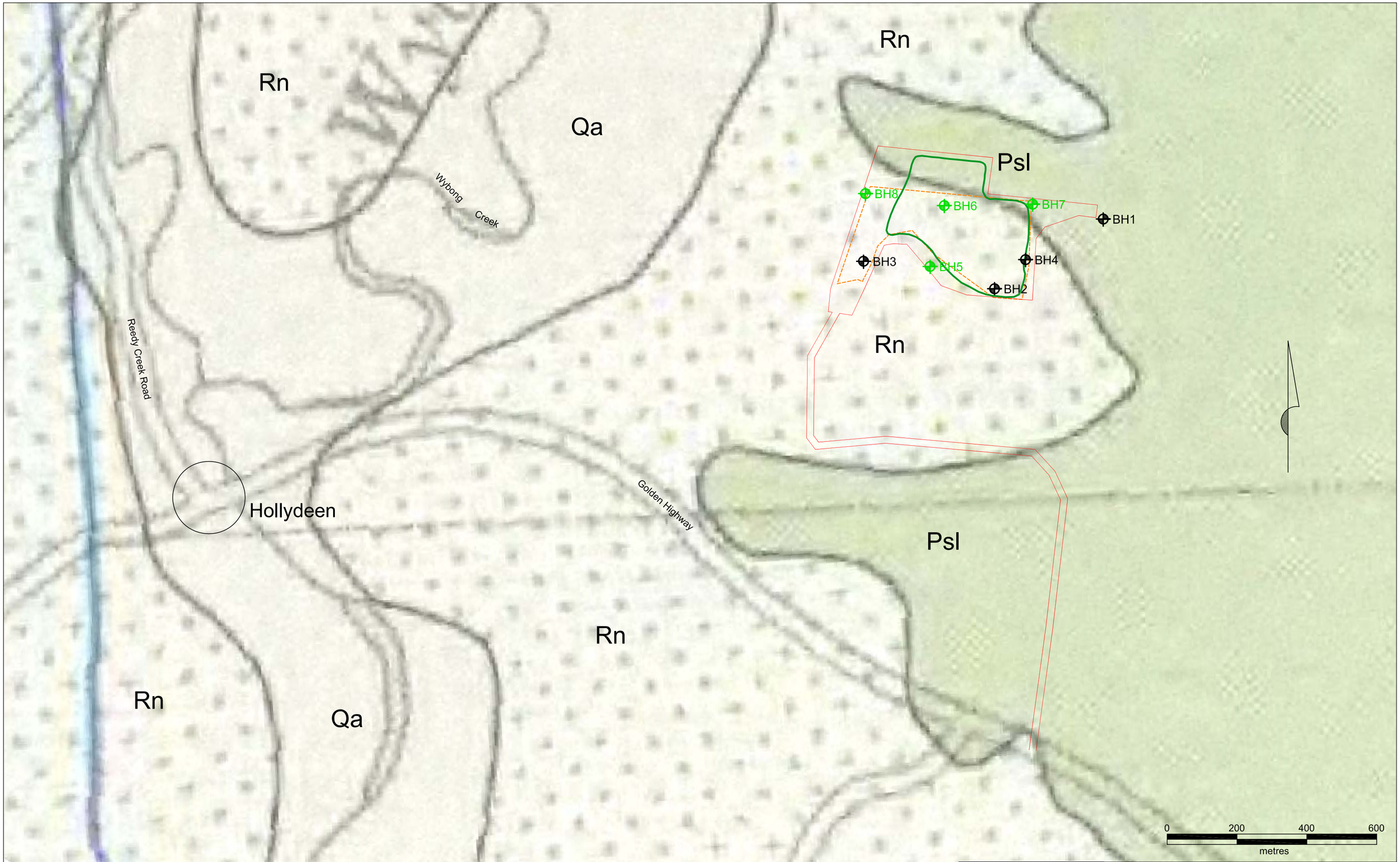
VGT QUARRY AREAS - RCA CONCEPTUAL QUARRY AND TEST LOCATION PLAN PROPOSED QUARRY LOT 2 'DOLWENDEE' ESTATE GOLDEN HIGHWAY HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1
DRAWN BY	JE	SCALE	1 : 2500 (A3)	DRAWING No 1	REV 1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE

