

APPENDIX

W

INLAND
RAIL 

Geotechnical

Part 2 of 2

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT


ARTC

The Australian Government is delivering
Inland Rail through the Australian
Rail Track Corporation (ARTC), in
partnership with the private sector.

Shrink Swell Index

SHRINK SWELL INDEX TEST REPORT

Test Method AS 1289 7.1.1

Client	Golder Associates Pty Limited	Report No.	GA101181-ISS
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR02
Test Date	14/11/2018	Report Date	20/11/2018

Project	Inland Rail Section 320
Description	CLAY-brown

Sample No.	320-01-BH2201-U00200
Client ID	320-01-BH2201
Depth (m)	2-2.18

RESULTS OF TESTING

SWELL SPECIMEN

Swell Pressure (kPa) *	150
Wet Density (t/m³)	2.04
Initial Moisture Content (%)	22.9
Final Moisture Content (%)	21.4
Swell (%)	1.8

SHRINKAGE SPECIMEN

Estimated Inert Inclusions (%)	10-20
Extent of Crumbling	Nil
Extent of Cracking	Slight
Moisture (%)	21.4
Shrinkage (%)	6.7

SHRINK SWELL INDEX (Iss) (%)	4.2
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Notes/Remarks:

* Swell pressure determination in accordance with test method AS4133.3.3

Sample/s supplied by client

Tested as received

Page: 1 of 1 REP02304

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Tested at Trilab Brisbane Laboratory

Authorised Signatory



C. Channon



Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Triaxial Compression -Consolidated Undrained

TRIAXIAL TEST REPORT

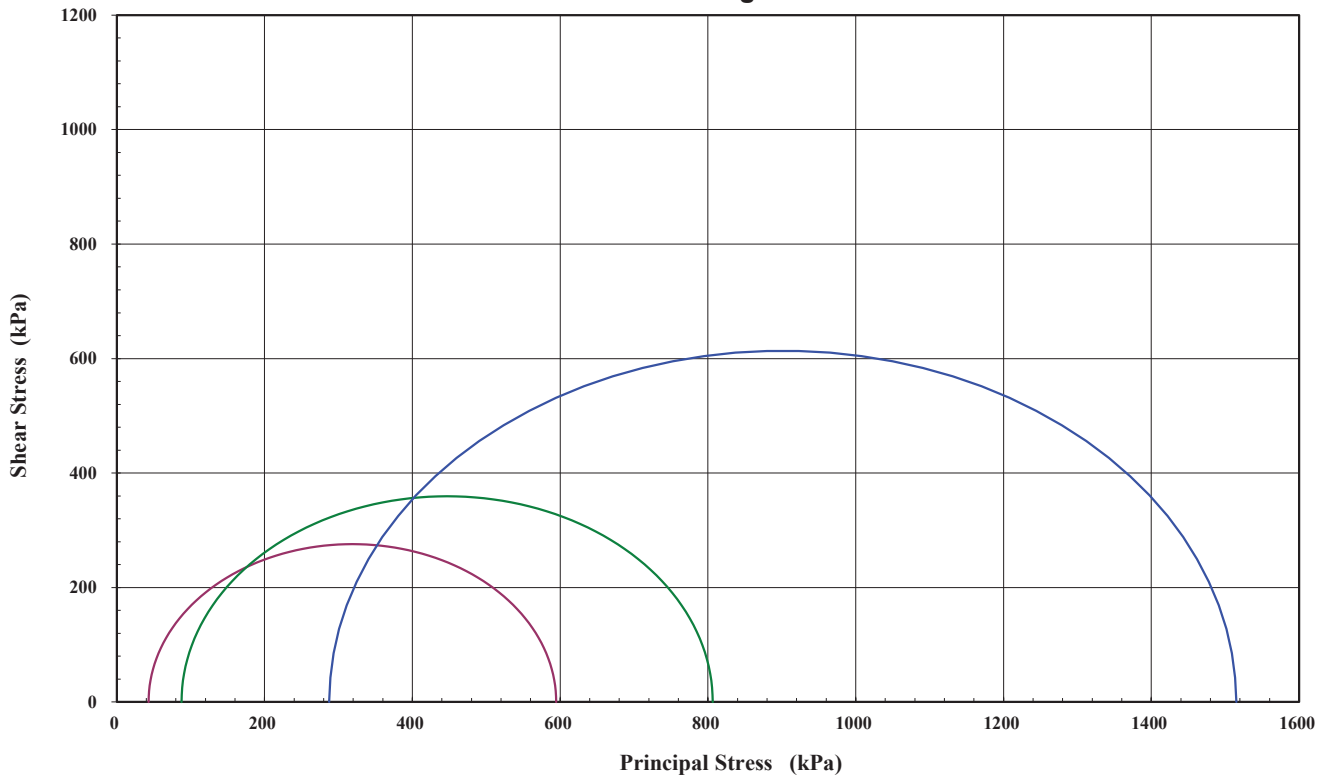
Test Method: AS1289.6.4.2

Client: Golder Associates Pty Limited	Report No.: GA102082 - CU
Address: PO Box 1734 MILTON BC QLD 4064	Request No.: Golder_1893795_TR04
Project: Inland Rail Section 320	Test Date: 25/01/2019
Project No.: 1893795	Report Date: 14/02/2019
Client Sample No.: 320-01-BH2103-C00510	
BoreHole: 320-01-BH2103	Depth From (m): 5.1
	Depth To (m): 5.4
Description: GRAVELLY SILTY CLAY-brown/grey	

SAMPLE & TEST DETAILS

Initial Height: 106.0 mm	Initial Moisture Content: 19.1 %	Rate of Strain: 0.006 %/min
Initial Diameter: 51.8 mm	Final Moisture Content: 24.0 %	B Response: 99 %
L/D Ratio: 2.0 : 1	Wet Density: 1.92 t/m ³	
	Dry Density: 1.61 t/m ³	

Mohr Circle Diagram



Failure Criteria: Peak Principal Stress Ratio

Sample Type: Single Individual Undisturbed Specimen	Remarks: Tested as Received
Sample/s supplied by the client	Note: Graph not to scale

Page 1 of 6

REP03001

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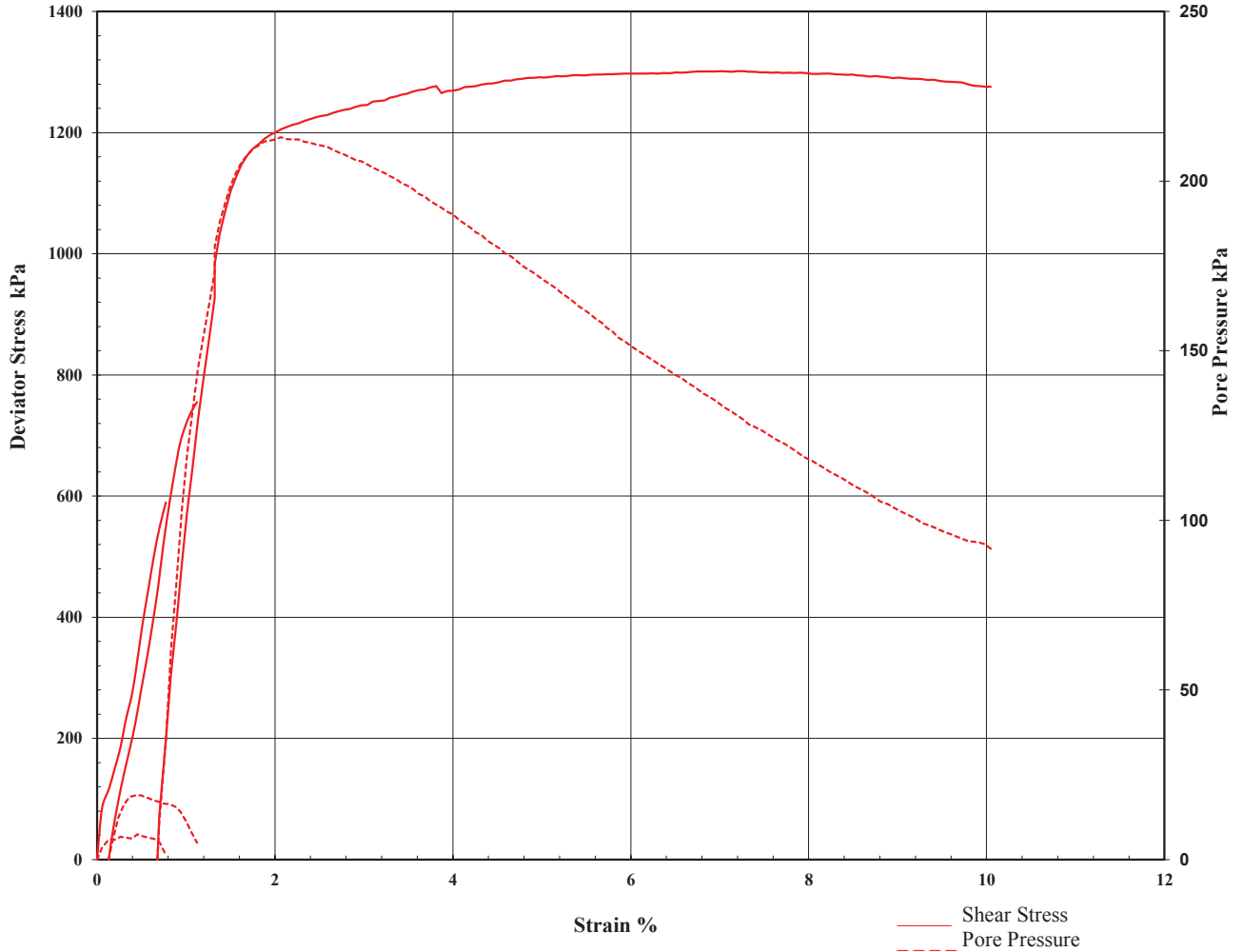
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Limited

Report No.: GA102082 - CU

Stress/Strain & Pore Pressure/Strain Diagram



FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	Principal Effective Stresses			Deviator Stress	Strain
					s'_1	s'_3	s'_1 / s'_3		
48 kPa	551 kPa	503 kPa	503 kPa	508 kPa	595 kPa	43 kPa	13.798	552 kPa	0.71 %
99 kPa	602 kPa	503 kPa	503 kPa	514 kPa	806 kPa	88 kPa	9.196	719 kPa	1.00 %
498 kPa	1001 kPa	503 kPa	503 kPa	714 kPa	1515 kPa	288 kPa	5.270	1228 kPa	2.52 %

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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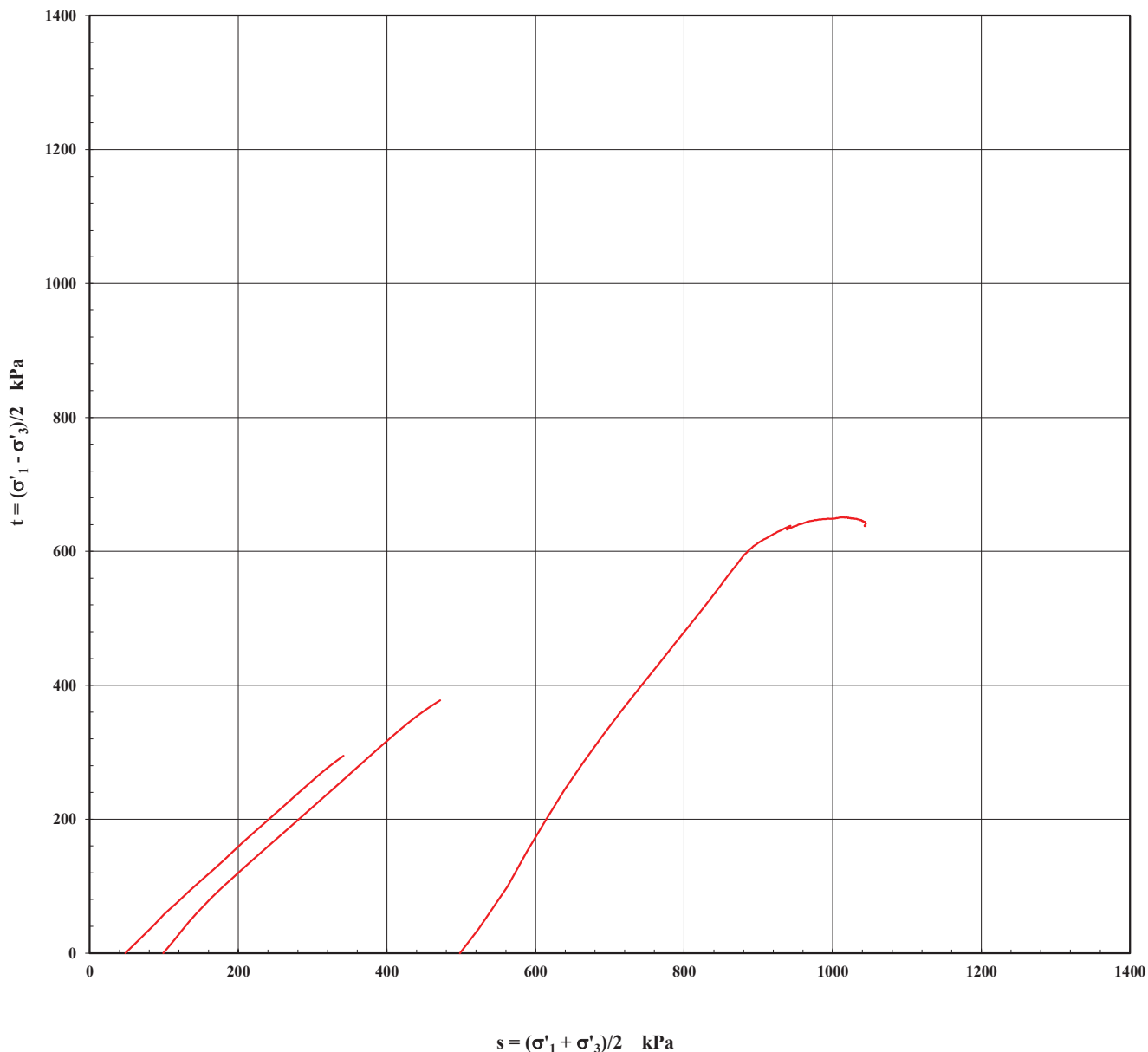
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Limited

Report No.: GA102082 - CU

MIT Method - Effective Stress Path



Note: Graph not to scale.

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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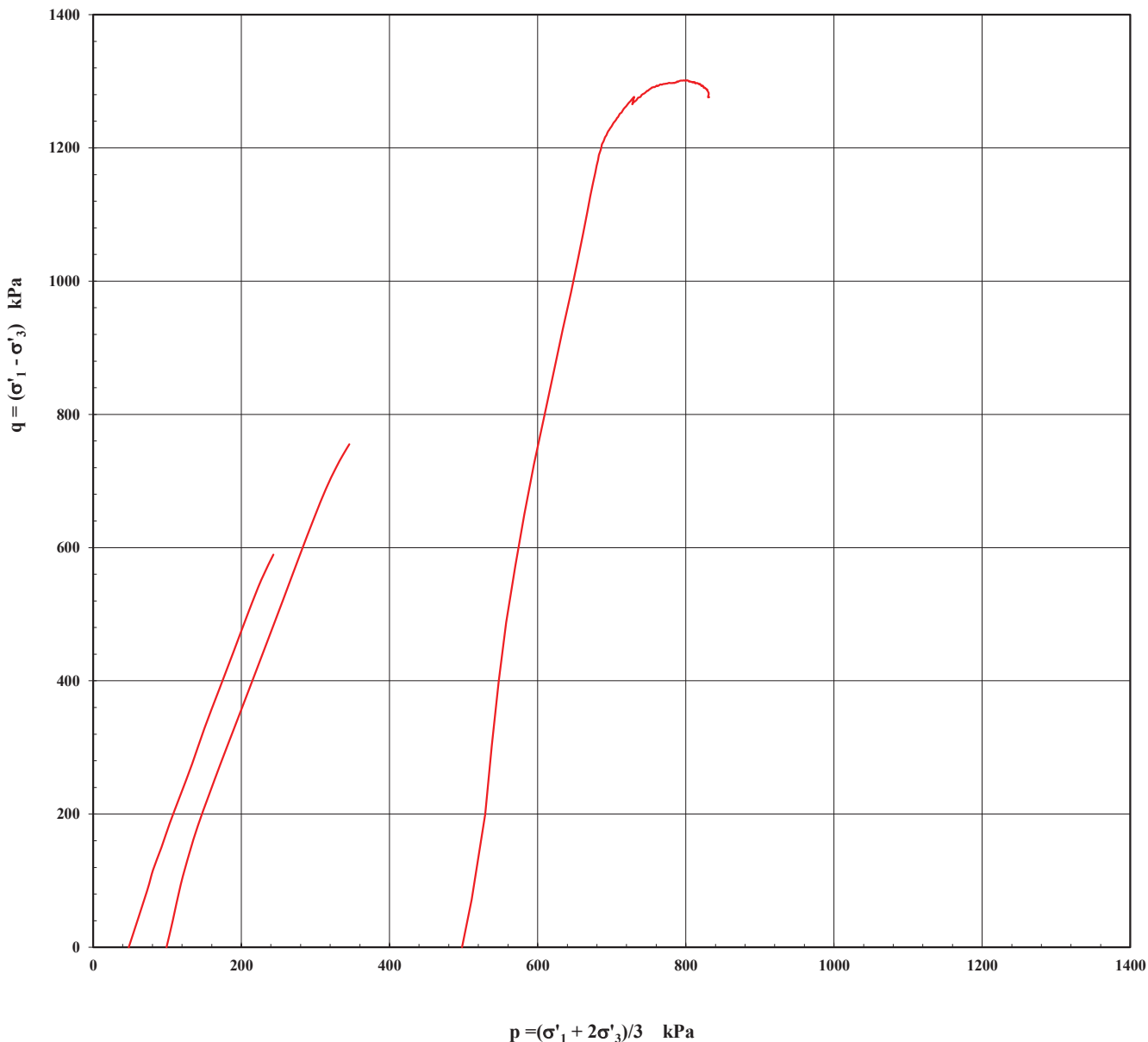
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Limited

Report No.: GA102082 - CU

Cambridge Method - Effective Stress Path



Note: Graph not to scale.

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Limited

Report No.: GA102082 - CU

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102082	DATE: 21/01/19
BOREHOLE:	320-01-BH2103	DEPTH: 5.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102082	DATE: 4/2/19
BOREHOLE:	320-01-BH2103	DEPTH: 5.1



Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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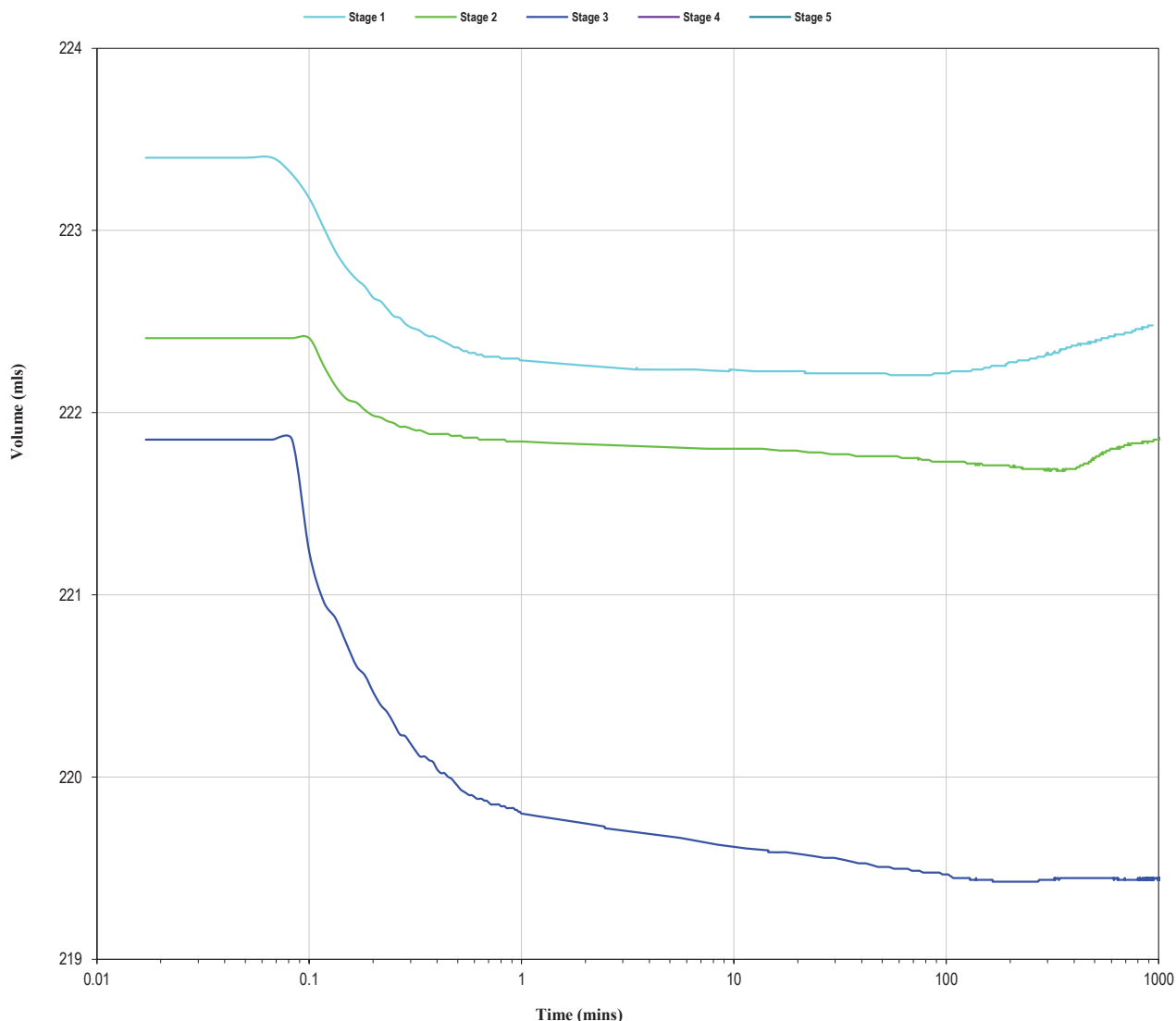
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Limited

Report No.: GA102082 - CU

Volume v's Time (Log Scale)



	Stage 1	Stage 2	Stage 3
Cv (m ² /year) :	208.10	485.67	201.90
Mv (m ² /MN) :	0.098	0.068	0.032
k (m/s) :	6.32E-09	1.03E-08	2.01E-09

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Triaxial Compression - Rock

STRENGTH OF ROCK MATERIAL IN TRIAXIAL COMPRESSION

ASTM D7012

Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client	Golder Associates Pty Limited	Report No.	GA102209-RTX
		Request No.	320-01-BH2101
Address	PO Box 1734 MILTON BC QLD 4064	Test Date	29/01/2019
		Report Date	30/01/2019
Project	Inland Rail Section 320	Depth From (m)	104
Bore Hole	320-01-BH2101	Depth To (m)	104.3
Description	C		
Sample Type	Single Individual Rock Core Specimen		
		Sample No:	320-01-BH2101-TWR : 320-01-BH2101-MOI

Sample Details

Average Sample Diameter (mm)	60.8	Moisture Content (%)	8.1
Sample Height (mm)	132.0	Wet Density (t/m ³)	2.20
Duration of Test (min)	22:11:00	Dry Density (t/m ³)	2.04
Rate of Strain (%/min)	0.05	Bedding (°)	5
Rupture Angle (°)	30	Test Apparatus	RTR2500 Triaxial Machine

Mode of Failure Shear

Intact Test Results

	Value at Plastic Deformation	Value at Plastic Deformation	Value at Plastic Deformation	Peak Value
Confining Pressure (MPa)	12.00	24.10	48.12	48.12
Calc'd Peak Deviator Stress (MPa)	3.10	6.70	-	-
Deviator Stress (MPa)	3.07	6.63	11.3	11.4
Axial Strain (µe)	1613	5563	22878	28760
Diametral Strain (µe)	-185	29	-5822	-8821
Tangent Modulus (GPa)	1.92	1.35	3.39	-
Poisson's Ratio	0.146	0.001	0.008	-

Residual Test Results

Confining Pressure (MPa)	48.13	34.88	11.82
Residual Deviator Stress (MPa)	11.2	10.8	10.6
Axial Strain (µe)	37875	42053	45756
Diametral Strain (µe)	-14339	-18384	-21525

Notes/Remarks:

Sample/s supplied by client

Tested as received

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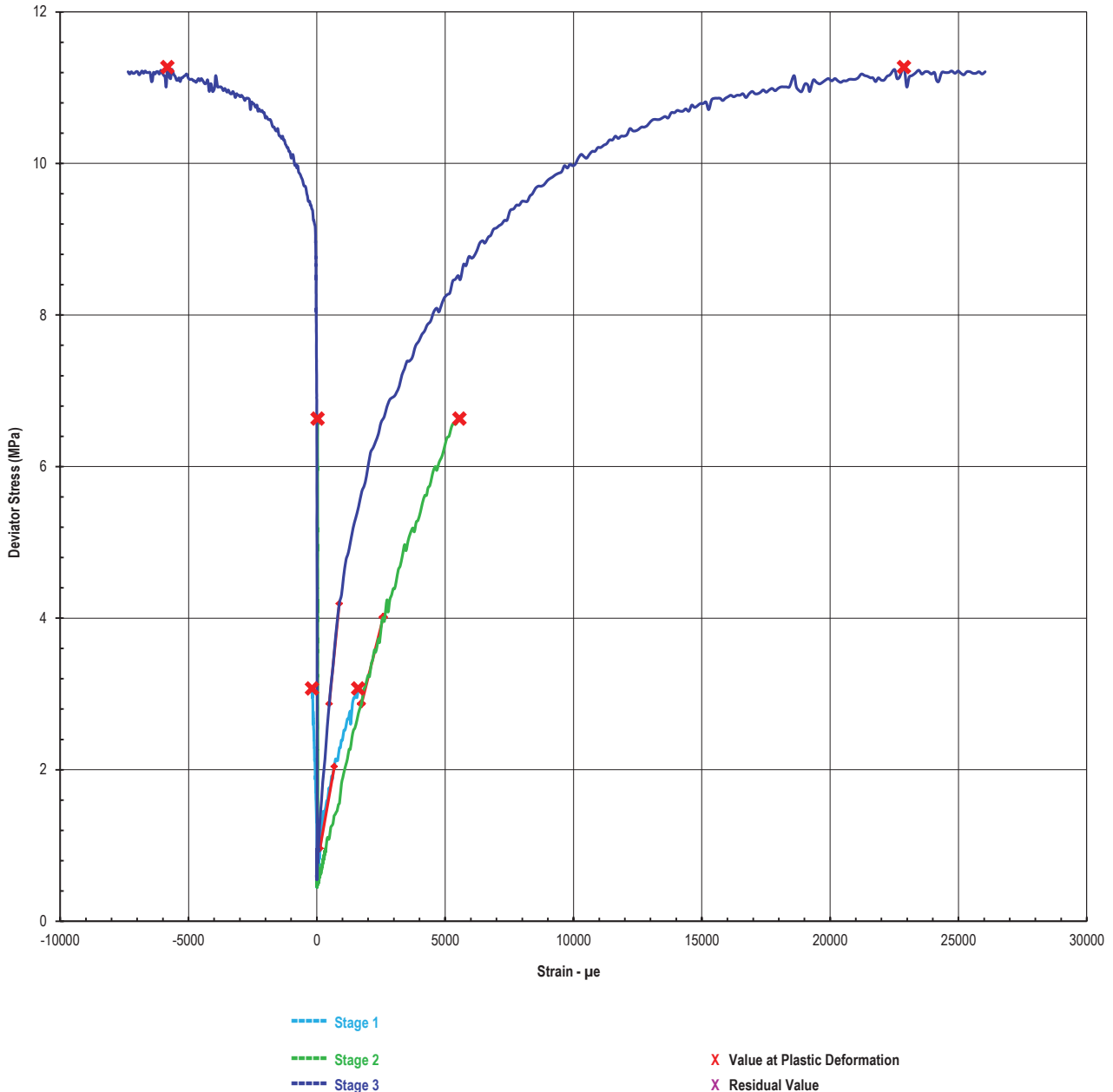
Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client Golder Associates Pty Limited

Report No.

GA102209-RTX

Deviator Stress vs Axial Strain Plots



Notes/Remarks:

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Sample/s supplied by client

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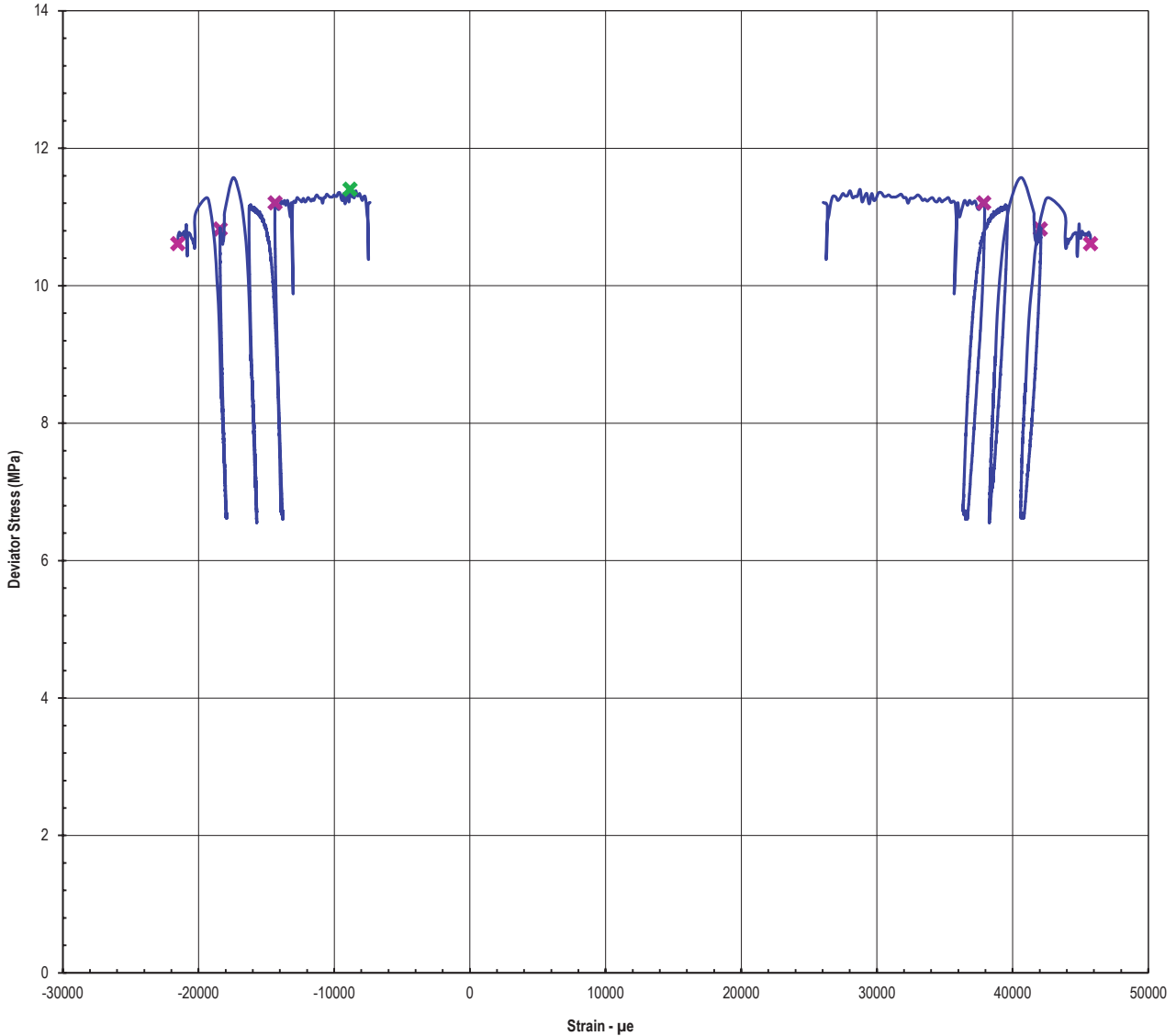
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Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client Golder Associates Pty Limited

Report No. GA102209-RTX

Deviator Stress vs Axial Strain Plots



----- Sta

Peak Value

----- Sta

Value at Plastic Deformation

----- Sta

Residual Value

Notes/Remarks:

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Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client	Golder Associates Pty Limited	Report No.	GA102209-RTX
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Before and After Test Photos

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102209	DATE: 21/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 104



Notes/Remarks:

Sample/s supplied by client Photo not to scale
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STRENGTH OF ROCK MATERIAL IN TRIAXIAL COMPRESSION

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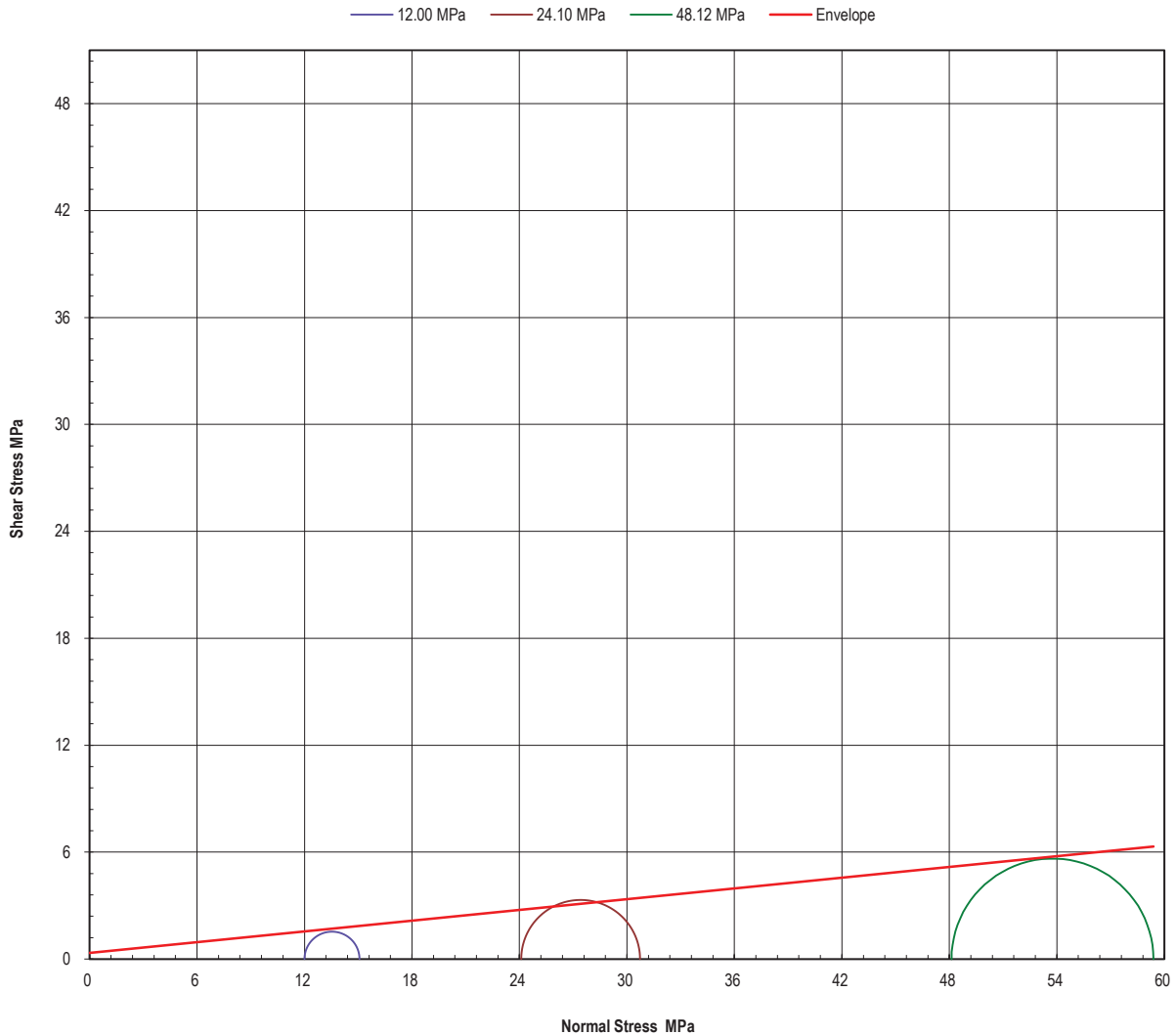
Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client Golder Associates Pty Limited

Report No. GA102209-RTX

Plastic Deformation - Mohr Circle Plot



Estimated Envelope - (Calculated at plastic deformation on each Stage)

Angle	5.7	°
Cohesion	0.34	MPa
Correlation	0.9949	

Notes/Remarks:

Sample/s supplied by client
Graph not to scale
Tested as received

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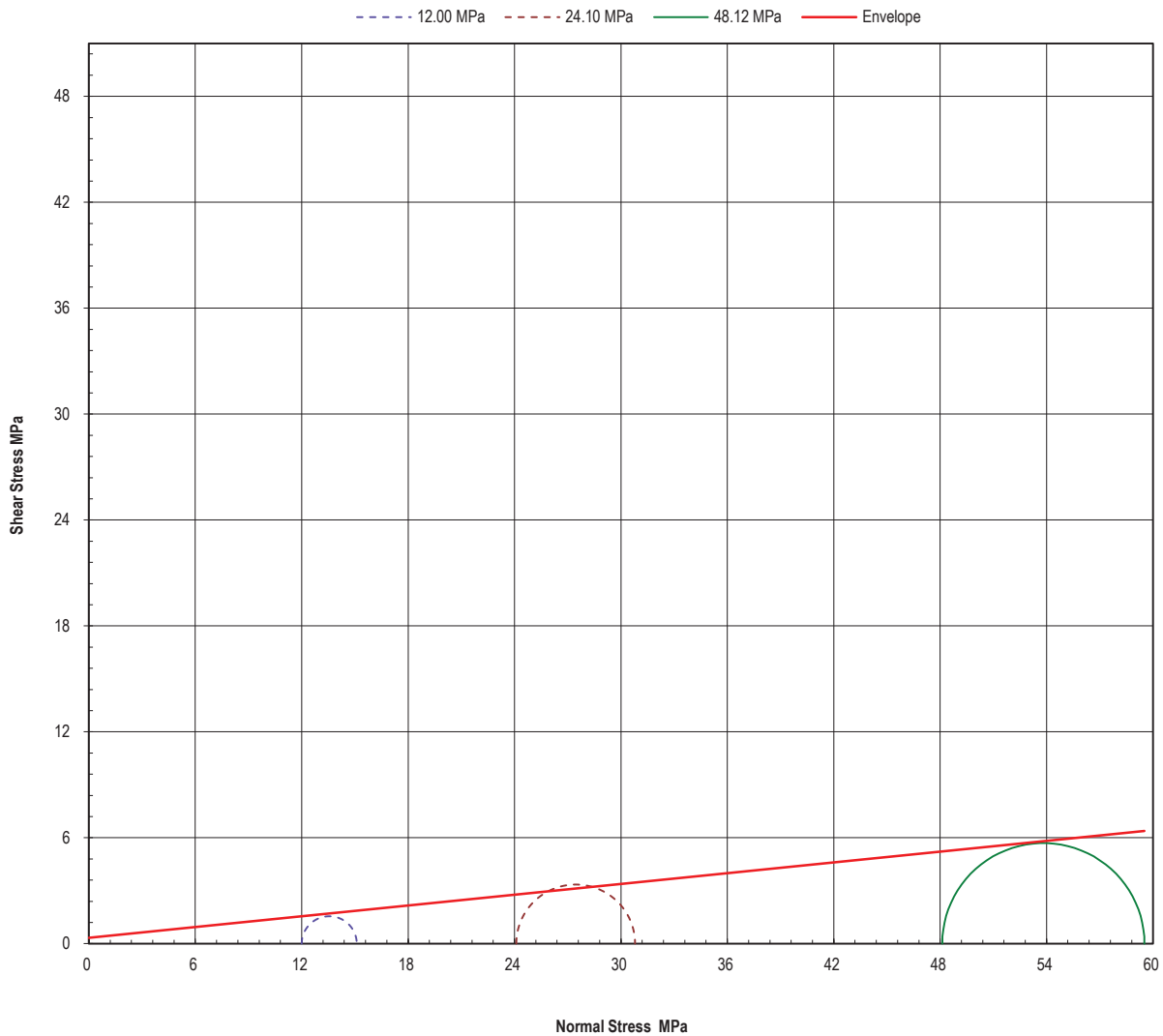
Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client Golder Associates Pty Limited

Report No. GA102209-RTX

Calculated Peak Stress Mohr Circle Plot



Calculated Peak Envelope

Angle	5.8	°
Cohesion	0.34	MPa
Correlation	0.9950	

Notes/Remarks:

Sample/s supplied by client Graph not to scale
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Page 6 of 8 REP16601

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STRENGTH OF ROCK MATERIAL IN TRIAXIAL COMPRESSION

ASTM D7012

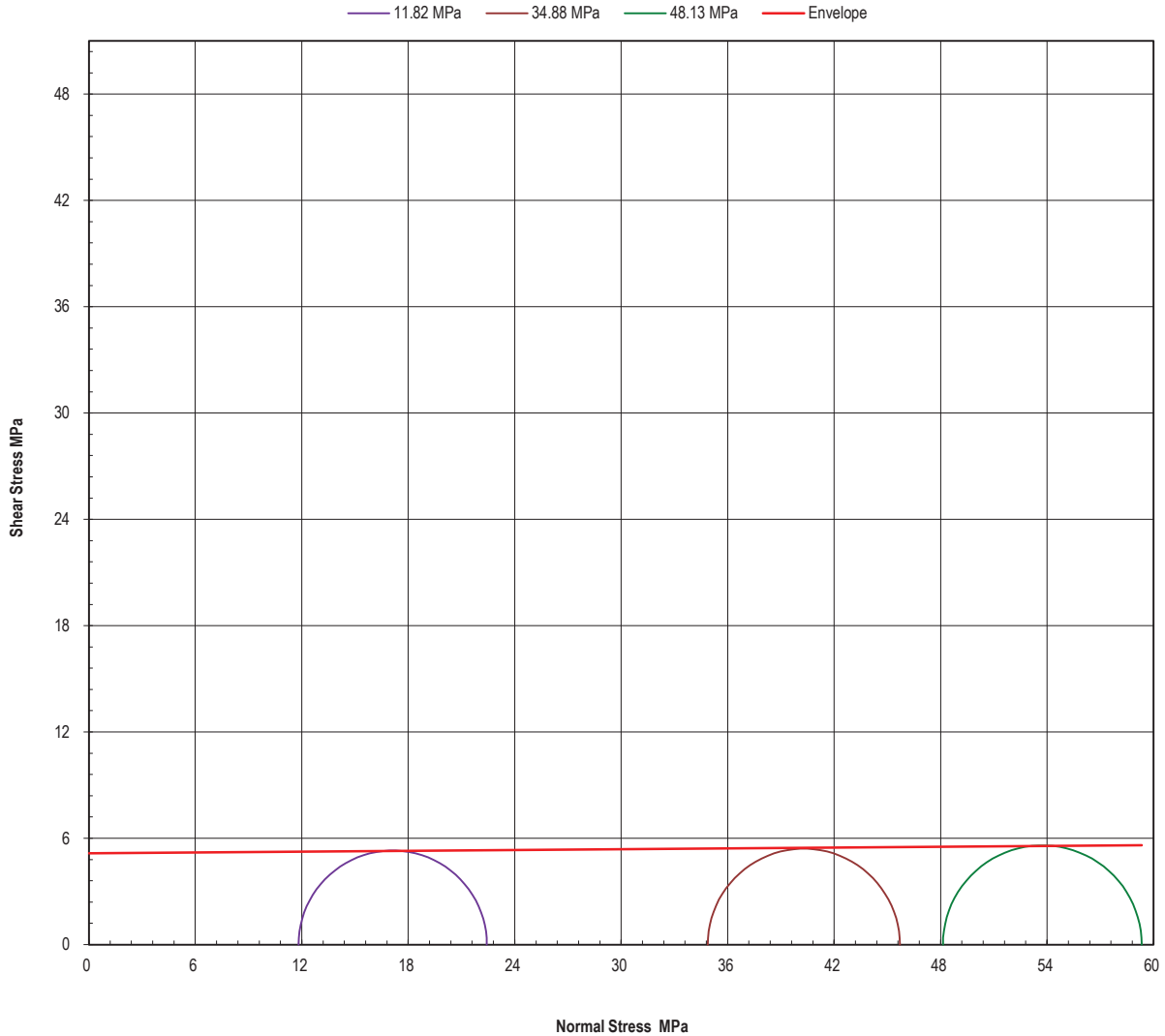
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Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client Golder Associates Pty Limited

Report No. GA102209-RTX

Residual Stress Mohr Circle Plot



Estimated Residual Envelope

Angle	0.4	°
Cohesion	5.15	MPa
Correlation	0.9502	

Notes/Remarks:

Sample/s supplied by client Graph not to scale
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STRENGTH OF ROCK MATERIAL IN TRIAXIAL COMPRESSION

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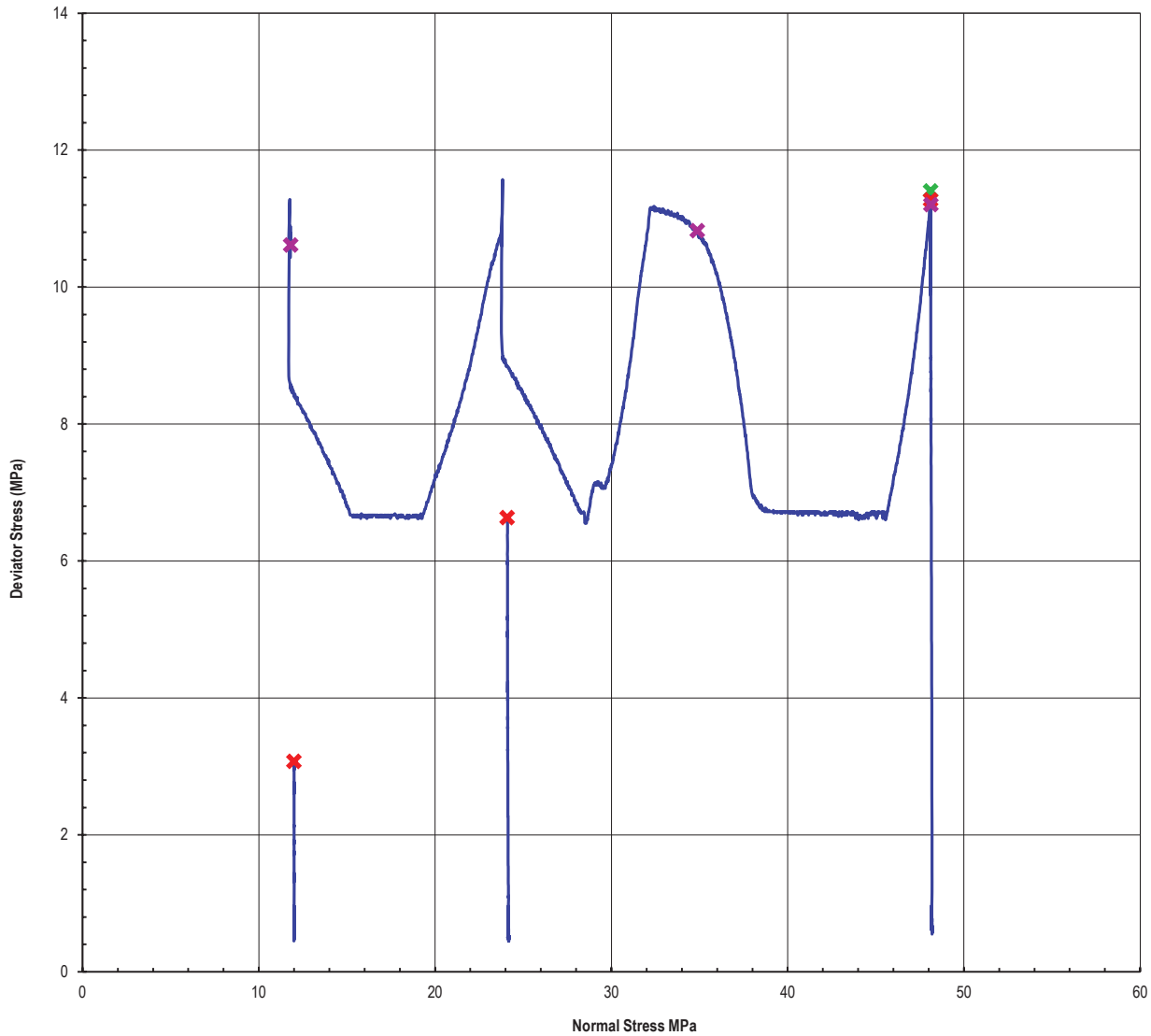
Method B : Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements

Client Golder Associates Pty Limited

Report No.

