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REPORT No GLA2017-01

INVESTIGATION OF SAND & SANDSTONE RESOURCES

MAROOTA

NSW

Report Prepared For Deerubbin Local Aboriginal Land Council

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April 2017

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LIST OF DIGITAL FILES

Report	RGLA2017-01.pdf
Appendices	RGLA2017-01_App.pdf
Data	RGLA2017-01_Data-Files

EXECUTIVE SUMMARY

A ten hole drilling programme, comprising five diamond cored and five open holes, was completed during January-February 2017 on a proposed friable sandstone extraction site at Maroota, NSW owned by the Deerrubin Local Aboriginal Land Council.

Four of the diamond cored holes (DMDDH07, DMDDH09, DMDDH10 and DMDDH11) have been used for resource estimation, while all of the other holes were drilled for ground water studies and to examine areas that may be considered for resource potential at some later time. All of the four resource holes intersected the upper part of the Hawkesbury Sandstone unit with hole DMDDH07 intersecting the basal part of the overlying Ashfield Shale. Total drilled in the 10 holes was 327.2m, while the four resource estimation holes totalled 175.7m.

The core drilling gave satisfactory results, with good core recovery.

The aircore (AC) and reverse circulation percussion (RCP) open hole drilling methods were well suited to this deposit and generally gave consistent sample return. None of the open hole samples have been tested so far, but they have been retained in storage for later testing.

Geophysical logging of the holes accessible to the logging gear provided useful information, especially from the sonic and density logs. From the sonic logs the in situ bulk density of the sandstone within the extraction boundary was determined to be 2.2t/m³. The sonic log has shown the non-rippable sandstone (>3200m/s) within the extraction boundary is: DMDDH07 = 11%, DMDDH09 = 18.6%, and DMDDH11 = 35.1%. All other rock is considered rippable or marginally rippable as indicted in the Caterpillar Handbook for a D10R dozer.

The Maroota resource is contained within a proposed extraction area covering 49.9ha. Within this outline the sandstone resources have been classified as Indicated Resources. The raw sandstone estimates are presented in **Table 1** within the proposed pit.

TABLE 1
TOTAL RAW SANDSTONE RESOURCE ESTIMATES

Pit Area (m²)	498,882					
Ashfield Shale (m²)	23,380					
	RAW SANDSTONE (m³)	DENSITY (t/m³)	RAW SANDSTONE (t)	SANDSTONE Less Fe+C/Sh (%)	SANDSTONE Less Fe+C/Sh (t)	Wastes (t)
Pit Volume	9,273,673					
Less Ashfield Shale	73,250	2.2				161,150
Less Soil/unmined	237,751	2.2				523,052
TOTAL	8,962,672	2.2	19,717,878	95.4	18,810,856	907,022
SANDSTONE (Rounded)			20 Million		19 Million	1.6 Million

Based on the core drill hole lithology logs, after making allowances for rejection of ironstone and clay/shale (4.6%), the yield of sandstone = 95.4%. The Indicated Resource of raw sandstone is estimated to be **19 million tonnes**.

Washed size grading tests were completed on 27 samples of core from holes DMDDH07, DMDDH09, DMDDH10, and DMDDH11 after light crushing to liberate the grains.

From the core test data, both raw sand and ‘product’ sand mean size gradings are presented for the Indicated Resources in the deposit. Results are summarised in **Table 2**.

TABLE 2
AVERAGE RAW AND PRODUCT SIZE GRADINGS FOR CORE SAMPLES
(% PASSING – DATA USED FOR RESOURCE ESTIMATION)

APERTURE (mm)		2.36	1.18	0.600	0.425	0.300	0.150	0.075
RAW	Interval m							
DMDDH07, 3.73-34.61m	30.55	100.0	92.7	78.9	63.4	45.6	24.1	16.6
DMDDH09, 13.2-34.54m	32.65	100.0	93.2	76.3	54.1	34.5	18.5	13.6
DMDDH10, 0.40-29.81m	29.40	100.0	92.3	76.6	54.6	32.2	15.6	10.3
DMDDH11, 2.52-33.00m	30.48	100.0	95.4	80.0	58.9	39.4	19.6	11.5
Wtd Mean		100	93.4	77.9	57.7	37.9	19.5	13.0
‘PRODUCT’ (all -2.36 + 0.075mm)								
DMDDH07, 3.73-34.61m	30.55	100.0	91.2	74.6	56.0	34.7	9.0	0.0
DMDDH09, 13.2-34.54m	32.65	100.0	92.2	72.6	46.9	24.3	5.8	0.0
DMDDH10, 0.40-29.81m	29.40	100.0	91.5	73.9	49.5	24.6	5.9	0.0
DMDDH11, 2.52-33.00m	30.48	100.0	93.7	74.9	49.5	24.3	6.1	0.0
Wtd Mean		100.0	92.2	74.0	50.4	27.0	6.7	0.0

From the raw sandstone in **Table 2** the washing plant losses will be: 0% oversize (+2.36mm) and 13.0% fines (-0.075mm) for a total estimated recovery of 87% after screening and washing. Presented in **Table 3** is the expected product sand resource estimate.

TABLE 3
PRODUCT SAND RESOURCE ESTIMATE
(Assuming all +6.7mm and –0.075mm material is removed)

	RAW SANDSTONE (t)	EXPECTED WASH % YIELD	PRODUCT (million t)	SAND PRODUCT ROUNDED
Sand	18,810,856	87.0	16,365,445	16 Mt
Waste		13.0	2,445,411	
Total		100.0	18,810,856	

The DLALC Maroota sandstone resource within the defined proposed extraction pit area is well suited to the production of fine-grained concrete aggregates as defined by AS2758.1. From this investigation it is concluded that a raw sandstone resource comprising 20 million tonnes occurs within the proposed pit. After rejecting ironstone and other clay/shale materials the raw sandstone available for wash plant feed will be 19 million tonnes. With a wash plant yield of 87% the resources will produce in the order of 16 million tonnes of sand. Extraction waste and wash plant rejects will comprise a total of 4.0 million tonnes to be placed into the pit void as fill.

Further investigation work is suggested in **Section 8** of the report; however this can be delayed until the project has demonstrated economic feasibility and is closer to granting of extraction approvals.

