GILBERT SUTHERLAND

27 July 2017

Lismore City Council
PO Box 1138
Lismore NSW 2480

Attention: Greg Buckler

Dear Greg,

Re: Proposed quarrying of cap rock in southern pit, and potential effect on groundwater

Further to our recent correspondence, Gilbert and Sutherland (G&S) has reviewed the proposed quarrying of cap rock form the southern pit and the potential for that extraction to effect groundwater.

Summary

G&S understand that due to increased demand, Blakebrook Quarry have identified a target for additional extraction to the north of the southern pit and submitted an application for that work. That target is presented below in **Drawing 001**. The target area approaches as close as 85 m to the southern groundwater monitoring cluster, and as such that cluster provides relevant data for the target. The elevation of the target varies from approximately 127.5 mAHD to 132 mAHD, and G&S understand that the top four to six metres of rock are expected to be removed.

Southern groundwater monitoring cluster

Within the southern cluster are three bores (BQS1S, S1I and S1L), each targeting a different water bearing zones. The water bearing zones interflow and are formed of vesicular and fractured basalt and sediments between successive basalt flows which form the ridge on which Blakebrook Quarry is situated. Groundwater has been recorded using down-hole loggers, and that data is retrieved regularly for download by Mat Baker of GDCS.

To analyse the level data and any potential effects, all heights and depths have been converted to mAHD.

The groundwater levels in the southern monitoring cluster can be tabulated as follows:

Monitoring Bore	Target water bearing zone	Minimum groundwater level (mAHD)	Maximum groundwater level (mAHD)
BQS1S	shallow	101.55	105.64
BQS1I	intermediate	84.00	84.83
BQS1D	deep	53.59	53.97

Table 1: minimum and maximum groundwater levels for the period 6 September 2016 to 6 June 2017

Conceptual model

A conceptual model has been produced showing three different water bearing zones (shallow, intermediate and deep) and relative pressure head levels. The depths of these water bearing zones were obtained from G&S drilling borelogs whilst the pressure head levels were the maximum groundwater levels shown in Table 1. The location of the conceptual model cross section is shown in Drawing 001 and the model itself presented in Drawing 002.

Conclusions and recommendations

The highest groundwater level in the southern area is that of the shallow water bearing zone at a maximum of 105.64 mAHD, recorded in the period between 6 September 2016 and 6 June 2017. It is understood that extraction will be to a depth of approximately 122mAHD. As such the water bearing zones will not be interfered with by the proposed extraction. Indeed a buffer of greater than 15m will be maintained. The current regime of groundwater monitoring should continue.

We trust this is acceptable. Please do not hesitate to contact this office if you require any further details or elaboration.

Yours faithfully,

Chris Anderson
Director/Principal Environmental Engineer/Scientist
BEngEnv BScLan&Wat Man
MEIANZ MIEAust

for David Winterbotham
Senior Geoscientist
BSc(Hons)

Attachment 1: Drawings

Author Chris Anderson and David Winterbotham
Our Reference 11737_GWA_WSDW4D_072017.DOCX
Your Reference
By ☐ Courier ☑ Email ☐ Facsimile ☐ Post
Enclosures 2

ORIENTATION

SCALE 1:1 600

20 40 60 80
metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- Proposed Southern Extraction Pit (ERM 2011)
- Proposed Rock Extraction Area
- Cross Section A-A'

SOURCES

Image & Proposed Southern Extraction Pit boundary :	Groundwork Plus - 2011 Proposed Extraction Limits drawing (1043.037)
Proposed Rock Extraction Area:	Lismore City Council - Received by CMA from Greg Buckler via email (19/07/2017)