GA102209-RTX

Deviator Stress vs Normal Stress Plot



X Peak Value

X Value at Plastic Deformation

X Residual Value

Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received

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Point Load Index Testing

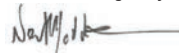
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101184	101185	101186	101188	
Client Sample No	320-01-BH2201-C00780	320-01-BH2201-C01140	320-01-BH2201-C01504	320-01-BH2201-C01808	
Bore Hole	320-01-BH2201	320-01-BH2201	320-01-BH2201	320-01-BH2201	
Depth From/To (m)	7.80-7.90	11.40-11.60	15.04-15.14	18.08-18.18	
Description	C	C	C	C	
Is (MPa)	0.09	0.21	0.17	2.21	
Is(50) (MPa)	0.09	0.21	0.17	1.99	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	101191	101192	101193	101195	
Client Sample No	320-01-BH2209-C00550	320-01-BH2209-C01190	320-01-BH2209-C01460	320-01-BH2209-C01670	
Bore Hole	320-01-BH2209	320-01-BH2209	320-01-BH2209	320-01-BH2209	
Depth From/To (m)	5.50-10.00	11.90-12.00	14.60-14.70	16.70-16.80	
Description	C	C	C	C	
Is (MPa)	0.06	1.14	3.40	0.67	
Is(50) (MPa)	0.06	1.15	3.19	0.66	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 1 of 7
					REP02102

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N. Maddison



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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

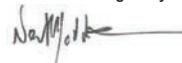
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101196	101197	101200	101201	
Client Sample No	320-01-BH2209-C02000	320-01-BH2209-C02000	320-01-BH2212-C00660	320-01-BH2212-C00950	
Bore Hole	320-01-BH2209	320-01-BH2209	320-01-BH2212	320-01-BH2212	
Depth From/To (m)	20.00-20.10	20.00-20.49	6.60-6.70	9.50-9.60	
Description	C	C	C	C	
Is (MPa)	0.43	0.75	0.51	0.08	
Is(50) (MPa)	0.40	0.69	0.50	0.08	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	101203	101204	101205	101209	
Client Sample No	320-01-BH2212-C01360	320-01-BH2212-C01790	320-01-BH2212-C02000	320-01-BH2218-C00840	
Bore Hole	320-01-BH2212	320-01-BH2212	320-01-BH2212	320-01-BH2218	
Depth From/To (m)	13.60-13.70	17.90-18.00	20.00-20.10	8.40-8.50	
Description	C	C	C	C	
Is (MPa)	0.42	0.97	1.96	2.11	
Is(50) (MPa)	0.39	0.97	1.87	2.05	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 2 of 7 REP02102

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N. Maddison



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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101210	101211	101213	101214	
Client Sample No	320-01-BH2218-C00935	320-01-BH2218-C01000	320-01-BH2218-C01170	320-01-BH2218-C01200	
Bore Hole	320-01-BH2218	320-01-BH2218	320-01-BH2218	320-01-BH2218	
Depth From/To (m)	9.35-9.45	10.00-10.10	11.70-11.80	12.00-12.10	
Description	C	C	C	C	
Is (MPa)	0.79	1.63	3.97	2.85	
Is(50) (MPa)	0.78	1.58	3.74	2.78	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	101215	101216	101218	101219	
Client Sample No	320-01-BH2218-C01405	320-01-BH2218-C01500	320-01-BH2218-C01640	320-01-BH2218-C01880	
Bore Hole	320-01-BH2218	320-01-BH2218	320-01-BH2218	320-01-BH2218	
Depth From/To (m)	14.05-14.15	15.00-15.10	16.40-16.50	18.80-18.90	
Description	C	C	C	C	
Is (MPa)	1.73	4.13	3.98	4.68	
Is(50) (MPa)	1.68	4.05	3.80	4.22	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 3 of 7
					REP02102

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Authorised Signatory



N. Maddison



Laboratory No. 9926

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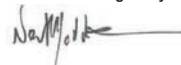
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101220	101184	101185	101186	
Client Sample No	320-01-BH2218-C02005	320-01-BH2201-C00780	320-01-BH2201-C01140	320-01-BH2201-C01504	
Bore Hole	320-01-BH2218	320-01-BH2201	320-01-BH2201	320-01-BH2201	
Depth From/To (m)	20.05-20.15	7.80-7.90	11.40-11.60	15.04-15.14	
Description	C	C	C	C	
Is (MPa)	2.63	0.04	0.17	0.25	
Is(50) (MPa)	2.45	0.04	0.17	0.25	
Load Direction	Axial	Diametral	Diametral	Diametral	
Trilab Sample No.	101188	101191	101192	101193	
Client Sample No	320-01-BH2201-C01808	320-01-BH2209-C00550	320-01-BH2209-C01190	320-01-BH2209-C01460	
Bore Hole	320-01-BH2201	320-01-BH2209	320-01-BH2209	320-01-BH2209	
Depth From/To (m)	18.08-18.18	5.50-10.00	11.90-12.00	14.60-14.70	
Description	C	C	C	C	
Is (MPa)	1.16	0.23	0.97	2.72	
Is(50) (MPa)	1.17	0.23	0.97	2.69	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 4 of 7
					REP02102

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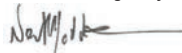
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101195	101196	101197	101200	
Client Sample No	320-01-BH2209-C01670	320-01-BH2209-C02000	320-01-BH2209-C02000	320-01-BH2212-C00660	
Bore Hole	320-01-BH2209	320-01-BH2209	320-01-BH2209	320-01-BH2212	
Depth From/To (m)	16.70-16.80	20.00-20.10	20.00-20.49	6.60-6.70	
Description	C	C	C	C	
Is (MPa)	0.28	0.39	0.65	0.12	
Is(50) (MPa)	0.28	0.39	0.65	0.12	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	101201	101203	101204	101205	
Client Sample No	320-01-BH2212-C00950	320-01-BH2212-C01360	320-01-BH2212-C01790	320-01-BH2212-C02000	
Bore Hole	320-01-BH2212	320-01-BH2212	320-01-BH2212	320-01-BH2212	
Depth From/To (m)	9.50-9.60	13.60-13.70	17.90-18.00	20.00-20.10	
Description	C	C	C	C	
Is (MPa)	0.17	0.06	1.22	1.25	
Is(50) (MPa)	0.17	0.06	1.22	1.26	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 5 of 7
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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Test Date				31/10/2018	
Report Date				6/11/2018	

Trilab Sample No.	101209	101210	101211	101213
Client Sample No	320-01-BH2218-C00840	320-01-BH2218-C00935	320-01-BH2218-C01000	320-01-BH2218-C01170
Bore Hole	320-01-BH2218	320-01-BH2218	320-01-BH2218	320-01-BH2218
Depth From/To (m)	8.40-8.50	9.35-9.45	10.00-10.10	11.70-11.80
Description	C	C	C	C
Is (MPa)	1.92	1.56	1.44	2.59
Is(50) (MPa)	1.91	1.56	1.44	2.59
Load Direction	Diametral	Diametral	Diametral	Diametral

Trilab Sample No.	101214	101215	101216	101218
Client Sample No	320-01-BH2218-C01200	320-01-BH2218-C01405	320-01-BH2218-C01500	320-01-BH2218-C01640
Bore Hole	320-01-BH2218	320-01-BH2218	320-01-BH2218	320-01-BH2218
Depth From/To (m)	12.00-12.10	14.05-14.15	15.00-15.10	16.40-16.50
Description	C	C	C	C
Is (MPa)	1.90	1.43	3.13	3.70
Is(50) (MPa)	1.90	1.43	3.16	3.69
Load Direction	Diametral	Diametral	Diametral	Diametral

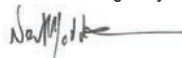
NOTES/REMARKS: Tested as received

Sample/s supplied by the client

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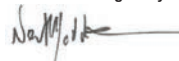
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101184-101220-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR02
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101219	101220			
Client Sample No	320-01-BH2218-C01880	320-01-BH2218-C02005			
Bore Hole	320-01-BH2218	320-01-BH2218			
Depth From/To (m)	18.80-18.90	20.05-20.15			
Description	C	C			
Is (MPa)	4.35	2.04			
Is(50) (MPa)	4.33	2.04			
Load Direction	Diametral	Diametral			
Trilab Sample No.					
Client Sample No					
Bore Hole					
Depth From/To (m)					
Description					
Is (MPa)					
Is(50) (MPa)					
Load Direction					
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 7 of 7 REP02102

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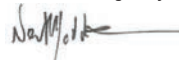
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101325-101334-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR03
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101325	101326	101327	101328	
Client Sample No	320-01-BH2217-C00290	320-01-BH2217-C00510	320-01-BH2217-C00520	320-01-BH2217-C00700	
Bore Hole	320-01-BH2217	320-01-BH2217	320-01-BH2217	320-01-BH2217	
Depth From/To (m)	2.90-3.00	5.10-5.20	5.20-5.40	7.00-7.10	
Description	C	C	C	C	
Is (MPa)	3.16	4.81	3.15	4.08	
Is(50) (MPa)	3.10	4.65	3.16	4.08	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	101329	101330	101331	101332	
Client Sample No	320-01-BH2217-C00710	320-01-BH2217-C01100	320-01-BH2217-C01600	320-01-BH2217-C01610	
Bore Hole	320-01-BH2217	320-01-BH2217	320-01-BH2217	320-01-BH2217	
Depth From/To (m)	7.10-7.30	11.00-11.10	16.00-16.10	16.10-16.30	
Description	C	C	C	C	
Is (MPa)	3.32	2.52	4.61	3.94	
Is(50) (MPa)	3.08	2.43	4.51	3.86	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 1 of 3
					REP02102

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

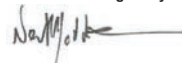
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101325-101334-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR03
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101333	101334	101325	101326	
Client Sample No	320-01-BH2217-C02025	320-01-BH2217-C02040	320-01-BH2217-C00290	320-01-BH2217-C00510	
Bore Hole	320-01-BH2217	320-01-BH2217	320-01-BH2217	320-01-BH2217	
Depth From/To (m)	20.25-20.35	20.40-20.57	2.90-3.00	5.10-5.20	
Description	C	C	C	C	
Is (MPa)	0.06	3.03	2.55	4.26	
Is(50) (MPa)	0.06	2.80	2.54	4.19	
Load Direction	Axial	Axial	Diametral	Diametral	
Trilab Sample No.	101327	101328	101329	101330	
Client Sample No	320-01-BH2217-C00520	320-01-BH2217-C00700	320-01-BH2217-C00710	320-01-BH2217-C01100	
Bore Hole	320-01-BH2217	320-01-BH2217	320-01-BH2217	320-01-BH2217	
Depth From/To (m)	5.20-5.40	7.00-7.10	7.10-7.30	11.00-11.10	
Description	C	C	C	C	
Is (MPa)	3.00	2.29	4.66	2.23	
Is(50) (MPa)	2.99	2.29	4.64	2.23	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 2 of 3 REP02102

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA101325-101334-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR03
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	101331	101332	101333	101334	
Client Sample No	320-01-BH2217-C01600	320-01-BH2217-C01610	320-01-BH2217-C02025	320-01-BH2217-C02040	
Bore Hole	320-01-BH2217	320-01-BH2217	320-01-BH2217	320-01-BH2217	
Depth From/To (m)	16.00-16.10	16.10-16.30	20.25-20.35	20.40-20.57	
Description	C	C	C	C	
Is (MPa)	4.44	4.06	1.56	1.56	
Is(50) (MPa)	4.43	4.05	1.53	1.53	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.					
Client Sample No					
Bore Hole					
Depth From/To (m)					
Description					
Is (MPa)					
Is(50) (MPa)					
Load Direction					
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 3 of 3 REP02102

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102052	102054	102055	102056	
Client Sample No	320-01-BH2102-C19600	320-01-BH2102-C19740	320-01-BH2102-C20140	320-01-BH2102-C20600	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2102	320-01-BH2102	
Depth From/To (m)	196.12-196.27	197.40-197.60	201.40-201.60	206.00-206.10	
Description	C	C	C	C	
Is (MPa)	0.51	0.01	0.05	0.09	
Is(50) (MPa)	0.56	0.01	0.06	0.08	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	102057	102059	102061	102064	
Client Sample No	320-01-BH2102-C20820	320-01-BH2102-C21140	320-01-BH2102-C21480	320-01-BH2102-C21780	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2102	320-01-BH2102	
Depth From/To (m)	208.20-208.40	211.40-211.60	214.62-24.78	217.80-217.90	
Description	C	C	C	C	
Is (MPa)	0.04	0.13	1.04	0.49	
Is(50) (MPa)	0.04	0.14	1.13	0.52	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 1 of 7
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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

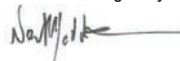
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
				Request No	Golder_1893795_TR04
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	23/01/2019
				Report Date	25/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102066	102068	102069	102072	
Client Sample No	320-01-BH2102-C21900	320-01-BH2102-C22100	320-01-BH2102-C22390	320-01-BH2102-C22720	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2102	320-01-BH2102	
Depth From/To (m)	219.00-219.10	221.00-221.10	223.90-224.00	227.20-227.40	
Description	C	C	C	C	
Is (MPa)	1.43	7.94	1.26	1.09	
Is(50) (MPa)	1.46	8.28	1.17	1.20	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	102074	102076	102083	102085	
Client Sample No	320-01-BH2102-C23310	320-01-BH2102-C23800	320-01-BH2103-C01050	320-01-BH2103-C01700	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2103	320-01-BH2103	
Depth From/To (m)	233.17-233.30	238.00-238.10	10.50-10.60	17.00-17.20	
Description	C	C	C	C	
Is (MPa)	0.32	0.03	0.06	0.50	
Is(50) (MPa)	0.34	0.03	0.06	0.53	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 2 of 7 REP02102

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
				Request No	Golder_1893795_TR04
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	23/01/2019
				Report Date	25/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102087	102089	102099	102100	
Client Sample No	320-01-BH2103-C01910	320-01-BH2103-C02480	320-01-BH2203-C01000	320-01-BH2203-C01200	
Bore Hole	320-01-BH2103	320-01-BH2103	320-01-BH2203	320-01-BH2203	
Depth From/To (m)	19.00-19.15	24.77-24.85	10.00-10.12	12.10-12.23	
Description	C	C	C	C	
Is (MPa)	0.38	0.33	0.18	0.33	
Is(50) (MPa)	0.39	0.29	0.18	0.31	
Load Direction	Axial	Axial		Axial	
Trilab Sample No.	102102	102103	102111	102112	
Client Sample No	320-01-BH2203-C01600	320-01-BH2203-C01950	320-01-BH2207-C01100	320-01-BH2207-C01600	
Bore Hole	320-01-BH2203	320-01-BH2203	320-01-BH2207	320-01-BH2207	
Depth From/To (m)	16.02-16.15	19.50-19.60	11.00-11.10	16.00-16.10	
Description	C	C	C	C	
Is (MPa)	0.51	4.24	0.10	0.22	
Is(50) (MPa)	0.47	4.19	0.10	0.22	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 3 of 7 REP02102

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Laboratory No. 9926

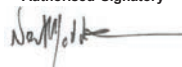
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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102113	102115	102119	102120	
Client Sample No	320-01-BH2207-C01800	320-01-BH2207-C02000	320-01-BH2215-C00740	320-01-BH2215-C01000	
Bore Hole	320-01-BH2207	320-01-BH2207	320-01-BH2215	320-01-BH2215	
Depth From/To (m)	18.00-18.10	20.00-20.11	7.40-7.50	10.00-10.10	
Description	C	C	C	C	
Is (MPa)	0.51	0.47	0.05	0.29	
Is(50) (MPa)	0.51	0.46	0.05	0.29	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	102122	102123	102124	102129	
Client Sample No	320-01-BH2215-C01370	320-01-BH2215-C01500	320-01-BH2215-C01950	320-01-BH2216-C00490	
Bore Hole	320-01-BH2215	320-01-BH2215	320-01-BH2215	320-01-BH2216	
Depth From/To (m)	13.60-13.73	15.00-15.10	19.50-19.60	4.90-5.00	
Description	C	C	C	C	
Is (MPa)	0.02	0.49	1.86	1.41	
Is(50) (MPa)	0.02	0.49	1.84	1.41	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 4 of 7 REP02102

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Authorised Signatory

 N. Maddison



Laboratory No. 9926

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited	Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC QLD 4064	Request No	Golder_1893795_TR04
		Test Date	23/01/2019
		Report Date	25/01/2019

Project	Inland Rail Section 320		
Project No	1893795		

Trilab Sample No.	102130	102131	102132	102134
Client Sample No	320-01-BH2216-C00700	320-01-BH2216-C01000	320-01-BH2216-C01500	320-01-BH2216-C01800
Bore Hole	320-01-BH2216	320-01-BH2216	320-01-BH2216	320-01-BH2216
Depth From/To (m)	7.00-7.12	10.00-10.10	15.00-15.10	18.00-18.10
Description	C	C	C	C
Is (MPa)	2.80	1.00	0.59	0.71
Is(50) (MPa)	2.75	0.99	0.59	0.72
Load Direction	Axial	Axial	Axial	Axial

Trilab Sample No.	102143	102145	102146	102148
Client Sample No	320-01-BH2301-C01109	320-01-BH2301-C01290	320-01-BH2301-C01470	320-01-BH2301-C01600
Bore Hole	320-01-BH2301	320-01-BH2301	320-01-BH2301	320-01-BH2301
Depth From/To (m)	11.09-11.20	12.90-13.00	14.70-14.80	16.00-16.10
Description	C	C	C	C
Is (MPa)	0.75	3.08	0.44	1.24
Is(50) (MPa)	0.72	3.08	0.44	1.23
Load Direction	Axial	Axial	Axial	Axial

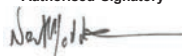
NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Page 5 of 7 REP02102

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Test Date				23/01/2019	
Report Date				25/01/2019	

Trilab Sample No.	102149	102151	102153	102154
Client Sample No	320-01-BH2301-C01800	320-01-BH2301-C02000	320-01-BH2302-C00110	320-01-BH2302-C00300
Bore Hole	320-01-BH2301	320-01-BH2301	320-01-BH2302	320-01-BH2302
Depth From/To (m)	18.00-18.10	20.00-20.10	1.10-1.20	3.01-3.12
Description	C	C	C	C
Is (MPa)	0.56	0.98	0.25	0.34
Is(50) (MPa)	0.53	0.98	0.25	0.34
Load Direction	Axial	Axial	Axial	Axial

Trilab Sample No.	102156	102157	102160	102161
Client Sample No	320-01-BH2302-C00500	320-01-BH2302-C00700	320-01-BH2302-C00900	320-01-BH2302-C01200
Bore Hole	320-01-BH2302	320-01-BH2302	320-01-BH2302	320-01-BH2302
Depth From/To (m)	5.00-5.10	7.00-7.11	9.00-9.10	12.00-12.10
Description	C	C	C	C
Is (MPa)	0.54	0.37	0.69	0.35
Is(50) (MPa)	0.54	0.37	0.69	0.35
Load Direction	Axial	Axial	Axial	Axial

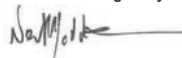
NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Page 6 of 7 REP02102

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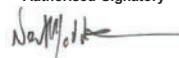
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102163	102164	102166	102167	
Client Sample No	320-01-BH2302-C01400	320-01-BH2302-C01700	320-01-BH2302-C02000	320-01-BH2302-C02390	
Bore Hole	320-01-BH2302	320-01-BH2302	320-01-BH2302	320-01-BH2302	
Depth From/To (m)	14.00-14.10	17.00-17.10	20.00-20.10	23.90-24.00	
Description	C	C	C	C	
Is (MPa)	1.51	0.69	0.31	0.39	
Is(50) (MPa)	1.50	0.68	0.31	0.39	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	102169	102170			
Client Sample No	320-01-BH2302-C02800	320-01-BH2302-C03000			
Bore Hole	320-01-BH2302	320-01-BH2302			
Depth From/To (m)	28.00-28.11	30.00-30.10			
Description	C	C			
Is (MPa)	0.25	0.35			
Is(50) (MPa)	0.25	0.35			
Load Direction	Axial	Axial			
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 7 of 7 REP02102

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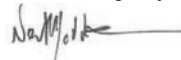
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102052	102054	102055	102056	
Client Sample No	320-01-BH2102-C19600	320-01-BH2102-C19740	320-01-BH2102-C20140	320-01-BH2102-C20600	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2102	320-01-BH2102	
Depth From/To (m)	196.12-196.27	197.40-197.60	201.40-201.60	206.00-206.10	
Description	C	C	C	C	
Is (MPa)	1.82	0.00	0.05	0.17	
Is(50) (MPa)	1.97	0.00	0.05	0.18	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102057	102059	102061	102064	
Client Sample No	320-01-BH2102-C20820	320-01-BH2102-C21140	320-01-BH2102-C21480	320-01-BH2102-C21780	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2102	320-01-BH2102	
Depth From/To (m)	208.20-208.40	211.40-211.60	214.62-214.78	217.80-217.90	
Description	C	C	C	C	
Is (MPa)	0.06	0.01	2.86	0.30	
Is(50) (MPa)	0.06	0.01	3.00	0.31	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 1 of 7
					REP02102

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Trilab Pty Ltd ABN 25 065 630 506

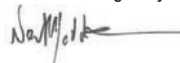
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102066	102068	102069	102072	
Client Sample No	320-01-BH2102-C21900	320-01-BH2102-C22100	320-01-BH2102-C22390	320-01-BH2102-C22720	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2102	320-01-BH2102	
Depth From/To (m)	219.00-219.10	221.00-221.10	223.90-224.00	227.20-227.40	
Description	C	C	C	C	
Is (MPa)	1.75	5.20	1.00	1.66	
Is(50) (MPa)	1.80	5.57	1.06	1.67	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102074	102076	102083	102085	
Client Sample No	320-01-BH2102-C23310	320-01-BH2102-C23800	320-01-BH2103-C01050	320-01-BH2103-C01700	
Bore Hole	320-01-BH2102	320-01-BH2102	320-01-BH2103	320-01-BH2103	
Depth From/To (m)	233.17-233.30	238.00-238.10	10.50-10.60	17.00-17.20	
Description	C	C	C	C	
Is (MPa)	0.06	0.01	0.16	0.61	
Is(50) (MPa)	0.06	0.01	0.15	0.61	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 2 of 7
					REP02102

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Laboratory No. 9926

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
				Request No	Golder_1893795_TR04
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	23/01/2019
				Report Date	25/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102087	102089	102099	102100	
Client Sample No	320-01-BH2103-C01910	320-01-BH2103-C02480	320-01-BH2203-C01000	320-01-BH2203-C01200	
Bore Hole	320-01-BH2103	320-01-BH2103	320-01-BH2203	320-01-BH2203	
Depth From/To (m)	19.00-19.15	24.77-24.85	10.00-10.12	12.10-12.23	
Description	C	C	C	C	
Is (MPa)	0.22	0.19	0.03	0.05	
Is(50) (MPa)	0.22	0.19	0.03	0.05	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102102	102103	102111	102112	
Client Sample No	320-01-BH2203-C01600	320-01-BH2203-C01950	320-01-BH2207-C01100	320-01-BH2207-C01600	
Bore Hole	320-01-BH2203	320-01-BH2203	320-01-BH2207	320-01-BH2207	
Depth From/To (m)	16.02-16.15	19.50-19.60	11.00-11.10	16.00-16.10	
Description	C	C	C	C	
Is (MPa)	0.28	1.20	0.06	0.21	
Is(50) (MPa)	0.28	1.20	0.06	0.21	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received + Irregular Lump				
Sample/s supplied by the client					Page 3 of 7 REP02102

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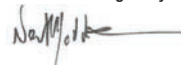
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
				Request No	Golder_1893795_TR04
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	23/01/2019
				Report Date	25/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102113	102115	102119	102120	
Client Sample No	320-01-BH2207-C01800	320-01-BH2207-C02000	320-01-BH2215-C00740	320-01-BH2215-C01000	
Bore Hole	320-01-BH2207	320-01-BH2207	320-01-BH2215	320-01-BH2215	
Depth From/To (m)	18.00-18.10	20.00-20.10	7.40-7.50	10.00-10.10	
Description	C	C	C	C	
Is (MPa)	0.31	0.10	0.16	0.36	
Is(50) (MPa)	0.31	0.10	0.16	0.36	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102122	102123	102124	102129	
Client Sample No	320-01-BH2215-C01370	320-01-BH2215-C01500	320-01-BH2215-C01950	320-01-BH2216-C00490	
Bore Hole	320-01-BH2215	320-01-BH2215	320-01-BH2215	320-01-BH2216	
Depth From/To (m)	13.60-13.73	15.00-15.10	19.50-19.60	4.90-5.00	
Description	C	C	C	C	
Is (MPa)	0.03	0.56	1.63	0.62	
Is(50) (MPa)	0.03	0.56	1.63	0.63	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 4 of 7 REP02102

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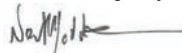
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
				Request No	Golder_1893795_TR04
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	23/01/2019
				Report Date	25/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102130	102131	102132	102134	
Client Sample No	320-01-BH2216-C00700	320-01-BH2216-C01000	320-01-BH2216-C01500	320-01-BH2216-C01800	
Bore Hole	320-01-BH2216	320-01-BH2216	320-01-BH2216	320-01-BH2216	
Depth From/To (m)	7.00-7.12	10.00-10.10	15.00-15.10	18.00-18.10	
Description	C	C	C	C	
Is (MPa)	2.72	0.50	0.33	0.90	
Is(50) (MPa)	2.70	0.50	0.33	0.90	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102143	102145	102146	102148	
Client Sample No	320-01-BH2301-C01109	320-01-BH2301-C01290	320-01-BH2301-C01470	320-01-BH2301-C01600	
Bore Hole	320-01-BH2301	320-01-BH2301	320-01-BH2301	320-01-BH2301	
Depth From/To (m)	11.09-11.20	12.90-13.00	14.70-14.80	16.00-16.10	
Description	C	C	C	C	
Is (MPa)	0.31	1.65	0.28	1.07	
Is(50) (MPa)	0.31	1.64	0.28	1.07	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 5 of 7 REP02102

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Laboratory No. 9926

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Test Date				23/01/2019	
Report Date				25/01/2019	

Trilab Sample No.	102149	102151	102153	102154
Client Sample No	320-01-BH2301-C01800	320-01-BH2301-C02000	320-01-BH2302-C00110	320-01-BH2302-C00300
Bore Hole	320-01-BH2301	320-01-BH2301	320-01-BH2302	320-01-BH2302
Depth From/To (m)	18.00-18.10	20.00-20.10	1.10-1.20	3.01-3.12
Description	C	C	C	C
Is (MPa)	0.58	0.60	0.29	0.12
Is(50) (MPa)	0.58	0.60	0.29	0.11
Load Direction	Diametral	Diametral	Diametral	Diametral

Trilab Sample No.	102156	102157	102160	102161
Client Sample No	320-01-BH2302-C00500	320-01-BH2302-C00700	320-01-BH2302-C00900	320-01-BH2302-C01200
Bore Hole	320-01-BH2302	320-01-BH2302	320-01-BH2302	320-01-BH2302
Depth From/To (m)	5.00-5.10	7.00-7.11	9.00-9.10	12.00-12.10
Description	C	C	C	C
Is (MPa)	0.38	0.21	0.42	0.22
Is(50) (MPa)	0.38	0.21	0.42	0.22
Load Direction	Diametral	Diametral	Diametral	Diametral

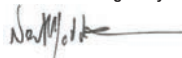
NOTES/REMARKS: Tested as received

Sample/s supplied by the client

Page 6 of 7 REP02102

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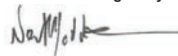
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102052-102170-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	Golder_1893795_TR04
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102163	102164	102166	102167	
Client Sample No	320-01-BH2302-C01400	320-01-BH2302-C01700	320-01-BH2302-C02000	320-01-BH2302-C02390	
Bore Hole	320-01-BH2302	320-01-BH2302	320-01-BH2302	320-01-BH2302	
Depth From/To (m)	14.00-14.10	17.00-17.10	20.00-20.10	23.90-24.00	
Description	C	C	C	C	
Is (MPa)	2.33	0.47	0.23	0.07	
Is(50) (MPa)	2.31	0.47	0.23	0.07	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102169	102170			
Client Sample No	320-01-BH2302-C02800	320-01-BH2302-C03000			
Bore Hole	320-01-BH2302	320-01-BH2302			
Depth From/To (m)	28.00-28.11	30.00-30.10			
Description	C	C			
Is (MPa)	0.40	0.25			
Is(50) (MPa)	0.40	0.25			
Load Direction	Diametral	Diametral			
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 7 of 7 REP02102

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Authorised Signatory



N. Maddison



Laboratory No. 9926

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102180-102249-PL
Address	PO Box 1734 MILTON BC	QLD	4064	Request No	1893795_TR01
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102180	102182	102183	102187	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	78.57-78.72	80.0-80.23	82.61-82.76	93.53-93.66	
Description	C	C	C	C	
Is (MPa)	0.37	0.33	0.31	0.41	
Is(50) (MPa)	0.40	0.35	0.34	0.44	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	102195	102197	102199	102205	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	93.53-93.75	93.61-93.75	95.60-95.73	96.40-96.58	
Description	C	C	C	C	
Is (MPa)	3.65	0.17	2.47	0.50	
Is(50) (MPa)	4.01	0.18	2.73	0.55	
Load Direction	Axial	Axial	Axial	Axial	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 1 of 4 REP02102

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

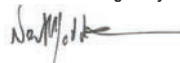
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102180-102249-PL
				Request No	1893795_TR01
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	22/01/2019
				Report Date	23/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102213	102215	102219	102224	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	102.88-103	105.00-105.08	105.80-106.00	108.70-109.00	
Description	C	C	C	C	
Is (MPa)	0.17	0.12	0.02	0.11	
Is(50) (MPa)	0.18	0.14	0.03	0.13	
Load Direction	Axial	Axial	Axial	Axial	
Trilab Sample No.	102243	102244	102249	102180	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	129.33-129.50	131.03-131.14	140.38-140.74	78.57-78.72	
Description	C	C	C	C	
Is (MPa)	0.32	0.40	0.05	0.51	
Is(50) (MPa)	0.35	0.41	0.05	0.52	
Load Direction	Axial	Axial	Axial	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 2 of 4 REP02102

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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102180-102249-PL
				Request No	1893795_TR01
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	22/01/2019
				Report Date	23/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102182	102183	102187	102195	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	80.0-80.23	82.61-82.76	93.53-93.66	93.53-93.75	
Description	C	C	C	C	
Is (MPa)	0.37	0.33	0.39	3.36	
Is(50) (MPa)	0.40	0.35	0.40	3.53	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102197	102199	102205	102213	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	93.61-93.75	95.60-95.73	96.40-96.58	102.88-103	
Description	C	C	C	C	
Is (MPa)	0.48	2.57	4.96	0.08	
Is(50) (MPa)	0.45	2.73	5.32	0.09	
Load Direction	Diametral	Diametral	Diametral	Diametral	
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 3 of 4 REP02102

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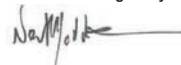
POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	Golder Associates Pty Limited			Report No.	GA102180-102249-PL
				Request No	1893795_TR01
Address	PO Box 1734 MILTON BC	QLD	4064	Test Date	22/01/2019
				Report Date	23/01/2019
Project	Inland Rail Section 320				
Project No	1893795				
Trilab Sample No.	102215	102219	102224	102243	
Client Sample No	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Bore Hole	320-01-BH2101	320-01-BH2101	320-01-BH2101	320-01-BH2101	
Depth From/To (m)	105.00-105.08	105.80-106.00	108.70-109.00	129.33-129.50	
Description	C	C	C	C	
Is (MPa)	0.09	0.00	0.05	0.23	
Is(50) (MPa)	0.10	0.00	0.05	0.24	
Load Direction	Diametral	Diametral	Diametral	Diametral	
Trilab Sample No.	102244	102249			
Client Sample No	320-01-BH2101	320-01-BH2101			
Bore Hole	320-01-BH2101	320-01-BH2101			
Depth From/To (m)	131.03-131.14	140.38-140.74			
Description	C	C			
Is (MPa)	0.17	0.06			
Is(50) (MPa)	0.19	0.06			
Load Direction	Diametral	Diametral			
NOTES/REMARKS:	Tested as received				
Sample/s supplied by the client					Page 4 of 4 REP02102

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Unconfined Compressive Strength of Rock

UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101187-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR02
Project	Inland Rail Section 320	Test Date	5/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2201-C01700
Bore Hole	320-01-BH2201	Depth From (m)	17
		Depth To (m)	18
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 1.41 MPa

Young's Modulus

Poisson Ratio

Tangent 0.627 GPa

0.331

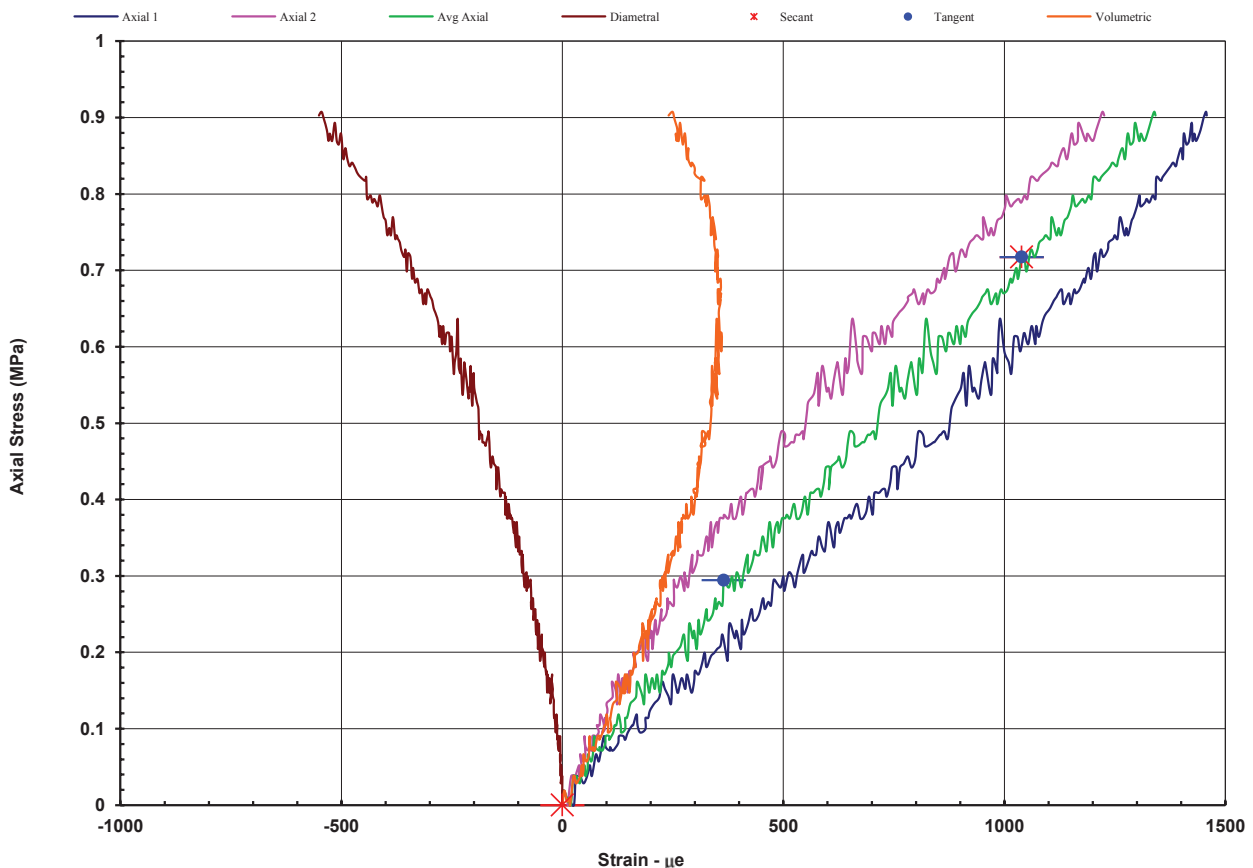
from 20 % to 50 % of Max UCS

Secant 0.691 GPa

0.331

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received.

Page 1 of 2 REP03603

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory



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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101187-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	7.7
Sample Height (mm)	142.0	Wet Density (t/m ³)	2.34
Duration of Test (min)	4.87	Dry Density (t/m ³)	2.17
Rate of Loading (MPa/min)	0.29	Bedding (°)	40
Mode of Failure	Shear	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101187	DATE: 05/11/18
BOREHOLE:	320-01-BH2201	DEPTH: 17



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101187	DATE: 05/11/18
BOREHOLE:	320-01-BH2201	DEPTH: 17



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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Page 2 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101190-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR02
Project	Inland Rail Section 320	Test Date	31/10/2018
Project No.	1893795	Client Sample No.	320-01-BH2209-C00550
Bore Hole	320-01-BH2209	Depth From (m)	5.5
		Depth To (m)	7
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 9.35 MPa

Young's Modulus

Poisson Ratio

Tangent 3.08 GPa

0.029

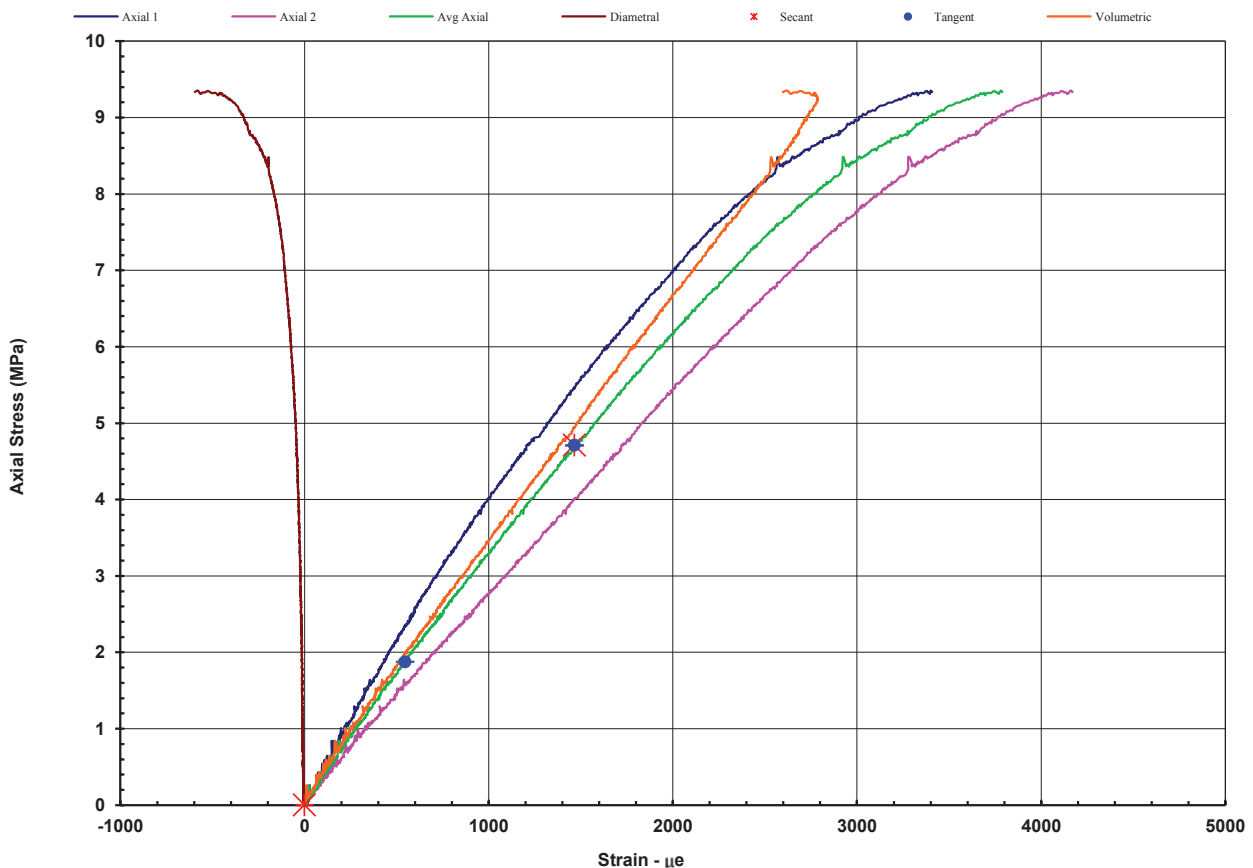
from 20 % to 50 % of Max UCS

Secant 3.21 GPa

0.030

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received.