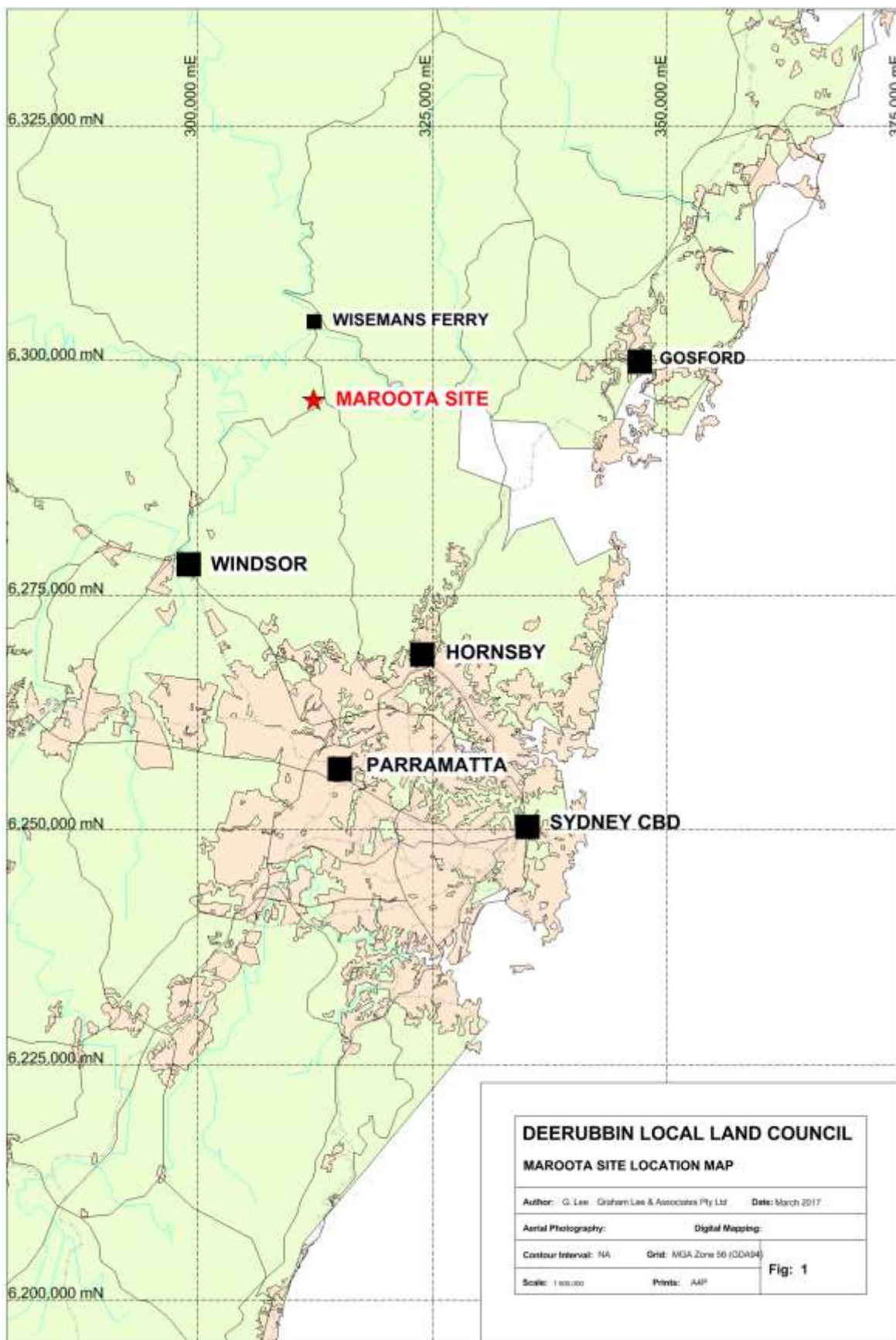


FIGURE 1. Maroota location map.

REPORT

1. INTRODUCTION

Deerubbin Local Aboriginal Land Council (DLALC) is investigating the feasibility of producing sand from a property at Maroota, NSW. The site is located about 65km to the north north-west of Sydney, near Wisemans Ferry, see **Figure 1**.

The property was formerly crown land, and fronts Wisemans Ferry Road about 500m south of the intersection with Old Northern Road. Drainage from the site is via un-named tributaries of Douglass Creek, flowing initially to the northwest and then north into the Nepean River upstream of Wisemans Ferry.

The proposed extraction area on the property is sited generally on the outcropping sandstone ridge system extending north westwards from near the frontage to Wisemans Ferry Road with proposed extraction generally above the 141m AHD contour.

Drilling investigations were conducted during January and February of 2017 and comprised both open holes and diamond core drilling to gain an understanding of the distribution and quality of both the Tertiary alluvial deposits in the eastern areas of the property and the friable Hawkesbury Sandstone along the ridges which form the main potential resource. **Figure 2** presents an aerial photograph showing the boundary of the property and the locations of the drill holes.

While sand resources occur in two separate geological units (Hawkesbury Sandstone and the overlying Tertiary alluvial deposits) on the property, the main resource is the Hawkesbury Sandstone and this unit forms the basis of resource estimates given later in this report.

This document is intended for company internal purposes, rather than for investment decision making. It aims to provide a complete project geological data compilation for: technical assessment, project planning, project approvals, project implementation, and other internal company operations.

The document has been prepared by a competent person with more than 5 years relevant experience in construction materials, and in similar styles of mineral occurrence to that encountered at Maroota.

2. GEOLOGY

2.1 Regional Geology

The resources on the property occur as two separate geological units. The older and larger resource is the sandstones belonging to the Hawkesbury Sandstone formation deposited during the Triassic Period (195 to 225 million years ago). Hawkesbury Sandstone is the predominant sandstone unit outcropping in the region surrounding Sydney. In some locations, the Hawkesbury Sandstone has lenses of pale to dark grey shale interbedded within the generally massive sandstone.

In the Maroota district some of the higher ridge lines are capped by shales of the Ashfield Shale which immediately overlies the Hawkesbury Sandstone, but the occurrence is restricted to the topographically higher areas.

The younger and smaller resource is the Tertiary sand (and other alluvial sediments) accumulated along the former course of the Nepean River. These Tertiary deposits overly the Hawkesbury Sandstone and/or the shales of the Ashfield Shale unit, and are dated as being deposited between 65 and 45 million years ago. These are best observed in the extraction pits, such as PF Formation on the corner of Wisemans Ferry and Old Northern Roads, but parts of the unit also extend into the eastern part of the property along Wisemans Ferry Road.

2.2 Site Geology

Proposed sandstone extraction will be from the Hawkesbury Sandstone, along a relatively flat plateau and adjoining ridge line areas.

Figure 3 is a geological map of the property and surrounds. It is based on the geological map prepared by Etheridge (1980) from his detailed investigations of the Maroota Tertiary deposits. The modifications shown on **Figure 3** are based on the recent Deerrubin drilling, and show extensions of the units mapped as Ashfield Shale (which was intersected in the top of hole DMDDH07, **Photograph 1**) and the basal Tertiary “Clay/Silty Clay” unit overlain by the “Sand” unit (intersected in holes DMDDH03, DMDDH07, DMAC01, and DMAC02D). On the Deerrubin property, the unit that Etheridge describes as “Clay/Silty Clay” comprises mainly heavy mottled grey and red clay, while the “Sand” unit comprises interbedded thin sand beds, clayey sand, and clay; with core losses which are expected to be the thicker cleaner sand beds in the unit.

Based on the diamond drilling, the Hawkesbury Sandstone comprises variably friable to competent, fine to medium grained, moderate to poorly sorted, variously pale-coloured sandstones and clayey

sandstone, see **Photographs 2 and 3**. Based on bedding measurements in the core the sandstone is flat lying with cross bedded units showing dips generally of up to 20°. Thin pale greyish coloured clay, with darker grey shale is interbedded near the bottom of some of the drill holes (**Photograph 4**), but the depth varies sufficiently to suggest that these shales represent lenses rather than a single continuous bed. Cemented hard dark brown and red ironstone bands are distributed throughout the unit, both along bedding (**Photograph 5**) and as thickened liesegang bands (**Photograph 6**) through the body of the sandstone units.

It is interesting to note that at the bottom of DMDDH07 from 56.45m to 60.0m which is the end of the hole (i.e. from 136.65 to 133.2m AHD) a thickness of 3.55m, a massive, well sorted, fine-medium, pale grey flat lying sandstone bed was intersected (**Photograph 7**). On exposure to the air over a period of 2 weeks, this bed had changed colour from pale grey to pale brownish-yellow (**Photograph 8** after 6 weeks). The bed is believed to be “Yellow Block” sandstone which is the material used for colonial building construction in central Sydney. It represents a target for further investigations as this stone is in scarce supply and is highly sought after. None of the other drill holes in the project extended to sufficient depth to intersect this bed, and hole DMDDH07 did not determine the full thickness of the unit.



Photograph 1: Ashfield Shale from DMDDH07, sample shown is from 2.45 to 2.80m.



Photograph 2: Typical medium grained coloured sandstone from DMDDH07, sample shown is from 15.1 to 15.4m.



Photograph 3: Typical pale medium-coarse grained sandstone from DMDDH07, sample shown is from 24.15 to 24.5m.



Photograph 4: Shale lens overlying a shale rip up unit where shale fragments have been mixed with sandstone. DMDDH09, 35.0 to 35.4m. This shale occurs beneath the proposed pit bottom.



Photograph 5: Bedding conformable ironstone band in sandstone. DMDDH09, 41.4 to 41.55m. This is typical of most of the ironstone occurring on the site.



Photograph 6: Liesegang banded ironstone developed in sandstone. DMDDH09, 28.4 to 28.8m. Less often occurring form of ironstone, but often quite thick where it does occur.