CDT–DWG–A3H–001/1



LEGEND

- Borehole location BH1 to BH4 drilled April 2012
- Borehole location BH5 to BH8 drilled September 2014
- RCA quarry concept, December 2014
- VGT project area, July 2015
- VGT extraction area, July 2015

NSW Geological Survey Geology

Symbol	Name	Description
Qa	Quaternary Alluvium	Silt, sand, gravel
Rn	Narrabeen Group	Conglomerate & sandstone, with minor siltstone, claystone
Psl	Wollombi Coal Measures	Coal seams, claystone, siltstone, sandstone, conglomerate

Geology based on NSW DMR Hunter Coalfield Regional Geology, 1 : 100000 (1993)

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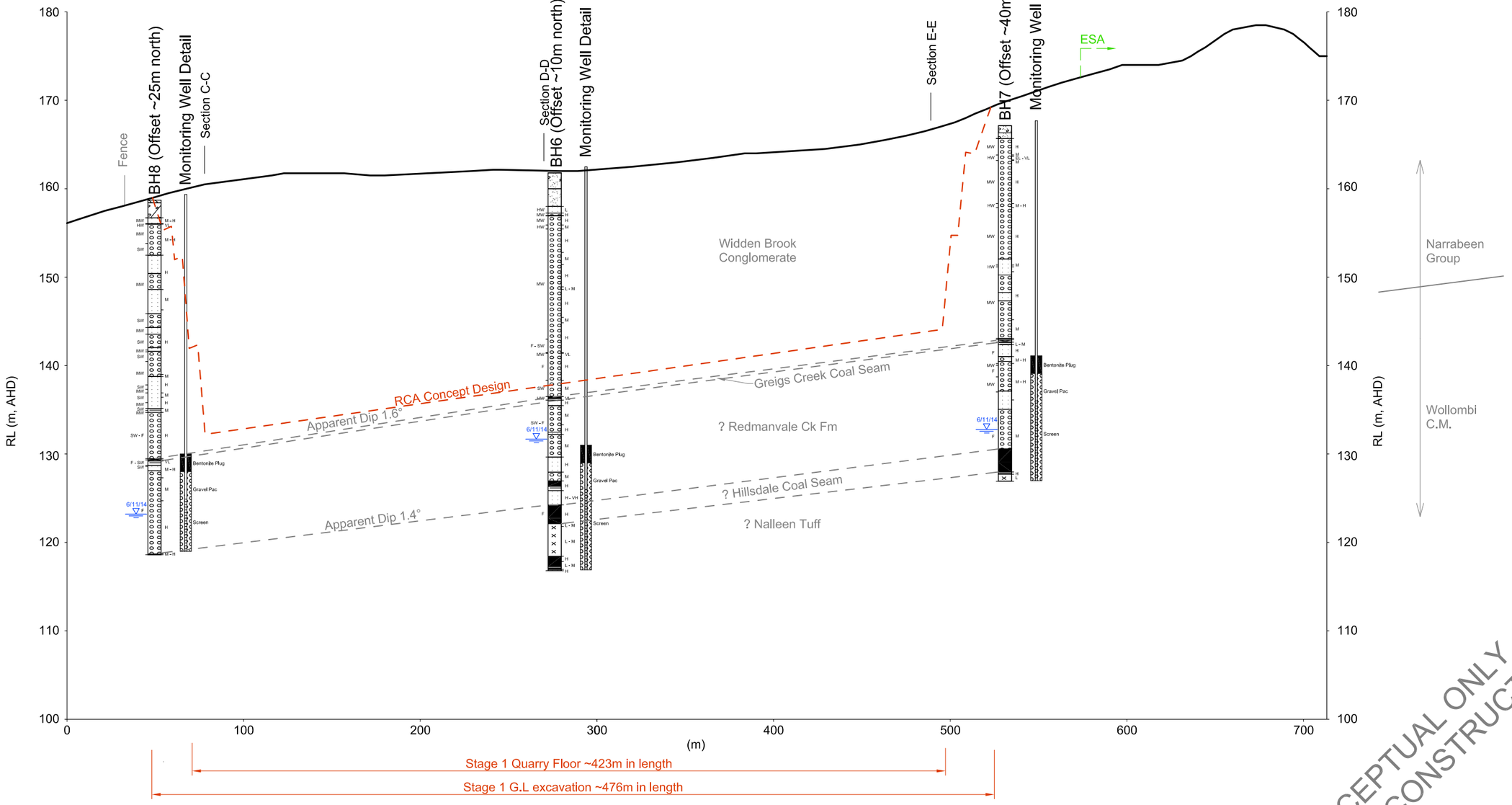
INFERRED GEOLOGY
PROPOSED QUARRY
LOT 2 'DOLWENDEE' ESTATE
GOLDEN HIGHWAY
HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1
DRAWN BY	JE	SCALE	1 : 10000 (A3)	DRAWING No 2	REV 1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE

CDT-DWG-A3H-001/1



CONCEPTUAL ONLY
NOT FOR CONSTRUCTION

BOREHOLE ID

Soil consistency xx

Water level — Groundwater level in piezometer

Rock Weathering (see legend) xx — xx Estimated Rock Strength (see legend)

Geotechnical Section A-A Through RCA Stage 1 Quarry Conceptual Design

Conceptual Quarry Design for Resources Estimation Based on:

1. 2H:1V batter for Soil/Extremely weathered rock, where adjacent ground surface slopes towards quarry
2. 1.5H:1V batter for Soil/EW rock, where adjacent ground surface slopes away from quarry
3. 5.7H:1V benches nominally 4m wide at maximum interval of 10m
4. 0.5H:1V batter for HW-SW competent massive bedrock, maximum height of 10m
5. 40H:1V adopted slope of quarry floor to promote drainage
6. Maximum quarry depth of 30m to suit depth of investigation boreholes

LEGEND

- Inferred Geology boundary
- RCA Conceptual Design
- Groundwater Level measured on 6/11/2014

Scale

Horizontal = 1 : 2500

Vertical = 1 : 500

Vertical Exaggeration 5 to 1

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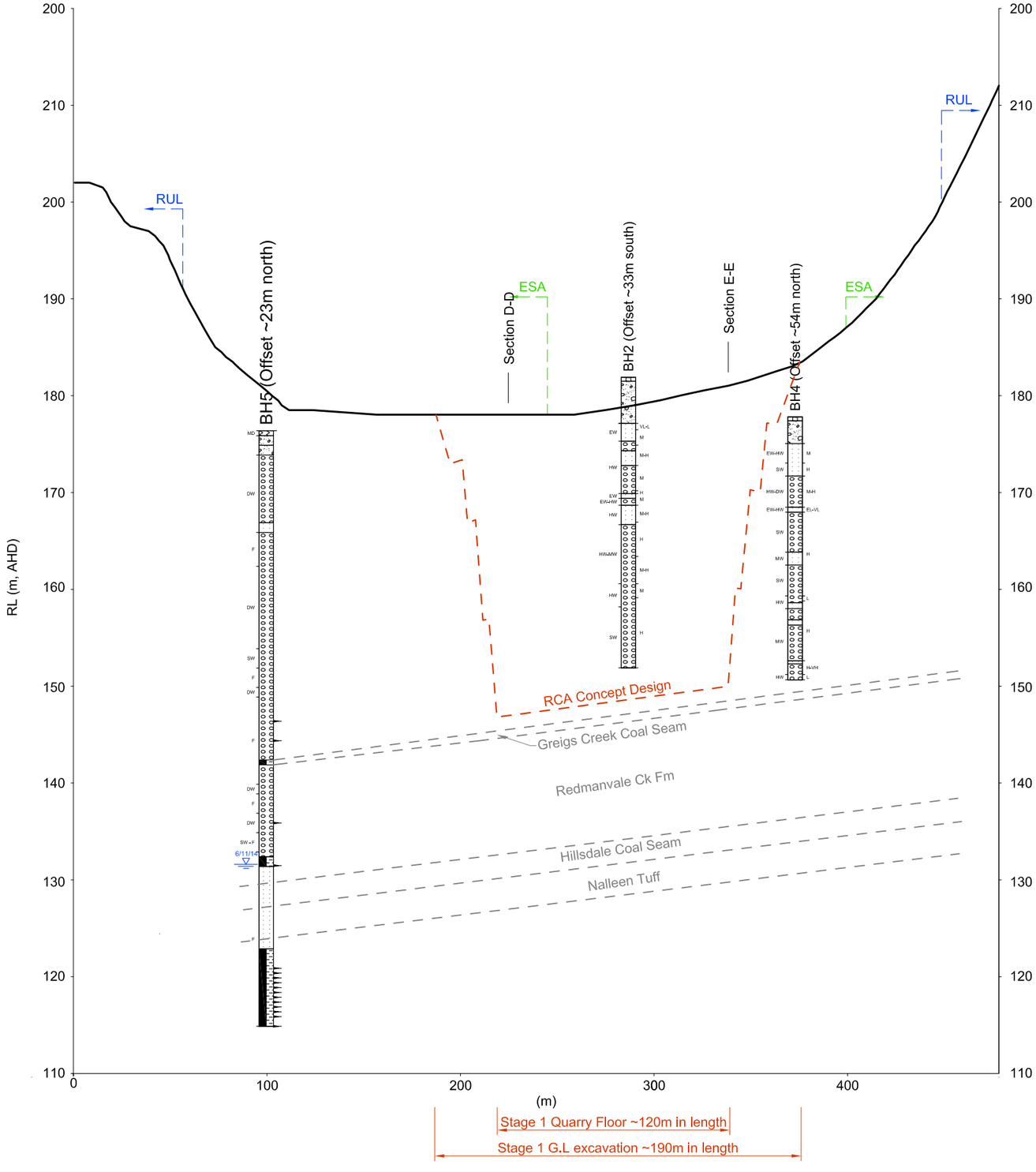
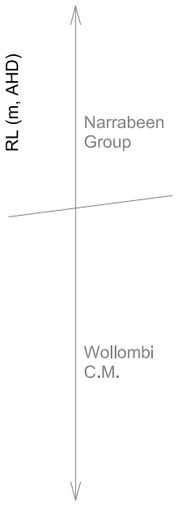
CONCEPTUAL GEOTECHNICAL SECTION A-A
PROPOSED QUARRY
LOT 2 'DOLWENDEE' ESTATE
GOLDEN HIGHWAY
HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1
DRAWN BY	JE	SCALE	As Shown	DRAWING No 3	REV 1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE

CDT-DWG-A3H-001/1





LEGEND

- Inferred Geology
- RCA Conceptual Design
- Groundwater Level measured on 6/11/2014

Scale

Horizontal = 1 : 2500

Vertical = 1 : 500

Vertical Exaggeration 5 to 1

CONCEPTUAL ONLY
NOT FOR CONSTRUCTION

Soil consistency xx

Water level — Groundwater level in piezometer

Rock Weathering (see legend) xx — xx Estimated Rock Strength (see legend)

Geotechnical Section B-B Through RCA Stage 1 Quarry Conceptual Design

Conceptual Quarry Design for Resources Estimation Based on:

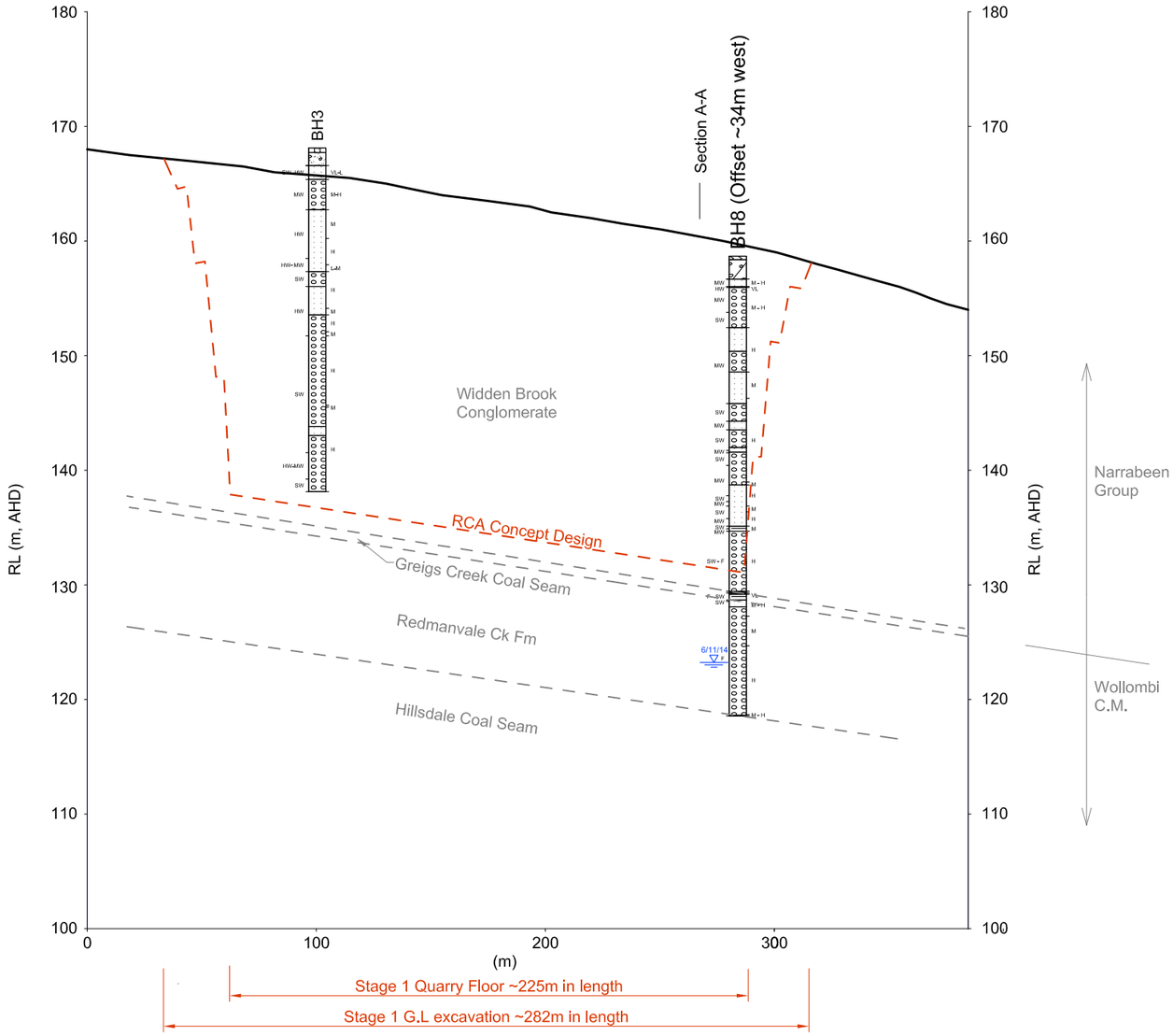
1. 2H:1V batter for Soil/Extremely weathered rock, where adjacent ground surface slopes towards quarry
2. 1.5H:1V batter for Soil/EW rock, where adjacent ground surface slopes away from quarry
3. 5.7H:1V benches nominally 4m wide at maximum interval of 10m
4. 0.5H:1V batter for HW-SW competent massive bedrock, maximum height of 10m
5. 40H:1V adopted slope of quarry floor to promote drainage
6. Maximum quarry depth of 30m to suit depth of investigation boreholes

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

CONCEPTUAL GEOTECHNICAL SECTION B-B
PROPOSED QUARRY
LOT 2 'DOLWENDEE' ESTATE
GOLDEN HIGHWAY
HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1
DRAWN BY	JE	SCALE	As Shown	DRAWING No 4	REV 1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE

CDT-DWG-A3H-001/1



BOREHOLE ID

Soil consistency xx

Water level — Groundwater level in piezometer

Rock Weathering xx (see legend) — xx Estimated Rock Strength (see legend)