Page 1 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101190-MOD
Average Sample Diameter (mm)	51.7	Moisture Content (%)	7.4
Sample Height (mm)	145.0	Wet Density (t/m ³)	2.26
Duration of Test (min)	10.27	Dry Density (t/m ³)	2.10
Rate of Loading (MPa/min)	0.91	Bedding (°)	5
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101190	DATE: 31/10/18
BOREHOLE:	320-01-BH2209	DEPTH: 5.5



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101190	DATE: 31/10/18
BOREHOLE:	320-01-BH2209	DEPTH: 5.5



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received.

Page 2 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101194-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR02
Project	Inland Rail Section 320	Test Date	3/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2209-C01650
Bore Hole	320-01-BH2209	Depth From (m)	16.5
		Depth To (m)	16.7

Description C
Sample Type Single Individual Rock Core Specimen

Uniaxial Compressive Strength 15.4 MPa

Young's Modulus

Poisson Ratio

Tangent 3.10 GPa

0.140

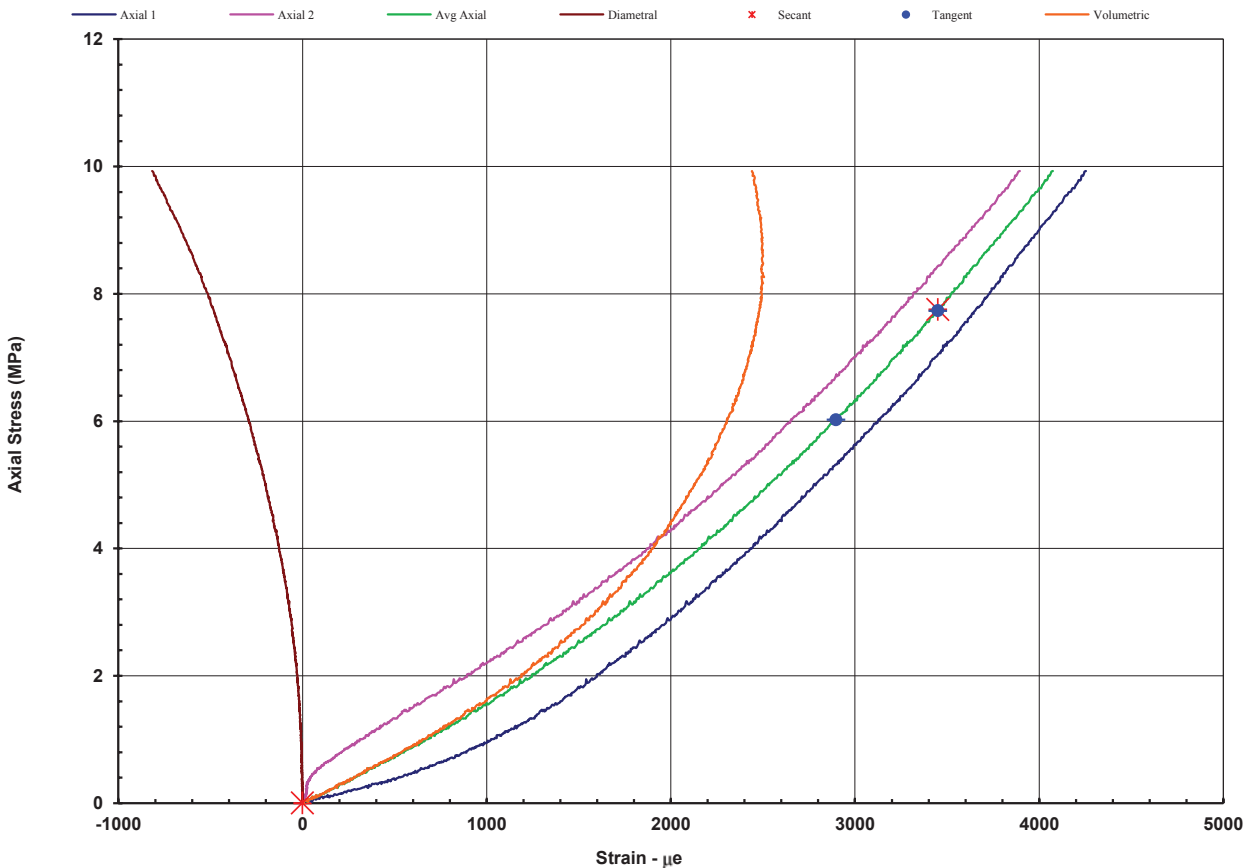
from 39 % to 50 % of Max UCS

Secant 2.25 GPa

0.140

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101194-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	6.9
Sample Height (mm)	141.2	Wet Density (t/m ³)	2.25
Duration of Test (min)	9.92	Dry Density (t/m ³)	2.10
Rate of Loading (MPa/min)	1.56	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101194	DATE: 03/11/18
BOREHOLE:	320-01-BH2209	DEPTH: 16.5



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101194	DATE: 03/11/18
BOREHOLE:	320-01-BH2209	DEPTH: 16.5



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received.

Page 2 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client Golder Associates Pty Limited	Report No. GA101202-MOD
Address PO Box 1734 MILTON BC QLD 4064	Request No. Golder_1893795_TR0
Project Inland Rail Section 320	Test Date 31/10/2018
Project No. 1893795	Report Date 2/11/2018
Client Sample No. 320-01-BH2212-C01340	
Bore Hole 320-01-BH2212 Depth From (m) 13.4	Depth To (m) 13.6
Description C	
Sample Type Single Individual Rock Core Specimen	

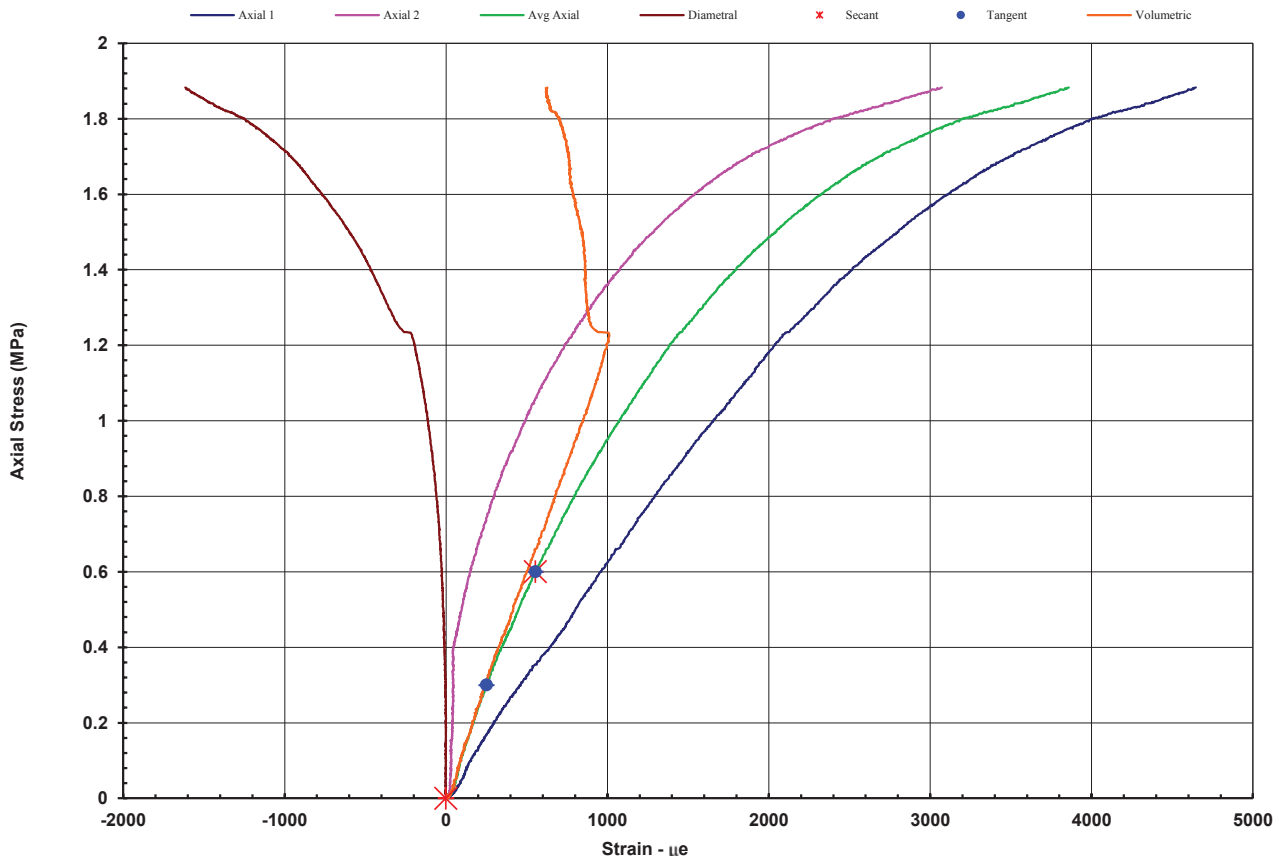
Uniaxial Compressive Strength 4.31 MPa

Young's Modulus

Poisson Ratio

Tangent 0.990 GPa	0.047	from 7 % to 14 % of Max UCS
Secant 1.08 GPa	0.047	from 0 % to 14 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2:P13402

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

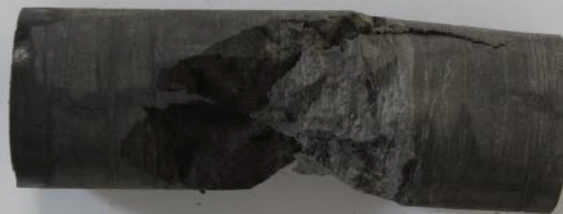
Client Golder Associates Pty Limited **Report No.** GA101202-MOD

Average Sample Diameter (mm)	51.3	Moisture Content (%)	11.6
Sample Height (mm)	142.9	Wet Density (t/m ³)	2.24
Duration of Test (min)	32.83	Dry Density (t/m ³)	2.01
Rate of Displacement (mm/min)	0.10	Bedding (°)	5
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101202	DATE: 31/10/18
BOREHOLE:	320-01-BH2212	DEPTH: 13.4



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101202	DATE: 31/10/18
BOREHOLE:	320-01-BH2212	DEPTH: 13.4



Notes/Remarks:

Sample/s supplied by client Photo not to scale Tested as received. Page 2 of 2 REP13402

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Trilab Pty Ltd ABN 25 065 630 506

UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101212-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR02
Project	Inland Rail Section 320	Test Date	31/10/2018
Project No.	1893795	Client Sample No.	320-01-BH2218-C01150
Bore Hole	320-01-BH2218	Depth From (m)	11.5
		Depth To (m)	11.7

Description C
Sample Type Single Individual Rock Core Specimen

Uniaxial Compressive Strength 29.0 MPa

Young's Modulus

Poisson Ratio

Tangent 17.3 GPa

0.108

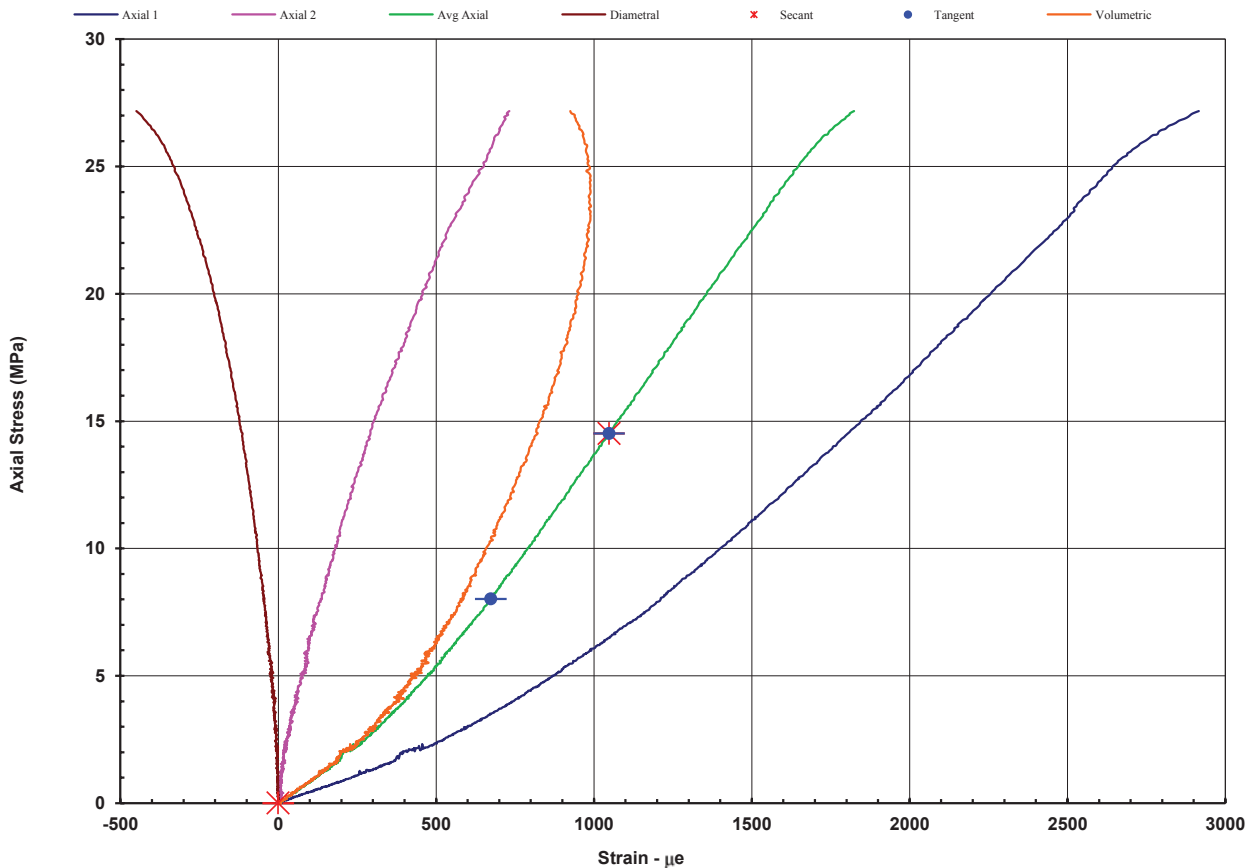
from 28 % to 50 % of Max UCS

Secant 13.8 GPa

0.108

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101212-MOD
Average Sample Diameter (mm)	51.7	Moisture Content (%)	4.2
Sample Height (mm)	140.0	Wet Density (t/m ³)	2.21
Duration of Test (min)	7.37	Dry Density (t/m ³)	2.12
Rate of Loading (MPa/min)	3.94	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101212	DATE: 31/10/18
BOREHOLE:	320-01-BH2218	DEPTH: 11.5



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101212	DATE: 31/10/18
BOREHOLE:	320-01-BH2218	DEPTH: 11.5



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received.

Page 2 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101217-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR02
Project	Inland Rail Section 320	Test Date	31/10/2018
Project No.	1893795	Client Sample No.	320-01-BH2218-C01620
Bore Hole	320-01-BH2218	Depth From (m)	16.2
		Depth To (m)	16.4
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 29.4 MPa

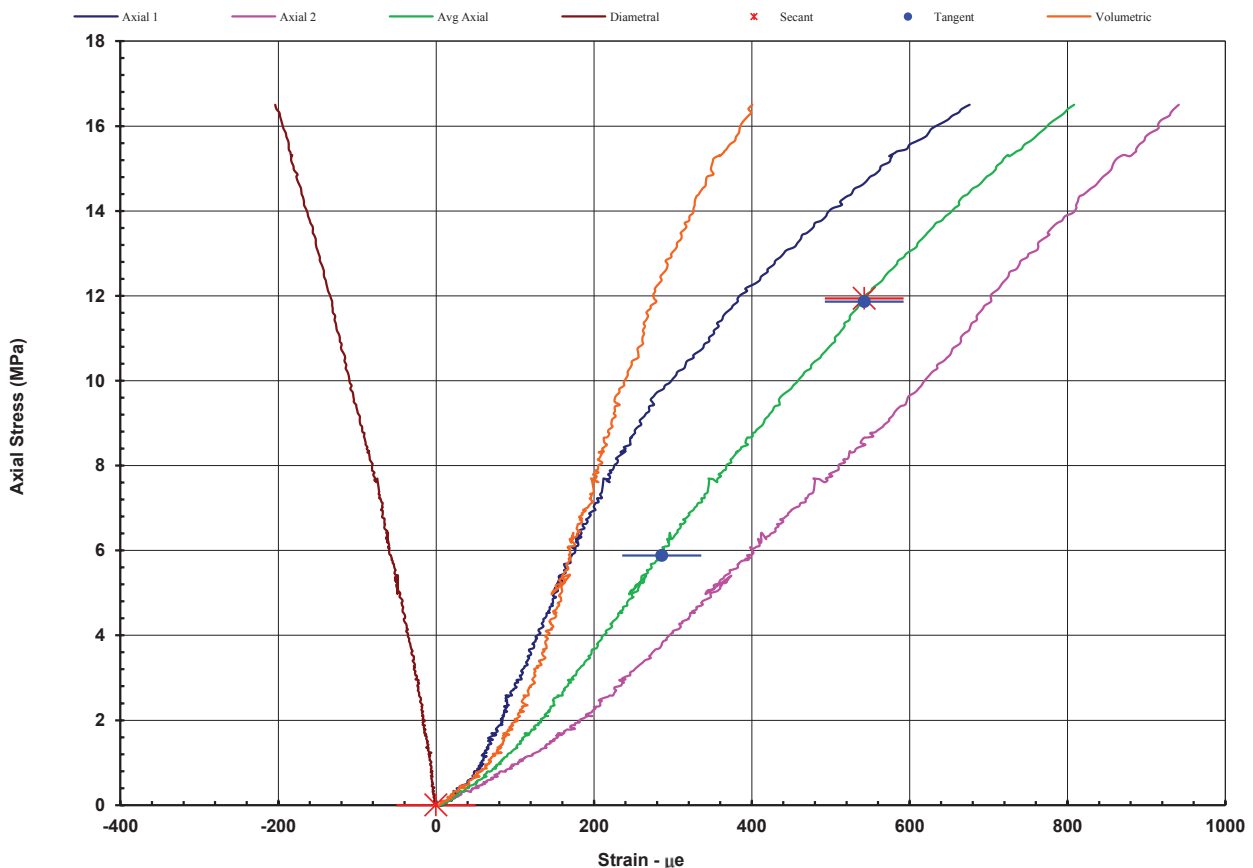
Young's Modulus

Tangent 23.3 GPa
Secant 22.0 GPa

Poisson Ratio

0.243 from 20 % to 40 % of Max UCS
0.245 from 0 % to 40 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101217-MOD
Average Sample Diameter (mm)	52.0	Moisture Content (%)	7.7
Sample Height (mm)	145.2	Wet Density (t/m ³)	2.28
Duration of Test (min)	5.25	Dry Density (t/m ³)	2.12
Rate of Loading (MPa/min)	5.59	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101217	DATE: 31/10/18
BOREHOLE:	320-01-BH2218	DEPTH: 16.2



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101217	DATE: 31/10/18
BOREHOLE:	320-01-BH2218	DEPTH: 16.2



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101325-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR03
Project	Inland Rail Section 320	Test Date	3/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2217-C00290
Bore Hole	320-01-BH2217	Depth From (m)	2.9
		Depth To (m)	3
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 41.8 MPa

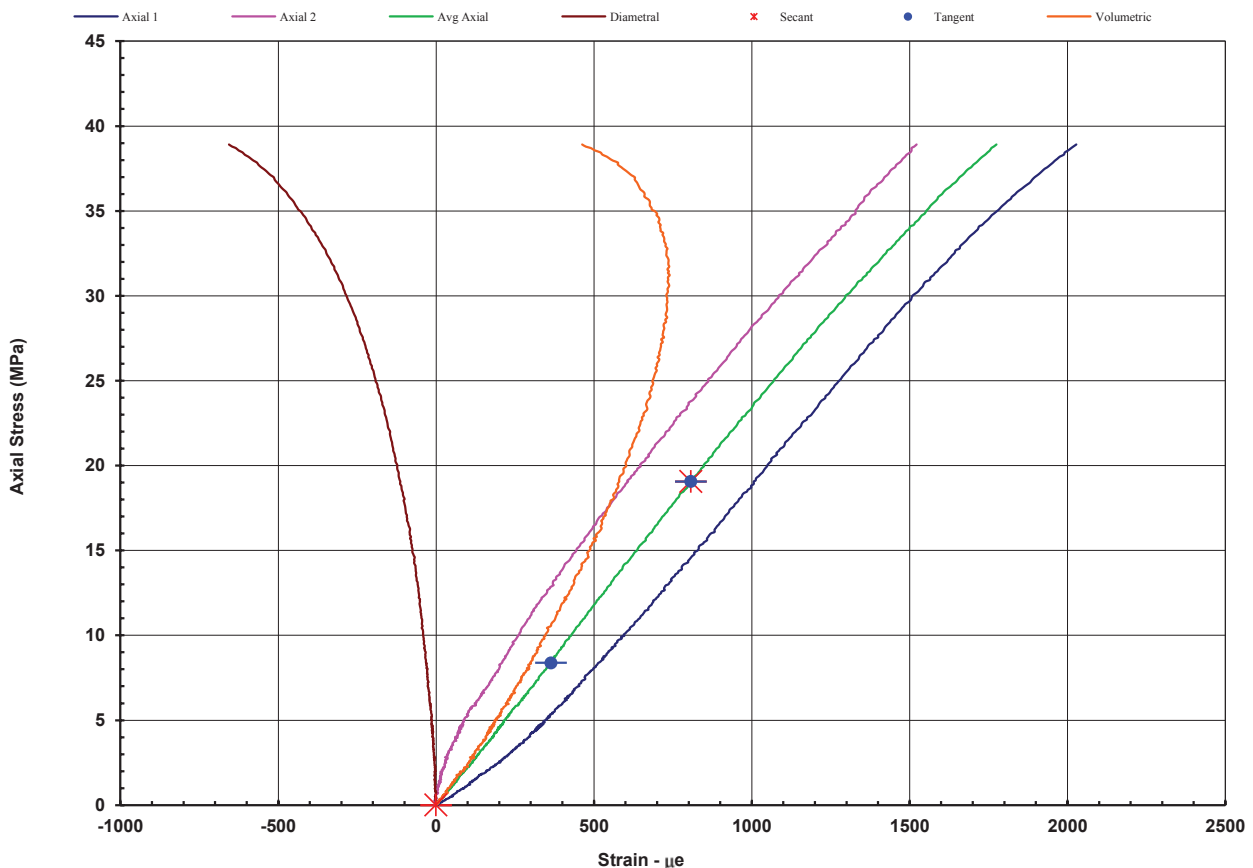
Young's Modulus

Tangent 24.1 GPa
Secant 23.6 GPa

Poisson Ratio

0.140 from 20 % to 45 % of Max UCS
0.140 from 0 % to 45 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101325-MOD
Average Sample Diameter (mm)	51.6	Moisture Content (%)	4.3
Sample Height (mm)	136.9	Wet Density (t/m ³)	2.23
Duration of Test (min)	5.10	Dry Density (t/m ³)	2.14
Rate of Loading (MPa/min)	8.20	Bedding (°)	25
Mode of Failure	Shear	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101325	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 2.9



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101325	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 2.9



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101327-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR03
Project	Inland Rail Section 320	Test Date	3/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2217-C00520
Bore Hole	320-01-BH2217	Depth From (m)	5.2
		Depth To (m)	5.4

Description C
Sample Type Single Individual Rock Core Specimen

Uniaxial Compressive Strength 32.0 MPa

Young's Modulus

Poisson Ratio

Tangent 17.8 GPa

0.061

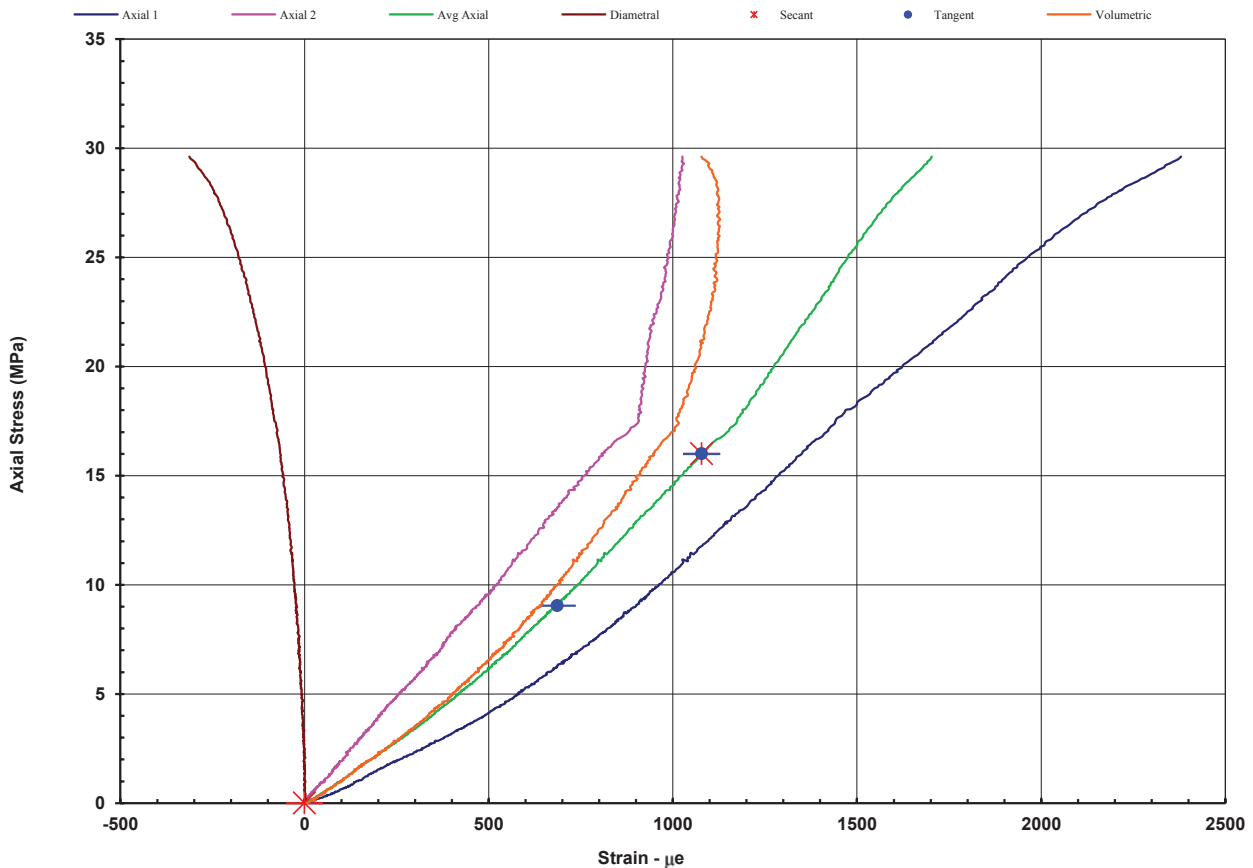
from 28 % to 50 % of Max UCS

Secant 14.8 GPa

0.061

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101327-MOD
Average Sample Diameter (mm)	51.7	Moisture Content (%)	3.9
Sample Height (mm)	144.5	Wet Density (t/m ³)	2.25
Duration of Test (min)	6.23	Dry Density (t/m ³)	2.17
Rate of Loading (MPa/min)	5.13	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101327	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 5.2



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101327	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 5.2



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101329-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR03
Project	Inland Rail Section 320	Test Date	3/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2217-C00710
Bore Hole	320-01-BH2217	Depth From (m)	7.1
		Depth To (m)	7.3
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 33.8 MPa

Young's Modulus

Poisson Ratio

Tangent 25.8 GPa

0.108

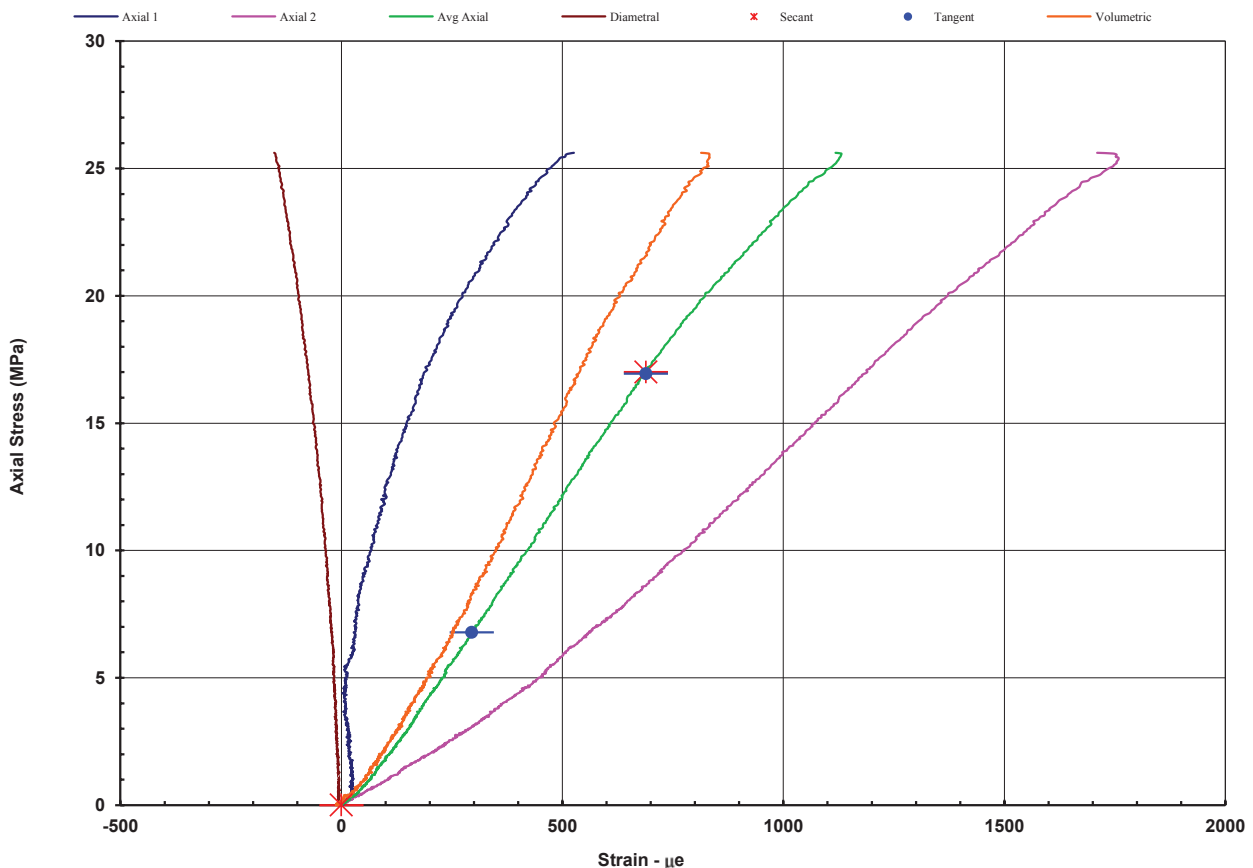
from 20 % to 50 % of Max UCS

Secant 24.7 GPa

0.109

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT


Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101329-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	4.7
Sample Height (mm)	141.1	Wet Density (t/m ³)	2.36
Duration of Test (min)	7.27	Dry Density (t/m ³)	2.25
Rate of Loading (MPa/min)	4.65	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101329	DATE: 3/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 7.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101329	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 7.1



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101332-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR03
Project	Inland Rail Section 320	Test Date	3/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2217-C01610
Bore Hole	320-01-BH2217	Depth From (m)	16.1
		Depth To (m)	16.3
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 51.9 MPa

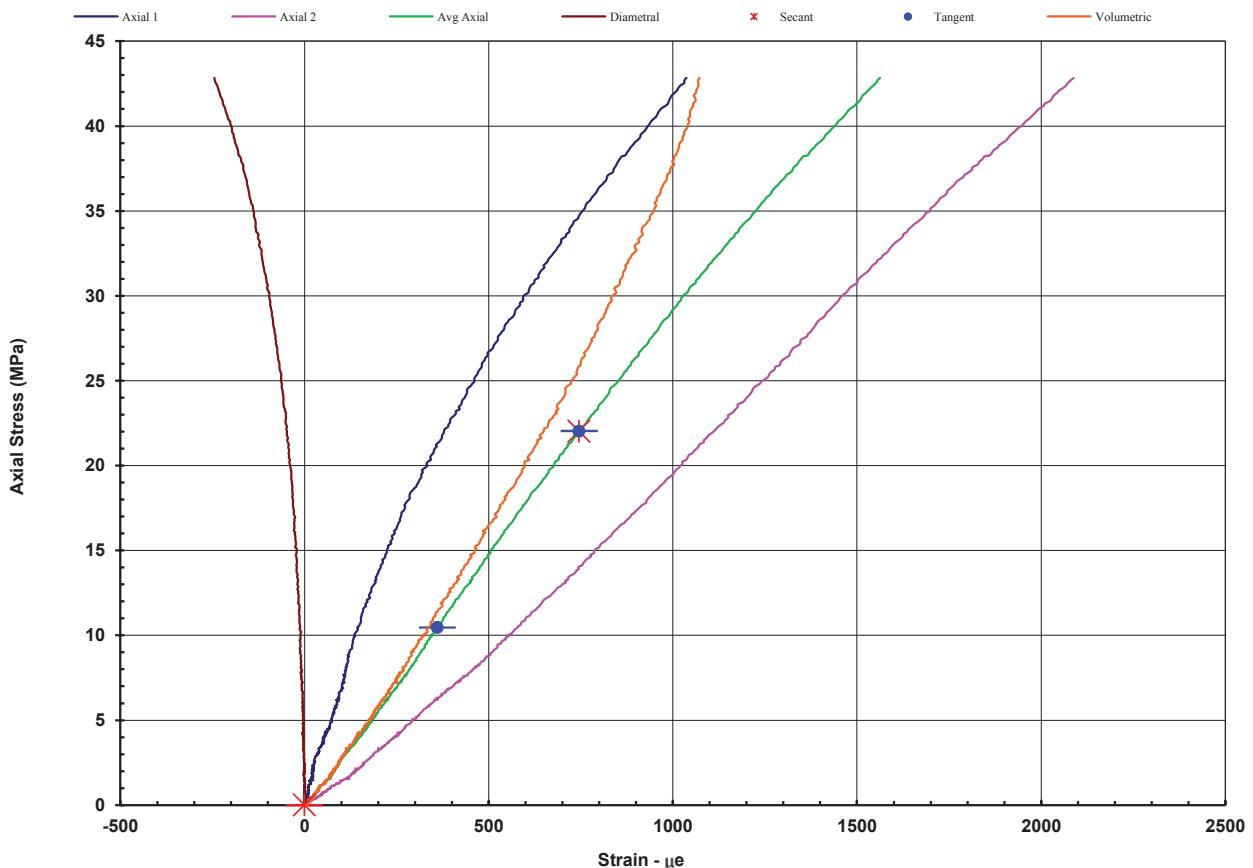
Young's Modulus

Tangent 30.1 GPa
Secant 29.6 GPa

Poisson Ratio

0.064 from 20 % to 42 % of Max UCS
0.064 from 0 % to 42 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101332-MOD
Average Sample Diameter (mm)	51.7	Moisture Content (%)	8.1
Sample Height (mm)	135.3	Wet Density (t/m ³)	2.32
Duration of Test (min)	5.23	Dry Density (t/m ³)	2.15
Rate of Loading (MPa/min)	9.92	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101332	DATE: 3/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 16.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101332	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 16.1



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101334-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR03
Project	Inland Rail Section 320	Test Date	3/11/2018
Project No.	1893795	Client Sample No.	320-01-BH2217-C02040
Bore Hole	320-01-BH2217	Depth From (m)	20.4
		Depth To (m)	20.57
Description	C		
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 19.6 MPa

Young's Modulus

Poisson Ratio

Tangent 9.09 GPa

0.159

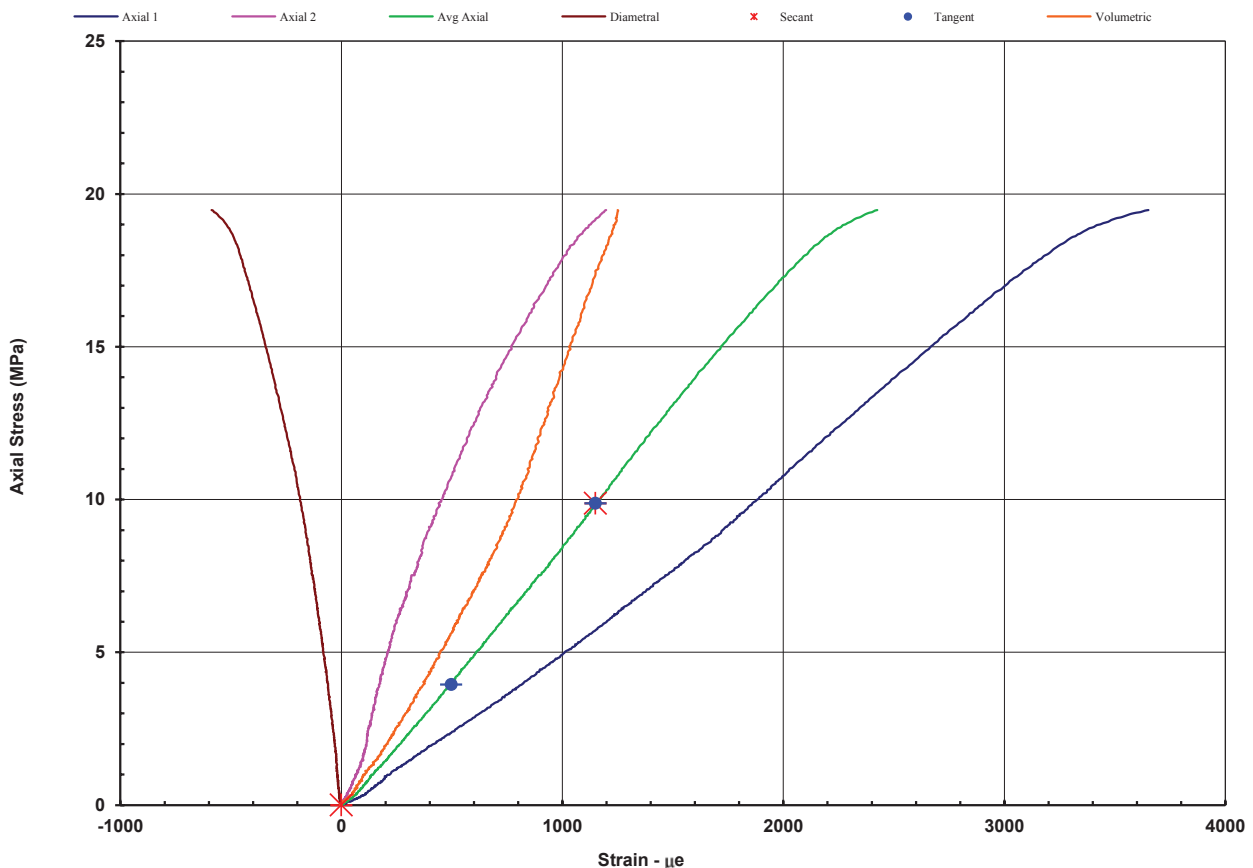
from 20 % to 50 % of Max UCS

Secant 8.59 GPa

0.159

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

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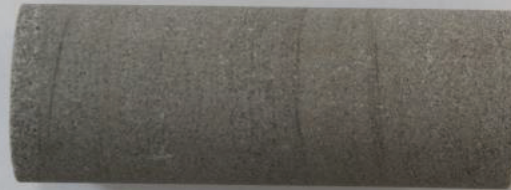
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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA101334-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	4.6
Sample Height (mm)	132.3	Wet Density (t/m ³)	2.48
Duration of Test (min)	5.88	Dry Density (t/m ³)	2.37
Rate of Loading (MPa/min)	3.34	Bedding (°)	5
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	101334	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 20.4



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	101334	DATE: 03/11/18
BOREHOLE:	320-01-BH2217	DEPTH: 20.4



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA102053-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	5/02/2019
Project No.	1893795	Depth From (m)	196.27
Bore Hole	320-01-BH2102	Depth To (m)	196.44
Description	C	Sample No.	320-01-BH2102-C19610-UCY : 320-01-BH2102-C19610-MOI
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 155 MPa

Young's Modulus

Poisson Ratio

Tangent 74.7 GPa

0.140

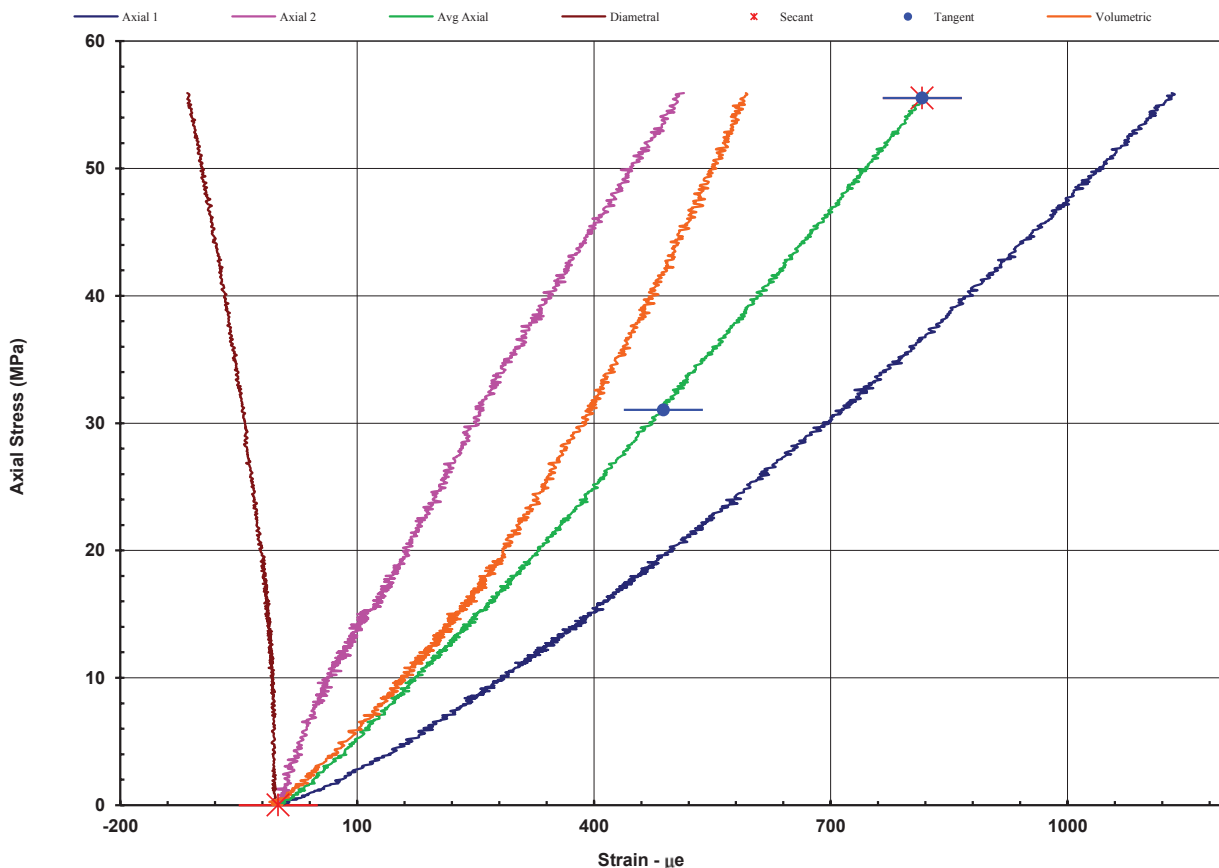
from 20 % to 36 % of Max UCS

Secant 68.1 GPa

0.140

from 0 % to 36 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

Tested as received.