Photograph 7: Yellow Block sandstone, medium grained, very well sorted, massive, photographed on 8 February 2017 just after being drilled. DMDDH07, sample shown is from 57.3 to 57.6m.



Photograph 8: The same core as in Photograph 7. Yellow Block sandstone photographed on 23 March 2017, six weeks after being drilled. The colour has changed from pale grey to brownish-yellow. DMDDH07, sample shown is from 57.3 to 57.6m.

3. PREVIOUS INVESTIGATIONS

There have been no previous published geological investigations conducted into the sandstone resources occurring on this property at Maroota. As a prelude to this current study the writer visited the site in 2009 and collected two surface outcrop samples of friable sandstone for determination of size grading. The results are recorded in Lee (2009).

The published work of Etheridge (1980) which was conducted by the Geological Survey of New South Wales, focussed on the Tertiary Maroota Sand, which overlies the Hawkesbury Sandstone.

Sand producers in the Maroota district utilise some of the Hawkesbury Sandstone as a feedstock. PF Formation is the closest operation and they access their wash plant site by traversing the property from the Wisemans Ferry Road within a corridor held under permissive occupancy lease titles.

4. INVESTIGATIONS

4.1 Survey

The approximate drill hole collar positions were located prior to drilling using a hand held GPS and the sites were marked on the ground with timber stakes. All collars were surveyed using Map Grid of Australia (MGA) co-ordinates and the GDA94 datum.

Prior to drilling, the sites were subjected to archaeological and flora studies, and where necessary they were shifted to avoid damage to anything sensitive.

Upon completion of all drilling, the actual collars were surveyed again using a hand held GPS with horizontal accuracy generally better than +/-10m, which based on past survey comparison data is mostly better than +/-5m. Collar elevations were taken from contoured project photogrammetry and contour mapping. Survey data is included in **Appendix 1**.

Collar locations and the total depth of the drill holes are listed in **Table 4.1**. **Figure 2** shows collar locations overlain onto an aerial image background.

TABLE 4.1
DRILL HOLE COLLARS

Hole ID	Method*	MGA Zone 56 mE	MGA Zone 56 mN	Collar AHD (m)	Total Depth (m)
DM01	AC	313340	6295812	204.6	12.0
DM02S	AC	313328	6295727	201.1	10.0
DM02D	AC/RCP	313322	6295723	200.1	31.0
DMDDH03	DDH	313044	6295428	192.7	45.5
DM04	RCP	313124	6295820	185.6	18.0
DMDDH05	AC/DDH	313277	6295625	192.0	27.0
DM06	AC	312814	6295833	165.0	8.0
DMDDH07	DDH	312608	6295585	193.2	60.0
DMDDH09	DDH	312355	6295918	187.9	45.5
DMDDH10	DDH	312368	6295606	173.8	35.1
DMDDH11	DDH	311882	6296206	172.3	35.1

- AC = aircore, RCP = reverse circulation percussion, DDH = diamond drill hole

4.2 Drilling

Drilling was undertaken by Blacklaws Drilling Pty Ltd from Elphinstone, Victoria. The drill used was a Mantis 300 rig, see **Photograph 9**. The same rig was used for diamond coring, and aircore and RC percussion drilling of open holes. The contractor was well known to the writer and had

been operating on other projects in NSW before this drilling. Operations commenced on 19 January and were completed on 10 February 2017.

Diamond coring was undertaken using an HQ3 bit and triple tube core barrel. All core recovered was boxed, logged, and photographed. Total length cored in six holes was 241.2m.

Open hole drilling comprised both aircore (AC) and reverse circulation percussion (RCP). Aircore with a 96mm diameter bit was used to drill to refusal when the sandstone was too hard for further penetration. For both AC and RCP the cuttings returned to the surface through a cyclone and the total sample was bagged. RCP drilling was used for holes that needed to penetrate into the hard sandstone (e.g. for piezometers) and used a 125mm diameter RC down hole hammer. Again cuttings returned to the surface through a cyclone and the whole sample was bagged. AC and RCP operate in the reverse circulation mode using a dual tube drill string, with the sample returning to the surface through the inner tube and thereby avoiding contamination from the outside of the hole as occurs using conventional circulation. Total length of AC and RCP was 86.0m.

The writer of this report supervised drilling and logged all samples recovered from the holes.



Photograph 9: Mantis 300 rig with air compressor during aircore drilling on DMAC01.



Photograph 10: Aircore bit used for drilling at Maroota.



Photograph 11: Reverse circulation down-hole-hammer bit used for percussion holes. The two airways on the bit face are partially blocked as the bit had just been retrieved from a wet ‘muddy’ hole where drill cuttings had pushed into the bit after the air flow had been stopped.

4.3 Down-Hole Geophysical Logging

Geophysical logging comprising density and sonic tools was run on all open holes by Groundsearch Australia Pty Ltd., from 178 Racecourse Rd, Rutherford NSW. The holes logged were:

DM02D-RCP
DDMDDH03
DM04-RCP
DMDDH07
DMDDH09
DMDDH11

The logs obtained from the tools employed comprised:

Sonic Tool: Velocity log

Density tool: Caliper, Natural gamma, Resistivity, Density (long spaced) Density (short spaced).

Geophysical data was made available as paper copies, LAS files on disc, and csv files by email.

4.4 Data Compilation

Data generated from the drilling was compiled into Excel spreadsheets comprising collar, survey, and lithological information; to enable generation of MapInfo files for producing the figures and plots presented in this report.

The geophysical csv logs were prepared into a form that allowed this data to be plotted as down-hole presentations, beside the graphic lithological plots.

4.5 Sample Testing

4.5.1 Bulk Density

Bulk density was determined from the geophysical density logs and no laboratory testing was undertaken to measure density.

4.5.2 Size Gradings on Drill Core Samples

Generally, only those samples of core that may have potential, based on the visual lithological logging, for future extraction and processing to yield a construction sand product were tested. These samples have been selected from drill holes within the resource area considered in **Section 6** later in the report. Core lithologies comprising thicker ironstone and the thicker mostly clay and shale were excluded. Core loss zones in the Hawkesbury Sandstone were mostly too small to be significant in testing and were ignored in preparing testing intervals.

Testing was conducted on sample intervals of the core generally representing up to 5m working sections in any future extraction pit. **Table 4.2** lists the 27 intervals tested from four of the diamond cored holes. Along with details of the lithology of the samples tested, **Table 4.2** also presents details on thickness and percentage of ironstone, clay (including shale and claystone), core losses, and sandstone in the interval tested.