PROJECT
BLAKEBROOK QUARRY GROUNDWATER ASSESSMENTS

CLIENT
LISMORE CITY COUNCIL

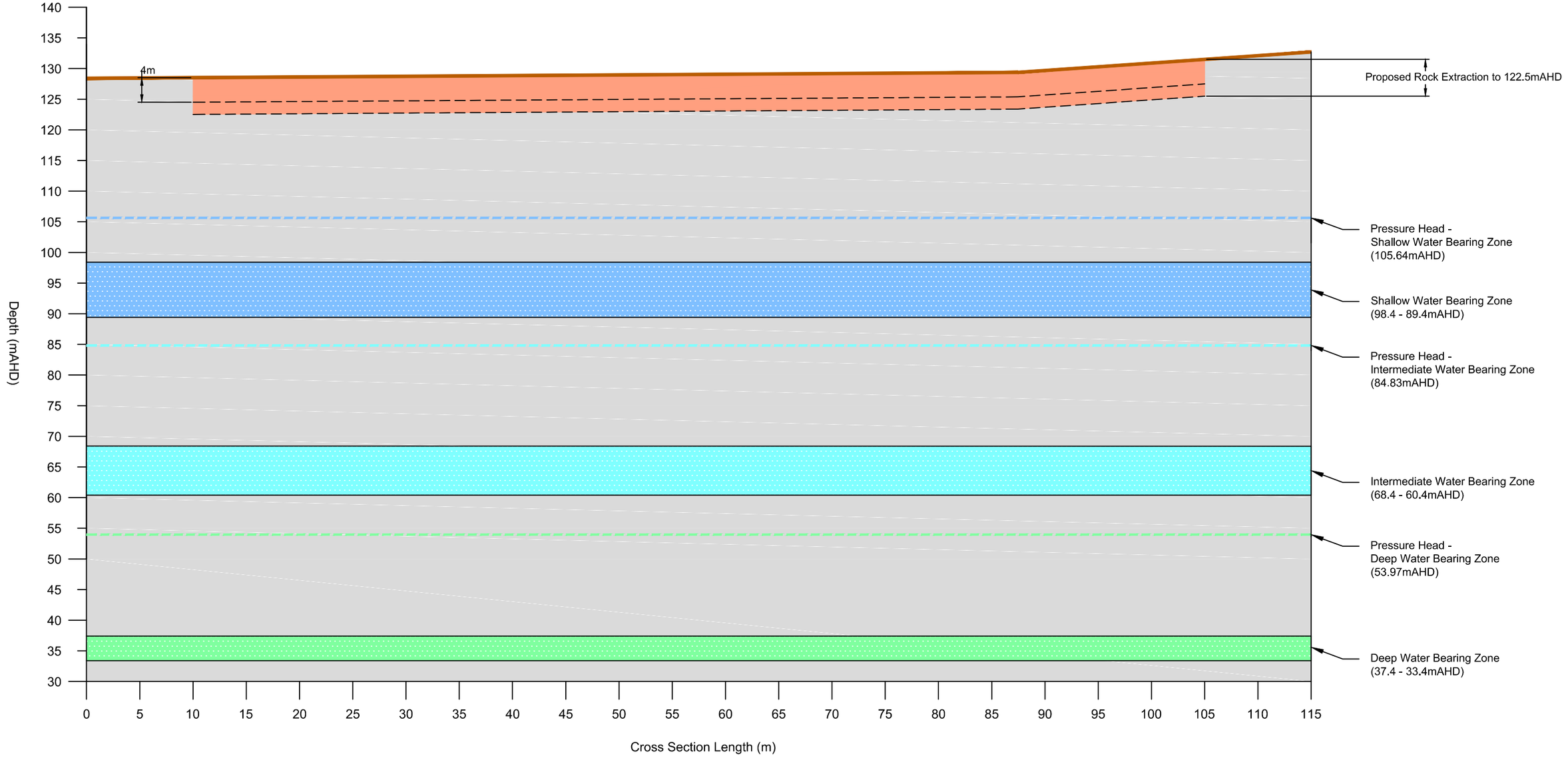
DRAWING
PROPOSED ROCK EXTRACTION AREA

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:1 600@A3	26/07/2017	WPS	CMA	11737	001	-

GILBERT SUTHERLAND

A

A'



ORIENTATION

SCALE
AS SHOWN

ROBINA

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Email robina@access.gs **www.access.gs**

LEGEND

- Existing Ground Surface
- 4 - 6m Proposed Rock Extraction
- Basalt
- Shallow Water Bearing Zone
- Intermediate Water Bearing Zone
- Deep Water Bearing Zone

SOURCES

Surface elevations: ELVIS - Geoscience Australia. Lismore City Council - monitoring well survey data received by CMA from Greg Buckler via email (24/07/2017)

Geology and water bearing zones: G&S borelogs. Drilling dates: 23/08/2016 - 25/08/2016

Groundwater levels: GDCS data package 05/07/2017

PROJECT
BLAKEBROOK QUARRY GROUNDWATER ASSESSMENTS

CLIENT
LISMORE CITY COUNCIL

DRAWING
PROPOSED ROCK EXTRACTION
CROSS SECTION A - A'

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
AS SHOWN	26/07/2017	WPS	CMA	11737	002	-

GILBERT SUTHERLAND

Attachment 2: Borelogs

NSW GOVERNMENT Department of Primary Industries Water

Form A Particulars of completed work

		1
Driller's Licence No:	DL2364	
Class of Licence:	4	
Driller's Name:	Cameron Sharp	
Assistant Driller:	Darrly Hunt	
Contractor:	Gilbert and Sutherland	
New bore	X	
Deepened		
Reconditioned		
Replacement bore		
Enlarged		
Other (specify)		
Final Depth	55 m	