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA102053-MOD
Average Sample Diameter (mm)	60.6	Moisture Content (%)	1.1
Sample Height (mm)	160.3	Wet Density (t/m ³)	2.87
Duration of Test (min)	12.42	Dry Density (t/m ³)	2.84
Rate of Loading (MPa/min)	12.49	Bedding (°)	Nil
Mode of Failure	Disintegration	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102053	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 196.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102053	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 196.1



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 2 of 2 REP03603

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

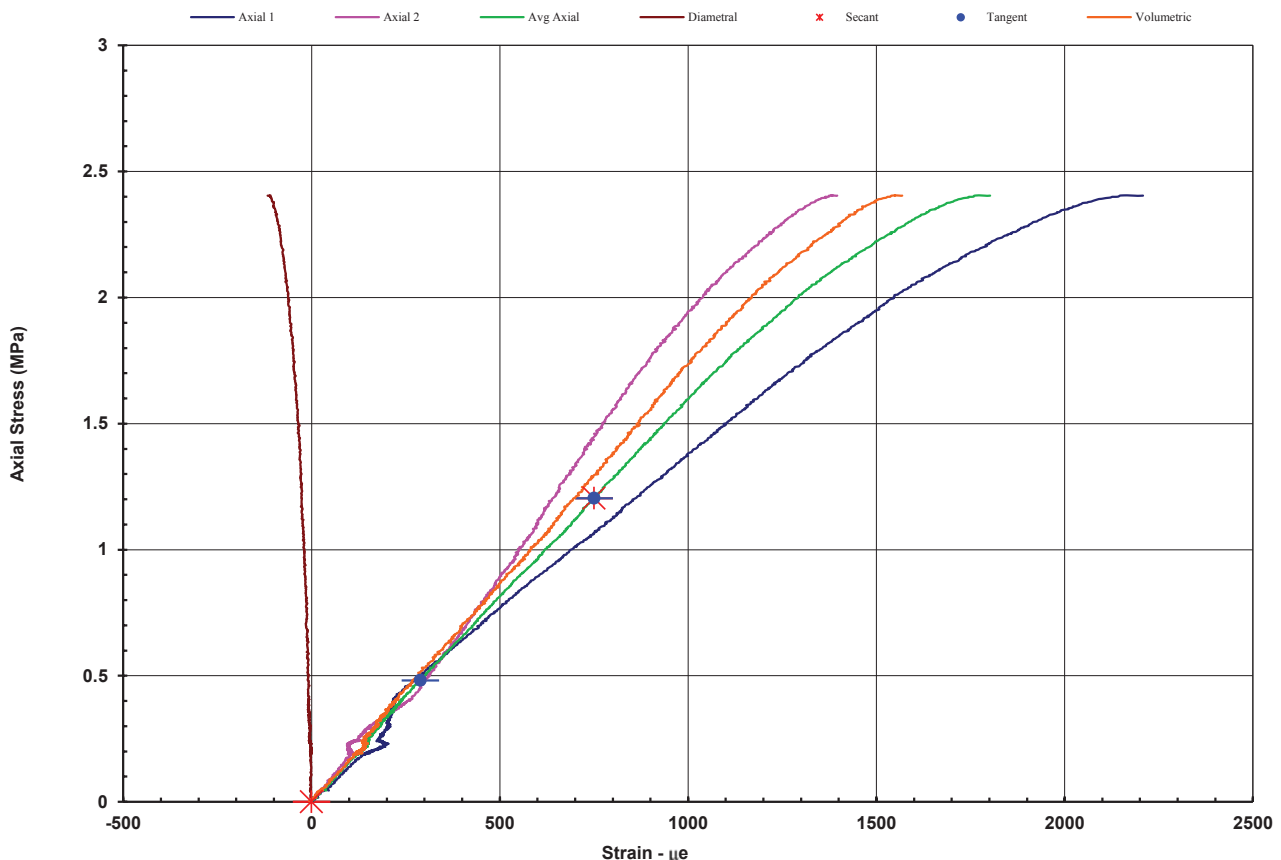
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102058-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	5/02/2019
Project No.	1893795	Depth From (m)	208.41
Bore Hole	320-01-BH2102	Depth To (m)	208.55
Description	C	Sample No.	320-01-BH2102-C20840-UCY : 320-01-BH2102-C20840-MOI
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 2.41 MPa

Young's Modulus		Poisson Ratio	
Tangent	1.57 GPa	0.036	from 20 % to 50 % of Max UCS
Secant	1.61 GPa	0.036	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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Authorised Signatory



N. Maddison



Laboratory No. 9926

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102058-MOD
Average Sample Diameter (mm)	58.7	Moisture Content (%)	15.2
Sample Height (mm)	147.6	Wet Density (t/m ³)	2.10
Duration of Test (min)	11.48	Dry Density (t/m ³)	1.82
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102058	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 208.4



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102058	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 208.4



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA102062-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	5/02/2019
Project No.	1893795	Depth From (m)	214.9
Bore Hole	320-01-BH2102	Depth To (m)	215
Description	C	Sample No.	320-01-BH2102-C21490-UCY : 320-01-BH2102-C21490-MOI
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 47.0 MPa

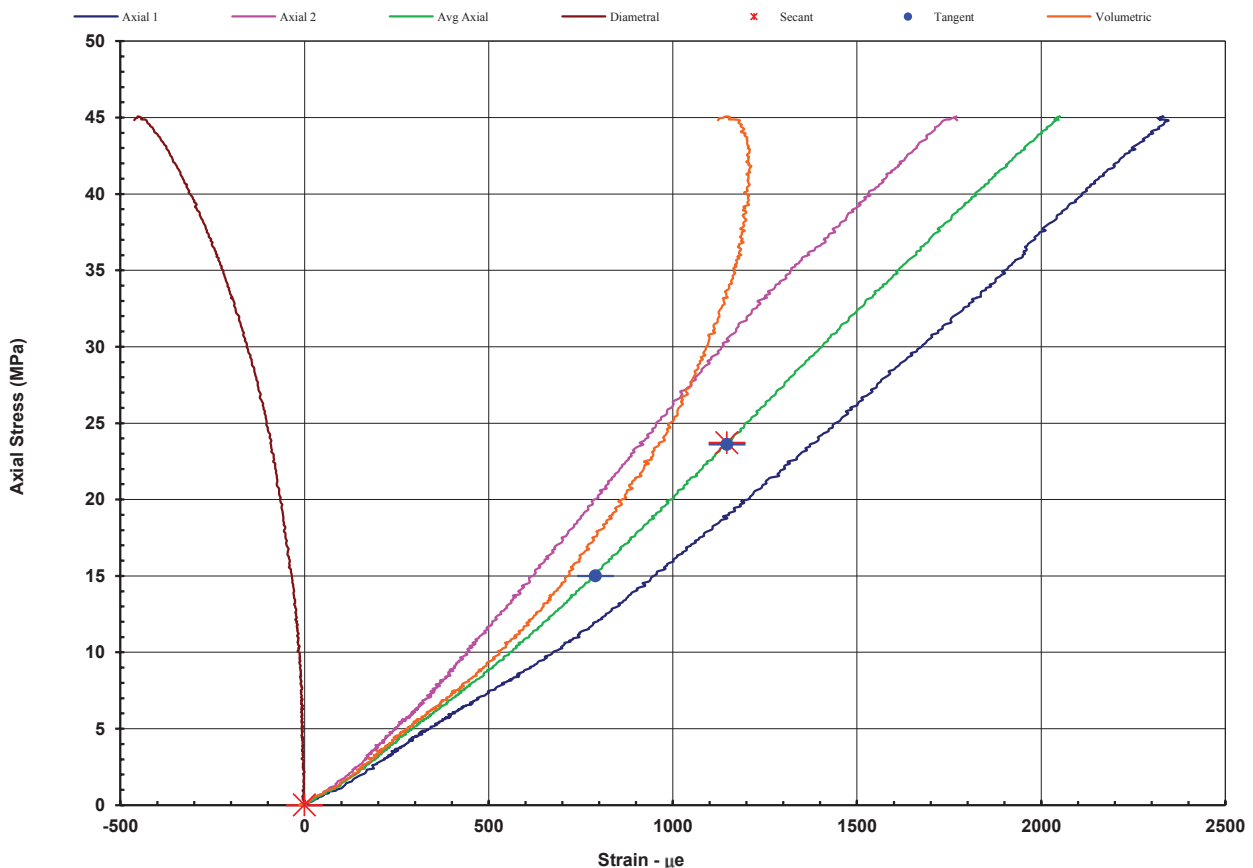
Young's Modulus

Tangent 24.1 GPa
Secant 20.7 GPa

Poisson Ratio

0.080 from 32 % to 50 % of Max UCS
0.081 from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.1

Client	Golder Associates Pty Limited	Report No.	GA102062-MOD
Average Sample Diameter (mm)	60.9	Moisture Content (%)	2.5
Sample Height (mm)	160.6	Wet Density (t/m ³)	2.63
Duration of Test (min)	6.30	Dry Density (t/m ³)	2.57
Rate of Loading (MPa/min)	7.46	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	Kelba 1000kN Load Cell

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102062	DATE: 05/02/19.
BOREHOLE:	320-01-BH2102	DEPTH: 214.9



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102062	DATE: 05/02/19.
BOREHOLE:	320-01-BH2102	DEPTH: 214.9



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102065-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	5/02/2019
Project No.	1893795	Depth From (m)	218.09	Report Date	6/02/2019
Bore Hole	320-01-BH2102	Depth To (m)	218.26	Sample No.	320-01-BH2102-C21800-UCY : 320-01-BH2102-C21800-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 2.25 MPa

Young's Modulus

Poisson Ratio

Tangent 1.27 GPa

0.105

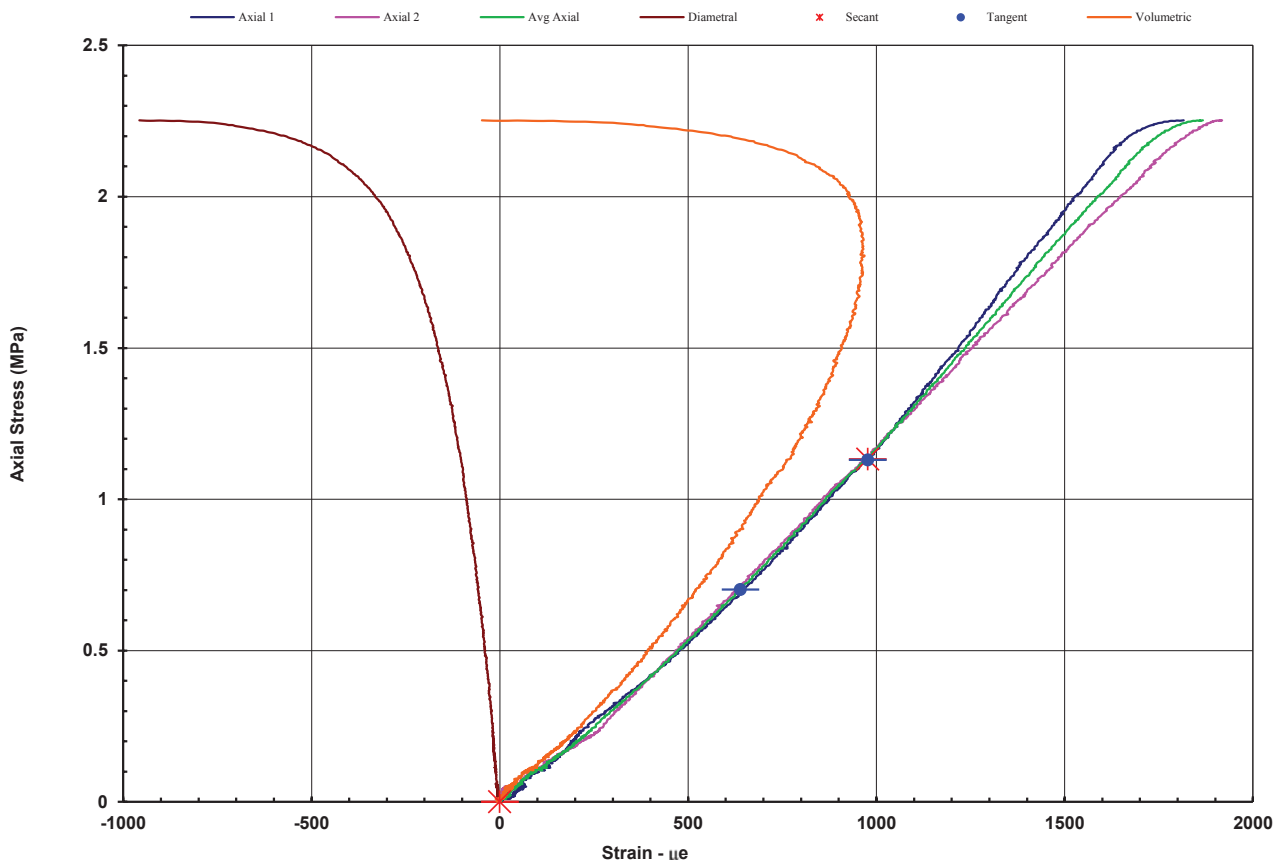
from 31 % to 50 % of Max UCS

Secant 1.16 GPa

0.106

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

The length to diameter ratio falls outside the test method limits of 2.5:1 to 3.0:1.

Sample/s supplied by client

Graph not to scale

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102065-MOD
Average Sample Diameter (mm)	60.5	Moisture Content (%)	33.4
Sample Height (mm)	143.1	Wet Density (t/m ³)	1.81
Duration of Test (min)	9.58	Dry Density (t/m ³)	1.36
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102065	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 218



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102065	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 218



Notes/Remarks:

The length to diameter ratio falls outside the test method limits of 2.5:1 to 3.0:1.

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

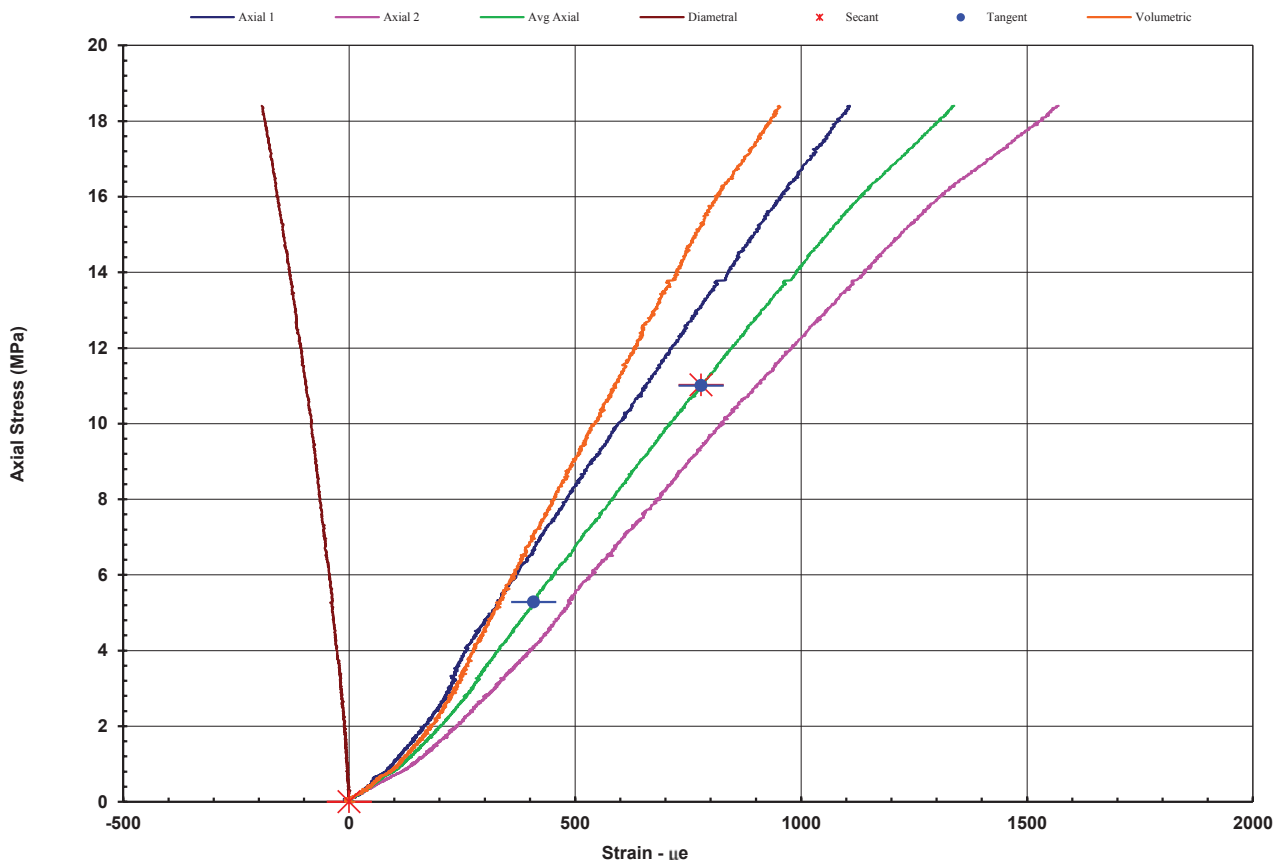
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102070-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	5/02/2019
Project No.	1893795	Depth From (m)	224.07	Report Date	6/02/2019
Bore Hole	320-01-BH2102	Depth To (m)	224.22	Sample No.	320-01-BH2102-C22400-UCY : 320-01-BH2102-C22400-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 26.4 MPa

<u>Young's Modulus</u>		<u>Poisson Ratio</u>	
Tangent	15.4 GPa	0.122	from 20 % to 42 % of Max UCS
Secant	14.1 GPa	0.123	from 0 % to 42 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102070-MOD
Average Sample Diameter (mm)	59.7	Moisture Content (%)	7.6
Sample Height (mm)	159.4	Wet Density (t/m ³)	2.43
Duration of Test (min)	25.15	Dry Density (t/m ³)	2.25
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102070	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 224



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102070	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 224



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

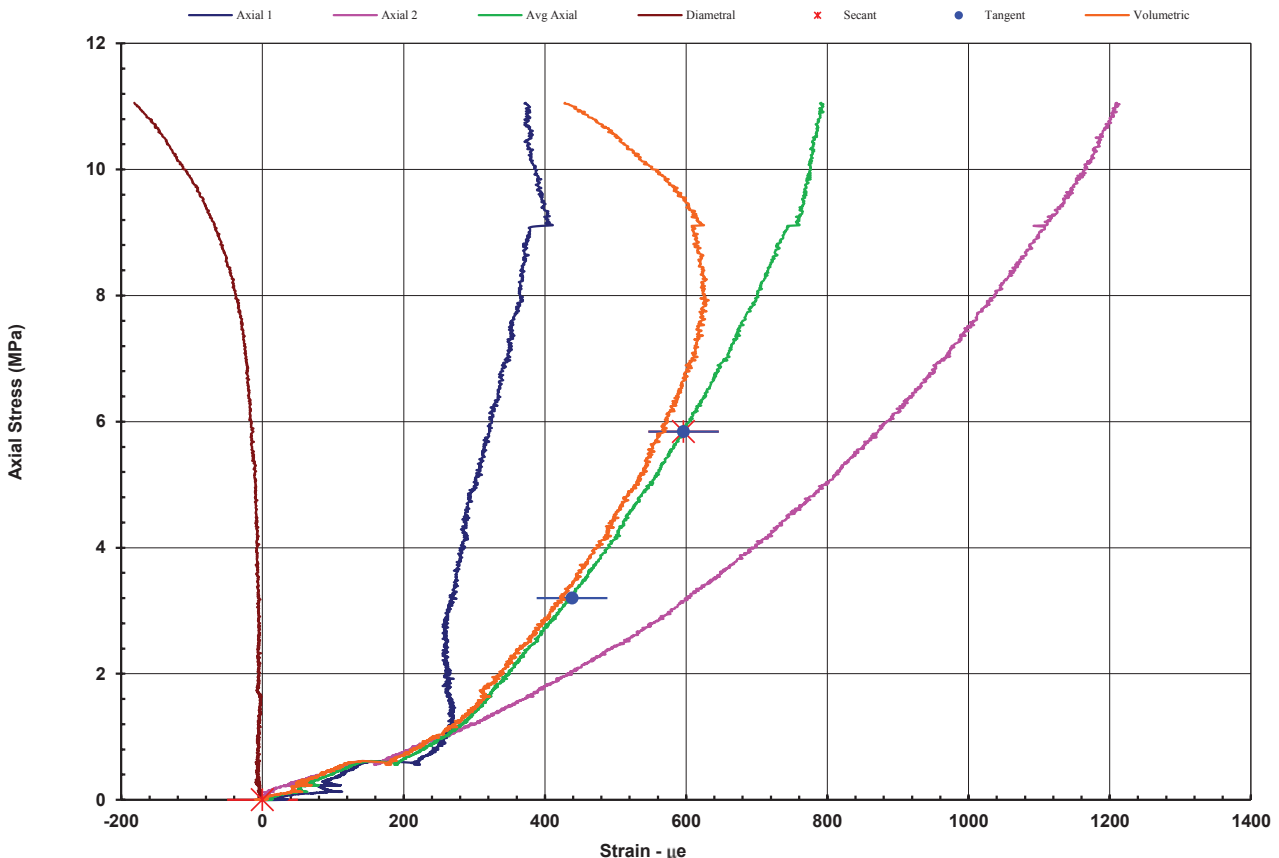
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102073-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	5/02/2019
Project No.	1893795	Depth From (m)	227.5
Bore Hole	320-01-BH2102	Depth To (m)	227.65
Description	C	Sample No.	320-01-BH2102-C22740-UCY : 320-01-BH2102-C22740-MOI
Sample Type	Single Individual Rock Core Specimen		

Uniaxial Compressive Strength 11.7 MPa

Young's Modulus		Poisson Ratio	
Tangent	16.7 GPa	0.021	from 27 % to 50 % of Max UCS
Secant	9.79 GPa	0.021	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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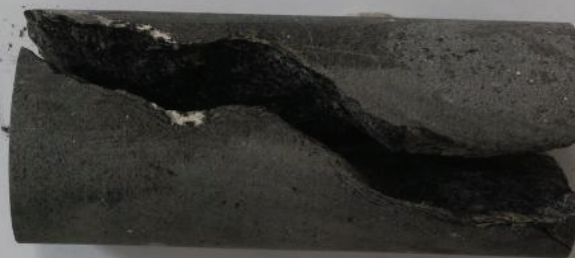
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102073-MOD
Average Sample Diameter (mm)	60.8	Moisture Content (%)	2.9
Sample Height (mm)	159.4	Wet Density (t/m ³)	2.61
Duration of Test (min)	17.68	Dry Density (t/m ³)	2.54
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102073	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 227.4



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102073	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 227.4



Notes/Remarks:

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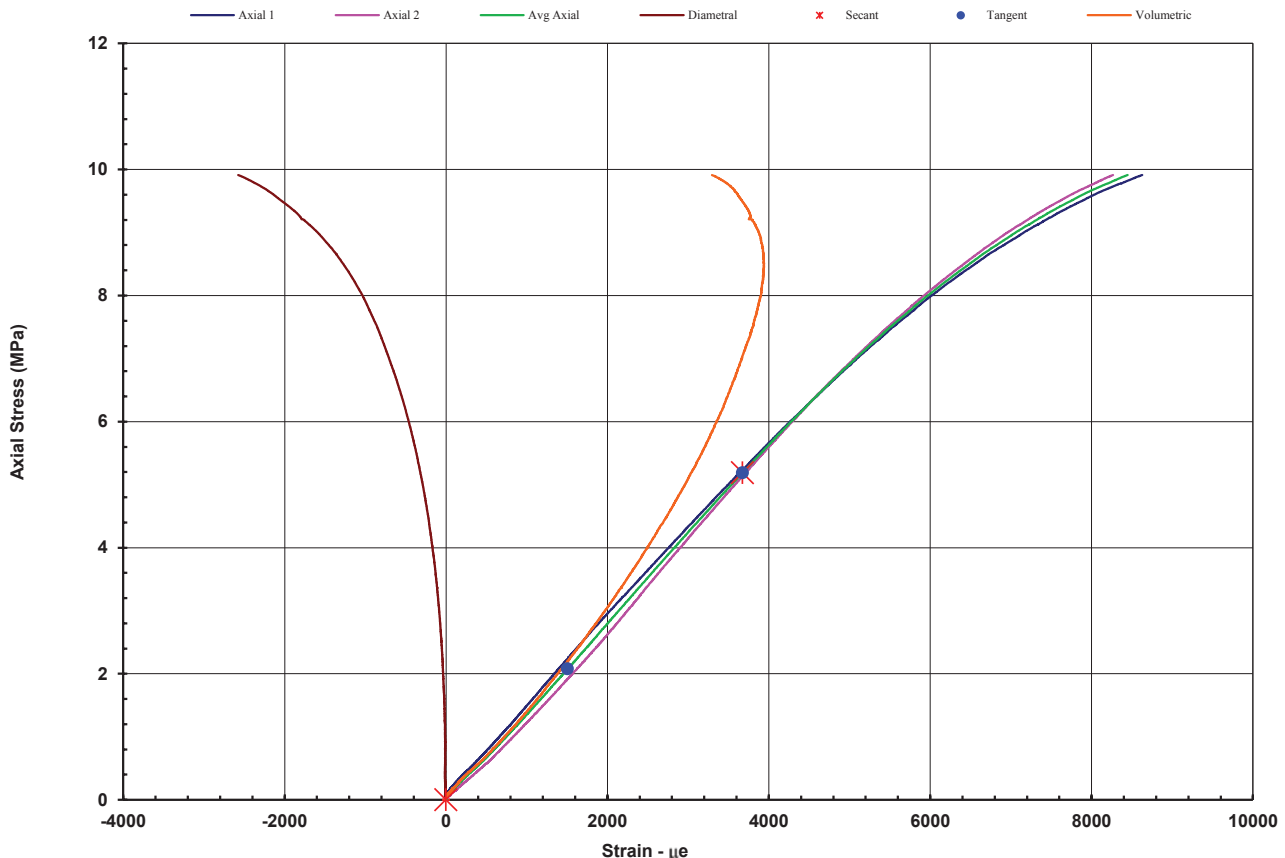
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102075-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	5/02/2019
Project No.	1893795	Depth From (m)	233	Report Date	6/02/2019
Bore Hole	320-01-BH2102	Depth To (m)	233.16	Sample No.	320-01-BH2102-C23320-UCY : 320-01-BH2102-C23320-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 10.4 MPa

<u>Young's Modulus</u>		<u>Poisson Ratio</u>	
Tangent	1.44 GPa	0.086	from 20 % to 50 % of Max UCS
Secant	1.41 GPa	0.086	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102075-MOD
Average Sample Diameter (mm)	60.5	Moisture Content (%)	6.7
Sample Height (mm)	157.6	Wet Density (t/m ³)	2.35
Duration of Test (min)	31.15	Dry Density (t/m ³)	2.20
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102075	DATE: 05/02/19.
BOREHOLE:	320-01-BH2102	DEPTH: 233.2



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102075	DATE: 05/02/19.
BOREHOLE:	320-01-BH2102	DEPTH: 233.2



Notes/Remarks:

Sample/s supplied by client

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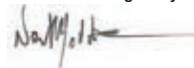
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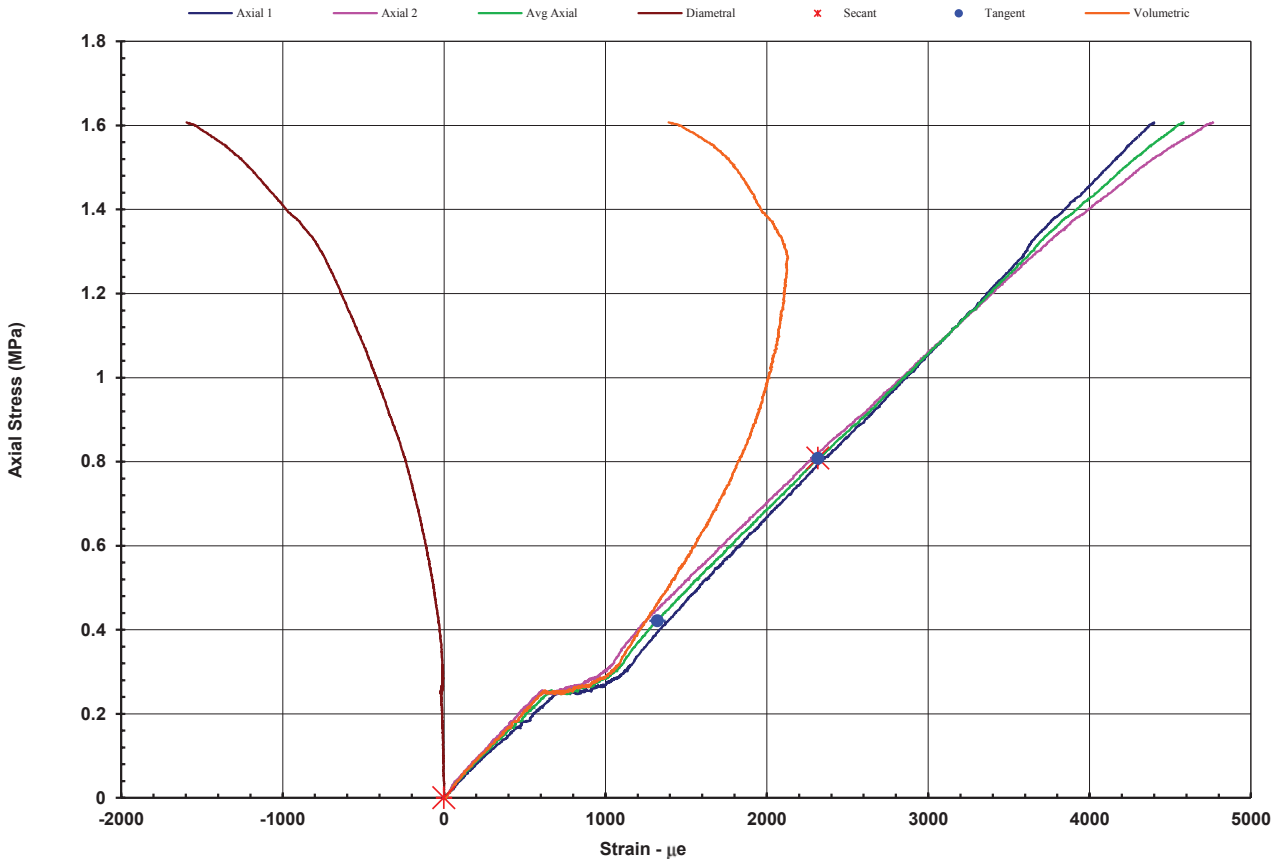
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102077-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	5/02/2019
Project No.	1893795	Depth From (m)	238.1
Bore Hole	320-01-BH2102	Depth To (m)	238.25
Description	C	Report Date	6/02/2019
Sample Type	Single Individual Rock Core Specimen		
Sample No.	320-01-BH2102-C23820-UCY : 320-01-BH2102-C23820-MOI		

Uniaxial Compressive Strength 1.61 MPa

Young's Modulus		Poisson Ratio	
Tangent	0.389 GPa	0.104	from 26 % to 50 % of Max UCS
Secant	0.349 GPa	0.105	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102077-MOD
Average Sample Diameter (mm)	60.4	Moisture Content (%)	12.5
Sample Height (mm)	157.5	Wet Density (t/m ³)	2.23
Duration of Test (min)	15.82	Dry Density (t/m ³)	1.98
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102077	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 238.2



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102077	DATE: 05/02/19
BOREHOLE:	320-01-BH2102	DEPTH: 238.2



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102084-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	29/01/2019
Project No.	1893795	Depth From (m)	10.18	Report Date	30/01/2019
Bore Hole	320-01-BH2103	Depth To (m)	10.32	Sample No.	320-01-BH2103-C01060-UCY : 320-01-BH2103-C01060-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 0.774 MPa

Young's Modulus

Poisson Ratio

Tangent 0.067 GPa

0.048

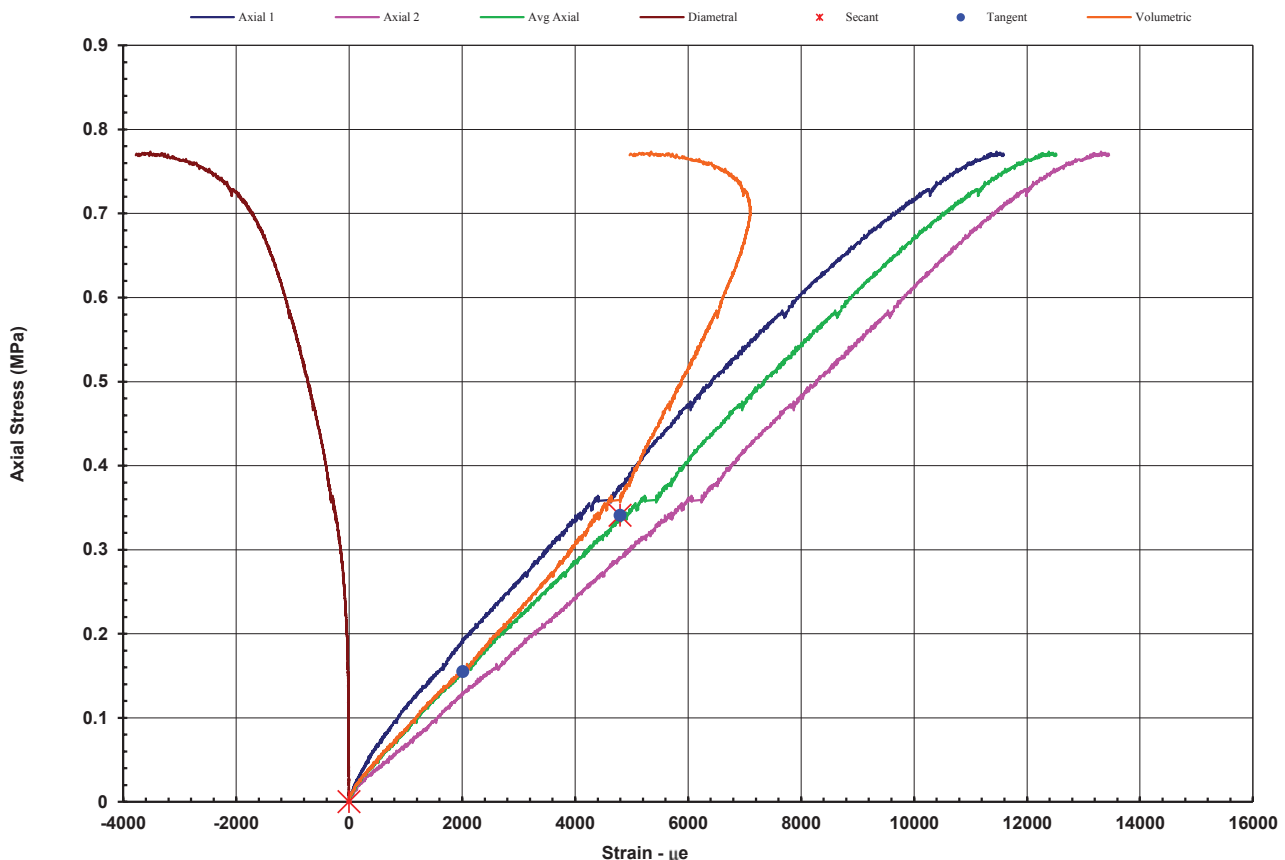
from 20 % to 44 % of Max UCS

Secant 0.071 GPa

0.048

from 0 % to 44 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102084-MOD
Average Sample Diameter (mm)	51.2	Moisture Content (%)	16.4
Sample Height (mm)	140.0	Wet Density (t/m ³)	2.06
Duration of Test (min)	28.53	Dry Density (t/m ³)	1.77
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102084	DATE: 29/01/19
BOREHOLE:	320-01-BH2103	DEPTH: 10.6



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102084	DATE: 29/01/19
BOREHOLE:	320-01-BH2103	DEPTH: 10.6



Notes/Remarks:

Sample/s supplied by client

Photo not to scale

Tested as received.