TABLE 4.2
CORE TEST SAMPLES FOR WASHED SIEVE ANALYSIS

DRILL HOLE	From	To	Thickness	Fe Stone	Clay	Core Loss	SANDSTONE (m)
DMDDH07	3.73	8.98	5.25	0.25 (4.8%)	0 (0%)	0 (0%)	5.00 (95.2%)
DMDDH07	9.31	14.58	5.27	0.185 (3.5%)	0.05 (0.9%)	0 (0%)	5.035 (95.5%)
DMDDH07	14.58	19.95	5.37	0.06 (1.1%)	0.01 (0.2%)	0 (0%)	5.30 (98.7%)
DMDDH07	19.95	25.02	5.07	0.04 (0.8%)	0.005 (0.1%)	0 (0%)	5.025 (99.1%)
DMDDH07	25.02	30.40	5.38	0 (0%)	0.005 (0.1%)	0.20 (3.7%)	5.175 (96.2%)
DMDDH07	30.40	34.61	4.21	0.09 (2.1%)	0.01 (0.2%)	0.10 (2.4%)	4.01 (95.2%)
DMDDH09	1.32	3.58	2.26	0 (0%)	0 (0%)	0 (0%)	2.26 (100.0%)
DMDDH09	4.15	9.50	5.35	0 (0%)	0 (0%)	0 (0%)	5.355 (100.0%)
DMDDH09	9.50	15.08	5.58	0 (0%)	0.02 (0.4%)	0 (0%)	5.56 (99.6%)
DMDDH09	15.08	20.00	4.92	0.01 (0.2%)	0 (0%)	0.20 (4.1%)	4.71 (95.7%)
DMDDH09	20.00	23.89	3.89	0.01 (0.3%)	0 (0%)	0 (0%)	3.88 (99.7%)
DMDDH09	23.89	27.50	3.61	0.01 (0.3%)	0 (0%)	0 (0%)	3.60 (99.7%)
DMDDH09	27.50	34.10	3.90	0.43 (10.8%)	0 (0%)	0 (0%)	3.48 (89.2%)
DMDDH09	34.10	35.54	3.14	0.07 (2.2%)	0 (0%)	0 (0%)	3.07 (89.2%)
DMDDH10	0.40	5.39	4.99	0 (0%)	0 (0%)	0.54 (10.8%)	4.54 (89.2%)
DMDDH10	5.40	9.13	3.73	0.14 (3.8%)	0 (0%)	0 (0%)	3.59 (96.2%)
DMDDH10	9.13	15.15	6.02	0.235 (3.9%)	0 (0%)	0 (0%)	5.785 (96.1)
DMDDH10	15.15	20.04	4.89	0.05 (1.0%)	0 (0%)	0.20 (4.1%)	4.64 (94.9%)
DMDDH10	20.04	25.35	5.31	0 (0%)	0.04 (0.8%)	0 (0%)	5.27 (99.2%)
DMDDH10	25.35	29.81	4.46	0.645 (14.5%)	0 (0%)	0.05 (1.1%)	3.765 (84.4%)
DMDDH11	2.52	7.62	5.10	0 (0%)	0 (0%)	0 (0%)	5.1 (100.0%)
DMDDH11	7.62	12.62	5.00	0.015 (0.3%)	0.02 (0.4%)	0 (0%)	4.965 (99.3%)
DMDDH11	12.62	17.54	4.92	0.01 (0.2%)	0.06 (1.2%)	0 (0%)	4.85 (98.6%)
DMDDH11	17.54	22.42	4.88	0.005 (0.1%)	0 (0%)	0 (0%)	4.875 (99.9%)
DMDDH11	22.42	26.12	3.70	0.085 (2.3%)	0 (0%)	0 (0%)	3.615 (97.7%)
DMDDH11	26.12	31.31	5.19	0.005 (0.1%)	0 (0%)	0 (0%)	5.19 (99.9%)
DMDDH11	31.11	33.00	1.69	0.035 (2.1%)	0.46 (27.3%)	0.02 (1.2%)	1.17 (69.4%)

All core testing was conducted by the Coffey laboratory at Melrose Park. The testing procedure adopted was as follows:

1. Core was delivered to the laboratory in trays marked up into sample intervals.
1. Split the core representing each sample along the core axis. Ironstone bands and any clay/shale beds can be eliminated and left un-sampled and kept in the core tray. It may help in core splitting if the core is wet as this helps in breaking apart the rock by wetting the clay and other minerals between the quartz grains.
2. One half of the core is to be returned to the tray in the position and orientation from which it originally came. The other half can be placed into a container along with all other core halves for the sample interval for further testing.
3. Core trays when completed are to be retained for the client to collect.
4. The half core sample for testing is to be lightly crushed (a jaw crusher was used) taking care to minimize the breakage of quartz grains. Crush till the size of aggregated particles is suitable to representatively sub-sample for testing – say about 1.0 to 2.0kg. Re-bag the remainder of the sample not required for the following testing.
5. On the test sample disaggregate all remaining composite particles till they are liberated into individual sand grains, trying to minimise the breaking of quartz sand grains. This may best be achieved by allowing the sample to soak overnight in water and then agitating at about 30% solids in a suitable small drum (or other container) for about 10 minutes. Then decanting the water carrying clay and fine silt, followed by screening at about 2.36 or 1.0mm as appropriate and then inspecting for aggregated particles which may need further breaking by hand in a mortar and pestle. Note: that resistant hard ironstone aggregates are normally rejected as oversize during treatment of this type of sandstone and can be rejected during laboratory treatment. It is important to determine the quantity of clay and fine silt, by difference from the original sample treated.
6. Record the clay and fine silt rejected. Record any other material rejected and bag for later inspection by the client.
7. On the material passing 2.36mm, treat by washed sieve analysis according to AS1141.11.1.
8. Report results relative to the original raw sample.
9. Retain all sample remainders after completing the test work for collection.

5. RESULTS

5.1 Survey Data

Drill hole collar survey data is presented in **Appendix 1** of this report and **Figure 2** shows the locations of drill holes overlain onto the aerial photograph of the site. Two cross sections lines are also shown on **Figure 2**.

5.2 Drill Hole Lithology Logs

Detailed drill core lithology log information is presented in **Appendix 2** of this report along with graphic presentations, and photographs of the core from each of the six diamond cored holes.

For each of the six the aircore and percussion drill holes, **Appendix 2** contains lithological descriptions for the bagged cuttings, a graphic presentation for the hole, and photographs of a chip tray containing a small amount of the cuttings.

5.3 Down-Hole Geophysical Data

Geophysical logs are presented in **Appendix 2** beside the graphic log. The presentation shows the natural gamma, short spaced density, and velocity plots for holes DM02D, DMDDH03, DM04, DMDDH07, DMDDH09, and DMDDH11. Logs were not obtained for DM02S (since the deeper nearby hole DM02D was logged), DMDDH05 (hole was blocked 4m below the collar preventing safe entry to the hole for logging), DM06 (hole too shallow for any recording), and DMDDH10 (hole was being drilled at time of logging having been delayed due to rain).

The full geophysical data set is included into the data package accompanying this report. It includes PDF images of the plotted data as well as the LAS files.

5.3.1 *Bulk Density*

Using the density data from the geophysical logs an in situ rock bulk density has been calculated.

The csv data files contain compensated density log (CDL) results which are calculated density values determined from the long and short spaced density records and are reported at 0.01m intervals down the hole. These records were used to calculate the rock bulk density for the intervals representing the samples sent for laboratory testing, and also were calculated for the total hole intersection of Hawkesbury Sandstone. The results are presented in **Table 5.1**.

TABLE 5.1
BULK DENSITY CALCULATED VALUES FROM CDL DATA FILES

DRILL HOLE	FROM (m)	TO (m)	INTERVAL (m)	INTERVAL DENSITY (g/cc)	MEAN BULK DENSITY (t/m ³)
<u>Sampled Intervals Only</u>					
DMDDH07	3.73	34.61	30.88	2.279	
DMDDH09	1.32	27.50	26.18	2.202	
DMDDH11	2.52	26.13	23.61	2.229	
Total			80.67		2.24
<u>All Available Data From Holes</u>					
DMDDH03	18.07	44.80	26.73	2.335	
DMDDH07	3.73	59.50	55.77	2.324	
DMDDH09	1.32	41.88	40.56	2.248	
DMDDH11	2.52	34.62	32.10	2.228	
Total			155.16		2.29

From **Table 5.1** the mean bulk density for the sample intervals subjected to laboratory testing is 2.24t/m³. While samples from DMDDH10 were tested, no geophysical logs were obtained from this hole due to the delay in the program caused by wet weather.

For all of the Hawkesbury Sandstone, where geophysical logs were obtained, the density value is a little higher at 2.29t/m³. This higher result is partly due to a slightly greater content of ironstone and probably increased lithification in the rock beneath the tested intervals.

5.3.2 Sonic Logging (Velocity)

Sonic logs were obtained from holes DMDDH07, DMDDH09, and DMDDH11 within the extraction area. The sonic log can be used for prediction of sandstone rippability using a bulldozer fitted with rippers. According to the Caterpillar Handbook, sandstone is rippable using a D10R model with rock velocity up to 2,500m/s; and is marginally rippable between 2,500 –3,200m/s.