Geotechnical Section C-C Through RCA Stage 1 Quarry Conceptual Design

Conceptual Quarry Design for Resources Estimation Based on:

1. 2H:1V batter for Soil/Extremely weathered rock, where adjacent ground surface slopes towards quarry
2. 1.5H:1V batter for Soil/EW rock, where adjacent ground surface slopes away from quarry
3. 5.7H:1V benches nominally 4m wide at maximum interval of 10m
4. 0.5H:1V batter for HW-SW competent massive bedrock, maximum height of 10m
5. 40H:1V adopted slope of quarry floor to promote drainage
6. Maximum quarry depth of 30m to suit depth of investigation boreholes

LEGEND

- Inferred Geology
- RCA Conceptual Design
- Groundwater Level measured on 6/11/2014

Scale

Horizontal = 1 : 2500

Vertical = 1 : 500

Vertical Exaggeration 5 to 1

CONCEPTUAL ONLY
NOT FOR CONSTRUCTION

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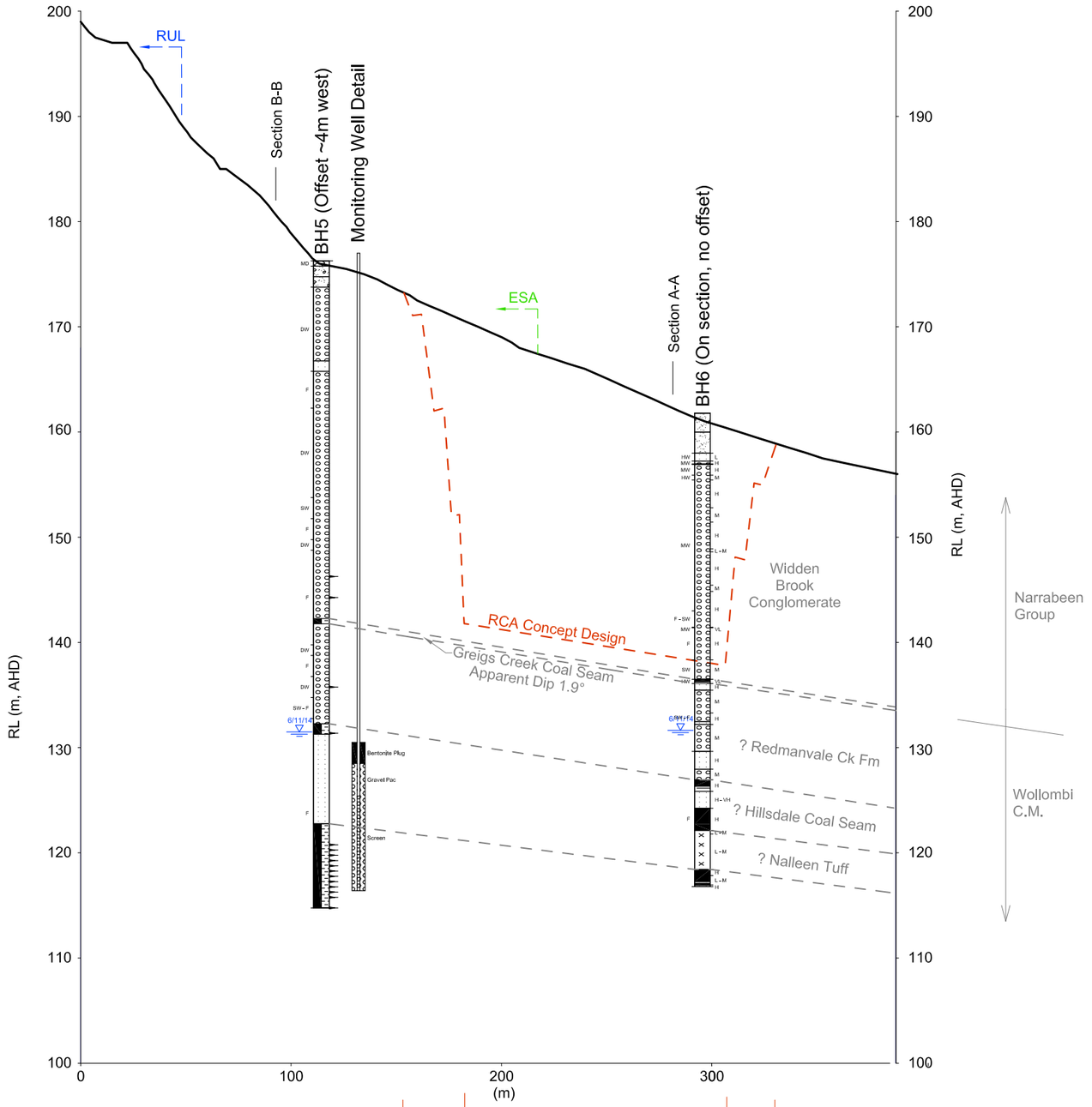
CONCEPTUAL GEOTECHNICAL SECTION C-C
PROPOSED QUARRY
LOT 2 'DOLWENDEE' ESTATE
GOLDEN HIGHWAY
HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1
DRAWN BY	JE	SCALE	As Shown	DRAWING No 5	REV 1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE

CDT-DWG-A3H-001/1



LEGEND

- Inferred Geology
- RCA Conceptual Design
- Groundwater Level measured on 6/11/2014

Scale

Horizontal = 1 : 2500

Vertical = 1 : 500

Vertical Exaggeration 5 to 1

CONCEPTUAL ONLY
NOT FOR CONSTRUCTION

BOREHOLE ID

Soil consistency xx

Water level — Groundwater level in piezometer

Rock Weathering (see legend) xx — xx Estimated Rock Strength (see legend)

Geotechnical Section D-D Through RCA Stage 1 Quarry Conceptual Design

Conceptual Quarry Design for Resources Estimation Based on:

1. 2H:1V batter for Soil/Extremely weathered rock, where adjacent ground surface slopes towards quarry
2. 1.5H:1V batter for Soil/EW rock, where adjacent ground surface slopes away from quarry
3. 5.7H:1V benches nominally 4m wide at maximum interval of 10m
4. 0.5H:1V batter for HW-SW competent massive bedrock, maximum height of 10m
5. 40H:1V adopted slope of quarry floor to promote drainage
6. Maximum quarry depth of 30m to suit depth of investigation boreholes

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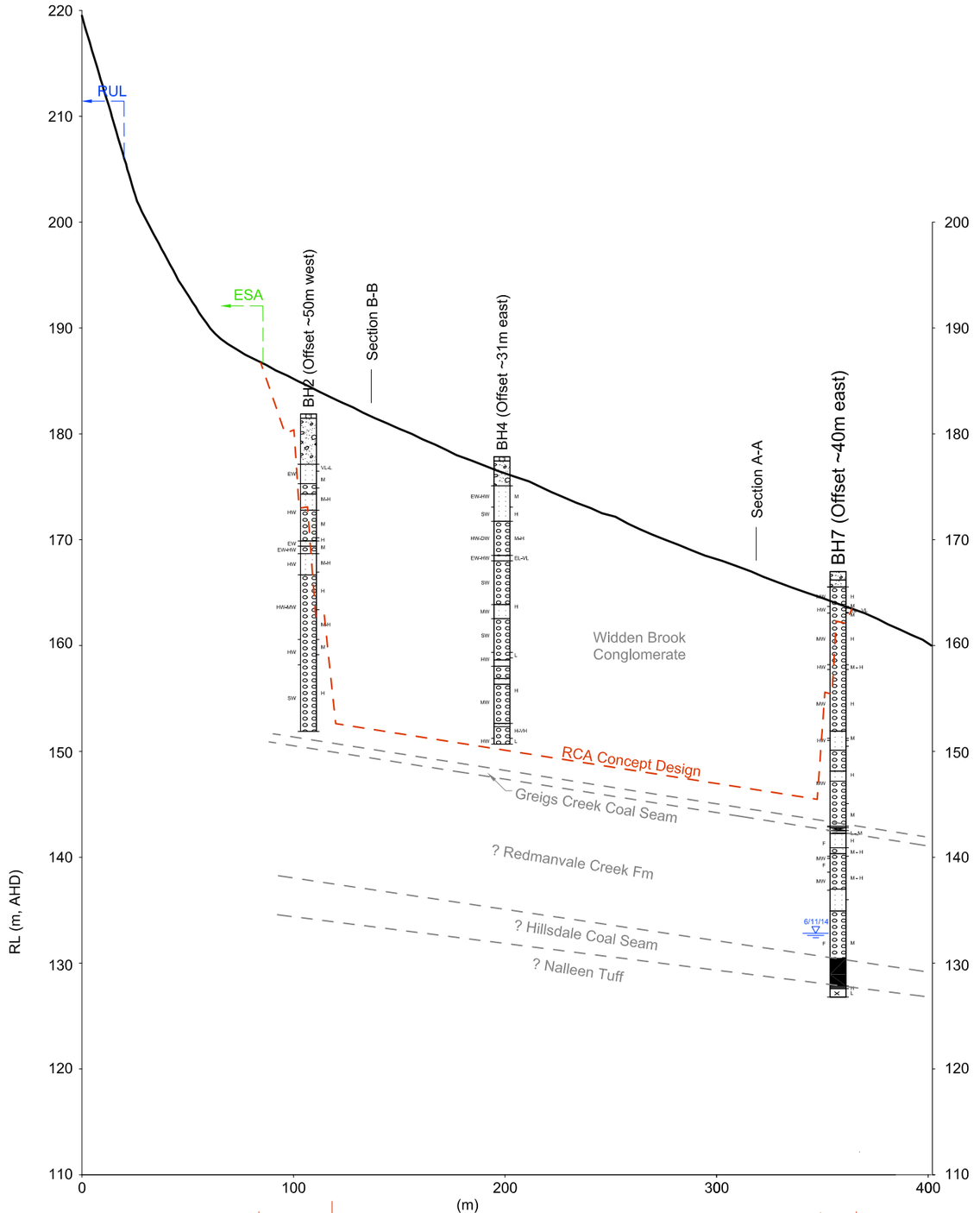
CONCEPTUAL GEOTECHNICAL SECTION D-D
PROPOSED QUARRY
LOT 2 'DOLWENDEE' ESTATE
GOLDEN HIGHWAY
HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1		
DRAWN BY	JE	SCALE	As Shown	DRAWING No	6	REV	1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE		

CDT-DWG-A3H-001/1



LEGEND

- Inferred Geology