Page 2 of 2 REP13402

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Authorised Signatory



N. Maddison



Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102088-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	30/01/2019
Project No.	1893795	Depth From (m)	19.15	Report Date	31/01/2019
Bore Hole	320-01-BH2103	Depth To (m)	19.3	Sample No.	320-01-BH2103-C01920-UCY : 320-01-BH2103-C01920-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 5.83 MPa

Young's Modulus

Poisson Ratio

Tangent 1.76 GPa

0.078

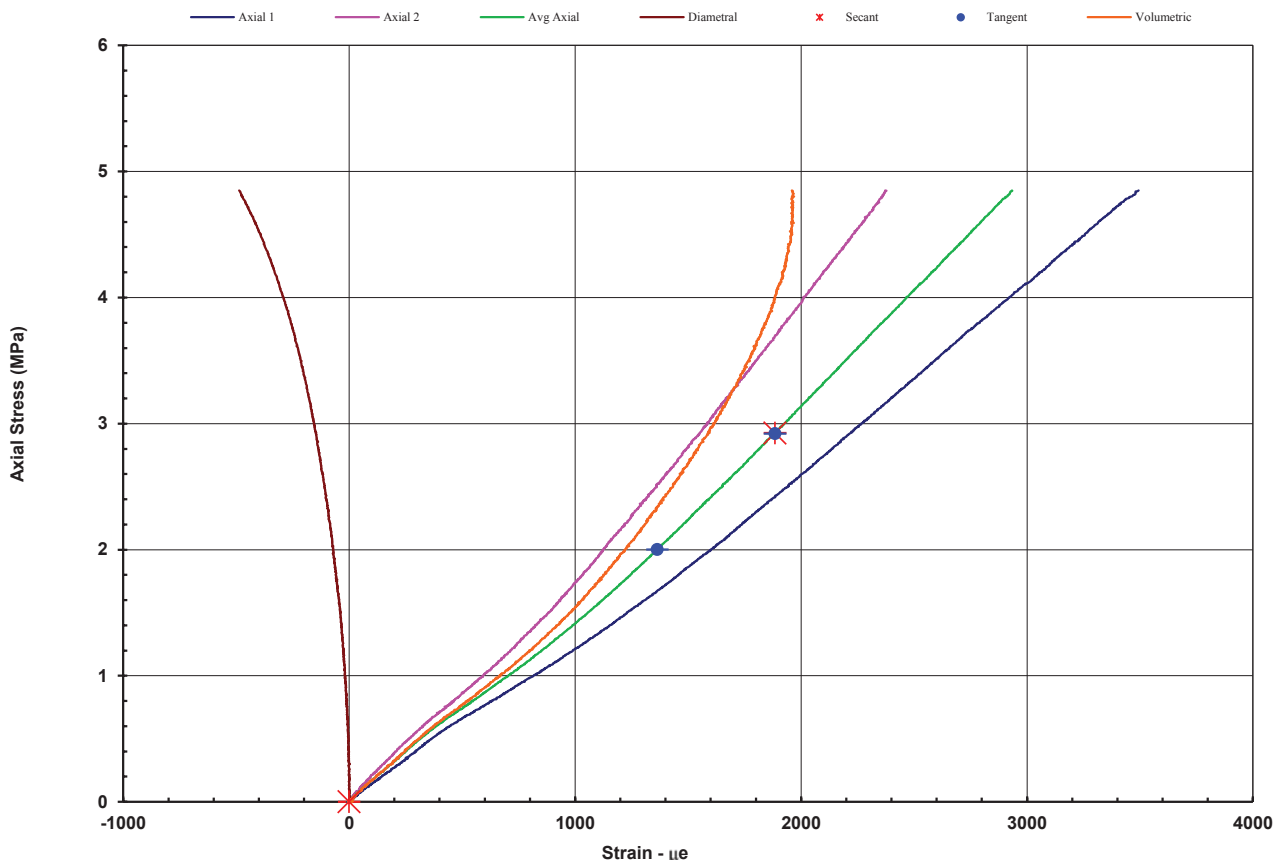
from 34 % to 50 % of Max UCS

Secant 1.55 GPa

0.078

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102088-MOD
Average Sample Diameter (mm)	51.9	Moisture Content (%)	8.6
Sample Height (mm)	139.1	Wet Density (t/m ³)	2.21
Duration of Test (min)	18.72	Dry Density (t/m ³)	2.04
Rate of Displacement (mm/min)	0.10	Bedding (°)	20
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102088	DATE: 30/01/19.
BOREHOLE:	320-01-BH2103	DEPTH: 19.2



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102088	DATE: 30/01/19.
BOREHOLE:	320-01-BH2103	DEPTH: 19.2



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102090-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR0
Project	Inland Rail Section 320			Test Date	25/01/2019
Project No.	1893795	Client Sample No.	320-01-BH2103-C02490		
Bore Hole	320-01-BH2103	Depth From (m)	24.85	Depth To (m)	25
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 2.72 MPa

Young's Modulus

Poisson Ratio

Tangent 0.517 GPa

0.082

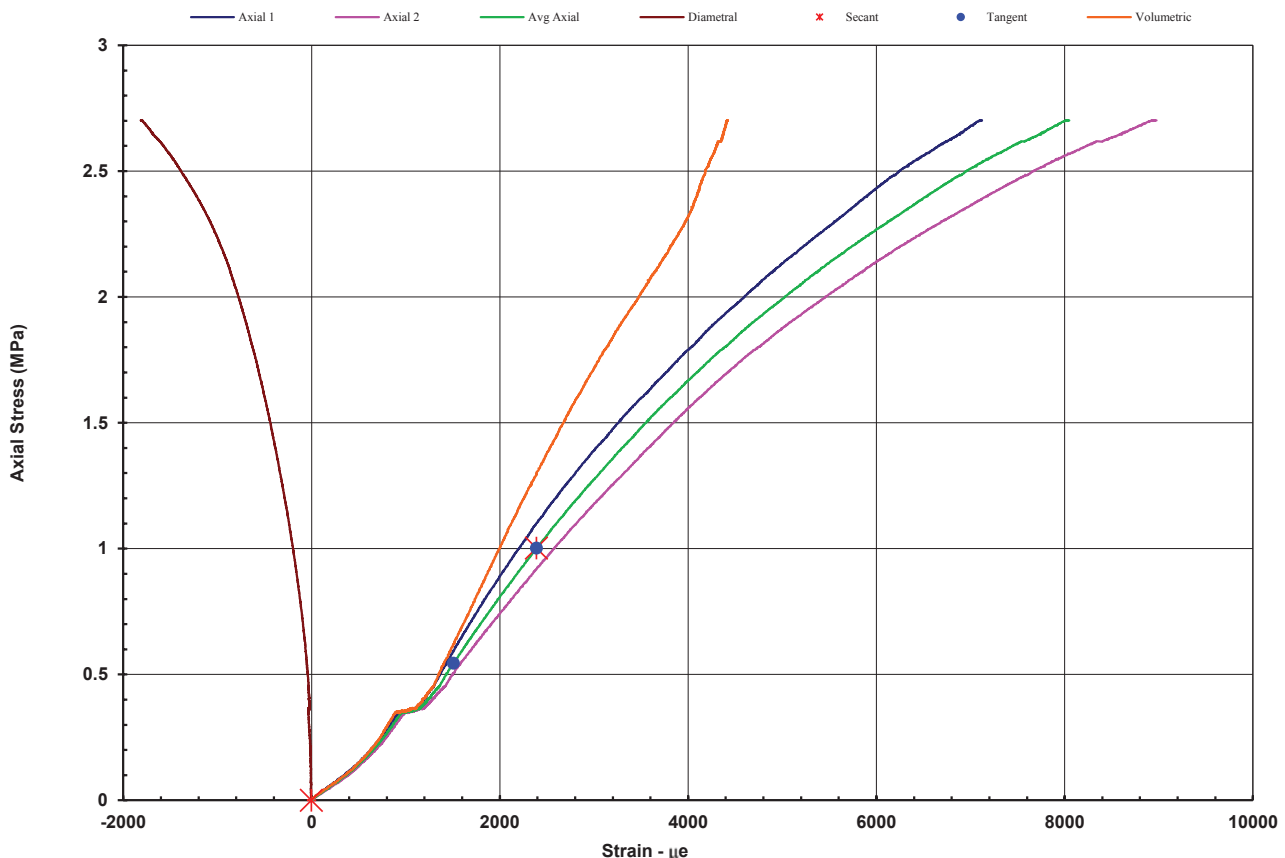
from 20 % to 37 % of Max UCS

Secant 0.419 GPa

0.082

from 0 % to 37 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102090-MOD
Average Sample Diameter (mm)	51.6	Moisture Content (%)	11.5
Sample Height (mm)	141.7	Wet Density (t/m ³)	2.20
Duration of Test (min)	25.65	Dry Density (t/m ³)	1.97
Rate of Displacement (mm/min)	0.10	Bedding (°)	5
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102090	DATE: 25/01/19
BOREHOLE:	320-01-BH2103	DEPTH: 24.9



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102090	DATE: 25/01/19
BOREHOLE:	320-01-BH2103	DEPTH: 24.9



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

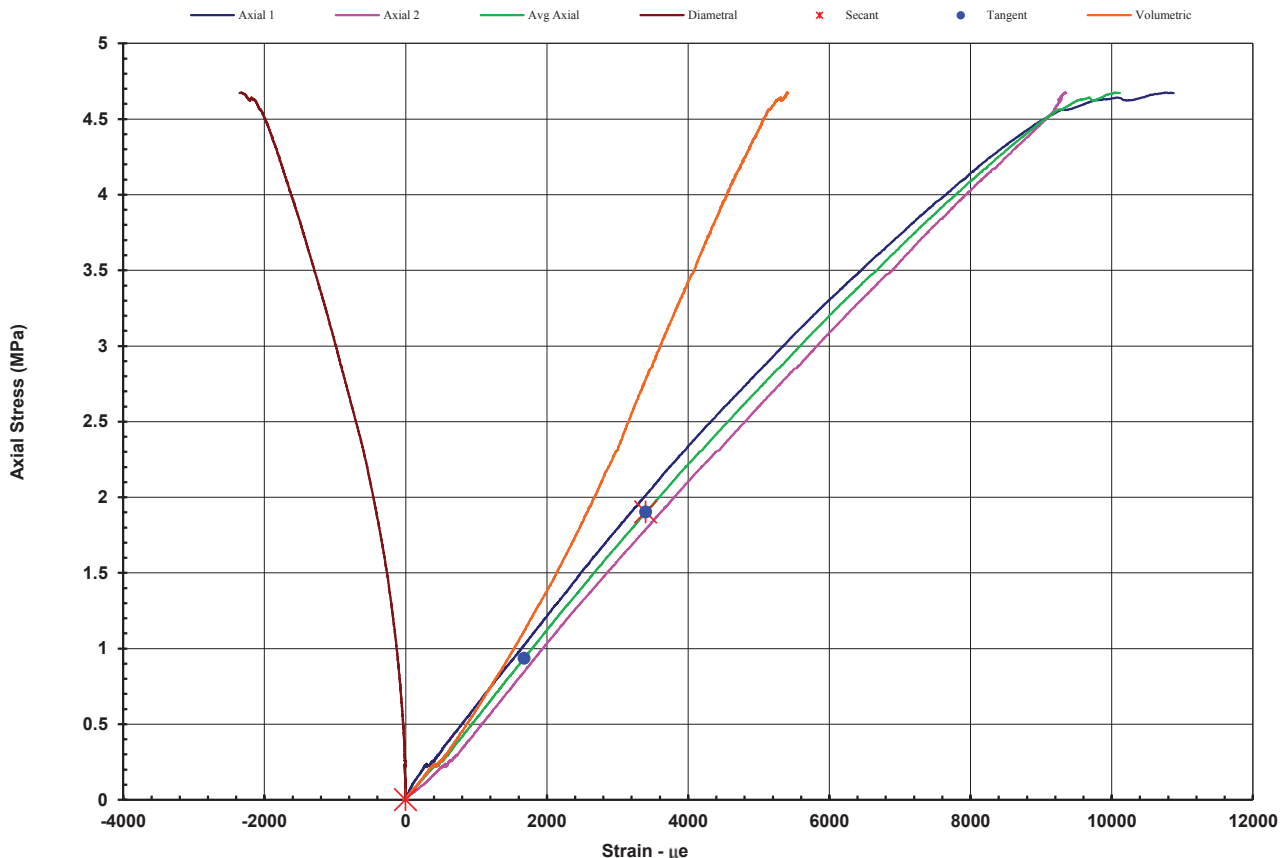
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102101-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	4/02/2019
Project No.	1893795	Depth From (m)	12	Report Date	5/02/2019
Bore Hole	320-01-BH2203	Depth To (m)	12.1	Sample No.	320-01-BH2203-C01210-UCY : 320-01-BH2203-C01210-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 4.68 MPa

<u>Young's Modulus</u>		<u>Poisson Ratio</u>	
Tangent	0.561 GPa	0.122	from 20 % to 41 % of Max UCS
Secant	0.559 GPa	0.122	from 0 % to 41 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

The length to diameter ratio falls outside the test method limits of 2.5:1 to 3.0:1.

Sample/s supplied by client

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Tested as received.

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102101-MOD
Average Sample Diameter (mm)	51.6	Moisture Content (%)	10.4
Sample Height (mm)	94.8	Wet Density (t/m ³)	2.22
Duration of Test (min)	22.02	Dry Density (t/m ³)	2.01
Rate of Displacement (mm/min)	0.10	Bedding (°)	5
Mode of Failure	Disintegration	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102101	DATE: 04/02/19
BOREHOLE:	320-01-BH2203	DEPTH: 12.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102101	DATE: 04/02/19
BOREHOLE:	320-01-BH2203	DEPTH: 12.1



Notes/Remarks:

The length to diameter ratio falls outside the test method limits of 2.5:1 to 3.0:1.

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

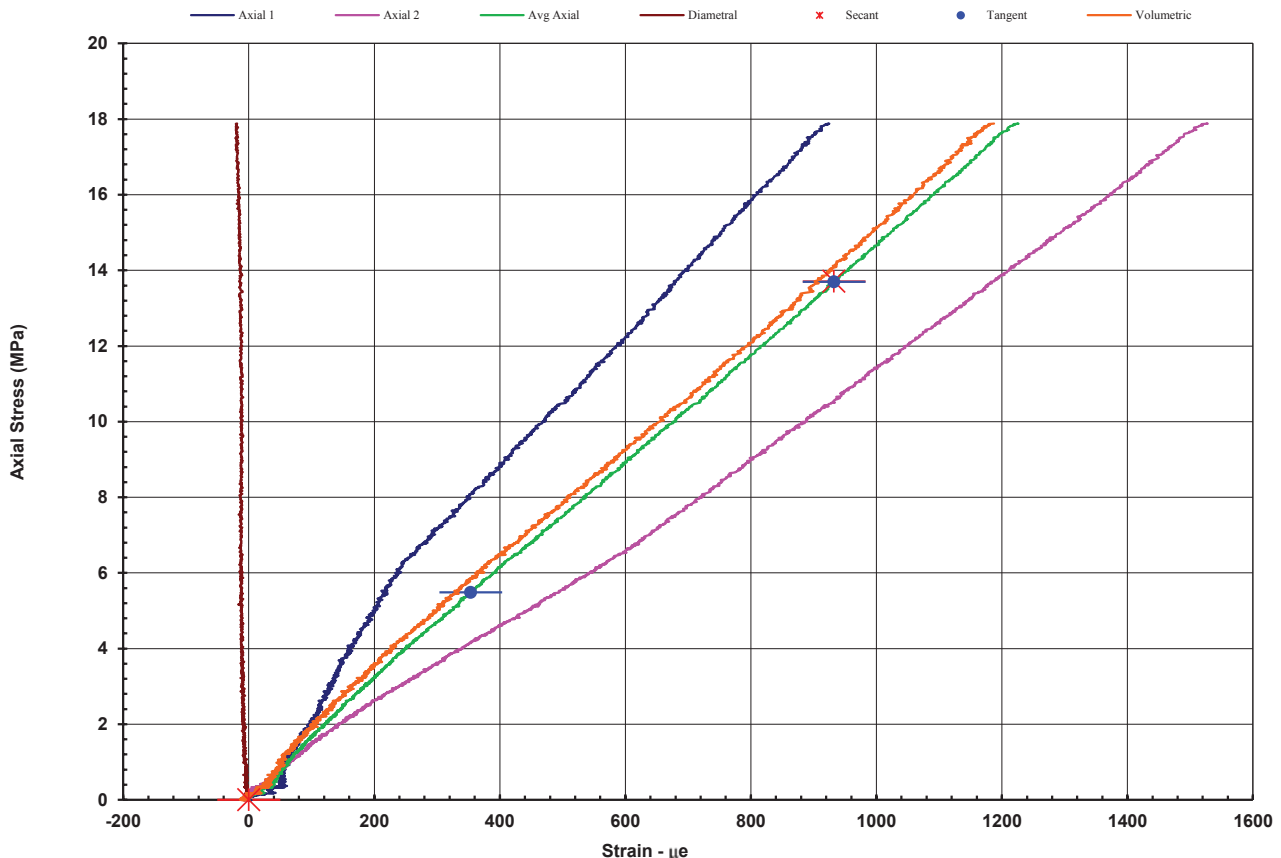
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102104-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	5/02/2019
Project No.	1893795	Depth From (m)	19.6
Bore Hole	320-01-BH2203	Depth To (m)	19.75
Description	C	Report Date	6/02/2019
Sample Type	Single Individual Rock Core Specimen		
Sample No.	320-01-BH2203-C01960-UCY : 320-01-BH2203-C01960-MOI		

Uniaxial Compressive Strength 27.4 MPa

Young's Modulus		Poisson Ratio	
Tangent	14.2 GPa	0.016	from 20 % to 50 % of Max UCS
Secant	14.7 GPa	0.017	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2 (EP13402)

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102104-MOD
Average Sample Diameter (mm)	51.7	Moisture Content (%)	1.6
Sample Height (mm)	140.6	Wet Density (t/m ³)	2.54
Duration of Test (min)	31.23	Dry Density (t/m ³)	2.49
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102104	DATE: 05/02/19
BOREHOLE:	320-01-BH2203	DEPTH: 19.6



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102104	DATE: 05/02/19
BOREHOLE:	320-01-BH2203	DEPTH: 19.6



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102114-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR0
Project	Inland Rail Section 320			Test Date	25/01/2019
Project No.	1893795		Client Sample No.	320-01-BH2207-C01810	
Bore Hole	320-01-BH2207	Depth From (m)	18.1	Depth To (m)	18.25
Description	C				
Sample Type	Single Individual Rock Core Specimen				

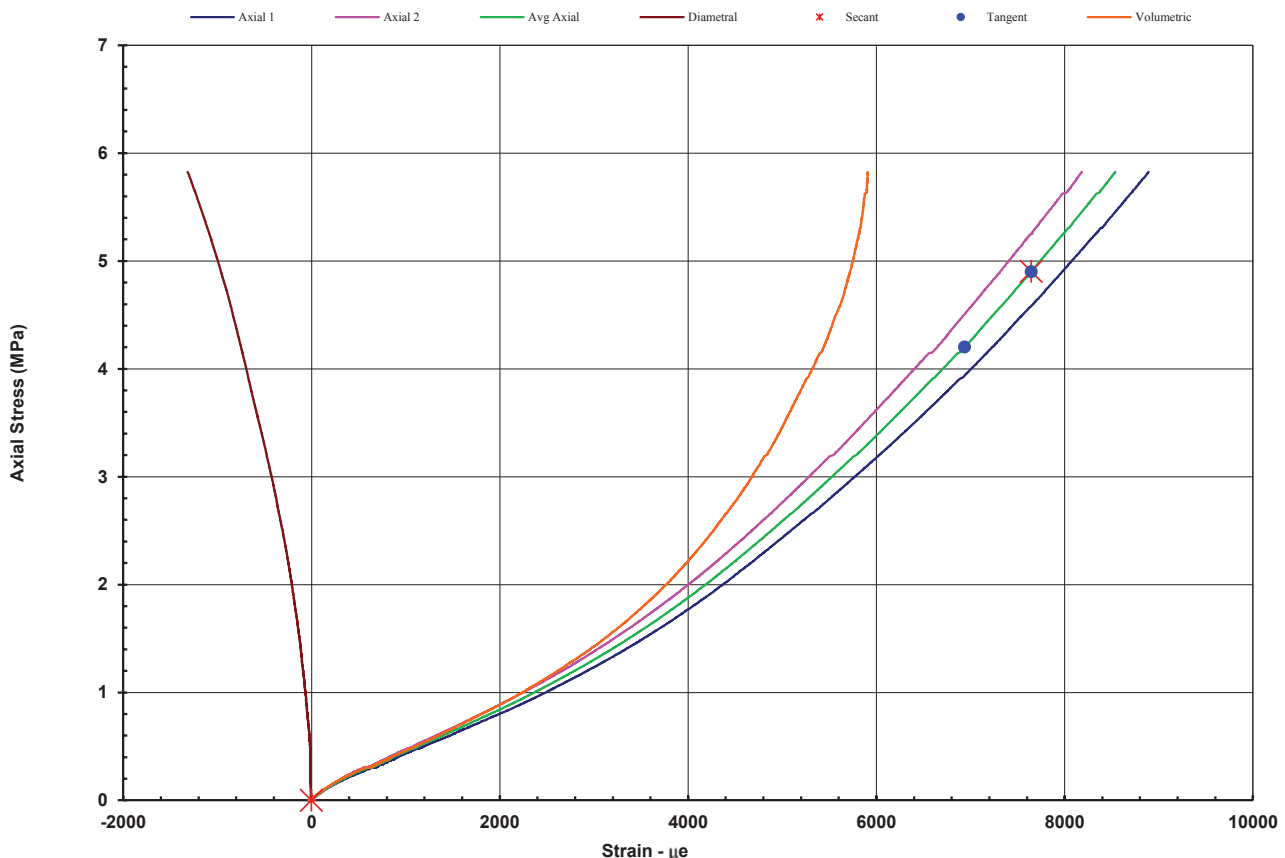
Uniaxial Compressive Strength 9.79 MPa

Young's Modulus

Poisson Ratio

Tangent	0.983 GPa	0.126	from 43 % to 50 % of Max UCS
Secant	0.641 GPa	0.126	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots




Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2:P13402

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client Golder Associates Pty Limited **Report No.** GA102114-MOD

Average Sample Diameter (mm)	51.9	Moisture Content (%)	8.0
Sample Height (mm)	142.2	Wet Density (t/m ³)	2.25
Duration of Test (min)	31.85	Dry Density (t/m ³)	2.08
Rate of Displacement (mm/min)	0.10	Bedding (°)	35
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102114	DATE: 25/01/19
BOREHOLE:	320-01-BH2207	DEPTH: 18.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102114	DATE: 25/01/19
BOREHOLE:	320-01-BH2207	DEPTH: 18.1



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102121-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	1/02/2019
Project No.	1893795	Depth From (m)	10.35	Report Date	4/02/2019
Bore Hole	320-01-BH2215	Depth To (m)	10.49	Sample No.	320-01-BH2215-C01010-UCY : 320-01-BH2215-C01010-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 2.46 MPa

Young's Modulus

Poisson Ratio

Tangent 0.561 GPa

0.028

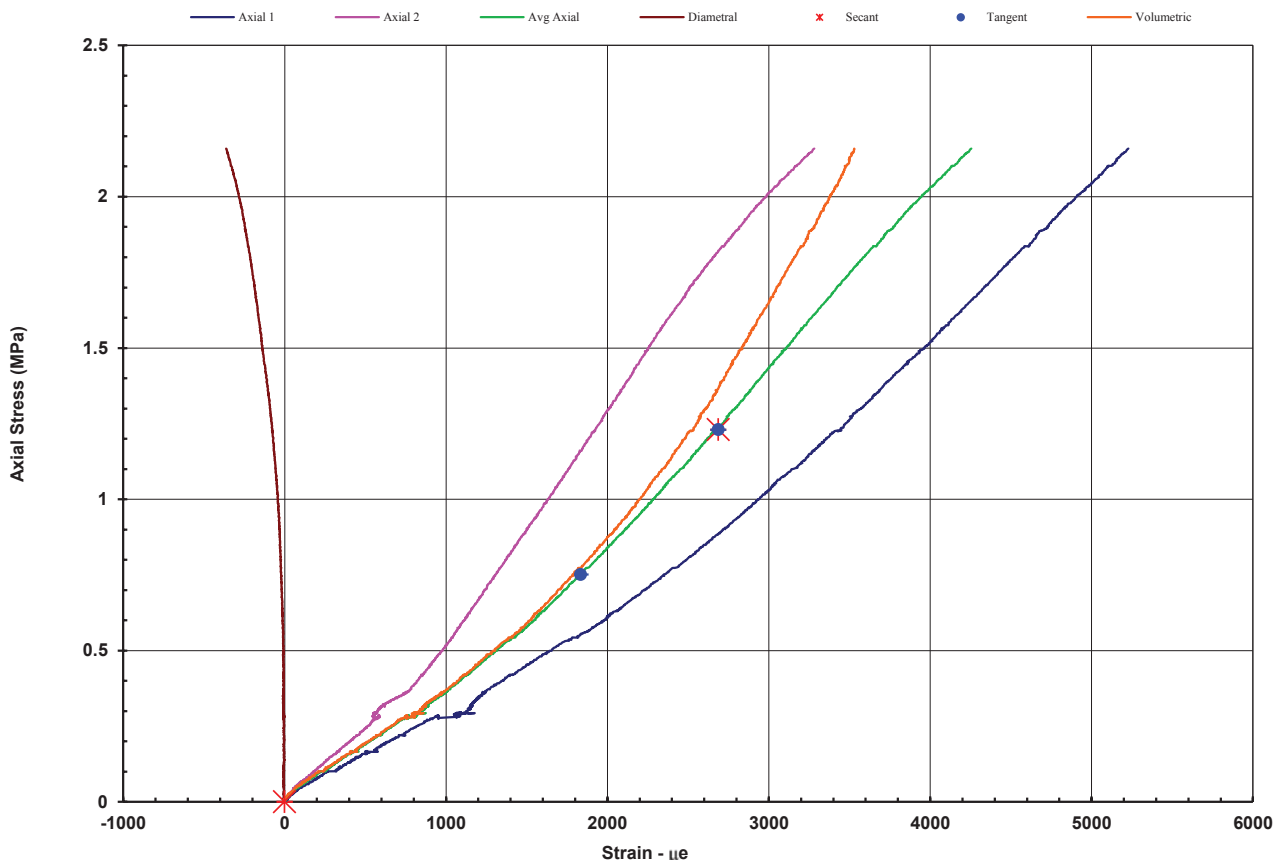
from 31 % to 50 % of Max UCS

Secant 0.458 GPa

0.028

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102121-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	5.7
Sample Height (mm)	137.4	Wet Density (t/m ³)	2.10
Duration of Test (min)	16.73	Dry Density (t/m ³)	1.99
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102121	DATE: 01/02/19
BOREHOLE:	320-01-BH2215	DEPTH: 10.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102121	DATE: 01/02/19
BOREHOLE:	320-01-BH2215	DEPTH: 10.1



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102125-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	1/02/2019
Project No.	1893795	Depth From (m)	19.6	Report Date	4/02/2019
Bore Hole	320-01-BH2215	Depth To (m)	19.8	Sample No.	320-01-BH2215-C01960-UCY : 320-01-BH2215-C01960-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 23.1 MPa

Young's Modulus

Poisson Ratio

Tangent 10.8 GPa

0.127

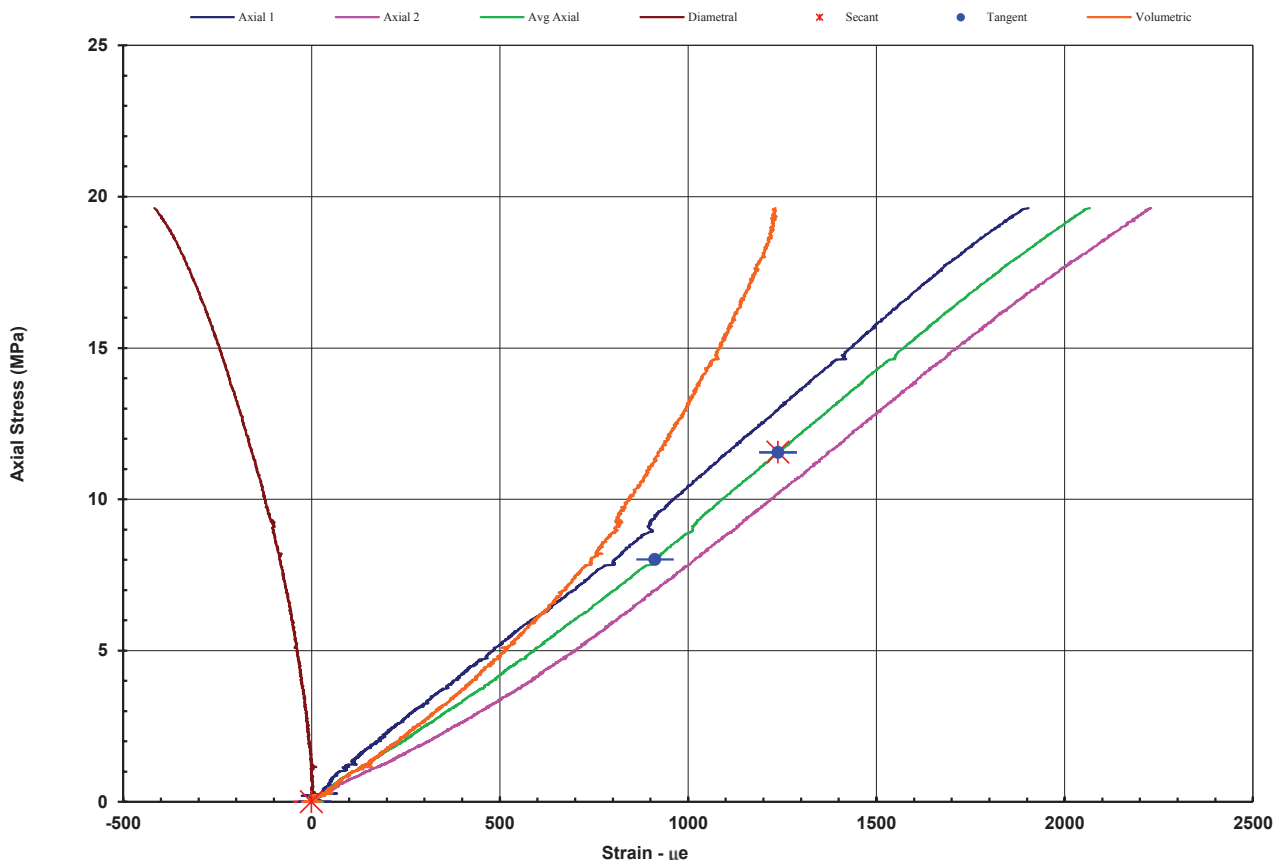
from 35 % to 50 % of Max UCS

Secant 9.33 GPa

0.128

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102125-MOD
Average Sample Diameter (mm)	52.0	Moisture Content (%)	3.1
Sample Height (mm)	140.0	Wet Density (t/m ³)	2.40
Duration of Test (min)	22.53	Dry Density (t/m ³)	2.32
Rate of Displacement (mm/min)	0.10	Bedding (°)	10
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102125	DATE: 01/02/19
BOREHOLE:	320-01-BH2215	DEPTH: 19.6



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102125	DATE: 01/02/19
BOREHOLE:	320-01-BH2215	DEPTH: 19.6



Notes/Remarks:

Sample/s supplied by client

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102133-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	1/02/2019
Project No.	1893795	Depth From (m)	15.1	Report Date	4/02/2019
Bore Hole	320-01-BH2216	Depth To (m)	15.3	Sample No.	320-01-BH2216-C01510-UCY : 320-01-BH2216-C01510-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 13.6 MPa

Young's Modulus

Poisson Ratio

Tangent 2.00 GPa

0.098

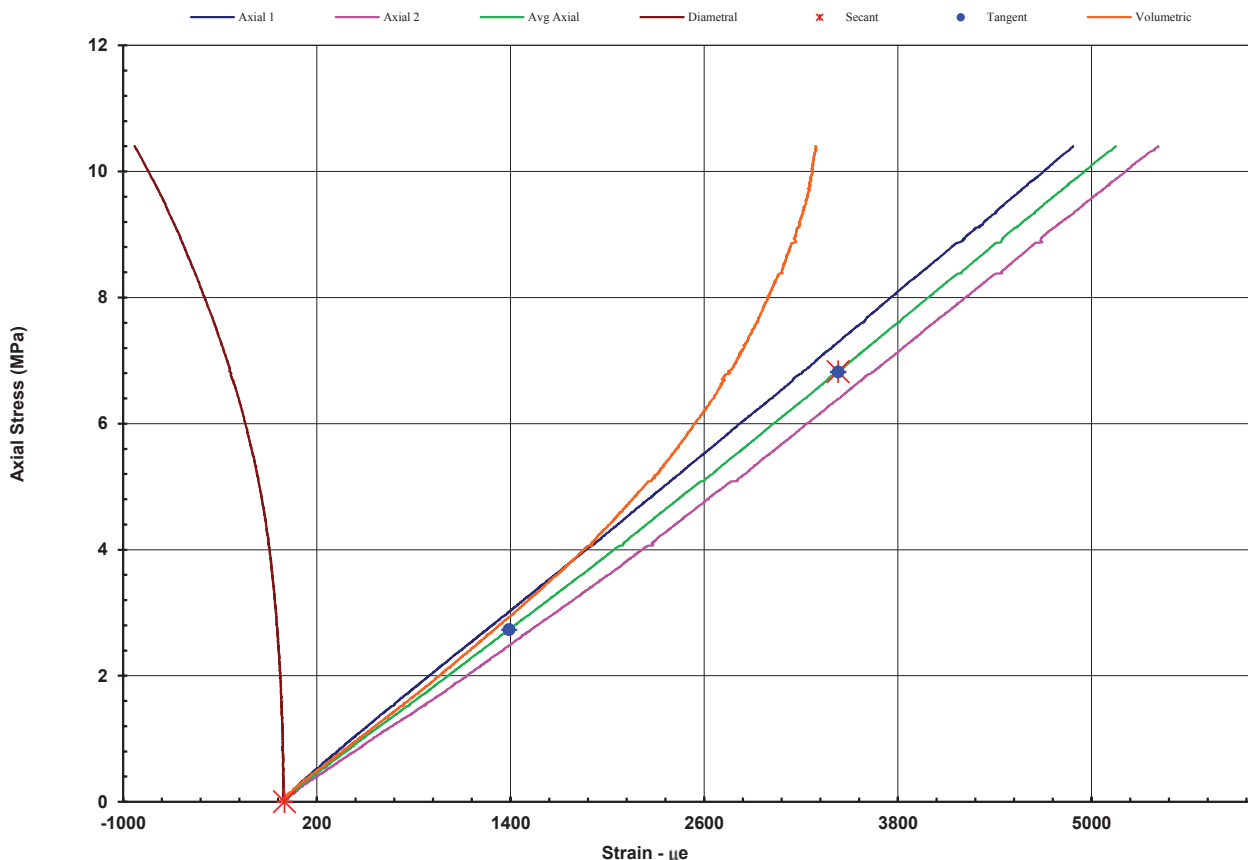
from 20 % to 50 % of Max UCS

Secant 1.99 GPa

0.099

from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

Sample/s supplied by client

Graph not to scale

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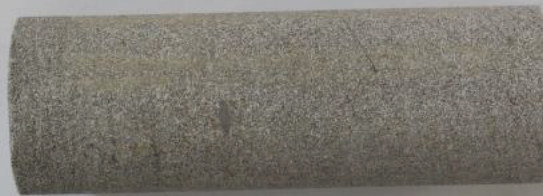
Trilab Pty Ltd ABN 25 065 630 506

UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102133-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	4.4
Sample Height (mm)	141.4	Wet Density (t/m ³)	2.39
Duration of Test (min)	26.13	Dry Density (t/m ³)	2.29
Rate of Displacement (mm/min)	0.10	Bedding (°)	20
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102133	DATE: 01/02/19
BOREHOLE:	320-01-BH2216	DEPTH: 15.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102133	DATE: 01/02/19
BOREHOLE:	320-01-BH2216	DEPTH: 15.1



Notes/Remarks:

Sample/s supplied by client

Photo not to scale

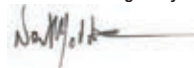
Tested as received.

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Laboratory No. 9926

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

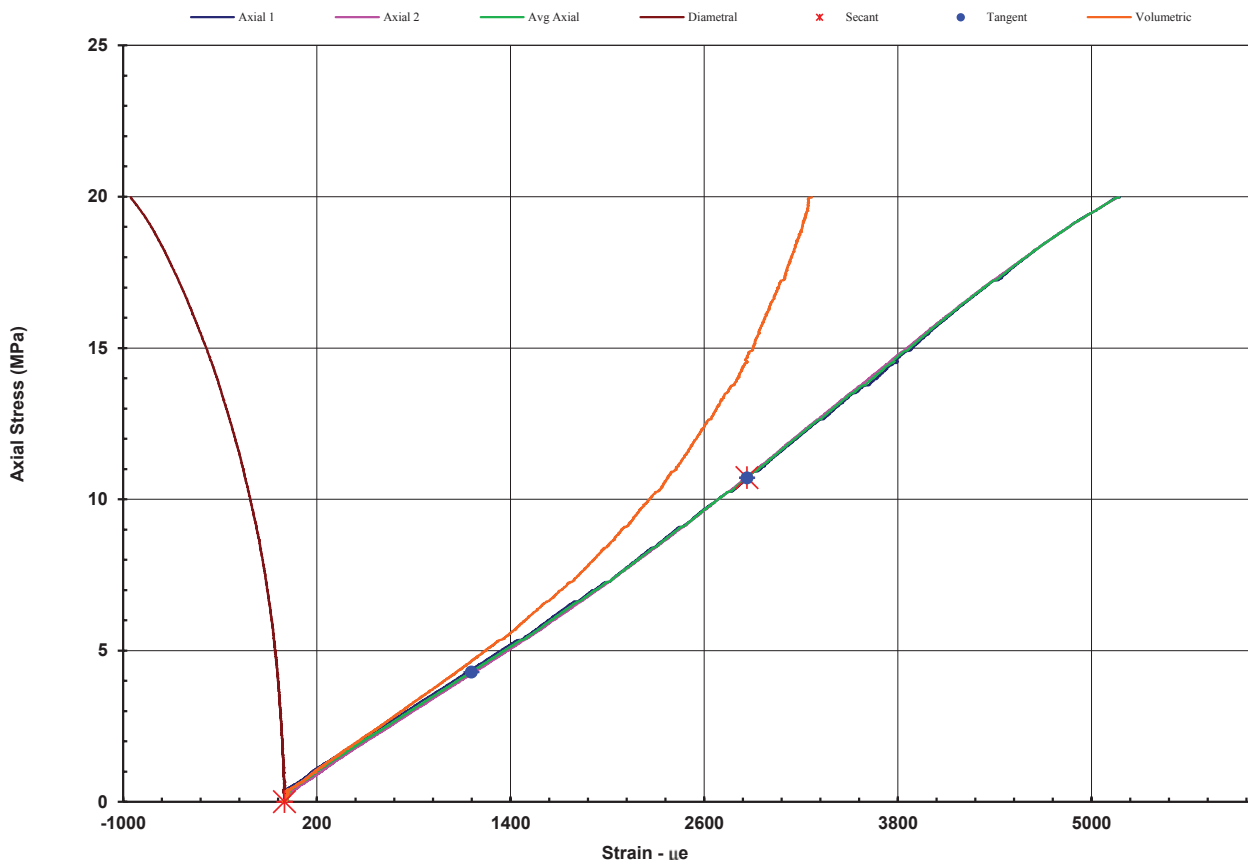
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102147-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320	Test Date	1/02/2019
Project No.	1893795	Depth From (m)	14.8
Bore Hole	320-01-BH2301	Depth To (m)	15
Description	C	Report Date	4/02/2019
Sample Type	Single Individual Rock Core Specimen		
Sample No.	320-01-BH2301-C01480-UCY : 320-01-BH2301-C01480-MOI		

Uniaxial Compressive Strength 21.4 MPa

Young's Modulus		Poisson Ratio	
Tangent	3.76 GPa	0.085	from 20 % to 50 % of Max UCS
Secant	3.74 GPa	0.086	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots




Notes/Remarks:

Sample/s supplied by client Graph not to scale Tested as received. Page 1 of 2 EP13402

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102147-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	4.2
Sample Height (mm)	141.7	Wet Density (t/m ³)	2.40
Duration of Test (min)	28.10	Dry Density (t/m ³)	2.30
Rate of Displacement (mm/min)	0.10	Bedding (°)	30
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102147	DATE: 01/02/19.
BOREHOLE:	320-01-BH2301	DEPTH: 14.8



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102147	DATE: 01/02/19.
BOREHOLE:	320-01-BH2301	DEPTH: 14.8



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

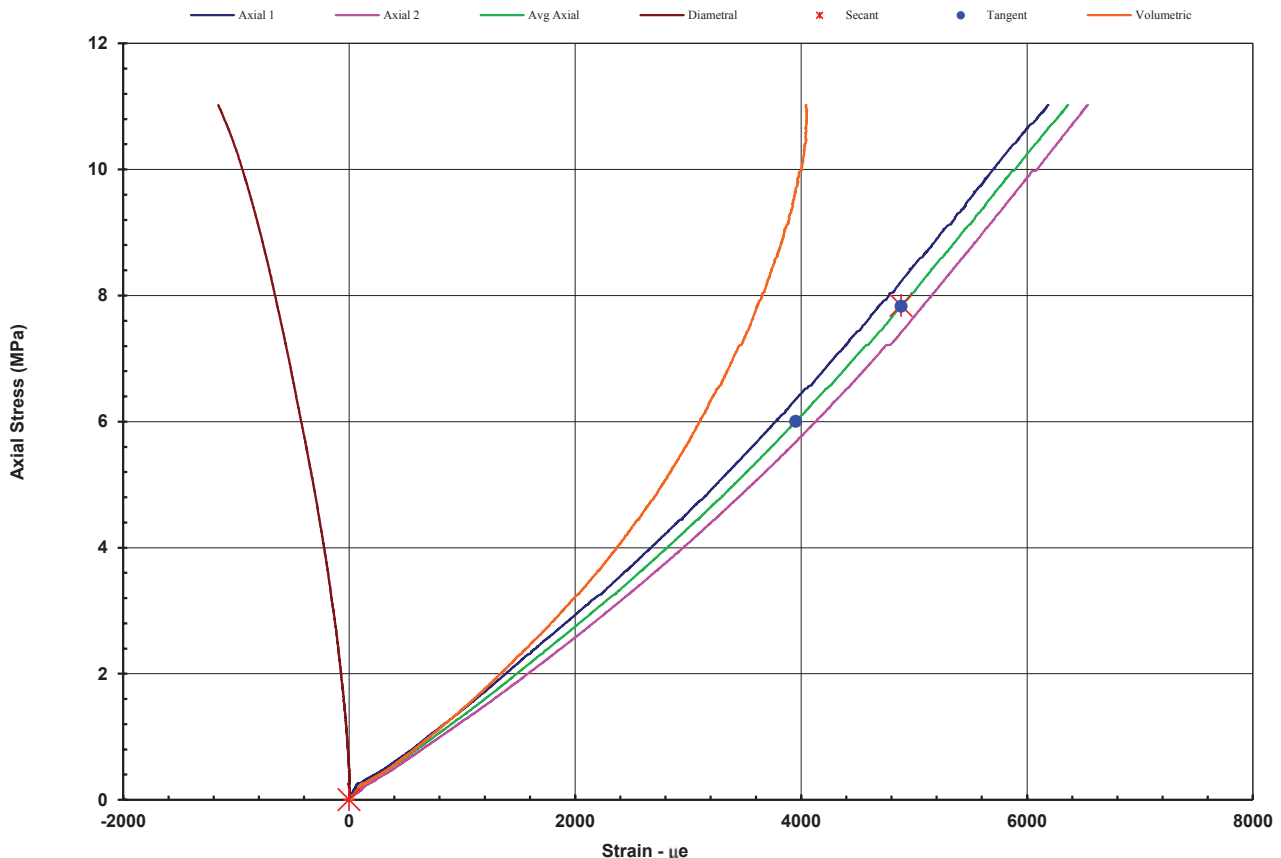
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102150-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR04
Project	Inland Rail Section 320			Test Date	1/02/2019
Project No.	1893795	Depth From (m)	18.14	Report Date	4/02/2019
Bore Hole	320-01-BH2301	Depth To (m)	18.29	Sample No.	320-01-BH2301-C01810-UCY : 320-01-BH2301-C01810-MOI
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 15.7 MPa

<u>Young's Modulus</u>		<u>Poisson Ratio</u>	
Tangent	1.96 GPa	0.130	from 38 % to 50 % of Max UCS
Secant	1.60 GPa	0.130	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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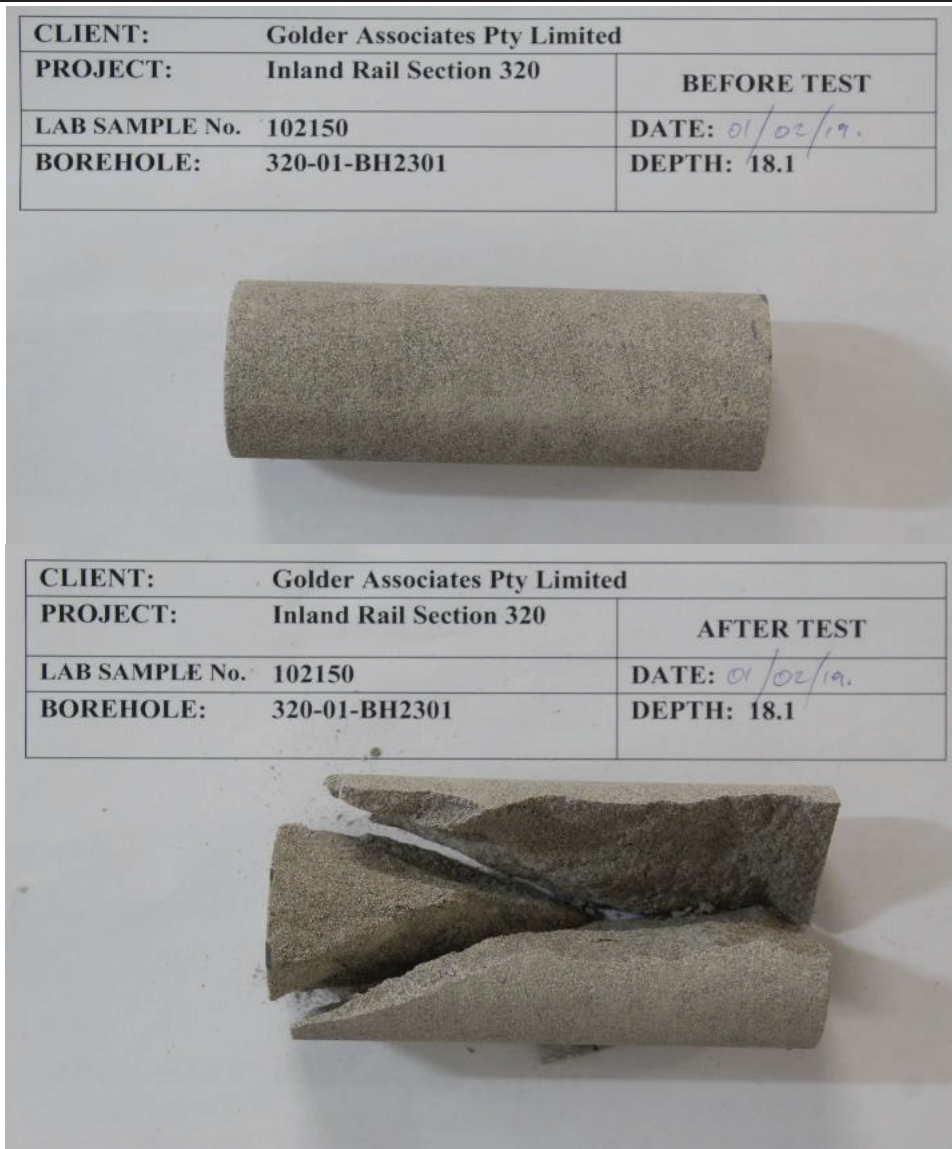
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Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited		Report No.	GA102150-MOD
Average Sample Diameter (mm)	51.8	Moisture Content (%)	6.0	
Sample Height (mm)	142.5	Wet Density (t/m ³)	2.35	
Duration of Test (min)	29.87	Dry Density (t/m ³)	2.21	
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil	
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine	



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client Golder Associates Pty Limited		Report No. GA102155-MOD
Address PO Box 1734 MILTON BC QLD 4064		Request No. Golder_1893795_TR0
Project Inland Rail Section 320		Test Date 25/01/2019
Project No. 1893795		Report Date 29/01/2019
Client Sample No. 320-01-BH2302-C00310		
Bore Hole 320-01-BH2302	Depth From (m) 3.12	Depth To (m) 3.27
Description C		
Sample Type Single Individual Rock Core Specimen		