Appendix 2 presents plots of the sonic logs of all of the drill holes for which this information was obtained and the reader should refer to this appendix to view the sonic logs in detail. Sonic logs are also show on the cross sections in **Figures 4 and 5**, but these are not as detailed as in **Appendix 2**. From an examination of the sonic data files the information presented in **Table 5 2** is relevant to the extraction area of the Maroota project. Only those intervals of sonic data which fall within the extraction pit area and above the pit bottom have been utilised in creating **Table 5.2**.

TABLE 5.2
SUMMARY OF RIPPABILITY BASED ON SONIC LOG VELOCITY DATA

	DMDDH07		DMDDH09		DMDDH11	
From - To	10.96m	31.4m	8.8m	33.6m	8.41m	30.7m
	Sum Metres	%	Sum Metres	%	Sum Metres	%
Rippable	6.90	33.8%	9.66	39.0%	1.00	4.5%
Marginally Rippable	11.30	55.3%	10.52	42.4%	13.47	60.4%
Non-Rippable	2.24	11.0%	4.62	18.6%	7.82	35.1%
Total	20.44m	100%	24.80m	100%	22.29m	100%

Rippable = <2500m/s Marginally Rippable = 2500-3200m/s Non-Rippable = >3200m/s

From **Table 5.2** it can be seen that holes DMDDH 07 and DMDDH09 have similar rippability characteristics while DMDDH11 (closer to the NW end of the ridge line has a significantly higher content of non-rippable sandstone. Hole DMDDH11 may require the use of a rock breaker to remove the hardest sandstone.

5.4 Sample Test Results

5.4.1 *Size Gradings on Drill Core Samples*

The 27 sandstone intervals tested by washed size grading are listed in **Appendix 3**, together with the laboratory reports from Coffey.

Table 5.2 presents some statistical data for these washed size grading results obtained from the 27 composite core samples tested.

TABLE 5.2
CORE SAMPLES WASHED SIZE GRADING RESULTS
% Passing Aperture

Hole ID	2.36mm	1.18mm	0.600mm	0.425mm	0.300mm	0.150mm	0.075mm
<u>Raw Sand</u>							
No Samples	27	27	27	27	27	27	27
Min	100	90	66	42	24	12	8
Max	100	97	85	76	62	30	19
Mean	100	93.1	77.1	56.6	36.2	18.5	12.7
Median	100	93	77	55	35	17	12
<u>'Product' Sand</u>							
No Samples	27	27	27	27	27	27	27
Min	100.0	88.4	62.2	35.6	15.9	3.4	0
Max	100.0	96.4	83.1	71.1	54.2	15.7	0
Mean	100.0	92.1	73.9	50.4	27.1	6.7	0
Median	100.0	92.0	73.0	47.8	24.7	6.1	0

The mean weighted for drill hole interval length was also calculated, but was found to be almost identical to the arithmetic mean, and so is not included in **Table 5.2**.

The laboratory reported verbally to the writer that only trace amounts of +2.36mm were encountered and these have been treated as nil in their reports.

In **Table 5.2** the results shown for the ‘Product’ sand have been determined by re-calculation of the sand grading with all of the -0.075mm material removed.

Figures 7 and 8 show the **Table 5.2** data as graphs, where the envelope plotted is the maximum and minimum values for each sieve shown in the table. The mean value is also plotted onto these graphs.

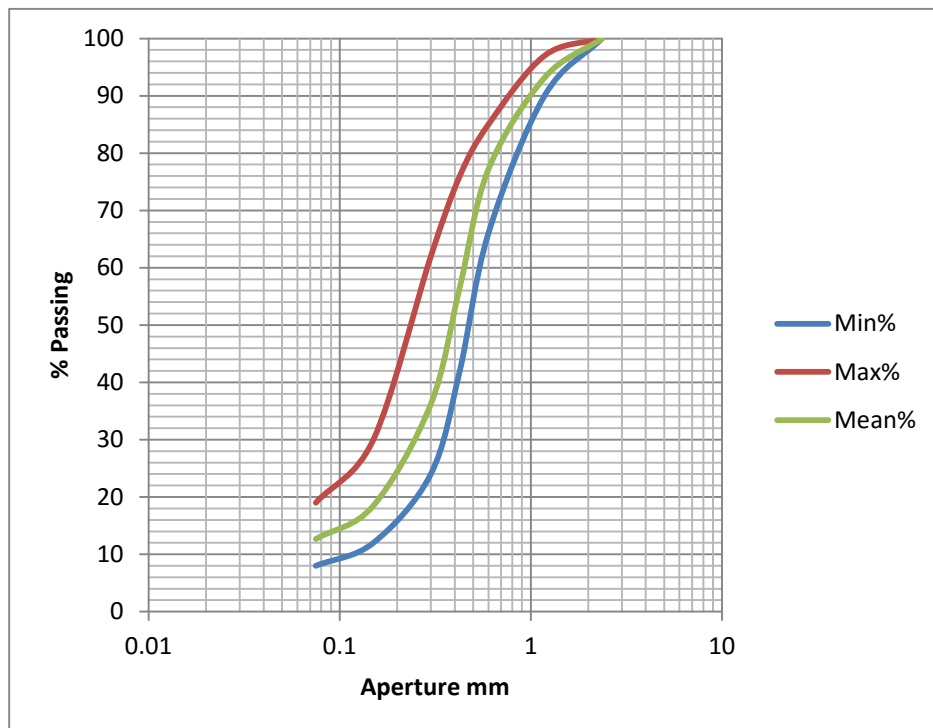


FIGURE 7. Raw sand size grading minimum, maximum, and mean data plotted for the 27 samples tested.

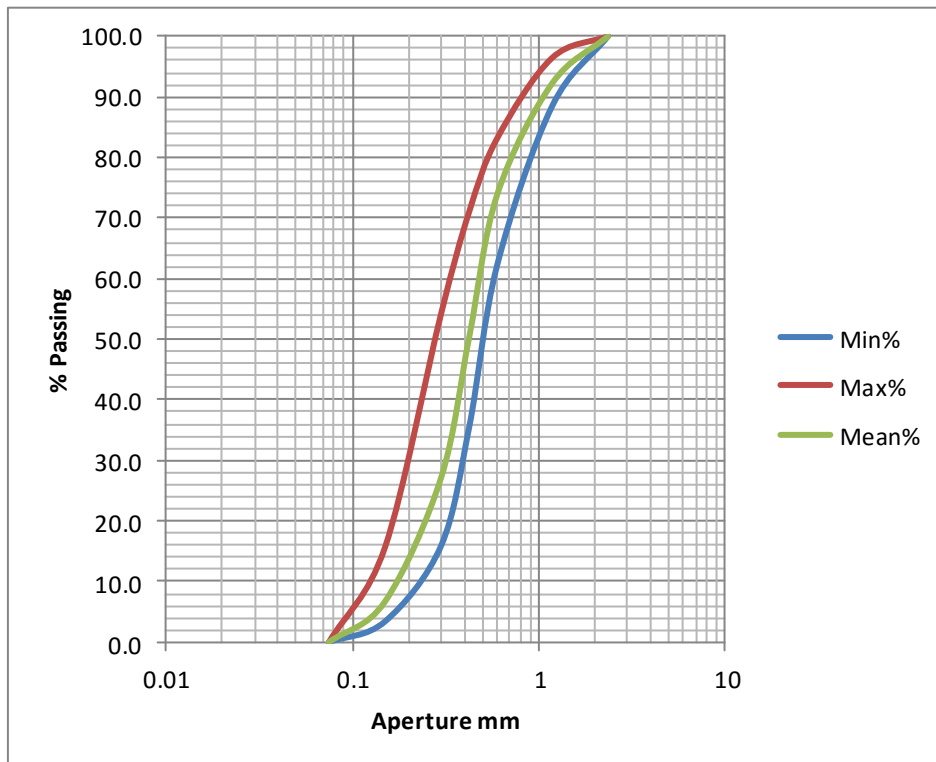


FIGURE 8. Calculated ‘Product’ sand size grading minimum, maximum, and mean data plotted for the 27 samples tested.

5.5 Cross Sections

Two cross sections presenting the geology through the sandstone resources have been prepared.