		2
Work Licence No:	30BL207399	
Name of Licensee:	Lismore City Council	
Intended Use:	Monitoring	
Completion Date:	25/8/16	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	55	120	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
38	43	5	30	0.195	0.195	1	H	30		15	300	

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
13	50		0	55	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 1

Centralisers installed {Yes/No}: No (indicate on sketch)

Sump installed {Yes/No}: Yes — From 52 m To 55 m

Pressure cemented {Yes/No}: No — From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	50		40	52	5	5			0.5	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	2	3	35	55	190	0.19
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					29	35	60	0.01
Method of placement of Gravel Pack	See Code 7: 1								

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Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: 30BL207399

BORE DEVELOPMENT — 8

Chemical used for breaking down drilling mud (Yes/No)	No	Name:	

Method	Bailing/Surging		Jetting		Airlifting		Backwashing		Pumping		Other:	
Duration		hrs		hrs	1	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION — 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION — 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method ____ See Code 4

WORK PARTLY BACKFILLED OR ABANDONED — 11

Original depth of work: ____ m Is work partly backfilled: (Yes/No) ____

Is work abandoned: (Yes/No) ____ Method of abandonment: Backfilled ____ Plugged ____ Capped ____

Has any casing been left in the work (Yes/No) ____ From ____ m To ____ m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)
1	0	35			

Site chosen by: Hydrogeologist ____ Geologist X Driller ____ Diviner ____ Client X Other ____ — 12

13

Lot No ____ DP No ____

Work Location Co ordinates Easting 524670 Northing 6817819 Zone 54

GPS: (Yes/No) Yes >> AMG/AGD ____ or MGA/GDA X (See explanation)

Longitude ____ Latitude ____

Please mark the work site with "X" on the CLID provided map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: _____ **Licensee:** _____

Date: 4/9/16 **Date:** _____

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

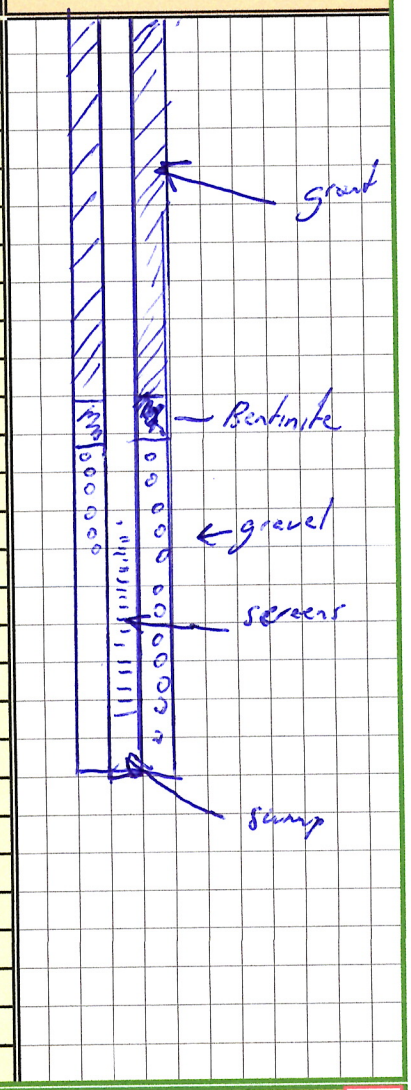
Form A Particulars of completed work

Work Licence No: 30BL207399

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

Depth From (m)	Depth To (m)	Description (See Code 15)
0	5	clay red
5	8	clay firm brown
8	55	bassalt firm blue

15 WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) Yes	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

Department of Primary Industries
Water

Form A Particulars of completed work

Driller's Licence No:	DL2364	1	
Class of Licence:	4		
Driller's Name:	Cameron Sharp		
Assistant Driller:	Darrly Hunt		
Contractor:	Gilbert and Sutherland		
New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	
Final Depth	73 m		

Work Licence No:	30BL207399 (2)
Name of Licensee:	Lismore City Council
Intended Use:	Monitoring
Completion Date:	24/8/16

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	73	120	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
34	39	5	30	0.195	0.195	1	H	30		15	300	
64	70	8	30	0.29	0.485	1	H	30		15	300	

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
13	50		0	73	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 1

Centralisers installed (Yes/No)	No	(indicate on sketch)						
Sump installed (Yes/No)	Yes	From	70	m	To	73	m	
Pressure cemented (Yes/No)	No	From		m	To		m	
Casing Protector cemented in place								