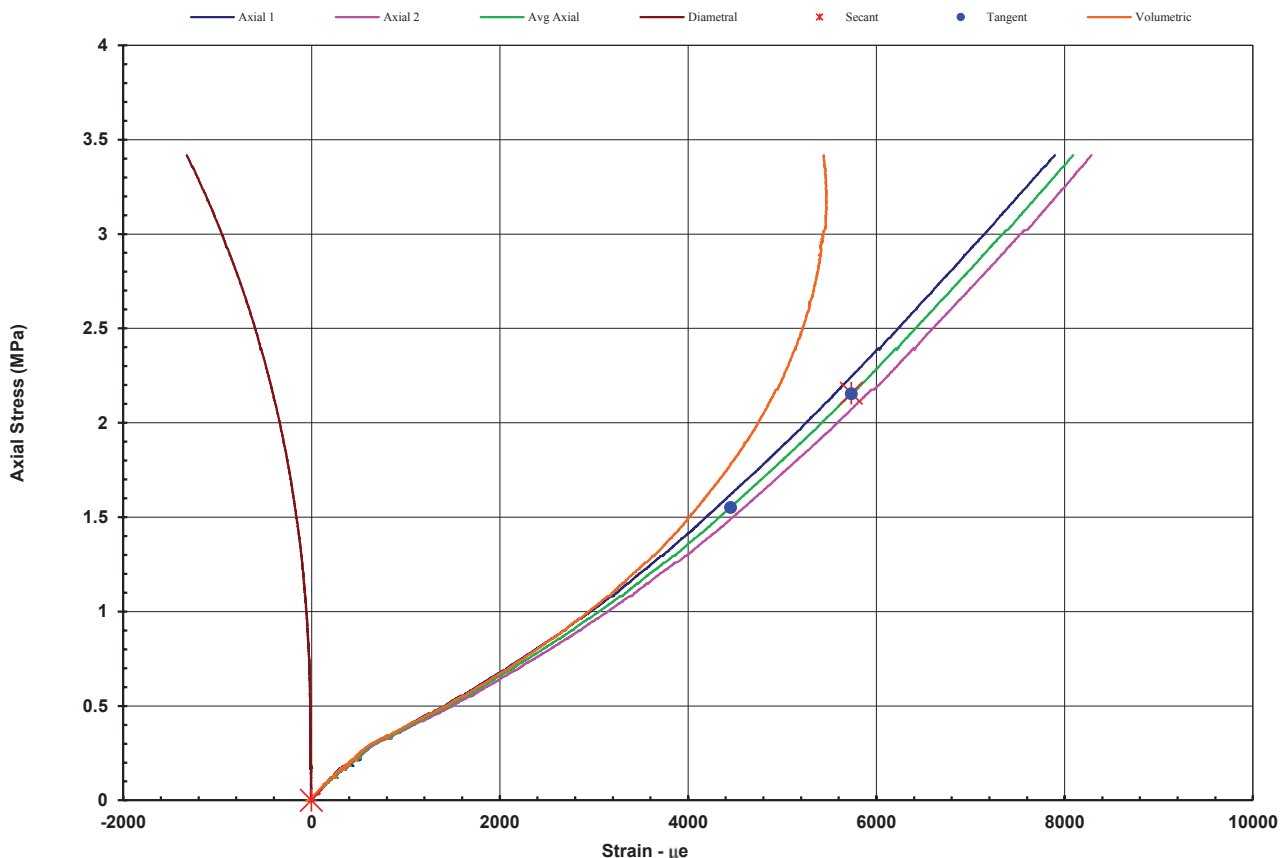
Uniaxial Compressive Strength 5.25 MPa

Young's Modulus

Poisson Ratio

Tangent 0.469 GPa	0.071	from 30 % to 41 % of Max UCS
Secant 0.376 GPa	0.072	from 0 % to 41 % of Max UCS

Axial Stress vs Strain Plots




Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited		Report No.	GA102155-MOD
Average Sample Diameter (mm)	51.1	Moisture Content (%)	7.7	
Sample Height (mm)	141.9	Wet Density (t/m ³)	2.22	
Duration of Test (min)	28.40	Dry Density (t/m ³)	2.06	
Rate of Displacement (mm/min)	0.10	Bedding (°)	25	
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine	

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102155	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 3.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102155	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 3.1



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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102158-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR0
Project	Inland Rail Section 320	Test Date	25/01/2019
Project No.	1893795	Report Date	29/01/2019
Bore Hole	320-01-BH2302	Client Sample No.	320-01-BH2302-C00710
Depth From (m)	7.12	Depth To (m)	7.28
Description	C		
Sample Type	Single Individual Rock Core Specimen		

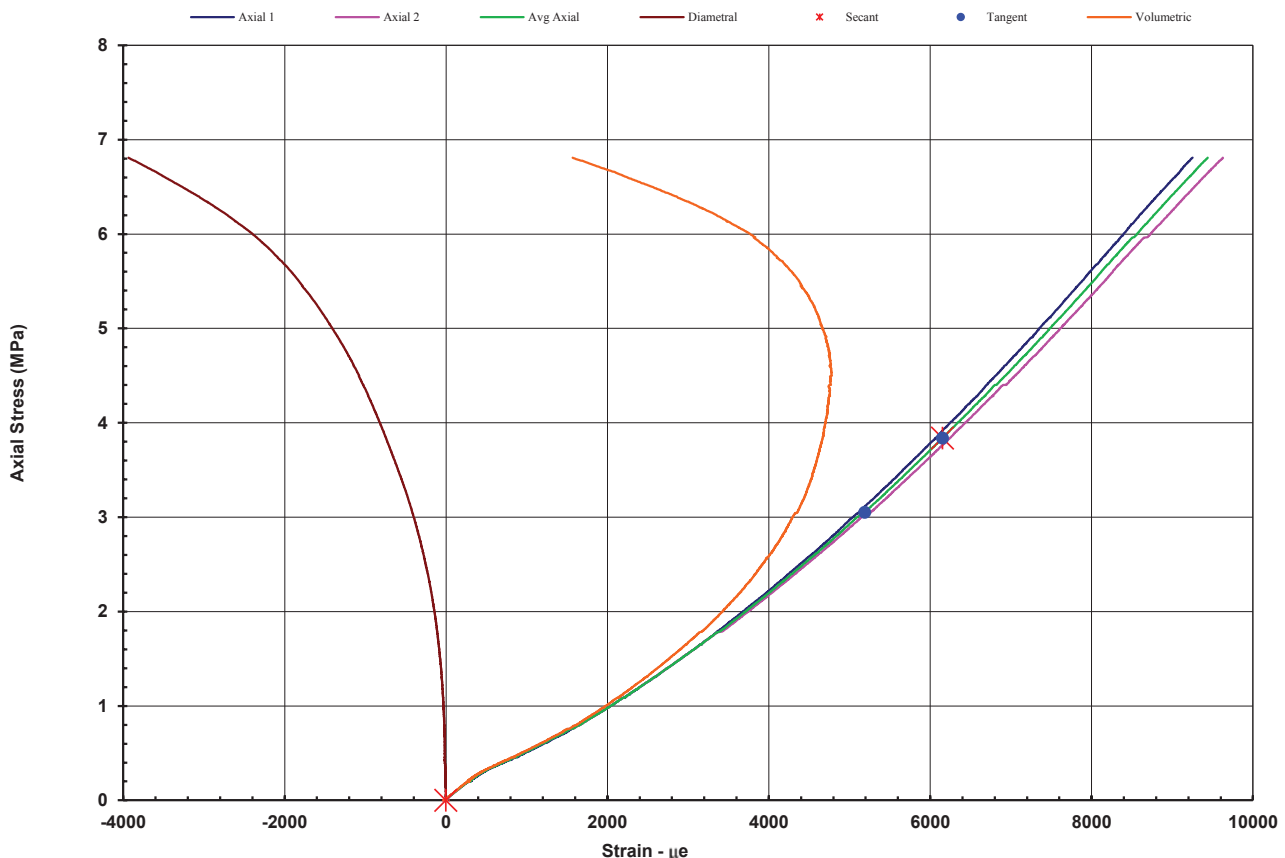
Uniaxial Compressive Strength 7.67 MPa

Young's Modulus

Poisson Ratio

Tangent	0.817 GPa	0.121	from 40 % to 50 % of Max UCS
Secant	0.624 GPa	0.121	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited		Report No.	GA102158-MOD
Average Sample Diameter (mm)	51.9	Moisture Content (%)	7.2	
Sample Height (mm)	140.3	Wet Density (t/m ³)	2.22	
Duration of Test (min)	27.95	Dry Density (t/m ³)	2.08	
Rate of Displacement (mm/min)	0.10	Bedding (°)	10	
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine	

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102158	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 7.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102158	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 7.1



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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102162-MOD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	Golder_1893795_TR0
Project	Inland Rail Section 320	Test Date	25/01/2019
Project No.	1893795	Report Date	29/01/2019
Bore Hole	320-01-BH2302	Client Sample No.	320-01-BH2302-C01210
Depth From (m)	12.1	Depth To (m)	12.3
Description	C		
Sample Type	Single Individual Rock Core Specimen		

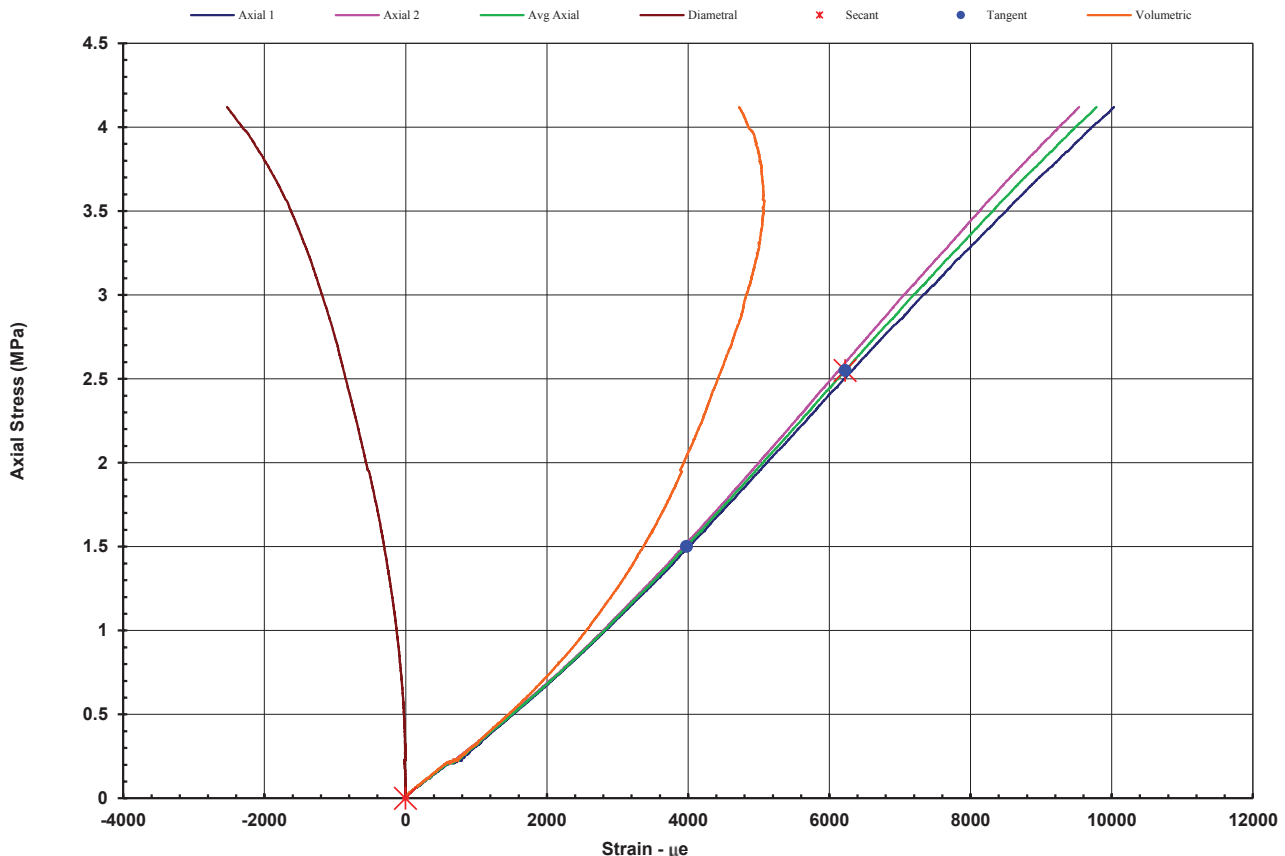
Uniaxial Compressive Strength 5.09 MPa

Young's Modulus

Poisson Ratio

Tangent	0.466 GPa	0.141	from 29 % to 50 % of Max UCS
Secant	0.409 GPa	0.141	from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102162-MOD
Average Sample Diameter (mm)	51.0	Moisture Content (%)	8.2
Sample Height (mm)	142.5	Wet Density (t/m ³)	2.25
Duration of Test (min)	31.80	Dry Density (t/m ³)	2.08
Rate of Displacement (mm/min)	0.10	Bedding (°)	5
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102162	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 12.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102162	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 12.1



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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited			Report No.	GA102165-MOD
Address	PO Box 1734 MILTON BC	QLD	4064	Request No.	Golder_1893795_TR0
Project	Inland Rail Section 320			Test Date	25/01/2019
Project No.	1893795		Client Sample No.	320-01-BH2302-C01710	
Bore Hole	320-01-BH2302	Depth From (m)	17.1	Depth To (m)	17.25
Description	C				
Sample Type	Single Individual Rock Core Specimen				

Uniaxial Compressive Strength 12.7 MPa

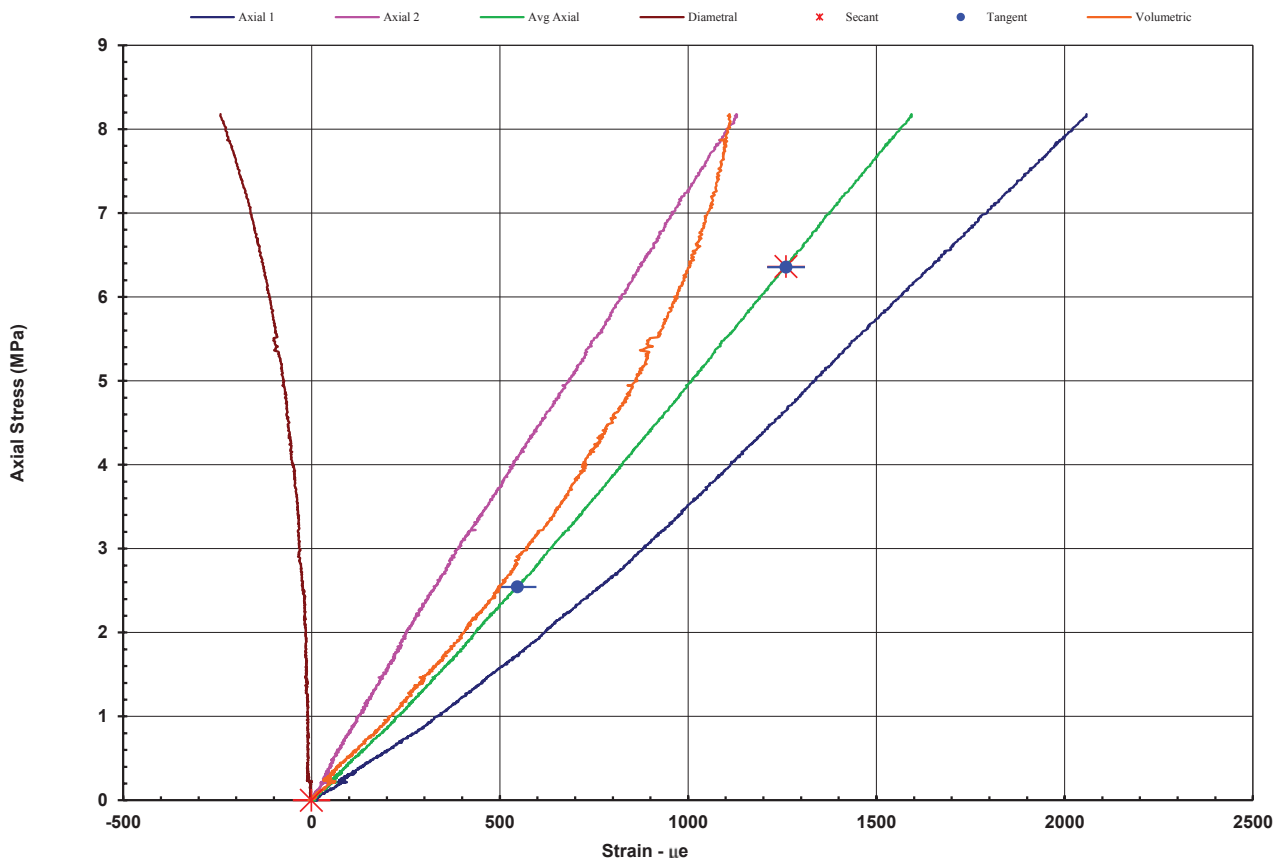
Young's Modulus

Tangent 5.34 GPa
Secant 5.05 GPa

Poisson Ratio

0.100 from 20 % to 50 % of Max UCS
0.102 from 0 % to 50 % of Max UCS

Axial Stress vs Strain Plots




Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102165-MOD
Average Sample Diameter (mm)	51.3	Moisture Content (%)	4.7
Sample Height (mm)	141.2	Wet Density (t/m ³)	2.22
Duration of Test (min)	21.23	Dry Density (t/m ³)	2.12
Rate of Displacement (mm/min)	0.10	Bedding (°)	45
Mode of Failure	Shear	Test Apparatus	100kN Compression Machine

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102165	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 17.1



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102165	DATE: 25/01/19
BOREHOLE:	320-01-BH2302	DEPTH: 17.1



Notes/Remarks:

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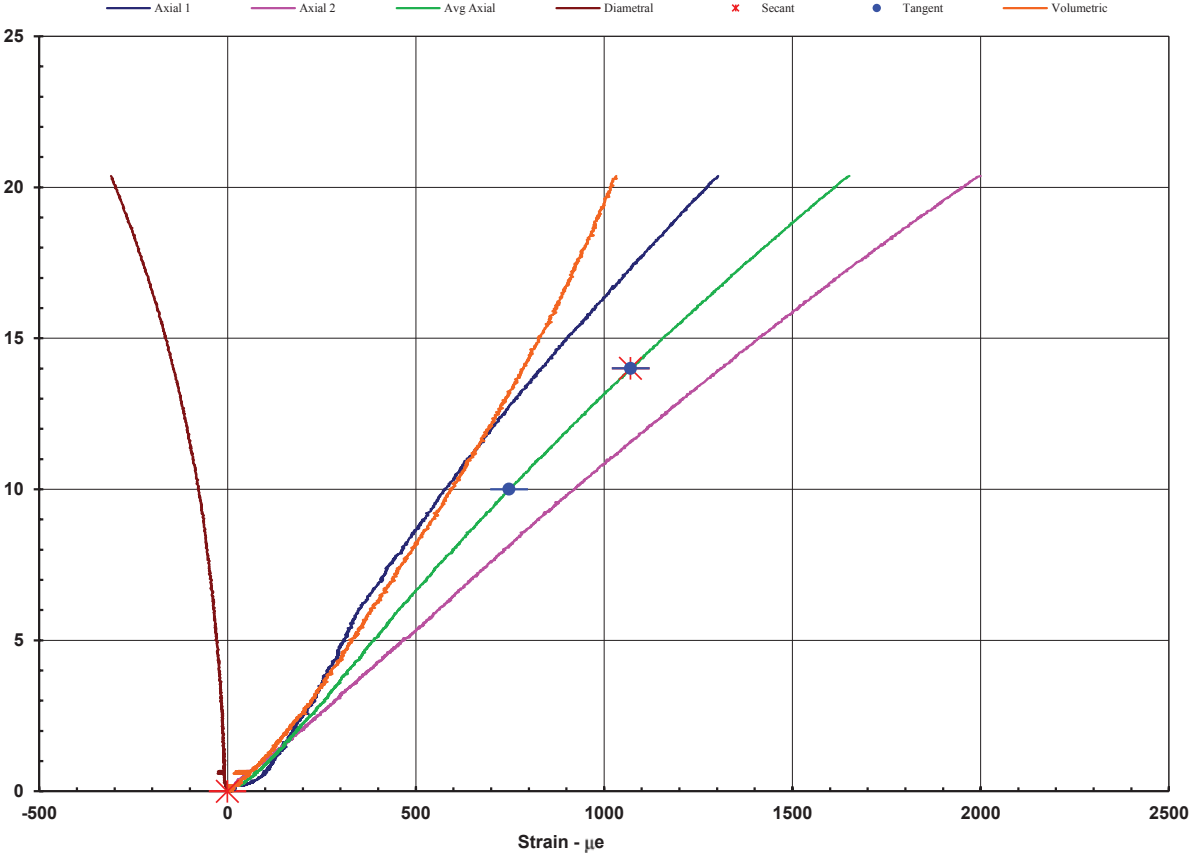
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UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT					
Test Method: AS 4133.4.3.2 & AS 4133.1.1.1					
Client	Golder Associates Pty Limited			Report No.	GA102168-MOD
Address	PO Box 1734 MILTON BC QLD 4064			Request No.	Golder_1893795_TR0
Project	Inland Rail Section 320			Test Date	25/01/2019
Project No.	1893795		Client Sample No.	320-01-BH2302-C02400	
Bore Hole	320-01-BH2302	Depth From (m)	24.04	Depth To (m)	24.19
Description	C				
Sample Type	Single Individual Rock Core Specimen				
Uniaxial Compressive Strength 32.1 MPa					
Young's Modulus			Poisson Ratio		
Tangent 12.4 GPa			0.134 from 31 % to 44 % of Max UCS		
Secant 13.1 GPa			0.134 from 0 % to 44 % of Max UCS		
Axial Stress vs Strain Plots					
					
Notes/Remarks:					
Sample/s supplied by client		Graph not to scale		Tested as received.	

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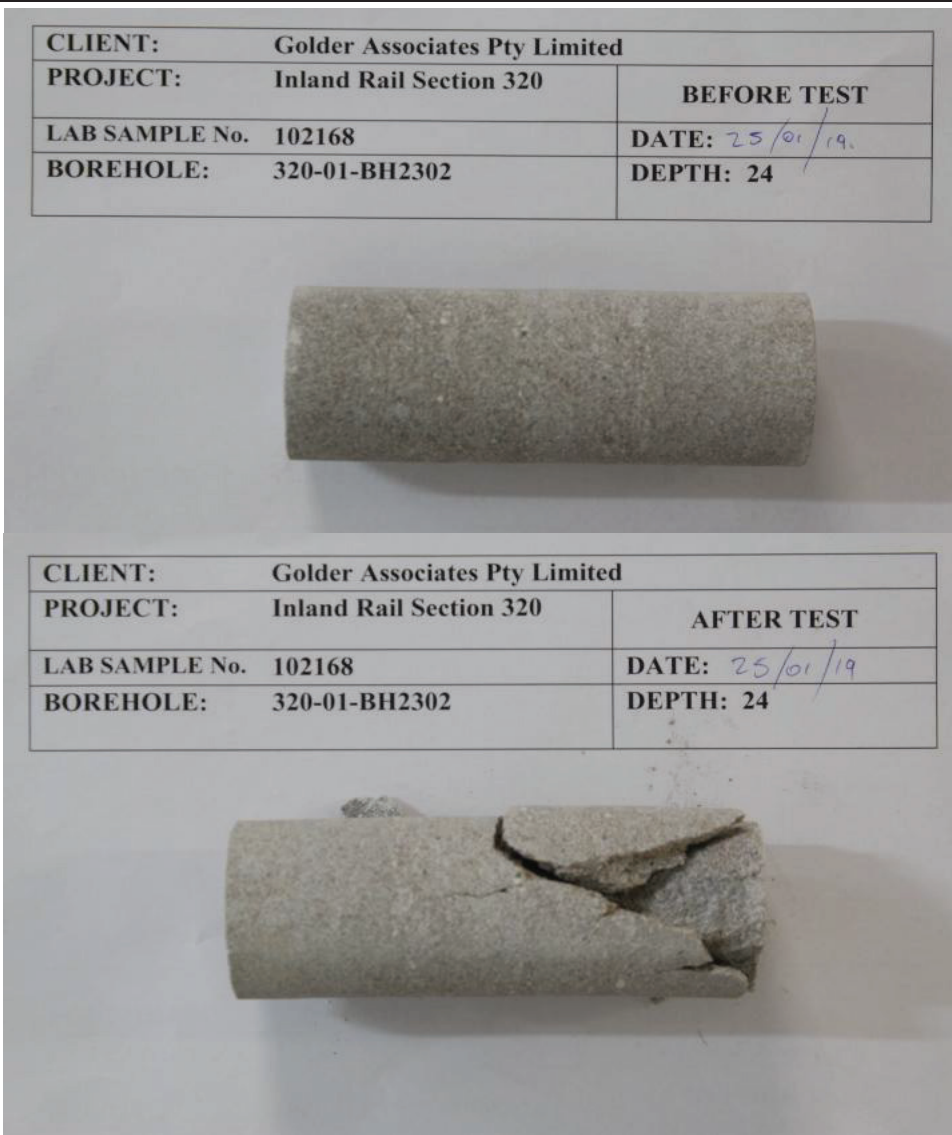


UNIAXIAL COMPRESSIVE STRENGTH & DEFORMATION TEST REPORT

Test Method: AS 4133.4.3.2 & AS 4133.1.1.1

Client Golder Associates Pty Limited **Report No.** GA102168-MOD

Average Sample Diameter (mm)	51.7	Moisture Content (%)	3.6
Sample Height (mm)	141.2	Wet Density (t/m ³)	2.47
Duration of Test (min)	28.03	Dry Density (t/m ³)	2.39
Rate of Displacement (mm/min)	0.10	Bedding (°)	Nil
Mode of Failure	Conical	Test Apparatus	100kN Compression Machine



Notes/Remarks:

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.1 & AS 4133.1.1.1

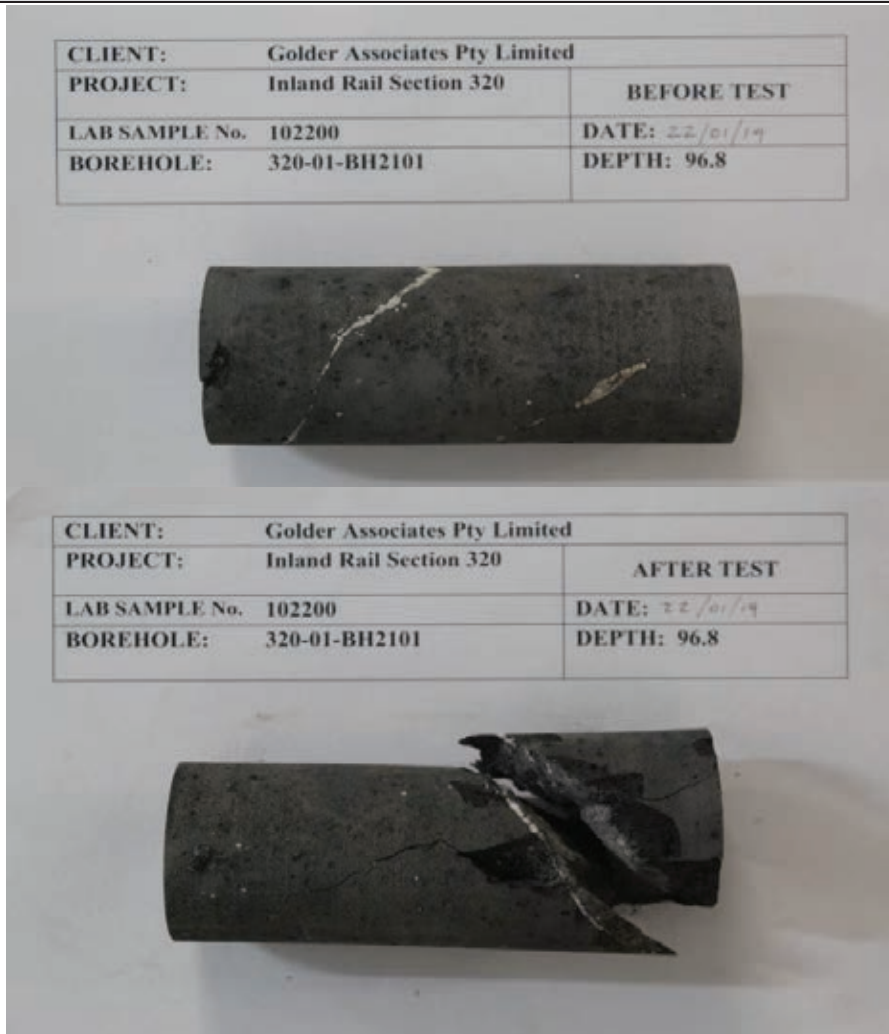
Client	Golder Associates Pty Limited	Report No.	GA102200-UCS
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
Bore Hole:	320-01-BH2101	Report Date	23/01/2019
Client Sample No.	320-01-BH2101	Project No	1893795
Description	C	Depth From (m)	96.64
		Depth To (m)	96.81

Test Details

Specimen Length (mm)	161.1	Moisture Content (%)	3.3
Specimen Diameter (mm)	60.7	Wet Density (t/m ³)	2.59
Mode of Failure	Shear	Dry Density (t/m ³)	2.50
Test Duration (Min:Sec)	7:11		

UCS (MPa) 39.4

Before and After Photo's



NOTES/REMARKS:

Stored and tested as received
Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

Photo not to scale

Page: 1 of 1 REP02702

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory



N. Maddison



Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.1 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102206-UCS
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
Bore Hole:	320-01-BH2101	Report Date	23/01/2019
Client Sample No.	320-01-BH2101	Project No	1893795
Description	C	Depth From (m)	103.1
		Depth To (m)	103.26

Test Details

Specimen Length (mm)	161.0	Moisture Content (%)	1.1
Specimen Diameter (mm)	60.8	Wet Density (t/m ³)	2.81
Mode of Failure	Disintegration	Dry Density (t/m ³)	2.78
Test Duration (Min:Sec)	9:38		

UCS (MPa) 150

Before and After Photo's



NOTES/REMARKS:

Stored and tested as received
Sample/s supplied by the client

Test Apparatus - Kelba 1000 kN Load Cell

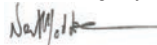
Photo not to scale

Page: 1 of 1 REP02702

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Authorised Signatory



N. Maddison



Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102210-UCS
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
		Report Date	23/01/2019
		Project No.	1893795

Bore Hole	320-01-BH2101
Client Sample No:	320-01-BH2101
Depth From (m)	104.32
Depth To (m)	104.48
Description	C
Wet Density (t/m ³)	2.19
Moisture Content (%)	8.1
Specimen Length (mm)	161.0
Specimen Diameter (mm)	60.8
Mode of Failure	Shear
Rate of Displacement (mm/min)	0.1
Test Duration (Min:Sec)	21:38



UCS (MPa)	3.56
-----------	------

NOTES/REMARKS:

Stored and tested as received
Sample/s supplied by the client


Test Apparatus - 100kN Compression Machine

Photo not to scale
Page: 1 of 1 REP13302

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C. Purvis



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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102216-UCS
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
		Report Date	23/01/2019
		Project No.	1893795

Bore Hole	320-01-BH2101
Client Sample No:	320-01-BH2101
Depth From (m)	105.17
Depth To (m)	105.29
Description	C
Wet Density (t/m ³)	2.23
Moisture Content (%)	13.5
Specimen Length (mm)	126.1 *
Specimen Diameter (mm)	60.6
Mode of Failure	Conical
Rate of Displacement (mm/min)	0.1
Test Duration (Min:Sec)	18:04



UCS (MPa)	2.65
-----------	------


NOTES/REMARKS:

Stored and tested as received * Length to diameter ratio less than 2.5:1 Photo not to scale
 Sample/s supplied by the client Test Apparatus - 100kN Compression Machine Page: 1 of 1 REP13302

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UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.2 & AS 4133.1.1.1

Client	Golder Associates Pty Limited	Report No.	GA102225-UCS
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
		Report Date	23/01/2019
		Project No.	1893795

Bore Hole	320-01-BH2101
Client Sample No:	320-01-BH2101
Depth From (m)	109.02
Depth To (m)	109.22
Description	C
Wet Density (t/m ³)	2.12
Moisture Content (%)	9.5
Specimen Length (mm)	160.8
Specimen Diameter (mm)	60.4
Mode of Failure	Shear
Rate of Displacement (mm/min)	0.1
Test Duration (Min:Sec)	20:28



UCS (MPa)	4.73
-----------	------

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Sample/s supplied by the client

Test Apparatus - 100kN Compression Machine

Photo not to scale
Page: 1 of 1 REP13302

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Petrographic Analyses Reports

Petrology report on one core sample.

February 2019

**Dr Rowena Duckworth
MAIG, MAusIMM, FSEG**

Mintex Petrological Solutions



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Email: rowenaduckworth@bigpond.com

Client: Chris Channon - Trilab Pty Ltd

Mintex report number: 410219



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Introduction

This report details the results of transmitted light microscopy observations on one core sample GA102224 (320-01-BH2101-108.70-109.00m) submitted by Trilab Pty Ltd. Darren Richardson of Ingham Petrographics prepared a cover slipped thin section from the sample.

A full petrographic description of the section was undertaken using transmitted light microscopy and observations are listed below.

Summary

- The supplied rock is identified as a sandstone.
- 55% quartz content in the sandstone occurs as unstrained grains of crystalline quartz.
- Mica, chlorite and clays form approximately 25% of the rock.
- For engineering purposes, the sample may be summarised as:
 - Containing 55% total free silica, which is unstrained,
 - Quartz crystals occur as fine to coarse subangular to subrounded, anhedral grains between 0.3-0.5mm across, possessing a hardness of 7 on the Mohs scale, and are commonly clean.
 - Containing 58% robust and durable minerals and 25% weak minerals.
 - Predicted to be innocuous in relation to alkali silica reactivity in concrete.
 - Interpreted to be suitable for use as a source for concrete aggregate pursuant to Australian Standards 2758.1, Queensland Department of Transport and Main Roads Standards MRTS70 Fine Concrete Aggregate.
 - Contains no observable asbestiform minerals

Sample Description

The sample GA102224 / 320-01-BH2101 / 108.70-109.00m is pale brown in colour with a darker weathered surround. Grain size is fairly homogenous around 0.5mm. The interstitial cement is finer grained and softer than the sand-sized grains which form the bulk of the sample. Porosity is around 5%.



Microscopic Observations

Petrographic analysis shows that this rock is a sedimentary clastic rock that can be classified as a *sub-arkosic arenaceous sandstone*.

It can be described as a well sorted, medium-grained sandstone with dominant quartz grains and lesser altered feldspar grains hosted in a chloritic matrix. Minor opaques are present (often with orange iron staining indicative of iron oxide/sulphide grains). Rare quartz rich lithic clasts occur. Porosity is approximately 5%.

The sandstone is composed dominantly of 55% quartz and 23% clay-altered feldspar grains. The grain size of these silicate components is 0.2-0.5mm.

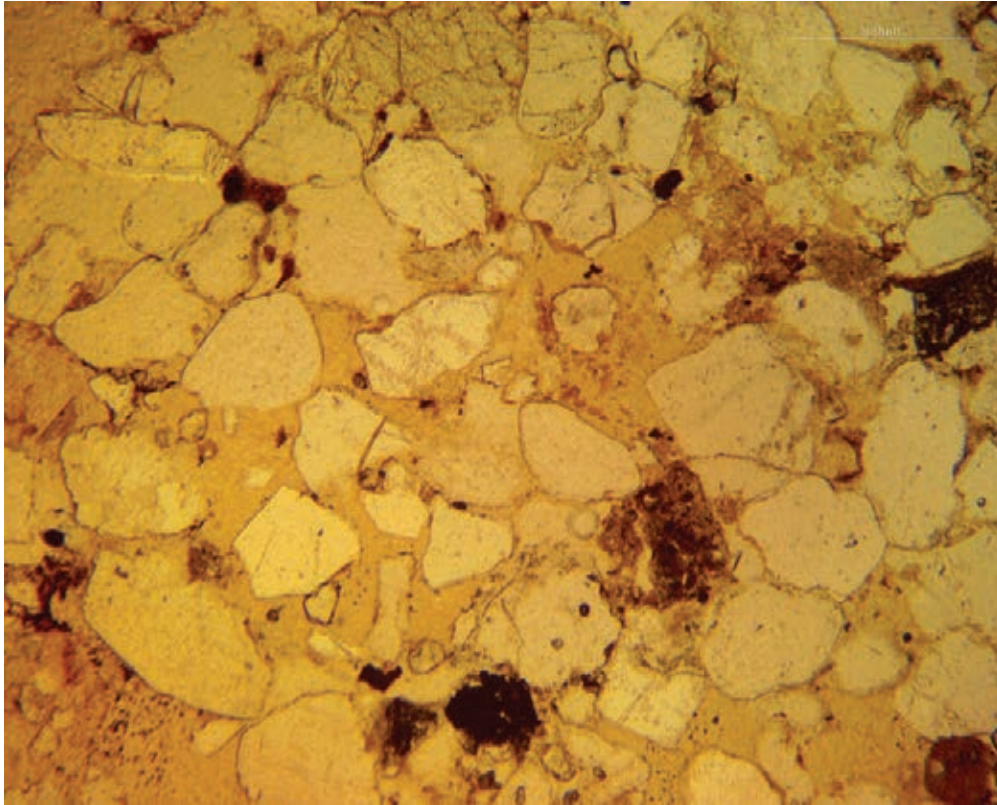
Quartz occurs as discrete anhedral subrounded-subangular grains, 0.3-0.5mm across, occasionally with sutured grain boundaries, but with no evidence of strain.

Clay altered probable feldspar grains (alteration is partial to almost complete) are present as discrete anhedral grains and these range in size from 0.2-0.4mm. These make up 23% of the sample, and 20% of this is *clay* after feldspar.

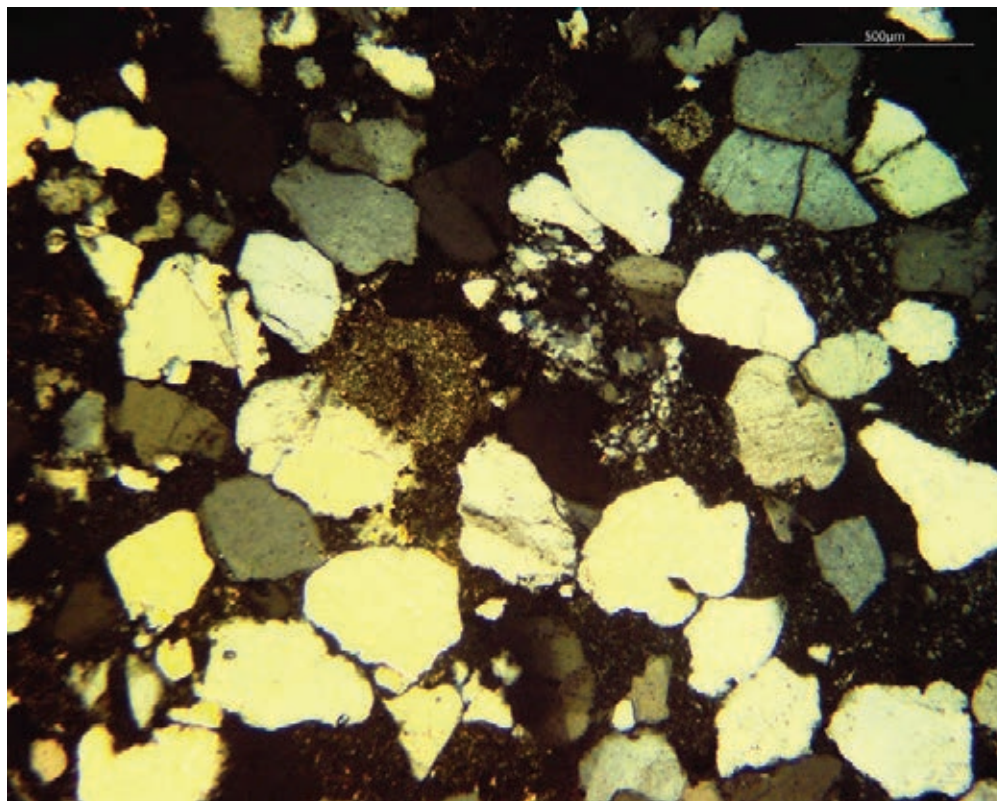
Opaques make up 2% of the sample. Occasional grains of white mica (muscovite are present). The cementing matrix is composed of very fine-grained chlorite.

One 0.2mm subrounded lithic clast was observed which is composed of interlocking strained quartz grains.

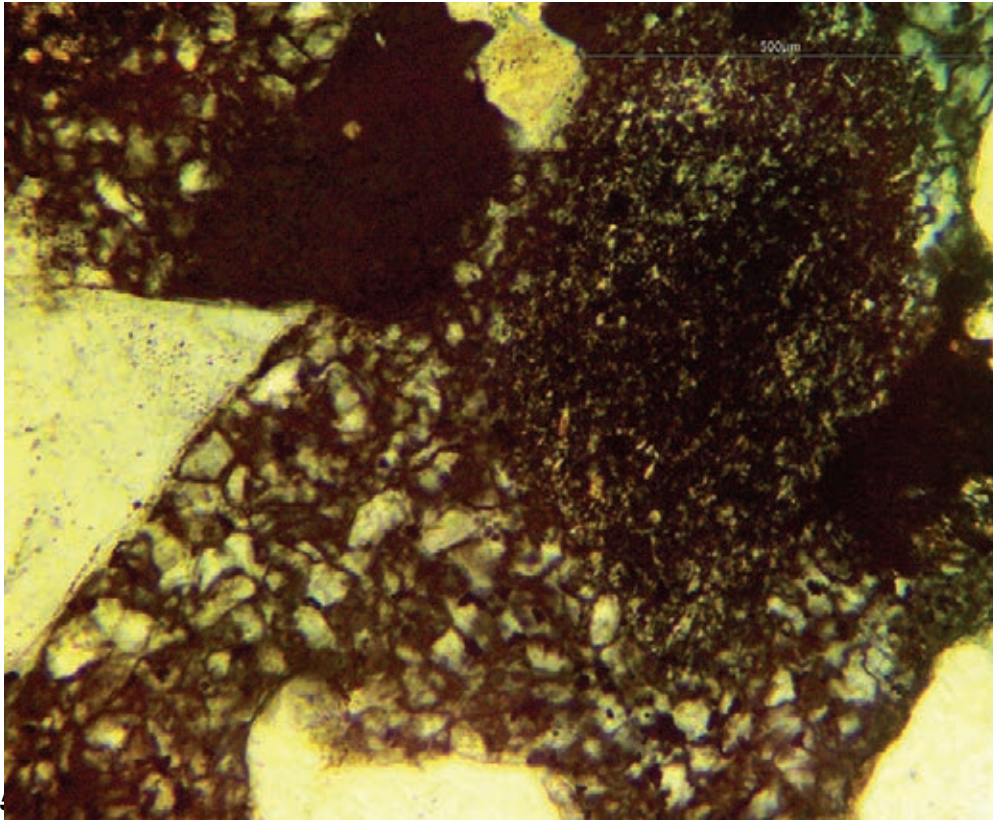
Photographs and a mode based on a count of 200 widely spaced grains (Table 1) appear below.



Plane polarised photomicrographs (x4) showing subrounded-subangular colourless quartz grains in fine grained cement, with dark brown altered. Dark grains are opaques.



Cross polarised photomicrograph (x4) showing the texture of sub-rounded quartz grains, clay altered feldspar and one rare strained quartz lithic clast (centre).



Cross polarised photomicrograph (x10) showing nature of the fine grained chloritic matrix between the quartz grains and a fine-grained clay altered ex-feldspar grain.

A mode based on a count of 100 widely spaced grains is listed below in Table 1.

Table 1 – Modal Analysis of sample GA102224

MINERALS	MODE %	COMMENTS
Quartz	55	Anhedral, grain size from 0.3-0.5mm
Clay altered feldspar	23	Anhedral grains 0.2-0.4mm, 20% totally clay altered
Chlorite	11	Fine-grained, forms cement
Mica	4	Occasional grains, 0.2-0.4mm
Porosity	5	
Opaque phases- probable iron phases	2	Disseminated
Lithic clasts	<1	Rare
Total	100	

As defined by the Queensland Department of Main Roads Test Method (Standard Q-188) the free silica content is 55%, in the form of crystalline quartz grains.

Interpretation

Petrographic analysis indicates that the major components are quartz, clay altered feldspar and chlorite. The supplied sample is identified as a sub-arkosic arenaceous sandstone. Quartz is crystalline but not visibly strained.