Figure 2 shows the locations of the two section lines on plan, while **Figure 4** is a NW-SE section through holes DMDDH11, DMDDH09, and DMDDH07, and **Figure 5** is a W-E section through holes DMDDH10, DMDDH07, and DMDDH03. Each section includes the stratigraphy of the site as recorded from the drill core, the topographic surface, and the proposed bottom to the extraction pit. Plotted to the right hand side the hole trace is the sonic geophysical log and to the left is the % passing 0.300mm aperture.

6. RESOURCE ESTIMATES

Resources have been estimated for a single Hawkesbury sandstone domain within the property which has been intersected by four diamond drill holes. There are another five drill holes that have intersected this sandstone unit but fall outside the boundary of the area selected for the estimates. Continuity of the main sandstone bearing unit located near the top of the Hawkesbury Sandstone has been demonstrated by the drilling.

The resource extraction area is shown on **Figure 6** as a solid coloured elevation model within the proposed pit. Typical E-W cross sections through parts of the resource are presented as **Figures 4 and 5**.

6.1 Resource Model

A model of the sandstone resources on the property was constructed taking into account the following:

Boundaries: The 141m AHD contour is the lowest level along the incised creek system on the lower (northern-western) side of the resource area. From the lowest level the elevation rises along the northern boundary to AHD 170m at the eastern end of the extraction area; and along the southwestern boundary to AHD 155m. Cut faces extend along the southern and eastern boundaries till they reach the natural contours at AHD 170m and AHD 155m.

Batters: A 1 in 1 (45°) batter has been used for all cut finished pit walls which are mainly along the southern and eastern boundary.

Floor: The extraction is to be taken down to 2m above the highest permanent water table as determined from piezometers in drill holes. This pit bottom surface generally slopes to the south-west. Control on the surface, 2m above the highest water table in the drill holes is: DMDDH03 = 175.6m, DMDDH07 = 161.8m, DMDDH09 = 154.3m, DMDDH10 = 154.7m, and DMDDH11 = 141.6m. To create the bottom surface, drill hole intercepts are projected at right angles to the topographic ridge axis to meet the valley sides and then the contour is used to delineate the boundary.

Shale lenses: No significant shale lenses were included in the pit volume; however some shale was encountered in some holes beneath the planned pit bottom.

Construction: For estimation, a pit shell was created. The upper surface is the natural surface for which a DEM was prepared at 1m cell size. A bottom surface was created being 2m above the highest water table and was projected to the valley sides where it intersected the natural surface. Along the cut southern and eastern boundaries a 1 in 1 batter was created. A DEM with 1m cell size was created for this bottom surface.

Lithology: **Table 6.1** summarises the diamond drill hole lithology data used in preparing the resource estimates.

Core loss zones, which are small, are interpreted as representing the most friable sandstone and have been treated as being 100% sand in the modelled quantity estimates.

Data is presented in **Table 6.1** for all the diamond cored Hawkesbury Sandstone intervals, and separately for only those holes within the proposed extraction area being DMDDH07, 09, 10, and 11.

TABLE 6.1
SUMMARY OF DDH LITHOLOGY DATA USED FOR RESOURCE ESTIMATES

Lithotype	DMDDH03	DMDDH05	DMDDH07	DMDDH09	DMDDH10	DMDDH11	Total
Hole Total Depth (m)	27.62	20.5	56.27	42.5	35.1	35.1	217.09
Fe Stone (m)	2.27	0.26	1.45	1.41	1.02	0.41	6.82
<i>Fe Stone (%)</i>	<i>8.2</i>	<i>1.3</i>	<i>2.6</i>	<i>3.3</i>	<i>2.9</i>	<i>1.2</i>	<i>3.1</i>
Clay+Shale (m)	0.23	1.55	1.00	1.45	0.34	0.64	5.21
<i>Clay+Shale (%)</i>	<i>0.8</i>	<i>7.6</i>	<i>1.8</i>	<i>3.4</i>	<i>1.0</i>	<i>1.8</i>	<i>2.4</i>
Core Loss (m)	0.5	1.11	0.47	0.57	0.79	0.42	3.86
<i>Core Loss (%)</i>	<i>1.8</i>	<i>5.4</i>	<i>0.8</i>	<i>1.3</i>	<i>2.3</i>	<i>1.2</i>	<i>1.8</i>
Sand+Sandstone (m)	24.63	17.59	53.35	39.07	32.95	33.64	201.22
<i>Sand+Sandstone (%)</i>	<i>89.2</i>	<i>85.8</i>	<i>94.8</i>	<i>91.9</i>	<i>93.9</i>	<i>95.8</i>	<i>92.7</i>
Core Loss+Sand+Sandstone (m)	25.13	18.70	53.82	39.64	33.74	34.06	205.08
<i>Core Loss+Sand+Sandstone (%)</i>	<i>91.0</i>	<i>91.2</i>	<i>95.6</i>	<i>93.3</i>	<i>96.1</i>	<i>97.0</i>	<i>94.5</i>
Holes DMDDH07, 09, 10, 11 only							
Core Loss+Sand+Sandstone (m)			53.82	39.64	33.74	34.06	161.26
Core Loss+Sand+Sandstone (%)			95.6	93.3	96.1	97.0	95.4

Table only includes Hawkesbury Sandstone DDH intervals

6.2 Limiting Criteria

In preparing resource estimates the following limits have been applied.

Depth: Based on drilling and the proposed extraction pit design. A deduction of 0.5m has been applied to allow for topsoil to be removed and for sandstone to be left un-mined on the floor of the pit. In order to simplify estimation, the 0.5m has been assumed to occur as overburden and is removed from the top surface in the calculations.

Overburden: Apart from the soil allowance, there is a small area surrounding DMDDH07 with Ashfield Shale and clay overburden. In DMDDH07 it is 3.73m thick. An estimate of the Ashfield Shale volume is given in **Section 6.3**. In addition some small quantities of Tertiary sediments (mostly clay) similar to that encountered in DMDDH03 may occur in the eastern end of the extraction area but are not included in these estimates.

Interburden: Within the mine section there is no interburden to be selectively removed.

Ironstone: Since most of the ironstone in the resource is competent and will report as screen oversize in the wash plant, it has been deducted from the resource estimates. The average value presented in **Table 6.1** of 3.1% for the six diamond cored drill holes within and near to the resource has been considered as representative of the whole resource and surrounding area.

In situ density: Is based on results from the density geophysical logs. Results are given in **Table 5.1** for all available data on the samples selected for testing (which closely represents the mine working sections in these holes) and for all of the Hawkesbury Sandstone diamond core from the holes geophysically logged. A value of 2.2t/m^3 has been used for resource estimation.

Block: The resource has been treated as a single block with both a Bottom surface and an Upper (natural) surface.

Lithology: Has been determined by visual inspection of the drill hole samples.

Recovery: After excluding ironstone and clay/shale/claystone intersections from the four diamond cored holes within the proposed pit a recovery value of 95.4% is used in the resource estimates being the core loss + sand + sandstone intersected.

6.3 Ashfield Shale Overburden

An estimate of the volume of Ashfield Shale within the extraction area boundary was determined, assuming:

- The bottom surface is a flat horizontal plane, and that
- The bottom surface is the projection of the elevation determined from drill hole DMDDH07.

Estimation of the volume was undertaken by creating a boundary to the shale occurrence and then creating within this boundary:

- A DEM of the upper surface (being the natural topographic surface), and
- A lower DEM of the bottom surface.

The lower DEM was subtracted from the upper DEM to give the volume between the two surfaces.

As a result the Ashfield Shale:

Covers an area = $23,380\text{m}^2$, and
has a volume = $73,250\text{m}^3$

6.4 Sandstone Estimation Method

Using the resource model limiting criteria listed above in **Section 6.2**, a volume has been determined for the proposed extraction void.

In preparing the volume estimates, the size grading data was reviewed to ensure that mainly sandstone material was included into the resources.