- RCA Conceptual Design
- Groundwater Level measured on 6/11/2014

Scale

Horizontal = 1 : 2500

Vertical = 1 : 500

Vertical Exaggeration 5 to 1

CONCEPTUAL ONLY
NOT FOR CONSTRUCTION

Stage 1 Quarry Floor ~229m in length

Stage 1 G.L excavation ~282m in length

BOREHOLE ID

Soil consistency xx

Water level — Groundwater level in piezometer

Rock Weathering (see legend) xx — xx Estimated Rock Strength (see legend)

Geotechnical Section E-E Through RCA Stage 1 Quarry Conceptual Design

Conceptual Quarry Design for Resources Estimation Based on:

1. 2H:1V batter for Soil/Extremely weathered rock, where adjacent ground surface slopes towards quarry
2. 1.5H:1V batter for Soil/EW rock, where adjacent ground surface slopes away from quarry
3. 5.7H:1V benches nominally 4m wide at maximum interval of 10m
4. 0.5H:1V batter for HW-SW competent massive bedrock, maximum height of 10m
5. 40H:1V adopted slope of quarry floor to promote drainage
6. Maximum quarry depth of 30m to suit depth of investigation boreholes

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

CONCEPTUAL GEOTECHNICAL SECTION E-E
PROPOSED QUARRY
LOT 2 'DOLWENDEE' ESTATE
GOLDEN HIGHWAY
HOLLYDEEN

CLIENT	Upper Hunter Holdings Pty Ltd - Goat Farm Trust			RCA Ref	9325-203/1	
DRAWN BY	JE	SCALE	As Shown	DRAWING No	7	REV 1
APPROVED BY	RJC	DATE	5/11/2015	OFFICE	NEWCASTLE	

CDT-DWG-A3H-001/1