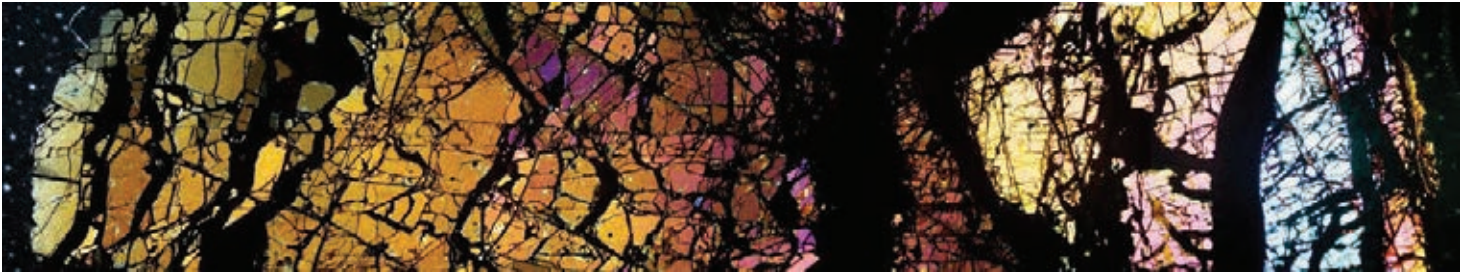
For industrial applications the supplied sample can be summarised as:

- Containing 55% free silica.
- Containing 55% unstrained quartz and <1% strained crystalline quartz in rare lithic clasts and is, on these grounds, considered unlikely to cause alkali silica reactivity in concrete.
- Contains 25% weak clay, chlorite and mica

The sandstone is predicted to be suitable for use as unbound pavement materials, pursuant to Australian Standards 2758.1, Queensland Department of Transport and Main Roads Standards MRTS70.

N.B. The petrology assessment for Alkali Silica Reactivity was based on:

- ASTM C 295 Standard Guide for Petrographic Assessment of Aggregates for Concrete
- AS2758.1 – 2014 Aggregates and rock for engineering purposes part 1: Concrete aggregates (Appendix B)
- AS1141 Standard Guide for the Method for sampling and testing aggregates



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ABN 980 6945 3445

PETROLOGICAL and GEOCHEMICAL CONSULTANTS

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



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PETROGRAPHIC REPORT ON THIN SECTION LABELLED (GA102073)

prepared for

**GOLDERS ASSOCIATES PTY LTD
MILTON**

Purchase Order: 20051
Invoice Number: 00008781
Client Ref: Morgan Midgley

Issued by

K. E. Spring B.Sc.(Hons), MAppSc

1 July 2019

GEOCHEMPET SERVICES, BRISBANE

Thin Section Sample Number: GA102073:302-01

Borehole: 320-01-BH2102

Depth: 227.5-227.65m

Source: Not Provided

Work Requested Petrographic analysis of provided thin section

Methods Account taken of ASTM C295 Standard Guide for *Petrographic Assessment of Aggregates for Concrete* and the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*

Identification Richly glassy basalt

Description

No sample was supplied, thin section only.

A thin section was supplied and detailed microscopic examination in transmitted, polarized light was undertaken. An approximate average composition of the rock, expressed in volume percent and based on a brief count of 100 widely spaced points falling within the thin section, is:

Primary Components

- 41% plagioclase feldspar
- 39% mesostasis of brown/black glass with microlites of pyroxene and opaque oxide
- <1% opaque oxide (magnetite and/or ilmenite) as discrete grains
- 3% orthopyroxene

Secondary Minerals

- 15% yellowish smectite clay
- 1% calcite
- 1% zeolite

Microscopically, the sectioned rock is seen to display finely crystalline and glassy igneous textures of basic volcanic style. The plagioclase laths are mainly 0.05 to 0.7 mm long with small grains of pyroxene and there is an interstitial, interconnected, black to brown, glassy mesostasis with microlites of opaque oxides and pyroxenes. Irregularly-shaped incipient vesicles were originally filled by a late, fractionated glass but are now entirely replaced by yellowish-green smectite clay and anisotropic zeolite.

The sectioned rock is characterised by randomly orientated, fresh laths of twinned plagioclase feldspar and small fresh clear pyroxene grains (probably diopside) within an inter-granular and intersertal texture. A network between the pyroxene and feldspar consists of a dark mesostasis which involves microlites of pyroxene and opaque oxide set in brown to black glass. There are a few tiny equant opaque oxides (probably magnetite) scattered in the groundmass. Smectite-

GEOCHEMPET SERVICES, BRISBANE

altered former mafic phenocrysts and crudely prismatic groundmass grains (probably former orthopyroxene) are relatively common. Other disseminated patches of a yellowish smectite (probably after a late glass) fill angular and irregular interstitial spaces (up to about 1 mm in size), some are less commonly filled by calcite and isotropic zeolite.

An intersecting pattern of thin fracture veins are filled by late calcite, isotropic zeolite and smectite clay.

Comments and Interpretations

The supplied thin section (labelled GA102073:320-01) is interpreted to be richly glassy, pyroxene basalt, a basic volcanic rock.

The basalt originally carries two types of glass: namely, a “normal” dark, silica-poor basaltic glass within an interstitial mesostasis and a more fractionated and silica-enriched glass formed as a late component filling former incipient vesicles.

Free Silica Content

Apparently nil. The supplied sample does not carry any free crystalline silica minerals. However, it is noteworthy that this sample carried late fractionated glass, so perhaps the glass concealed a trace of cryptocrystalline or amorphous silica.

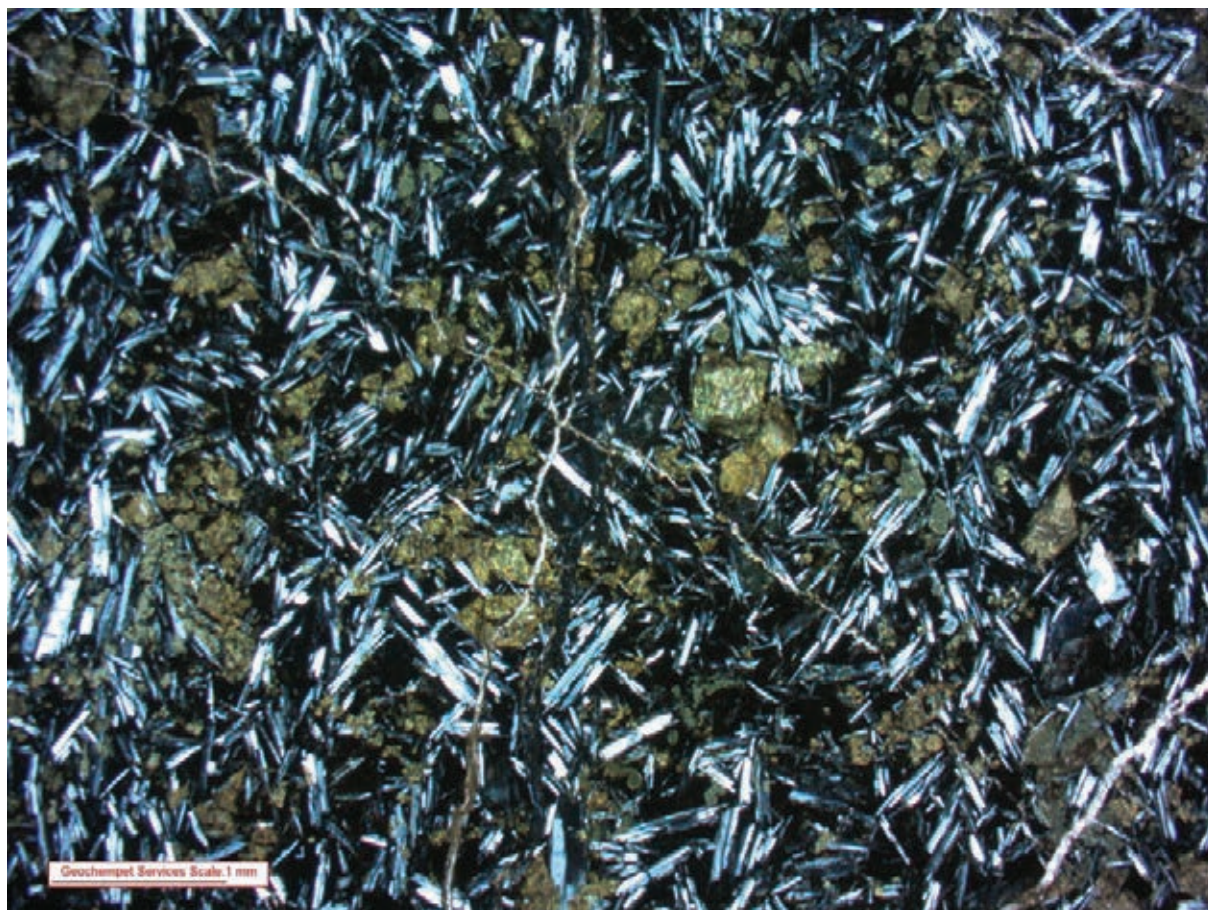
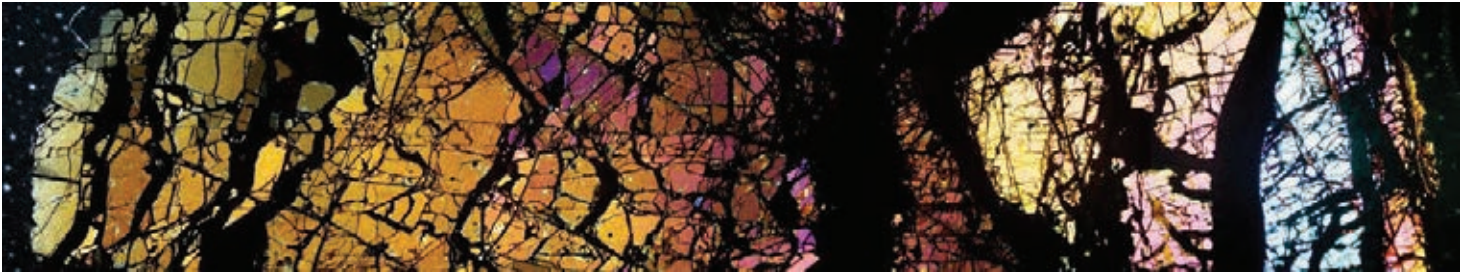


Plate 1. Digital photomicrograph at low magnification showing occurrence of patches of yellow smectite clay (after orthopyroxene and late glass) in a groundmass dominated by brown to black basaltic glass and abundant white plagioclase laths. Note the fine intersecting calcite veins in the image.



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PETROGRAPHIC REPORT ON THIN SECTION LABELLED (GA102075)

prepared for

**GOLDERS ASSOCIATES PTY LTD
MILTON**

Purchase Order: 20051
Invoice Number: 00008808
Client Ref: Morgan Midgley
Iain Turner

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
1 July 2019

GEOCHEMPET SERVICES, BRISBANE

Thin Section Sample Number: GA102075:320-01

Borehole: 320-01-BH2102

Depth: 233.0-233.16m

Source: Not Provided

Work Requested Petrographic analysis of provided thin section

Methods Account taken of ASTM C295 Standard Guide for *Petrographic Assessment of Aggregates for Concrete* and the AS2758.1 – 2014 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*

Identification Clay-cemented quartzose sandstone

Description

No sample was supplied, thin section only.

A thin section was supplied and detailed microscopic examination in transmitted, polarized light was undertaken. An approximate average composition of the rock, expressed in volume percent and based on a brief count of 100 widely spaced points falling within the thin section, is:

35%	quartz sand grains
1%	feldspar sand grains
1%	lithic clasts of acid volcanics
2%	quartzite clasts
<1%	epidote grains
53%	Illite-smectite clay matrix
8%	siderite
<1%	ferricrete fragments
trace	carbonaceous specks

In thin section, the rock is seen to be sandstone composed of clay cemented quartz and a few feldspar grains with minor acid volcanics and quartzite clasts.

Microscopically, the rocks display fine-grained arenaceous textures with poorly-sorted and loosely packed, angular, sub-angular to less commonly sub-rounded clasts, ranging from about 0.01 to 1 mm in size.

The sandstone is texturally matrix-supported by a moderately birefringent clay of mixed illite/smectite style. The dominant detrital grains are quartz grains, most of which show unstrained to mostly mild straining. Some of the quartz have preserved rims of quartz overgrowths indicating derivation from a sandstone that has suffered at least burial metamorphism. There also a few quartzite clasts showing a moderate degree of straining and may be derived from a cratonic source. Minor blocky, detrital feldspar grains are present. Lithic clasts appear to be devitrified acid tuffaceous clasts, composed of fine-grained quartzo-

GEOCHEMPET SERVICES, BRISBANE

feldspathic intergrowths. A few large ferricrete or ironstone fragments (around 1 mm in size) are noted in the sandstone matrix.

The late brownish siderite forms radial aggregates or nodules (sometime enclosing a quartz grain at its centre), which shows outer rims of expelled iron oxides. These nodules are relatively common and are scattered irregular in the matrix.

Comments and Interpretations

The supplied thin section (labelled GA102075:320-01) is interpreted to be clay-cemented quartzose sandstone, a sedimentary rock.

The sandstone is dominated by an interconnected clay matrix, with predominately quartz and minor feldspar grains along with a few lithic clasts of acid volcanic and quartzite style. The partial alteration of the sandstone by carbonates is attributed to diagenetic or hydrothermal processes after initial sedimentation. These sandstones are probably fairly mature with quartz persisting while other labile minerals are degraded to clays.

Free Silica Content

About 37%.

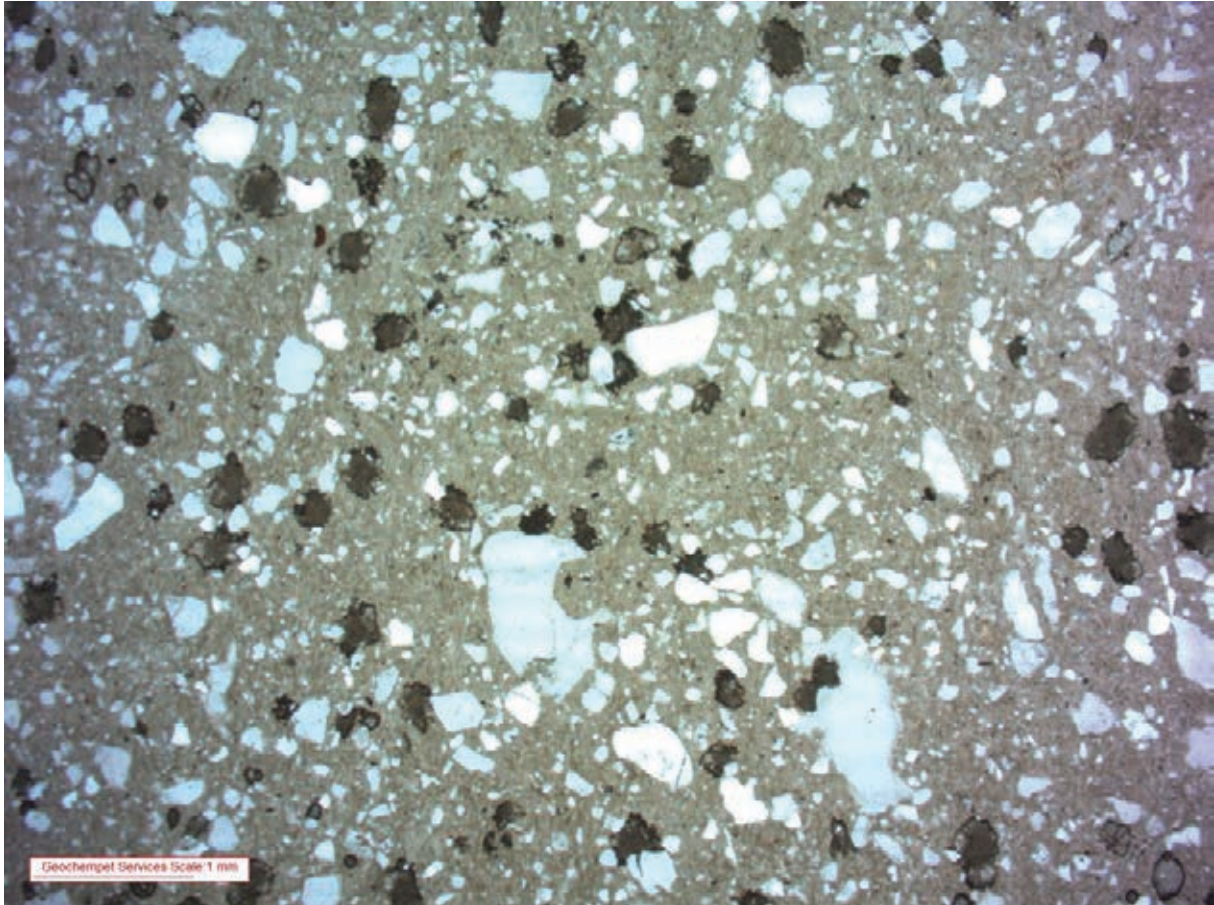


Plate 1. Digital photomicrograph at low magnification, plane polarised transmitted light showing abundant of quartz grains of various sizes and shapes occurring in an interconnected clay matrix. Note the brownish nodules of siderite overprinting parts of the matrix and closing some quartz grains.

Brazilian Disc -Tensile Strength

INDIRECT TENSILE - BRAZILIAN TEST REPORT

Test Method: ASTM D3967 - Standard Test Method for Splitting Tensile Strength of Intact Rock Core Specimens

Client	Golder Associates Pty Limited	Report No.	GA102207-BR
Address	PO Box 1734 MILTON BC QLD 4064	Test Date	22/01/2019
		Report Date	23/01/2019
Project	Inland Rail Section 320		

Sample No.	102207	102223			
Client ID	320-01-BH2101	320-01-BH2101			
Depth (m)	103.38-103.66	108.61-108.70			
Description	C	C			
Wet Density (t/m³)	2.83	2.02			
Moisture Content (%)	0.8	11.9			
Specimen Length (mm)	39.3	41.7			
Specimen Diameter (mm)	60.7	60.1			
Bedding Angle with Relation to Axial Plane (°)	Nil	Nil			
Bedding Parallel or Perpendicular to Direction of Loading	N/A	N/A			
Mode of Failure	Axial Splitting	Axial Splitting			
Test Duration (min:sec)	1:46	0:28			
Average Load Rate (MPa/sec)	0.086	0.004			
Load at Primary Failure (N)	34286	434			
TENSILE STRENGTH (MPa)	9.14	0.110			

TS = $0.636 \times \frac{\text{Load}}{\text{Diameter} \times \text{Length}}$ MPa

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP07102

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Cerchar Abrasivity

CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client	Golder Associates Pty Limited		Report No.	GA102062-CERC	
Address	PO Box 1734 MILTON BC QLD 4064		Request No.	Golder_1893795_TR04	
Project	Inland Rail Section 320		Test Date	31/01/2019	
Project No	1893795	Depth From (m)	214.9	Report Date	4/02/2019
Bore Hole	320-01-BH2102	Depth To (m)	215	Sample Type	Single Individual Rock Core Specimen
Description	C		Sample No	320-01-BH2102-C21490-CAT : 320-01-BH2102-C21490-MOI	

SAMPLE DETAILS

Sample Diameter (mm):	60.7	Moisture Content (%):	1.8
Sample Height (mm):	70.3	Dry Density (t/m³):	2.59
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	2.64

RESULTS OF TESTING

Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.06	0.55	0.04	0.36	0.00	0.00

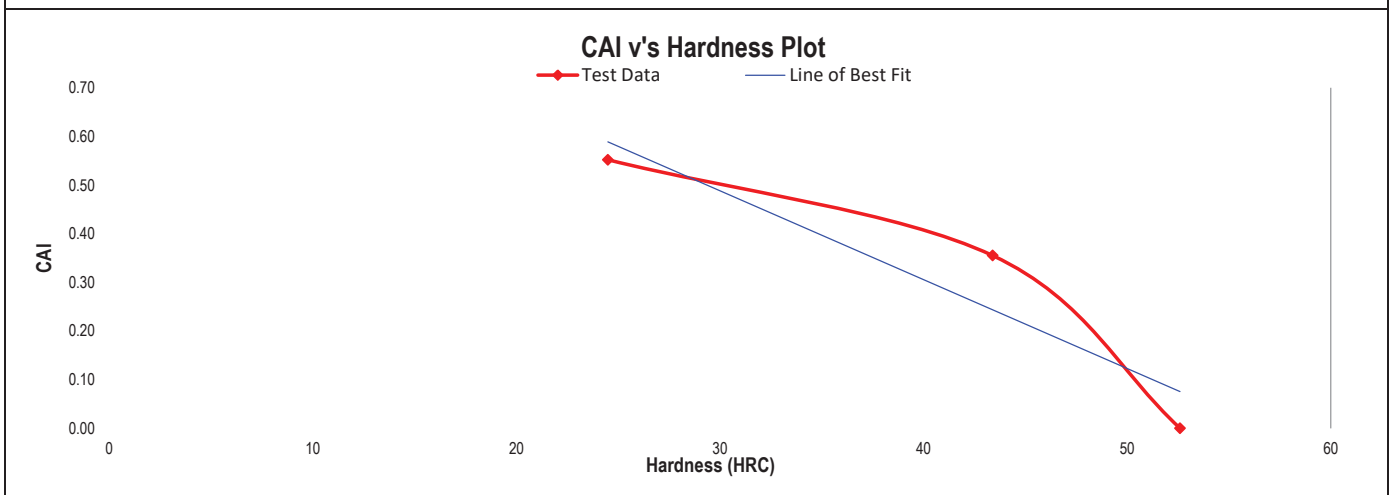
Linear Relationship between Tip Hardness and CAI

$$CAI = (-0.0183 \times HRC) + 1.0362$$

Average CAI_s (HRC55) = 0.51

Corrected for Smooth Saw Cut Surface

Classification : Low abrasiveness



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

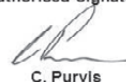
Page: 1 of 2

REP06801

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

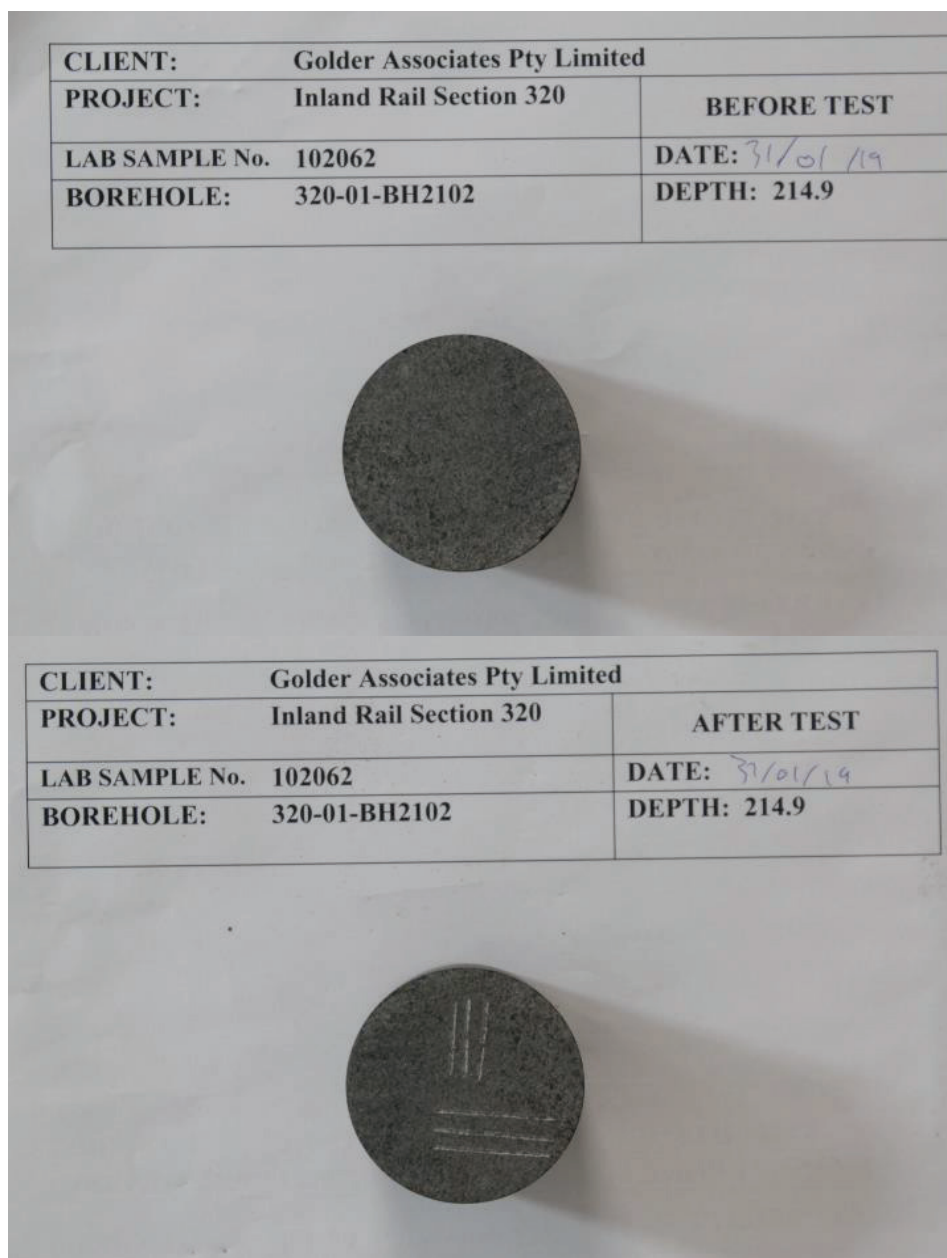
CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

Report No. GA102062-CERC

BEFORE & AFTER PHOTOS



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

REP06801

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited	Report No. GA102070-CERC
	Request No. Golder_1893795_TR04
Address PO Box 1734 MILTON BC QLD 4064	Test Date 31/01/2019
	Report Date 4/02/2019
Project Inland Rail Section 320	Sample Type Single Individual Rock Core Specimen
Project No 1893795	Depth From (m) 224.07
Bore Hole 320-01-BH2102	Depth To (m) 224.22
Description C	Sample No 320-01-BH2102-C22400-CAT : 320-01-BH2102-C22400-MOI

SAMPLE DETAILS

Sample Diameter (mm):	58.6	Moisture Content (%):	3.1
Sample Height (mm):	65.3	Dry Density (t/m³):	2.45
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	2.53

RESULTS OF TESTING

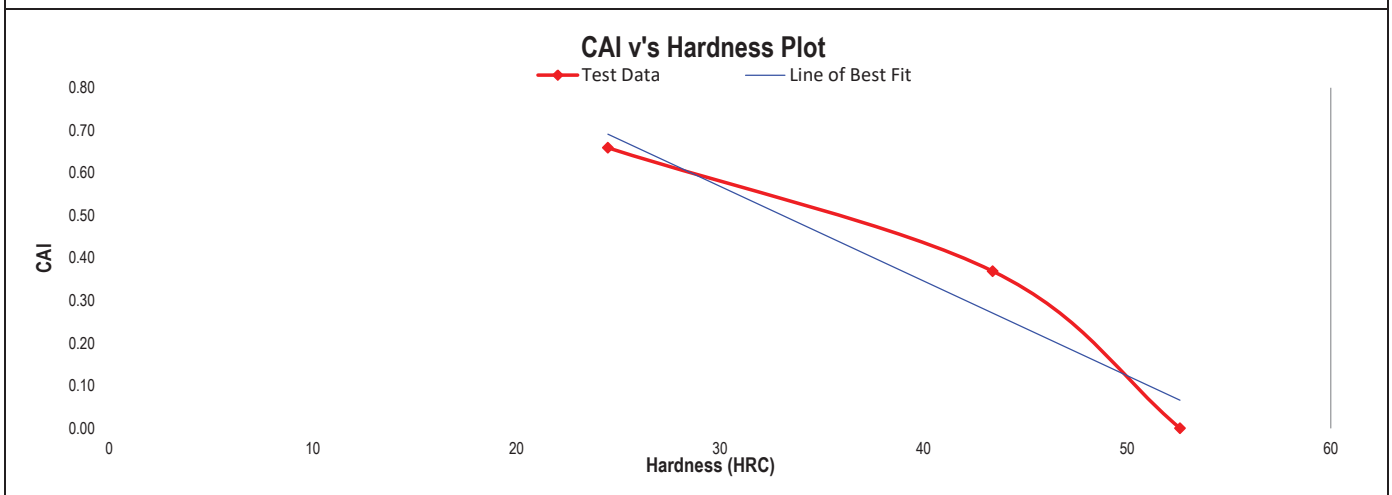
Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.07	0.66	0.04	0.37	0.00	0.00

Linear Relationship between Tip Hardness and CAI

$$\text{CAI} = (-0.0222 \times \text{HRC}) + 1.2362$$

Average CAI_s (HRC55) = 0.50 Corrected for Smooth Saw Cut Surface

Classification : Very low abrasiveness



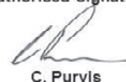
Remarks:

Sample/s supplied by client * CAI values corrected for smooth surface. Page: 1 of 2 REP06801

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

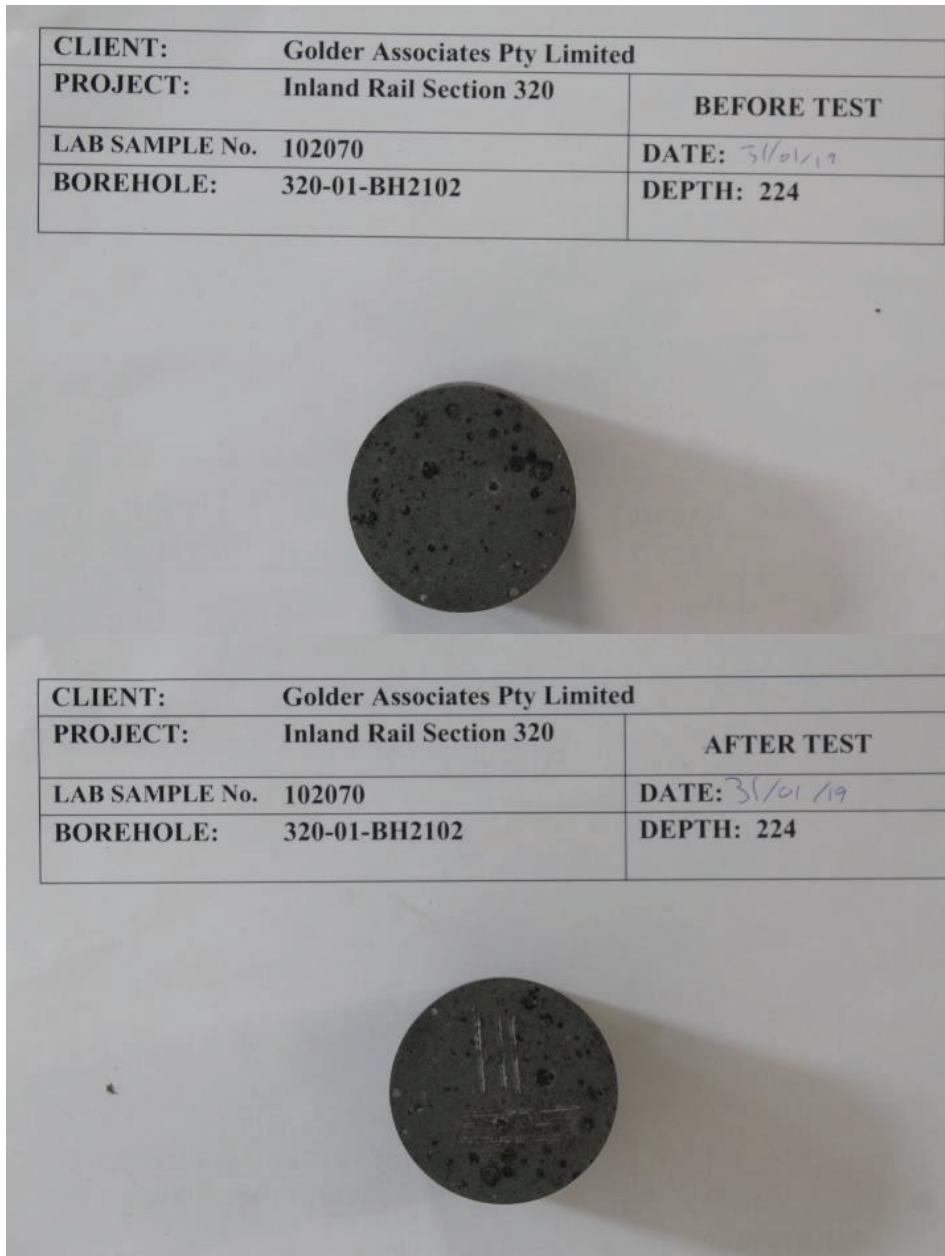
CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

Report No. GA102070-CERC

BEFORE & AFTER PHOTOS



Remarks:

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* CAI values corrected for smooth surface.

Page: 2 of 2

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CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited	Report No. GA102190-CERC
	Request No. 1893795_TR01
Address PO Box 1734 MILTON BC QLD 4064	Test Date 22/01/2019
	Report Date 23/01/2019
Project Inland Rail Section 320	Sample Type Single Individual Rock Core Specimen
Project No 1893795	Depth From (m) 89.5
Bore Hole 320-01-BH2101	Depth To (m) 89.65
Description C	Sample No 320-01-BH2101-CER : 320-01-BH2101-MOI

SAMPLE DETAILS

Sample Diameter (mm):	60.4	Moisture Content (%):	29.3
Sample Height (mm):	81.7	Dry Density (t/m³):	1.35
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	1.74

RESULTS OF TESTING

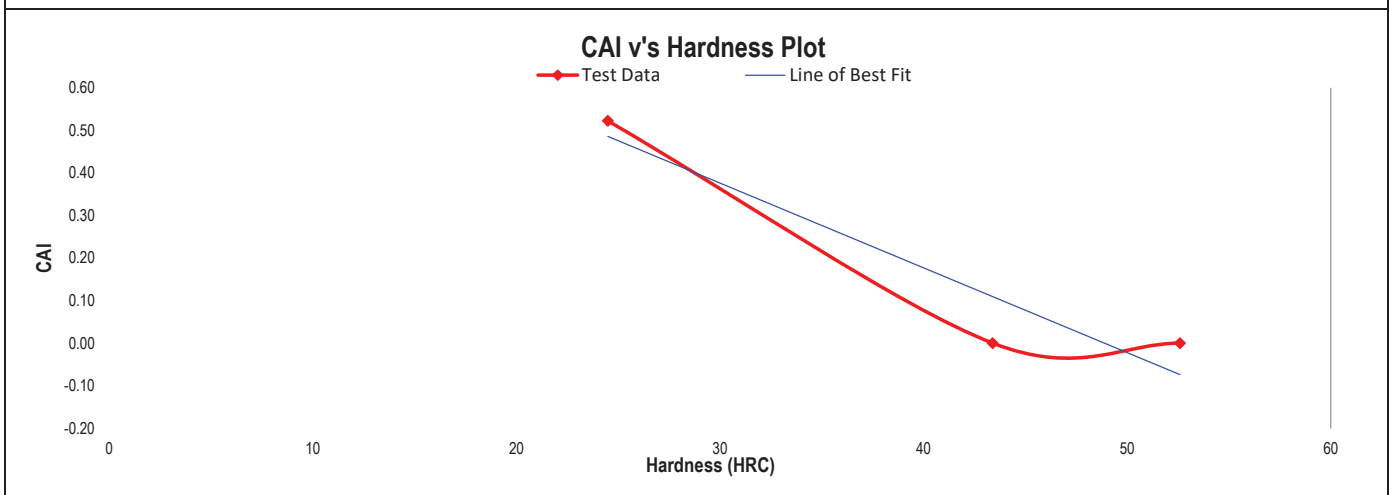
Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.05	0.52	0.00	0.00	0.00	0.00

Linear Relationship between Tip Hardness and CAI

$$\text{CAI} = (-0.0199 \times \text{HRC}) + 0.9742$$

Average CAI_s (HRC55) = 0.36 Corrected for Smooth Saw Cut Surface

Classification : Very low abrasiveness



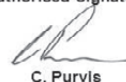
Remarks:

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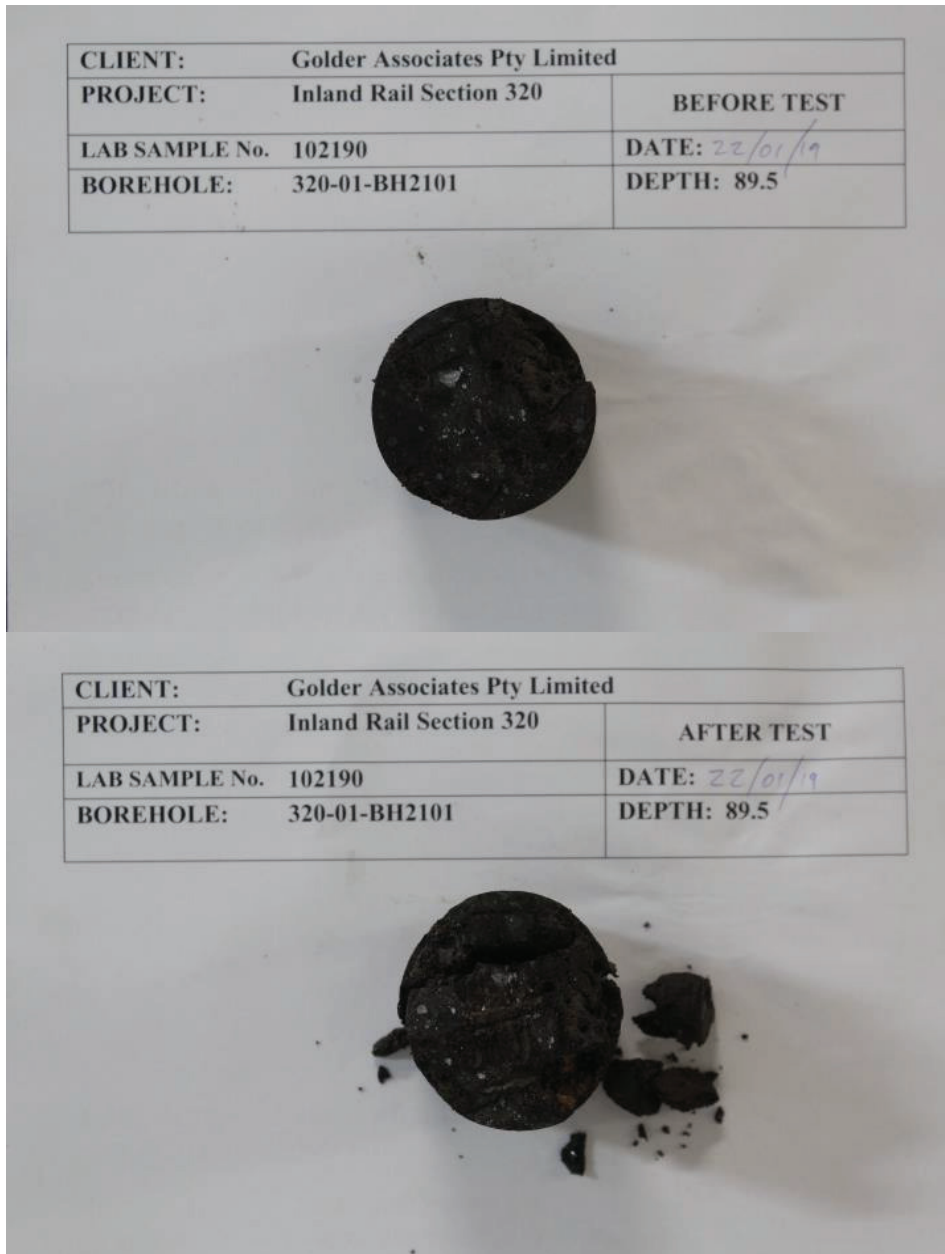
CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

Report No. GA102190-CERC

BEFORE & AFTER PHOTOS



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

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CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited	Report No. GA102201-CERC
	Request No. 1893795_TR01
Address PO Box 1734 MILTON BC QLD 4064	Test Date 22/01/2019
	Report Date 23/01/2019
Project Inland Rail Section 320	Sample Type Single Individual Rock Core Specimen
Project No 1893795	Depth From (m) 97.15
Bore Hole 320-01-BH2101	Depth To (m) 97.35
Description C	Sample No 320-01-BH2101-CER : 320-01-BH2101-MOI

SAMPLE DETAILS

Sample Diameter (mm):	60.4	Moisture Content (%):	2.6
Sample Height (mm):	82.5	Dry Density (t/m³):	2.54
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	2.61

RESULTS OF TESTING

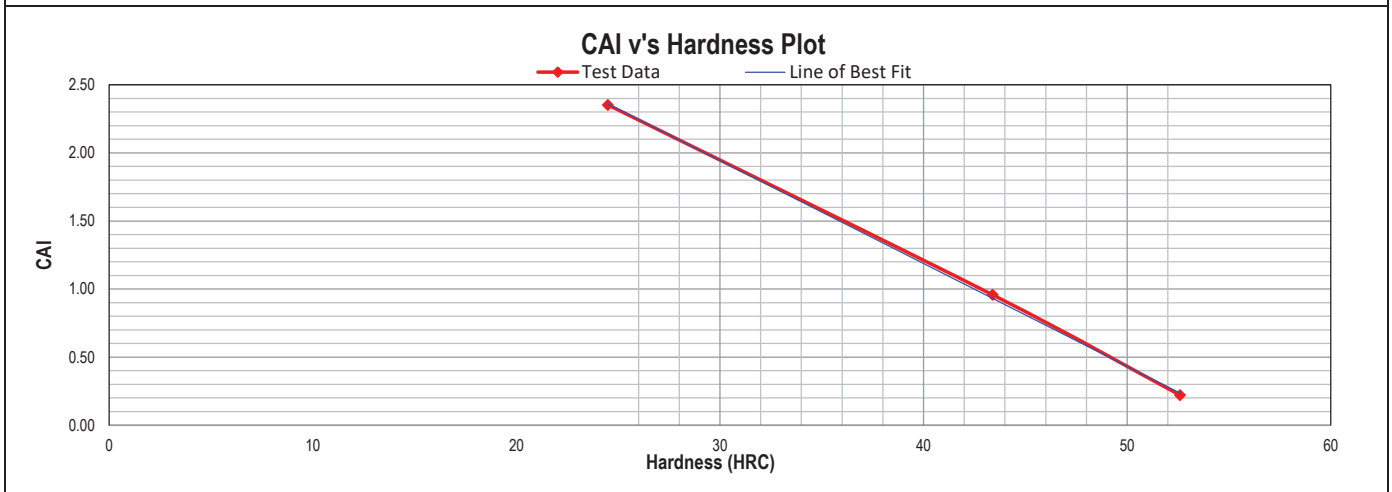
Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.24	2.35	0.10	0.96	0.02	0.22

Linear Relationship between Tip Hardness and CAI

$$\text{CAI} = (-0.0755 \times \text{HRC}) + 4.2106$$

Average CAI_s (HRC55) = 0.54 Corrected for Smooth Saw Cut Surface

Classification : Low abrasiveness



Remarks:

Sample/s supplied by client * CAI values corrected for smooth surface. Page: 1 of 2 REP06801

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

Report No. GA102201-CERC

BEFORE & AFTER PHOTOS

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102201	DATE: 22/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 97.15



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102201	DATE: 22/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 97.15



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited	Report No. GA102204-CERC
	Request No. 1893795_TR01
Address PO Box 1734 MILTON BC QLD 4064	Test Date 22/01/2019
	Report Date 23/01/2019
Project Inland Rail Section 320	Sample Type Single Individual Rock Core Specimen
Project No 1893795	Depth From (m) 102.65
Bore Hole 320-01-BH2101	Depth To (m) 102.75
Description C	Sample No 320-01-BH2101-CER : 320-01-BH2101-MOI

SAMPLE DETAILS

Sample Diameter (mm):	60.8	Moisture Content (%):	0.8
Sample Height (mm):	82.1	Dry Density (t/m³):	2.74
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	2.76