Estimates were produced using MapInfo Discovery software. The Upper DEM surface was constructed using 1m cell sizes and minimum curvature. The bottom DEM used 1m cell size and triangulation. Due to the small number of points available for the bottom surface a more realistic

DEM was produced using triangulation compared to minimum curvature. The upper and bottom DEMs were clipped to the boundary of the extraction area, and the bottom DEM surface was subtracted from the upper DEM surface to give the volume between the two surfaces. The volume was converted to tonnes using the density value of 2.2t/m³ determined from the geophysical logging.

6.5 Raw Sandstone Resource Estimates

Resource estimates are shown in **Table 6.2**. The raw sandstone resource estimates represent all the material within the pit shell. From **Table 6.1** the sandstone yield is 95.4% after allowing for removal of the ironstone and thin clay/shale and siltstone beds. Also removed is an allowance for 0.5m of topsoil over an area of 498,882m², being the surface area of the proposed extraction pit.

TABLE 6.2
TOTAL RAW SANDSTONE RESOURCE ESTIMATES

Pit Area (m²)	498,882					
Ashfield Shale (m²)	23,380					
	RAW SANDSTONE (m³)	DENSITY (t/m³)	RAW SANDSTONE (t)	SANDSTONE Less Fe+C/Sh (%)	SANDSTONE Less Fe+C/Sh (t)	Wastes (t)
Pit Volume	9,273,673					
Less Ashfield Shale	73,250	2.2				161,150
Less Soil/unmined	237,751	2.2				523,052
TOTAL	8,962,672	2.2	19,717,878	95.4	18,810,856	907,022
SANDSTONE (Rounded)			20 Million		19 Million	1.6 Million

From these estimates the allowances for materials that will not be processed are:

Ashfield Shale within pit area	=	161,150 tonnes
Top soil and extraction waste	=	523,052 tonnes
Total non-processed materials	=	684,202 tonnes
Ironstone & clay/shale/claystone	=	907,022 tonnes
Total Wastes	=	1,591,224 tonnes
Rounded	=	1.6 million tonnes

These materials will form part of the fill to be placed back into the completed extraction pit. The ironstone and clay/shale/claystone waste will be partly derived from the extraction operation where the larger and thick material will be rejected and partly from the screening at the front end of the washing plant; for simplicity it has all been accounted for at this pre-washing stage of the evaluation.

Material to be processed through the wash plant is therefore 18,810,856 tonnes which rounds to **19 million tonnes**.

The total estimates shown in **Table 6.2** are considered for reporting purposes as Indicated Resources, as defined by the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code (2004)).

Continuity of the horizontally bedded sandstone bearing unit within the bounds of the resource domain has been established by the 2017 drilling. Laboratory testing has shown the sand to be consistent both vertically and horizontally. The sandstone has been classed as “Resources” rather than “Reserves” because extraction approvals have not yet been obtained and it is yet to be determined if any part(s) of the resources will be subject to restrictions on extraction. As stated later in this report, further drilling on a closer grid would be appropriate as a part of any future upgrading of these Resource estimates to; Measured Resources, and/or Proved Reserves, and/or Probable Reserves ahead of extraction. For future Reserves, this could be done on a campaign basis as dictated by production, rather than attempting to upgrade the total Resource in one work program.

6.6 Resource Size Gradings

Table 6.3 shows raw sand size grading statistics for each drill hole within the Resource. In addition to the information shown, some calculations were conducted to weight each sample according to the sample interval but gave very similar results to the unweighted data presented.

Table 6.3 also presents weighted mean ‘product’ sand grading for the DDH core samples. This data is based on calculations to remove all of the -0.075mm material. These ‘product’ gradings give a guide to the likely product particle size grading and yield for whole of the Indicated Resource.

TABLE 6.3
AVERAGE RAW AND PRODUCT SAND SIZE GRADINGS FOR CORE SAMPLES
 (% PASSING – DATA USED FOR RESOURCE ESTIMATION)

APERTURE (mm)		2.36	1.18	0.600	0.425	0.300	0.150	0.075
RAW	Interval m							
DMDDH07, 3.73-34.61m	30.55	100.0	92.7	78.9	63.4	45.6	24.1	16.6
DMDDH09, 13.2-34.54m	32.65	100.0	93.2	76.3	54.1	34.5	18.5	13.6
DMDDH10, 0.40-29.81m	29.40	100.0	92.3	76.6	54.6	32.2	15.6	10.3
DMDDH11, 2.52-33.00m	30.48	100.0	95.4	80.0	58.9	39.4	19.6	11.5
Wtd Mean		100	93.4	77.9	57.7	37.9	19.5	13.0
'PRODUCT' (all -2.36 + 0.075mm)								
DMDDH07, 3.73-34.61m	30.55	100.0	91.2	74.6	56.0	34.7	9.0	0.0
DMDDH09, 13.2-34.54m	32.65	100.0	92.2	72.6	46.9	24.3	5.8	0.0
DMDDH10, 0.40-29.81m	29.40	100.0	91.5	73.9	49.5	24.6	5.9	0.0
DMDDH11, 2.52-33.00m	30.48	100.0	93.7	74.9	49.5	24.3	6.1	0.0
Wtd Mean		100.0	92.2	74.0	50.4	27.0	6.7	0.0

Reviewing **Table 6.3**, the material to be rejected by washing will be in the order of 13%, being the content of –0.075mm in the raw sand. While the washing process will remove some of the +0.075mm fine sand to waste, this will to some extent be compensated by leaving a small portion (usually about 2%) of the –0.075mm fraction in the product sand.

6.7 Product Sand Resource Estimates

Table 6.4 below, sets out the estimated product sand quantities for the Resource based on the removal of all of the –0.075mm from the raw sandstone quantity presented in **Table 6.2**. **Table 6.3** includes the calculated product grading for the Resource listed in **Table 6.2**, and the average grading is presented in a graphic form as **Figure 8** earlier in this report.

TABLE 6.4
PRODUCT SAND RESOURCE ESTIMATES
 (Assuming –0.075mm material is removed)

	RAW SANDSTONE (t)	EXPECTED WASH % YIELD	PRODUCT (million t)	SAND PRODUCT ROUNDED
Sand	18,810,856	87.0	16,365,445	16 Mt
Waste		13.0	2,445,411	
Total		100.0	18,810,856	

6.8 Comments On Resource Estimates

The Resources defined by drilling cover 49.9ha. **Figure 6** shows the boundary to the resource area, while **Figures 4 and 5** present typical cross sections through the extraction area.

The Resource of sandstone (**Table 6.2**) is approximately 20 million tonnes of raw in situ sandstone. From this resource after rejecting 4.6% of ironstone + clay/shale/claystone, the feed to the wash plant is 95.4% or 18 million tonnes. During washing, a further 13.0% is rejected as –0.075mm fines (**Table 6.4**) and the Resource has a yield of 83%, for a **final yield of 16 million tonnes of sand product**.

Total waste materials comprise:

Extraction non processed materials	= 1.6 million tonnes
Wash plant fines	= 2.4 million tonnes
Total waste	= 4.0 million tonnes

Table 1 from the JORC Code 2012 has been completed in respect of the investigations conducted to date on the Deerubbin property at Maroota. The completed JORC Table 1 is included into this report as **Appendix 4**.

7. DISCUSSION

7.1 Drilling Investigations

7.1.1 *DDH Core Samples*

The diamond drilling technique is well suited to the harder more competent sandstone occurring at Maroota, but is not well suited to the unconsolidated Tertiary sands units. Sample recovery was mostly excellent (100%) with only small intervals lost during drilling. Details of the core recoveries are recorded in the lithological logs, and are also shown on the graphic sections as black intervals. Both lithology logs and graphic sections are presented in **Appendix 2** together with the core photographs.

In light of the lithological logging and sample test results on the core, it is apparent that the following drilling-related points need to be considered in reviewing the test results:

- i) In the core it was easy to identify and measure the changes in lithology.
- ii) For the core, the samples selected for testing were divided at lithological breaks.
- iii) For the core drilling the core losses associated with the most friable sandstone are minimal and have little impact on the test results.