WATER ENTRY DESIGN (6)

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details: Length (mm)	Width (mm)	Alignment (See Code 6)
8	50		58	70	5	5			0.5	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	2	3	53	73	190	0.19
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					47	53	60	0.01
Method of placement of Gravel Pack (See Code 7)	1								

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Work Licence No: 30BL207399

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name:

Method	Bailing/Surging		Jetting		Airlifting		Backwashing		Pumping		Other:	
Duration		hrs		hrs	1	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type See Code 11	From depth (m)	To depth (m)	Sealing / fill type See Code 11	From depth (m)	To depth (m)
1	0	47			

Site chosen by: Hydrogeologist Geologist X Driller Diviner Client X Other 12

Lot No DP No 13

Work Location Co ordinates Easting 524670 Northing 6817819 Zone 54

GPS: (Yes/No) Yes >> AMG/AGD or MGA/GDA X (See explanation)

Longitude Latitude

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Work Licence No: 30BL207399

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

Depth From (m)	Depth To (m)	Description (See Code 15)
0	5	clay red
5	8	clay firm brown
8	66	bassalt firm blue
66	67.5	bassalt/clay broken
67.5	73	bassalt firm blue

15 WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) Yes	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT | Department of Primary Industries Water

Form A Particulars of completed work

Driller's Licence No:	DL2364	1
Class of Licence:	4	
Driller's Name:	Cameron Sharp	
Assistant Driller:	Darrly Hunt	
Contractor:	Gilbert and Sutherland	

New bore	X	Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 102.7 m

Work Licence No:	30BL207399	2
Name of Licensee:	Lismore City Council	
Intended Use:	Monitoring	
Completion Date:	23/8/16	

DRILLING DETAILS (3)

From (m)	To (m)	Hole Diameter (mm)	Drilling Method (See Code 3)
0	102.7	120	9

WATER BEARING ZONES (4)

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method (See Code 4)		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
34	39	5	30	0.195	0.195	1	H	30		15	300	
64	72	8	30	0.29	0.485	1	H	30		15	300	
95	99	4	30	0.73	1.215	1	H	30		15	300	

CASING / LINER DETAILS (5)

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
13	50		0	102.7	5

Casing support method (See Code 5): 2

Type of casing bottom (See Code 5): 1

Centralisers installed {Yes/No}	No	(indicate on sketch)					
Sump installed {Yes/No}	Yes	From	99	m	To	103	m
Pressure cemented {Yes/No}	No	From		m	To		m
Casing Protector cemented in place							

WATER ENTRY DESIGN (6)

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type (See Code 6)	Fixing (See Code 5)	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment (See Code 6)
8	50		87.7	99.7	5	5			0.5	H

GRAVEL PACK (7)

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	X	Graded	X	2	3	82.7	102.7	190	0.19
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)	Yes					76.7	82.7	60	0.01
Method of placement of Gravel Pack (See Code 7)			1						

For Departmental use only: G W

Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: 30BL207399

BORE DEVELOPMENT — 8

Chemical used for breaking down drilling mud (Yes/No)	No	Name:									
Method	Bailing/Surging		Jetting		Airlifting		Backwashing		Pumping		Other:	
Duration		hrs		hrs	1	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION — 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION — 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method ____ See Code 4

WORK PARTLY BACKFILLED OR ABANDONED — 11

Original depth of work: ____ m Is work partly backfilled: (Yes/No) ____

Is work abandoned: (Yes/No) ____ Method of abandonment: Backfilled ____ Plugged ____ Capped ____

Has any casing been left in the work (Yes/No) ____ From ____ m To ____ m

Sealing / fill type See Code 11	From depth (m)	To depth (m)	Sealing / fill type See Code 11	From depth (m)	To depth (m)
1	0	76.7			

Site chosen by: Hydrogeologist ____ Geologist X Driller ____ Diviner ____ Client X Other ____ — 12

— 13

Lot No ____ DP No ____

Work Location Co ordinates Easting 524670 Northing 6817819 Zone 54

GPS: (Yes/No) Yes >> AMG/AGD ____ or MGA/GDA X (See explanation)

Longitude ____ Latitude ____

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ---------- **Licensee:** ----------

Date: ---------- **Date:** ----------

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

Work Licence No: 30BL207399

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)	WORK CONSTRUCTION SKETCH
0	5	clay red	
5	8	clay firm brown	
8	66	bassalt firm blue	
66	67.5	bassalt/clay broken	
67.5	102.7	bassalt firm blue	

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) Yes	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