Overall, the diamond core was of good quality and well suited to producing good test samples representing the full interval to the bottom of the planned extraction pit. The fact that the sandstone is highly consistent between the drill intersections helps to increase the confidence that the deposit has been sufficiently drilled to obtain representative samples of the material intended to be extracted.

7.1.2 *Open Hole Samples*

Open hole drilling comprised both aircore (AC) and reverse circulation percussion (RCP). It was well suited to the parts of the site drilled using these techniques and the samples are of suitable good quality, but all of these holes are located outside of the propose extraction area. Most samples had consistent sample volume and will be useful for later testing, if it is desired to consider extraction from the locations represented by these holes.

7.2 Sample Testing

Test results are presented in **Appendix 3** as size gradings for each of the samples tested. Significant points to note are:

- i) All ironstone and clay, claystone, shale and siltstone bands were excluded from the test samples on the basis that if they were not removed by selective extraction such materials would be easily discarded in the wash plant. In the case of the ironstone it would report as screen oversize at the front-end screening stage of processing.
- ii) There is a significant quantity of composite grains still remaining in all of the test samples after laboratory processing. The instruction given to the laboratory clearly requested that composites of quartz sand be disaggregated before the sieve analysis was undertaken. Upon examining the washed sand samples returned from the laboratory it was apparent that between 10% and 20% of aggregates were present in all samples. This will impact on the size gradings presented (especially for the coarser apertures), and on the quantity of fine sand in the samples, and the quantity of slimes to be discarded.
- iii) It has been assumed in **Table 6.3** that all of the -0.075mm fraction will be rejected in calculating the recovery for the product sand. In reality, a small part of this -0.075mm fraction will be acceptable into the product sand to give about 2% -0.075mm in the final product. Also, some of the finer sand fractions (coarser than 0.075mm) may be lost to waste due to wash plant inefficiencies. However, overall estimated losses of the -0.075mm fraction based on these laboratory results may be less than will actually occur in a sand wash plant, principally due to the possibility that some of the fine fraction was not sufficiently liberated during sample testing so that it could report to the -0.075mm fraction during testing.
- iv) Considering further, the possibility that some of the -0.075mm fraction has not been liberated from the core samples during testing, and that there is an under estimation of this size fraction with a resultant over estimation of the product sand quantity. The magnitude may be of the order of 5%.

7.3 Comparison With PF Formation Product Sands

Table 7.1 sets out a comparison between the DLALC expected average washed product sand and the ‘Fine Washed Sand’ currently produced by PF Formation who operated from a site adjoining the DLALC land. Also included in **Table 7.1** is the mean grading for the three unwashed initial surface samples reported in Lee (2009)

TABLE 7.1
COMPARISON BETWEEN PF FORMATION PRODUCTS AND DLALC SAND
% Passing

Aperture (mm)	PF Formation 5/4/2017 ‘Fine Washed Sand’	DLALC Washed Sand	Sample 2 (2009)
4.75	100	100	100
2.36	99	100	100
1.18	96	92	94
0.600	88	74	60
0.425	72	50	37
0.300	46	27	20
0.150	10	7	10
0.075	2	0	8

Examining **Table 7.1**, it is apparent that the DLALC sand is coarser than the PF Formation ‘Fine Washed Sand’. This is at least in part attributed to the quantity of composite particles in the DLALC sand, and it is expected that if the number of composites was reduced to a low level by using appropriate washing equipment then the two size gradings would be similar.

The DLALC sand has a slightly finer grading to the mean of the three samples from the 2009 surface sampling.

Therefore it would seem that when the DLALC sand is properly disaggregated and washed the sand product will be similar to the PF Formation ‘Fine Washed Sand’ or maybe a little coarser.

7.4 Potential Applications

Based on the drilling and testing findings currently available, the DLALC Maroota site should be capable of producing sandstone and sand products to meet the following applications:

- Crushed sandstone for fill applications
- Washed sand for concrete and construction (especially fine sand)
- Mortar sand
- Rendering sand
- Some specialty applications

7.5 Resource Estimates

The following points need to be made in relation to the Resources estimates:

- i) All estimates are based on an in situ bulk density of 2.2 tonnes/m³ determined from an analysis of the geophysical density log data. This bulk density value is considered to be close to the overall actual value for this type of deposit.
- ii) While Resource estimates presented in this report are based on a drill hole spacing of between approximately 250m to 500m; it is recommended that holes more closely spaced (approximately 200m apart) be drilled prior to extraction. This will allow detailed extraction plans to be prepared making full allowance for selective mining to blend any variation in grain size, and to reject any materials not suitable for processing.
- iii) It is strongly recommended that ahead of extraction these resource estimates should be upgraded to Proved Reserves status by drilling at approximately 200m centres, or closer) on a regular campaign basis.

7.6 Extraction and Utilisation

The DLALC Maroota sandstone resource within the defined proposed extraction pit area is well suited to the production of fine-grained concrete aggregates as defined by AS2758.1. From this investigation it is concluded that a raw sandstone resource comprising 20 million tonnes occurs within the proposed pit. After rejecting ironstone and other clay/shale materials the raw sandstone available for wash plant feed will be 19 million tonnes. With a wash plant yield of 87% the resources will produce in the order of 16 million tonnes of sand. Extraction waste and wash plant rejects will comprise a total of 4.0 million tonnes to be placed into the pit void as fill.

7.7 Other Potential Resources on DLALC Property

Figure 9 shows the location of three other sand and sandstone resources that have not formed part of the estimates given in the document. These resources comprise:

- Two other Hawkesbury Sandstone resource areas removed from the resource considered herein. One of these areas, labelled “1” on **Figure 9**, adjoins the PF Formation boundary and would ideally be best worked jointly with extraction by PF Formation in order to maximise resource recovery. The other area labelled “2” also adjoins the PF Formation boundary, but is affected by existing permissive occupancies which may restrict the size of the potential resource available for extraction.
- Tertiary sand deposits located in the eastern areas of the property are labelled “3” on **Figure 9**. The sands mostly occur in the upper parts of the sequence.
- Tertiary clay resources in the eastern areas of the property labelled “3” on **Figure 9**. The better quality clay occurs in the lower parts of the sequence and were intersected during drilling, e.g. DMDDH03 9.49 to 17.83m. Such clay could be suitable for brick making.

8. RECOMMENDATIONS FOR FURTHER INVESTIGATIONS

8.1 Future Drilling

As a result of the investigations completed to date, it is suggested that further work be conducted as follows:

- Further test work particularly aimed at upgrading the washing process, and assessing the breakdown of the coarser aggregated particles in the washed 'product' sand from the recent laboratory testing. A major outcome from this work will be a process flowsheet suited to this particular deposit. Sufficient sample material should be available without having to drill more holes for this work.
- Undertake a more comprehensive suite of tests on the final product sand from the upgraded process to assess suitability for concrete fine aggregate. Tests should at least include: water absorption, sodium sulphate soundness, and petrography on the sand.
- Undertake tests to determine suitability for mortar sand and other potential products.
- To upgrade the friable sandstone resources to Proved Reserves status, drill holes spaced approximately 200m apart, especially to test for the presence of any significant shale lenses within the sandstone and to check for particle size grading changes. This drilling could use open hole RCP to reduce expenditure.
- Undertake geophysical logging of the holes to provide more detail particularly with respect to the rippability determined from the sonic log.
- Examine in more detail the yellow block sandstone resources. Include: petrography on core currently available from DMDDH07, field mapping at about AHD 135m to see if the unit can be observed in out crop in the valleys near DMDDH07. Then prepare a work program specifically to assess the quality and potential to extract the yellow block sandstone.

9. **REFERENCES**

- Etheridge, L.T., 1980 Geological Investigation and Resource Assessment of the Maroota Tertiary Alluvial Deposit. Geological Survey NSW Report No GS1980/201, August 1980.
- Lee, G., 2009 Preliminary Investigation of Sand Resources on Properties at Londonderry and Maroota NSW. Graham Lee & Associates Report No GLA2009-02. Prepared for Indigenous Business Services. April 2009.
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