RESULTS OF TESTING

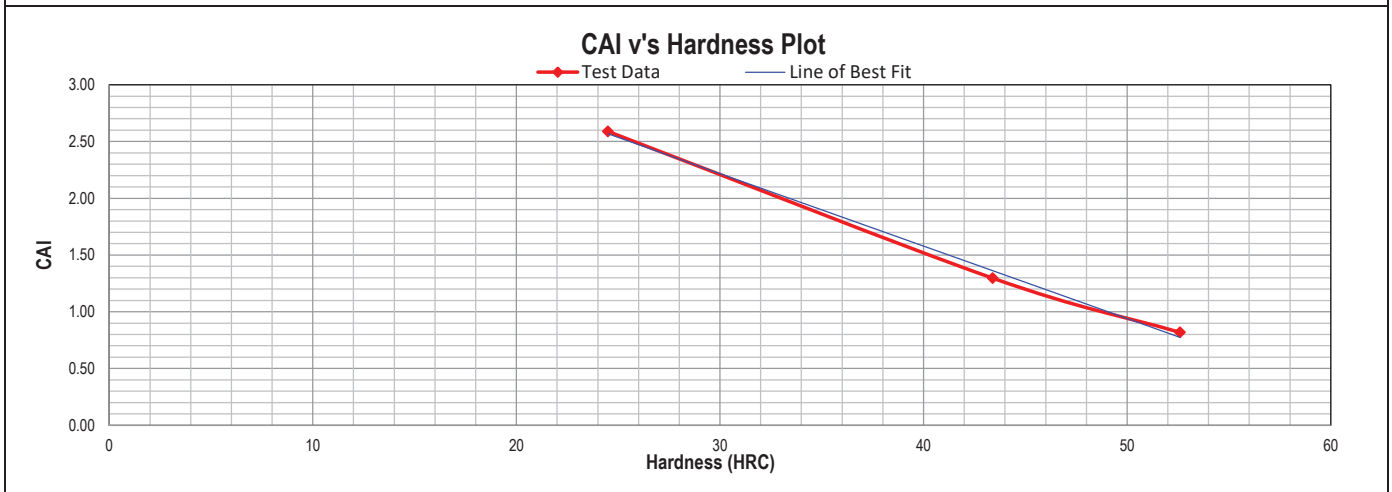
Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.26	2.59	0.13	1.30	0.08	0.82

Linear Relationship between Tip Hardness and CAI

$$\text{CAI} = (-0.0638 \times \text{HRC}) + 4.1314$$

Average CAI_s (HRC55) = 1.10 Corrected for Smooth Saw Cut Surface

Classification : Medium abrasiveness



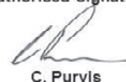
Remarks:

Sample/s supplied by client * CAI values corrected for smooth surface. Page: 1 of 2 REP06801

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CERCHAR ABRASIVITY INDEX TEST REPORT

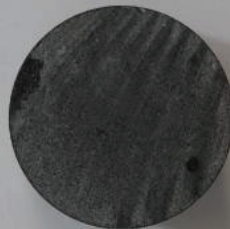
ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

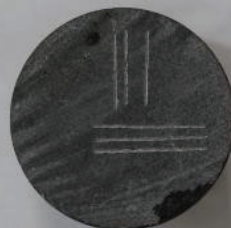
Report No. GA102204-CERC

BEFORE & AFTER PHOTOS

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102204	DATE: 22/10/19
BOREHOLE:	320-01-BH2101	DEPTH: 102.65



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102204	DATE: 22/10/19
BOREHOLE:	320-01-BH2101	DEPTH: 102.65



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client	Golder Associates Pty Limited	Report No.	GA102211-CERC
		Request No.	1893795_TR01
Address	PO Box 1734 MILTON BC QLD 4064	Test Date	22/01/2019
		Report Date	23/01/2019
Project	Inland Rail Section 320	Sample Type	Single Individual Rock Core Specimen
Project No	1893795	Depth From (m)	104.5
Bore Hole	320-01-BH2101	Depth To (m)	104.8
Description	C	Sample No	320-01-BH2101-CER : 320-01-BH2101-MOI

SAMPLE DETAILS

Sample Diameter (mm):	60.6	Moisture Content (%):	7.6
Sample Height (mm):	81.5	Dry Density (t/m³):	1.92
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	2.07

RESULTS OF TESTING

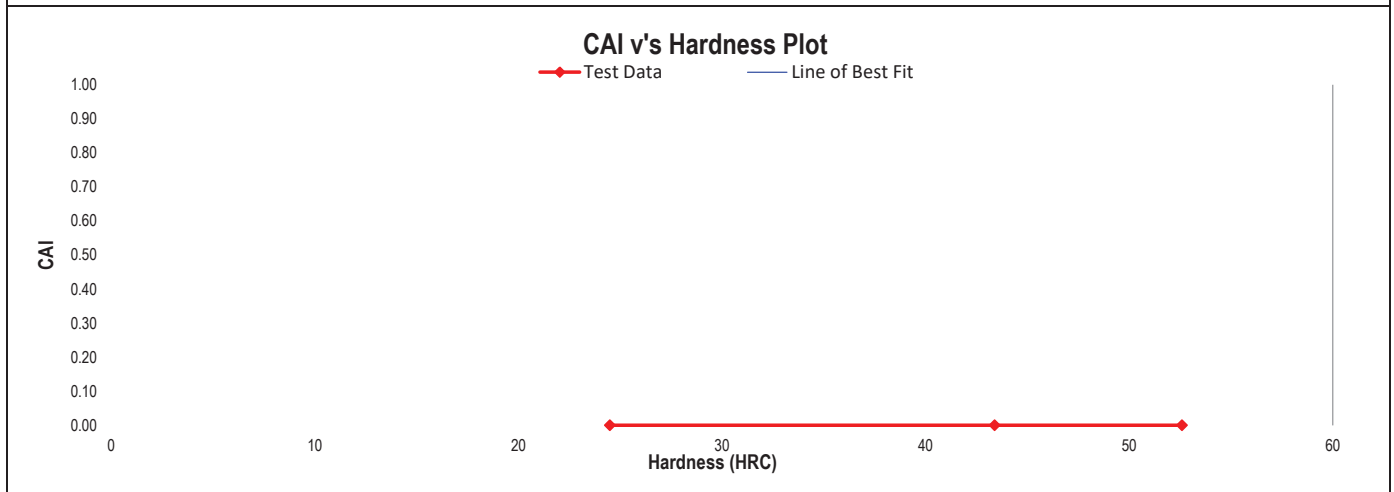
Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.00	0.00	0.00	0.00	0.00	0.00

Linear Relationship between Tip Hardness and CAI

$$\text{CAI} = (0 \times \text{HRC}) + 0$$

Average CAI_s (HRC55) = 0.48 Corrected for Smooth Saw Cut Surface

Classification : Very low abrasiveness



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

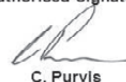
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CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

Report No. GA102211-CERC

BEFORE & AFTER PHOTOS

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102211	DATE: 22/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 104.5



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102211	DATE: 22/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 104.5



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

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CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client	Golder Associates Pty Limited		Report No.	GA102214-CERC	
Address	PO Box 1734 MILTON BC QLD 4064		Request No.	1893795_TR01	
Project	Inland Rail Section 320		Test Date	22/01/2019	
Project No	1893795	Depth From (m)	105.39	Report Date	23/01/2019
Bore Hole	320-01-BH2101	Depth To (m)	105.46	Sample Type	Single Individual Rock Core Specimen
Description	C		Sample No	320-01-BH2101-CER : 320-01-BH2101-MOI	

SAMPLE DETAILS

Sample Diameter (mm):	60.5	Moisture Content (%):	12.3
Sample Height (mm):	76.7	Dry Density (t/m³)	2.04
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³)	2.29

RESULTS OF TESTING

Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.00	0.00	0.00	0.00	0.00	0.00

Linear Relationship between Tip Hardness and CAI

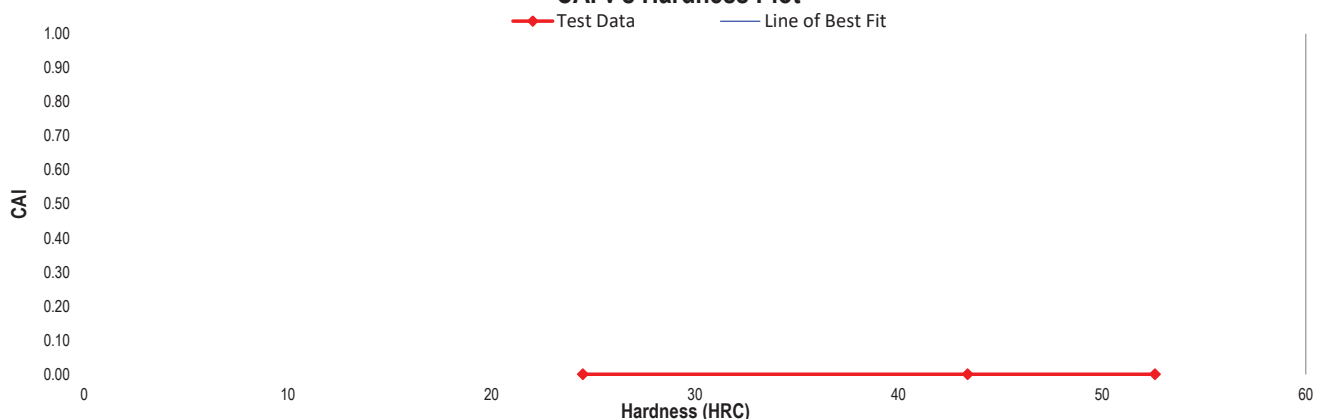
$$CAI = (0 \times HRC) + 0$$

Average CAI_s (HRC55) = 0.48

Corrected for Smooth Saw Cut Surface

Classification : Very low abrasiveness

CAI v's Hardness Plot



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 1 of 2

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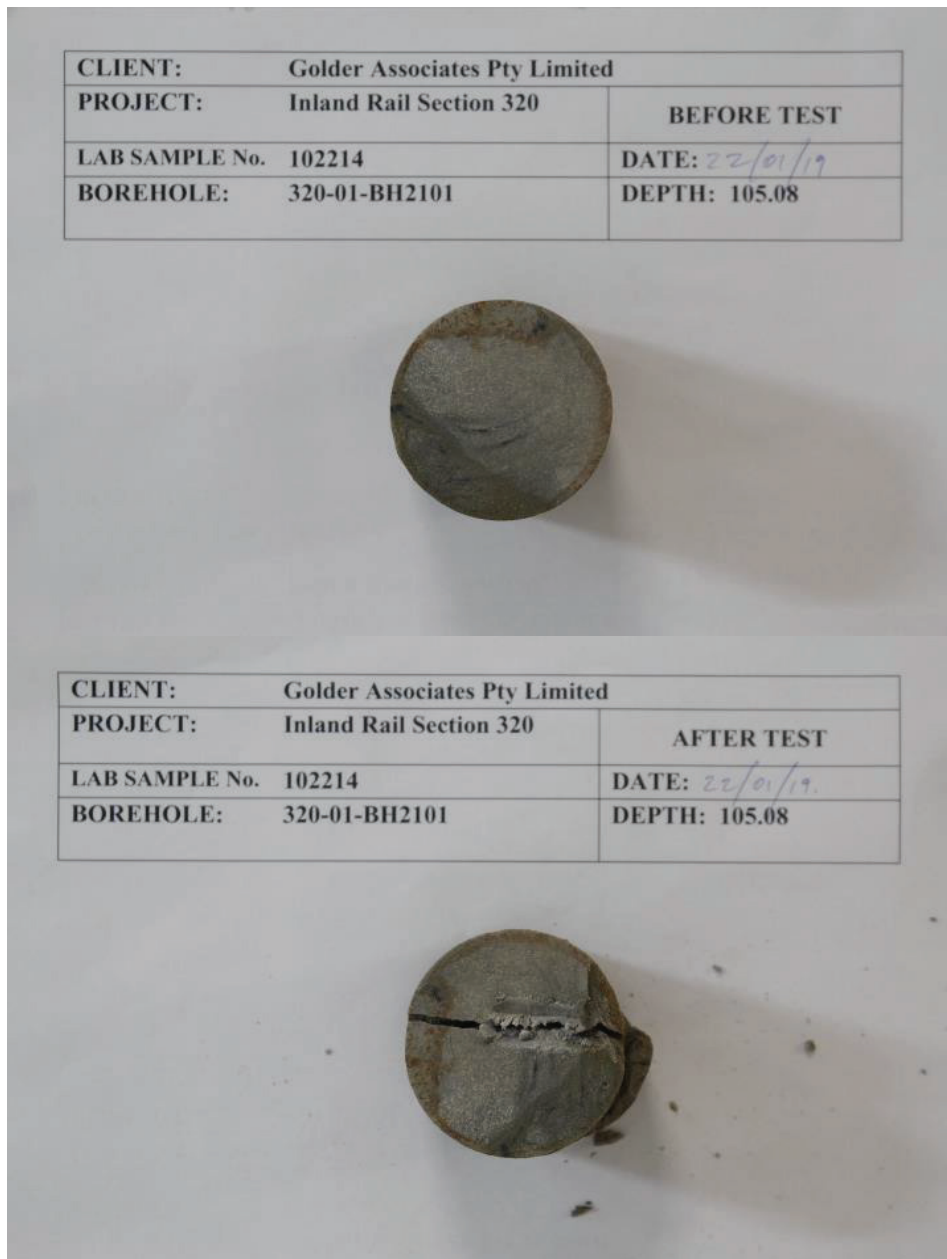
CERCHAR ABRASIVITY INDEX TEST REPORT

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Client Golder Associates Pty Limited

Report No. GA102214-CERC

BEFORE & AFTER PHOTOS



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

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CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited	Report No. GA102218-CERC
	Request No. 1893795_TR01
Address PO Box 1734 MILTON BC QLD 4064	Test Date 22/01/2019
	Report Date 23/01/2019
Project Inland Rail Section 320	Sample Type Single Individual Rock Core Specimen
Project No 1893795 Depth From (m) 105.7	
Bore Hole 320-01-BH2101 Depth To (m) 105.8	Sample No 320-01-BH2101-CER : 320-01-BH2101-MOI
Description C	

SAMPLE DETAILS

Sample Diameter (mm):	59.25	Moisture Content (%):	10.9
Sample Height (mm):	75.2	Dry Density (t/m³):	1.79
Surface Type :	Smooth (Saw Cut) Surface	Wet Density (t/m³):	1.99

RESULTS OF TESTING

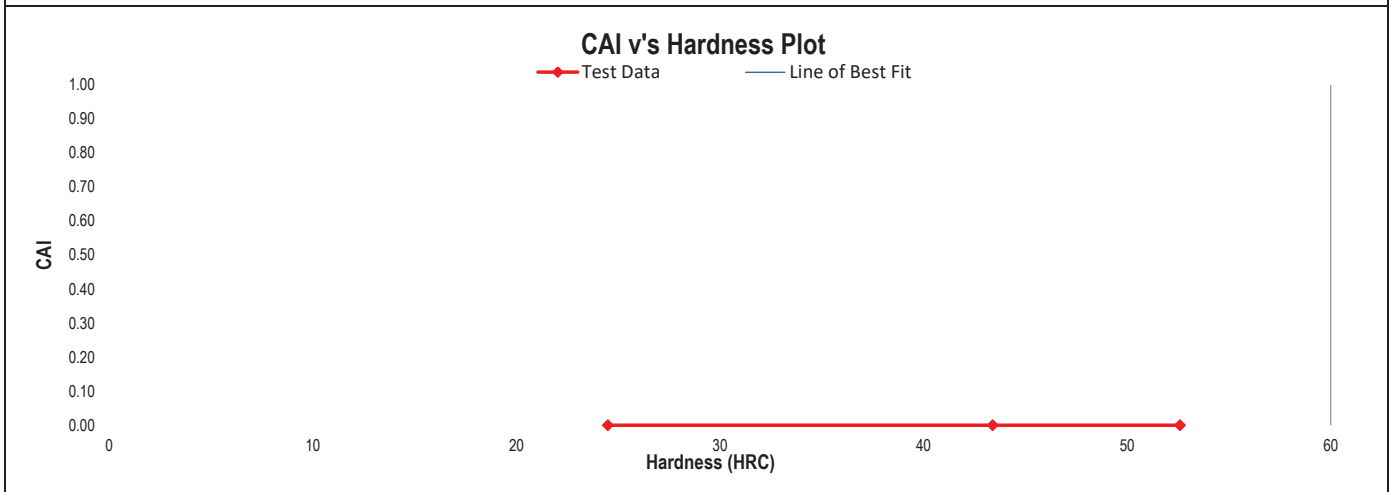
Hardness of Tip Used	25 HRC	Hardness of Tip Used	43 HRC	Hardness of Tip Used	53 HRC
Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI	Average Diameter (mm)	*CAI
0.00	0.00	0.00	0.00	0.00	0.00

Linear Relationship between Tip Hardness and CAI

$$\text{CAI} = (0 \times \text{HRC}) + 0$$

Average CAI_s (HRC55) = 0.48 Corrected for Smooth Saw Cut Surface

Classification : Very low abrasiveness



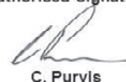
Remarks:

Sample/s supplied by client * CAI values corrected for smooth surface. Page: 1 of 2 REP06801

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory



C. Purvis



Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

CERCHAR ABRASIVITY INDEX TEST REPORT

ASTM D7625 - 10 - Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the Cerchar Method

Client Golder Associates Pty Limited

Report No. GA102218-CERC

BEFORE & AFTER PHOTOS

CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	BEFORE TEST
LAB SAMPLE No.	102218	DATE: 22/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 105.7



CLIENT:	Golder Associates Pty Limited	
PROJECT:	Inland Rail Section 320	AFTER TEST
LAB SAMPLE No.	102218	DATE: 22/01/19
BOREHOLE:	320-01-BH2101	DEPTH: 105.7



Remarks:

Sample/s supplied by client

* CAI values corrected for smooth surface.

Page: 2 of 2

REP06801

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Slake Durability

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102178-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	21/01/2019
Project No	1893795	Report Date	24/01/2019
Client Sample No.		320-01-BH2101	

Sample No.	102178
BoreHole	320-01-BH2101
Depth From (m)	76.5
Depth To (m)	76.7
Description	C
Slake Durability (1st cycle) (%)	97.5
Slake Durability (2nd cycle) (%)	97.3
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	20.3
Appearance of fragments retained in the drum	Original Form
Appearance of fragments passing through the drum	Fragments & Fines

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP02402

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102184-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
Project No	1893795	Report Date	24/01/2019
Client Sample No.	320-01-BH2101		

Sample No.	102184
BoreHole	320-01-BH2101
Depth From (m)	83.7
Depth To (m)	83.9
Description	C
Slake Durability (1st cycle) (%)	80.3
Slake Durability (2nd cycle) (%)	55.4
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	20.6
Appearance of fragments retained in the drum	Moderate Deterioration
Appearance of fragments passing through the drum	Fragments & Fines

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP02402

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102198-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
Project No	1893795	Report Date	24/01/2019
Client Sample No.		320-01-BH2101	

Sample No.	102198
BoreHole	320-01-BH2101
Depth From (m)	95.73
Depth To (m)	96
Description	C
Slake Durability (1st cycle) (%)	87.4
Slake Durability (2nd cycle) (%)	69.7
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	20.4
Appearance of fragments retained in the drum	Moderate Deterioration
Appearance of fragments passing through the drum	Fragments & Fines

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP02402

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102211-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
Project No	1893795	Report Date	24/01/2019
Client Sample No.		320-01-BH2101	

Sample No.	102211
BoreHole	320-01-BH2101
Depth From (m)	104.5
Depth To (m)	104.8
Description	C
Slake Durability (1st cycle) (%)	69.9
Slake Durability (2nd cycle) (%)	47.8
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	20.9
Appearance of fragments retained in the drum	Moderate Deterioration
Appearance of fragments passing through the drum	Fragments & Fines

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP02402

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102212-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	22/01/2019
Project No	1893795	Report Date	24/01/2019
Client Sample No.		320-01-BH2101	

Sample No.	102212
BoreHole	320-01-BH2101
Depth From (m)	104.8
Depth To (m)	105
Description	C
Slake Durability (1st cycle) (%)	76.6
Slake Durability (2nd cycle) (%)	58.5
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	20.6
Appearance of fragments retained in the drum	Moderate Deterioration
Appearance of fragments passing through the drum	Fragments & Fines

NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP02402

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C. Purvis



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Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102220-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	23/01/2019
Project No	1893795	Report Date	25/01/2019
Client Sample No.		320-01-BH2101	

Sample No.	102220
BoreHole	320-01-BH2101
Depth From (m)	106.05
Depth To (m)	106.22
Description	C
Slake Durability (1st cycle) (%)	0.1
Slake Durability (2nd cycle) (%)	0.1
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	29.1
Appearance of fragments retained in the drum	High Deterioration
Appearance of fragments passing through the drum	Fragments & Fines

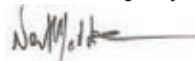
NOTES/REMARKS:

Sample/s supplied by the client

Page 1 of 1 REP02402

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Authorised Signatory



N. Maddison



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Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

SLAKE DURABILITY INDEX TEST REPORT

Test Method: AS 4133.3.4

Client	Golder Associates Pty Limited	Report No.	GA102240-SD
Address	PO Box 1734 MILTON BC QLD 4064	Request No.	1893795_TR01
Project	Inland Rail Section 320	Test Date	23/01/2019
Project No	1893795	Report Date	25/01/2019
Client Sample No.	320-01-BH2101		

Sample No.	102240
BoreHole	320-01-BH2101
Depth From (m)	128.3
Depth To (m)	128.44
Description	C
Slake Durability (1st cycle) (%)	88.7
Slake Durability (2nd cycle) (%)	80.8
Slake Durability (3rd cycle) (%)	-
Slake Durability (4th cycle) (%)	-
Water Used	Tap Water
Temperature (°C)	29.1
Appearance of fragments retained in the drum	Slight Deterioration
Appearance of fragments passing through the drum	Fragments & Fines

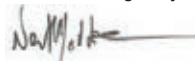
NOTES/REMARKS:

Sample/s supplied by the client

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N. Maddison



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Laboratory No. 9926

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Aggressivity



CERTIFICATE OF ANALYSIS

Work Order	: EB1828518	Page	: 1 of 2
Client	: TRILAB PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: THE ADMIN RESULTS	Contact	: Customer Services EB
Address	: 346A BILSEN RD GEEBUNG QLD, AUSTRALIA 4031	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3265 5656	Telephone	: +61-7-3243 7222
Project	: 1893795 - Inland Rail Section 320	Date Samples Received	: 21-Nov-2018 12:00
Order number	: 1911039	Date Analysis Commenced	: 23-Nov-2018
C-O-C number	: ----	Issue Date	: 28-Nov-2018 14:24
Sampler	: ----		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 4		
No. of samples analysed	: 4		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Diana Mesa	21C Organic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. -

Where moisture determination has been performed, results are reported on a dry weight basis. -

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. -

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference. -

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes. -

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details. -

Key : - CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

∅ = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- CORROSION ASSESSMENT: As per Australian Standard (AS2159-1995, section 6), the Exposure Classification for all samples is rated as Non Aggressive. ALS is not NATA accredited for this comment.

Analytical Results

Compound	CAS Number	LOR	Unit	Client sample ID			
				Client sampling date / time	Result	Result	Result
Sub-Matrix: SOIL							
(Matrix: SOIL)							
				101183 / 320-01-BH2201-S0050 0 / 5.00-5.20m [20-Nov-2018]	101189 / 320-01-BH2209-S0020 0 / 2.00-2.45m [20-Nov-2018]	101199 / 320-01-BH2212-S0035 0 / 3.50-3.95m [20-Nov-2018]	101208 / 320-01-BH2218-S0050 0 / 5.00-5.41m [20-Nov-2018]
				EB1828518-001 Result	EB1828518-002 Result	EB1828518-003 Result	EB1828518-004 Result
EA002: pH 1:5 (Soils)							
pH Value		0.1	pH Unit	8.7	9.0	6.4	9.5
EA055: Moisture Content (Dried @ 105-110°C)							
Moisture Content		1.0	%	12.6	15.9	14.6	10.9
ED040S : Soluble Sulfate by ICPAES							
Sulfate as SO4 2-	14808-79-8	10	mg/kg	30	20	10	10
ED045G: Chloride by Discrete Analyser							
Chloride	16887-00-6	10	mg/kg	780	310	<10	110



CERTIFICATE OF ANALYSIS

Work Order	: EB1902048	Page	: 1 of 2
Client	: TRILAB PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: THE ADMIN RESULTS	Contact	: Customer Services EB
Address	: 346A BILSEN RD GEEBUNG QLD, AUSTRALIA 4031	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3265 5656	Telephone	: +61-7-3243 7222
Project	: 1893795 - Inland Rail Section 320	Date Samples Received	: 25-Jan-2019 13:01
Order number	: BNE 1901037	Date Analysis Commenced	: 29-Jan-2019
C-O-C number	: ----	Issue Date	: 04-Feb-2019 10:25
Sampler	: ----		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 5		
No. of samples analysed	: 5		



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<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



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Where moisture determination has been performed, results are reported on a dry weight basis. -

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. -

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference. -

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes. -

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details. -

Key : - CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

∅ = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- CORROSION ASSESSMENT: As per Australian Standard (AS2159-1995, section 6), the Exposure Classification for all samples is rated Mild to Non Aggressive. ALS is not NATA accredited for this comment.

Analytical Results

Compound	CAS Number	LOR	Unit	Client sample ID	
				Client sampling date / time	Result
Sub-Matrix: SOIL					
(Matrix: SOIL)					
				102094 / 320-01-BH2203-S0035 0 / 3.50-3.95m	102097 / 320-01-BH2203-S0080 0 / 8.00-8.10m
				EB1902048-001	EB1902048-002
				24-Jan-2019 00:00	24-Jan-2019 00:00
				Result	Result
				8.0	8.2
EA002: pH 1:5 (Soils)		0.1	pH Unit		
				7.3	5.2
				9.8	
EA055: Moisture Content (Dried @ 105-110°C)					
		1.0	%	15.1	22.0
Moisture Content				16.8	12.5
				6.2	
ED040S : Soluble Sulfate by ICPAES					
	14808-79-8	10	mg/kg	20	<10
Sulfate as SO4 2-				70	40
ED045G: Chloride by Discrete Analyser					
	16887-00-6	10	mg/kg	220	240
Chloride				<10	160
				160	120

APPENDIX

W

Geotechnical

Appendix E Hydraulic
testing results

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT





WATER PRESSURE TEST (5 Stage)

Job No : 1893795	Hole No : BH2101	Drilling Method : HQ	Vertical depth to Groundwater	Revision No : 18
Client : FFJV	Dip (Deg) : -90	Hole Diameter (m) : 0.096	Immediately prior to test (m bgl) : 63.44	Used in analysis (m bgl) : 63.44
Project : Inland Rail	DH Interval Top (m) : 94.00	Downhole Tested Length (m) : 5.00	Pressure Gauge Height (m agl) : 0.00	Presumed Water Temperature : 26
Location : 320-01-BH2101	DH Interval Base (m) : 99.00	Packer Type : Pneumatic - Wireline - Double	Presumed Water Temperature : 26	Casing Inner Diameter (mm) : 77.80
Tested By : SK	Computed By : SK	Rock tested :	Casing Inner Diameter (mm) : 77.80	
Date : 20/08/2001	Date : 26/08/2018	Water Meter Reading in Litres	Checked By :	Date :

Pressure Stage	Gauge Pressure kPa	No	Actual	Time	Water Meter Readings		Volume (L)	Discharge (L/min)	Discharge/m (L/min/m)	Remarks
			Time (h:m:s)	Intervals (min)	Reading (Litres)					
P1	200	0	8:48:00	0	10792.0		0.00	0.00	0.00	c : 1
		1	8:49:00	01:00	10795.0		3.00	3.00	0.60	
		2	8:50:00	01:00	10798.0		3.00	3.00	0.60	
		3	8:51:00	01:00	10801.0		3.00	3.00	0.60	
		4	8:52:00	01:00	10803.0		2.00	2.00	0.40	
		5	8:53:00	01:00	10805.0		2.00	2.00	0.40	
		6	8:54:00	01:00	10808.0		3.00	3.00	0.60	
		7	8:55:00	01:00	10810.0		2.00	2.00	0.40	
		8	8:56:00	01:00	10814.0		4.00	4.00	0.80	
		9	8:57:00	01:00	10818.0		4.00	4.00	0.80	
		10	8:58:00	01:00	10823.0		5.00	5.00	1.00	
Total :							31.00	6.20	Start Date & Time :	
Average:							3.100	0.620		
P2	300	0	8:58:00	0	10823.0		0.00	0.00	0.00	c : 1
		1	8:59:00	01:00	10829.0		6.00	6.00	1.20	
		2	9:00:00	01:00	10835.0		6.00	6.00	1.20	
		3	9:01:00	01:00	10841.0		6.00	6.00	1.20	
		4	9:02:00	01:00	10846.0		5.00	5.00	1.00	
		5	9:03:00	01:00	10855.0		9.00	9.00	1.80	
		6	9:04:00	01:00	10858.0		3.00	3.00	0.60	
		7	9:05:00	01:00	10862.0		4.00	4.00	0.80	
		8	9:06:00	01:00	10869.0		7.00	7.00	1.40	
		9	9:07:00	01:00	10875.0		6.00	6.00	1.20	
		10	9:08:00	01:00	10882.0		7.00	7.00	1.40	
Total :							59.00	11.80		
Average:							5.900	1.180		
P3	400	0	9:08:00	0	10882.0		0.00	0.00	0.00	c : 1
		1	9:09:00	01:00	10889.0		7.00	7.00	1.40	
		2	9:10:00	01:00	10895.0		6.00	6.00	1.20	
		3	9:11:00	01:00	10902.0		7.00	7.00	1.40	
		4	9:12:00	01:00	10909.0		7.00	7.00	1.40	
		5	9:13:00	01:00	10916.0		7.00	7.00	1.40	
		6	9:14:00	01:00	10923.0		7.00	7.00	1.40	
		7	9:15:00	01:00	10929.0		6.00	6.00	1.20	
		8	9:16:00	01:00	10936.0		7.00	7.00	1.40	
		9	9:17:00	01:00	10944.0		8.00	8.00	1.60	
		10	9:18:00	01:00	10952.0		8.00	8.00	1.60	
Total :							70.00	14.00		
Average:							7.000	1.400		
P4	300	0	9:18:00	0	10952.0		0.00	0.00	0.00	c : 1
		1	9:19:00	01:00	10961.0		9.00	9.00	1.80	
		2	9:20:00	01:00	10966.0		5.00	5.00	1.00	
		3	9:21:00	01:00	10973.0		7.00	7.00	1.40	
		4	9:22:00	01:00	10979.0		6.00	6.00	1.20	
		5	9:23:00	01:00	10986.0		7.00	7.00	1.40	
		6	9:24:00	01:00	10992.0		6.00	6.00	1.20	
		7	9:25:00	01:00	10998.0		6.00	6.00	1.20	
		8	9:26:00	01:00	11004.0		6.00	6.00	1.20	
		9	9:27:00	01:00	11010.0		6.00	6.00	1.20	
		10	9:28:00	01:00	11016.0		6.00	6.00	1.20	
Total :							64.00	12.80		
Average:							6.400	1.280		
P5	300	0	9:28:00	0	11016.0		0.00	0.00	0.00	c : 1
		1	9:29:00	01:00	11020.0		4.00	4.00	0.80	
		2	9:30:00	01:00	11025.0		5.00	5.00	1.00	
		3	9:31:00	01:00	11030.0		5.00	5.00	1.00	
		4	9:32:00	01:00	11035.0		5.00	5.00	1.00	
		5	9:33:00	01:00	11040.0		5.00	5.00	1.00	
		6	9:34:00	01:00	11045.0		5.00	5.00	1.00	
		7	9:35:00	01:00	11049.0		4.00	4.00	0.80	
		8	9:36:00	01:00	11053.0		4.00	4.00	0.80	
		9	9:37:00	01:00	11057.0		4.00	4.00	0.80	
		10	9:38:00	01:00	11061.0		4.00	4.00	0.80	
Total :							45.00	9.00	Finish Date & Time :	
Average:							4.500	0.900		

TEST RESULTS

Stage No.	Lugeon (1933) Value	Lugeon Value Curve	Nett Pressures	Pressure Vs Flow	Interpreted Result & Hydraulic Conductivity
P1	0.8		822.1		H_{LOSS} 0.08 kPa Stage No. P1 Gauge Pressure 200 kPa Q 3.10 L/min H 83.8 m Interpreted Result 0.8 uL Reported k at Stage P1 Analytical Method 1: (ref = Golder geotechnical field notes draft 1997) $k = Q/H \times 6.10889 \times 10^{-5} \times ((\log(2L/D))/L)$ k = 9.1E-08 m/s Analytical Method 2 (ref = Sharp, J.C 1975 Pit Slope Manual, CANMET report) $k = 1/(2L \times 3.14) \times (Q/H) \ln(R/r) \text{ m/s}$ (convert L/min to m/s). Assume R = radius of influence of 100m & r = radius of borehole. k = 1.5E-07 m/s
P2	1.3		921.9		
P3	1.4		1021.7		
P4	1.4		921.8		
P5	1.4		622.0		
Lugeon (1933) method includes nett pressure in calculation that is Hp (gauge pressure) + Hg (height gauges above watertable) - Hf (head losses).					
Flow Type		COMMENTS			



WATER PRESSURE TEST (5 Stage)

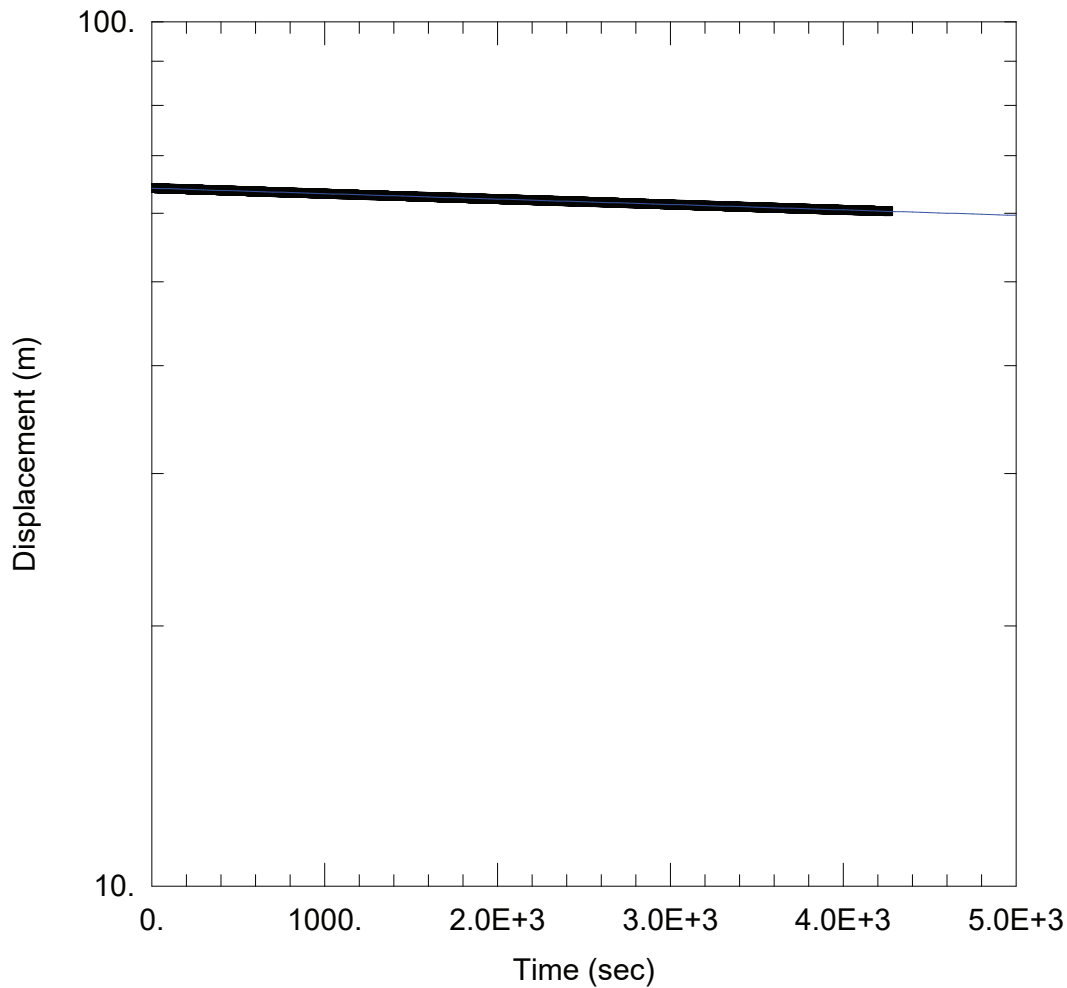
Revision N° : 18

Job N° : 1893795	Hole N° : BH2101	Drilling Method : HQ	Vertical depth to Groundwater : 63.18
Client : FFJV	Dip (Deg) : -90	Hole Diameter (m) : 0.096	Immediately prior to test (m bgl) : 63.18
Project : Inland Rail	DH Interval Top (m) : 103.00	Downhole Tested Length (m) : 4.00	Used in analysis (m bgl) : 63.18
Location : 320-01-BH2101	DH Interval Base (m) : 107.00	Packer Type : Pneumatic - Wireline - Double	Pressure Gauge Height (m agl) : 0.00
Tested By : SK	Computed By : SK	Rock tested :	Presumed Water Temperature : 26
Date : 17/08/2001	Date : 26/08/2018	Water Meter Reading in Litres	Casing Inner Diameter (mm) : 77.80

Pressure Stage	Gauge Pressure kPa	No	Actual	Time	Water Meter Readings		Volume (L)	Discharge (L/min)	Discharge/m (L/min/m)	Remarks
			Time (h:m:s)	Intervals (min)	Reading (Litres)					
P1	200	0	10:08:00	0	7190.0		0.00	0.00	0.00	c : 1
		1	10:09:00	01:00	7190.0		0.00	0.00	0.00	
		2	10:10:00	01:00	7192.0		2.00	2.00	0.50	
		3	10:11:00	01:00	7192.0		0.00	0.00	0.00	
		4	10:12:00	01:00	7192.0		0.00	0.00	0.00	
		5	10:13:00	01:00	7192.0		0.00	0.00	0.00	
		6	10:14:00	01:00	7192.0		0.00	0.00	0.00	
		7	10:15:00	01:00	7192.0		0.00	0.00	0.00	
		8	10:16:00	01:00	7193.0		1.00	1.00	0.25	
		9	10:17:00	01:00	7193.0		0.00	0.00	0.00	
		10	10:18:00	01:00	7193.0		0.00	0.00	0.00	
Total :							3.00	0.75		Start Date & Time :
Average:							0.300	0.075		
P2	300	0	10:18:00	0	7193.0		0.00	0.00	0.00	c : 1
		1	10:19:00	01:00	7194.0		1.00	1.00	0.25	
		2	10:20:00	01:00	7195.0		1.00	1.00	0.25	
		3	10:21:00	01:00	7195.0		0.00	0.00	0.00	
		4	10:22:00	01:00	7195.0		0.00	0.00	0.00	
		5	10:23:00	01:00	7196.0		1.00	1.00	0.25	
		6	10:24:00	01:00	7197.0		1.00	1.00	0.25	
		7	10:25:00	01:00	7197.0		0.00	0.00	0.00	
		8	10:26:00	01:00	7197.0		0.00	0.00	0.00	
		9	10:27:00	01:00	7198.0		1.00	1.00	0.25	
		10	10:28:00	01:00	7199.0		1.00	1.00	0.25	
Total :							6.00	1.50		
Average:							0.600	0.150		
P3	400	0	10:29:00	0	7199.0		0.00	0.00	0.00	c : 1
		1	10:30:00	01:00	7200.0		1.00	1.00	0.25	
		2	10:31:00	01:00	7201.0		1.00	1.00	0.25	
		3	10:32:00	01:00	7201.0		0.00	0.00	0.00	
		4	10:33:00	01:00	7202.0		1.00	1.00	0.25	
		5	10:34:00	01:00	7202.0		0.00	0.00	0.00	
		6	10:35:00	01:00	7203.0		1.00	1.00	0.25	
		7	10:36:00	01:00	7204.0		1.00	1.00	0.25	
		8	10:37:00	01:00	7205.0		1.00	1.00	0.25	
		9	10:38:00	01:00	7206.0		1.00	1.00	0.25	
		10	10:39:00	01:00	7207.0		1.00	1.00	0.25	
Total :							8.00	2.00		
Average:							0.800	0.200		
P4	300	0	10:39:00	0	7207.0		0.00	0.00	0.00	c : 1
		1	10:40:00	01:00	7207.0		0.00	0.00	0.00	
		2	10:41:00	01:00	7207.0		0.00	0.00	0.00	
		3	10:42:00	01:00	7207.0		0.00	0.00	0.00	
		4	10:43:00	01:00	7208.0		1.00	1.00	0.25	
		5	10:44:00	01:00	7208.0		0.00	0.00	0.00	
		6	10:45:00	01:00	7209.0		1.00	1.00	0.25	
		7	10:46:00	01:00	7209.0		0.00	0.00	0.00	
		8	10:47:00	01:00	7210.0		1.00	1.00	0.25	
		9	10:48:00	01:00	7210.0		0.00	0.00	0.00	
		10	10:49:00	01:00	7211.0		1.00	1.00	0.25	
Total :							4.00	1.00		
Average:							0.400	0.100		
P5		0	10:49:00	0	7211.0		0.00	0.00	0.00	c : 1
		1	10:50:00	01:00	7211.0		0.00	0.00	0.00	
		2	10:51:00	01:00	7211.0		0.00	0.00	0.00	
		3	10:52:00	01:00	7211.0		0.00	0.00	0.00	
		4	10:53:00	01:00	7212.0		1.00	1.00	0.25	
		5	10:54:00	01:00	7212.0		0.00	0.00	0.00	
		6	10:55:00	01:00	7212.0		0.00	0.00	0.00	
		7	10:56:00	01:00	7213.0		1.00	1.00	0.25	
		8	10:57:00	01:00	7213.0		0.00	0.00	0.00	
		9	10:58:00	01:00	7214.0		1.00	1.00	0.25	
		10	10:59:00	01:00	7214.0		0.00	0.00	0.00	
Total :							3.00	0.75		
Average:							0.300	0.075		

TEST RESULTS

Stage No.	Lugeon (1933) Value	Lugeon Value Curve	Nett Pressures	Pressure Vs Flow	Interpreted Result & Hydraulic Conductivity
P1	0.1		819.6		H _{LOSS} 0.00 kPa Stage No. P1 Gauge Pressure 200 kPa Q 0.30 L/min H 83.6 m Interpreted Result 0.1 uL Reported k at Stage P1 Analytical Method 1: (ref = Golder geotechnical field notes draft 1997) $k = Q/H \times 6.10889 \times 10^{-6} \times ((\log(2L/D))/L)$ k = 1.1E-08 m/s Analytical Method 2: (ref = Sharp, J.C 1975 Pit Slope Manual, CANMET report) $k = 1/(2L \times 3.14) \times (Q/H) \ln(R/r)$ m/s (convert L/min to m/s). Assume R = radius of influence of 100m & r = radius of borehole. k = 1.8E-08 m/s
P2	0.2		919.6		
P3	0.2		1019.6		
P4	0.1		919.6		
P5	0.1		619.6		
Lugeon (1933) method includes nett pressure in calculation that is Hp (gauge pressure) + Hg (height gauges above watertable) - Hf (head losses).					
Flow Type		COMMENTS			



320-01-BH2101 (FHT 74.0 M TO 79.0 M)

Data Set: V:\...\320-01-BH2101-Test6_Hvor.aqt

Date: 12/13/18

Time: 15:41:04

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 20/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test6)

Initial Displacement: 64.17 m

Static Water Column Height: 14.83 m

Total Well Penetration Depth: 14.83 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

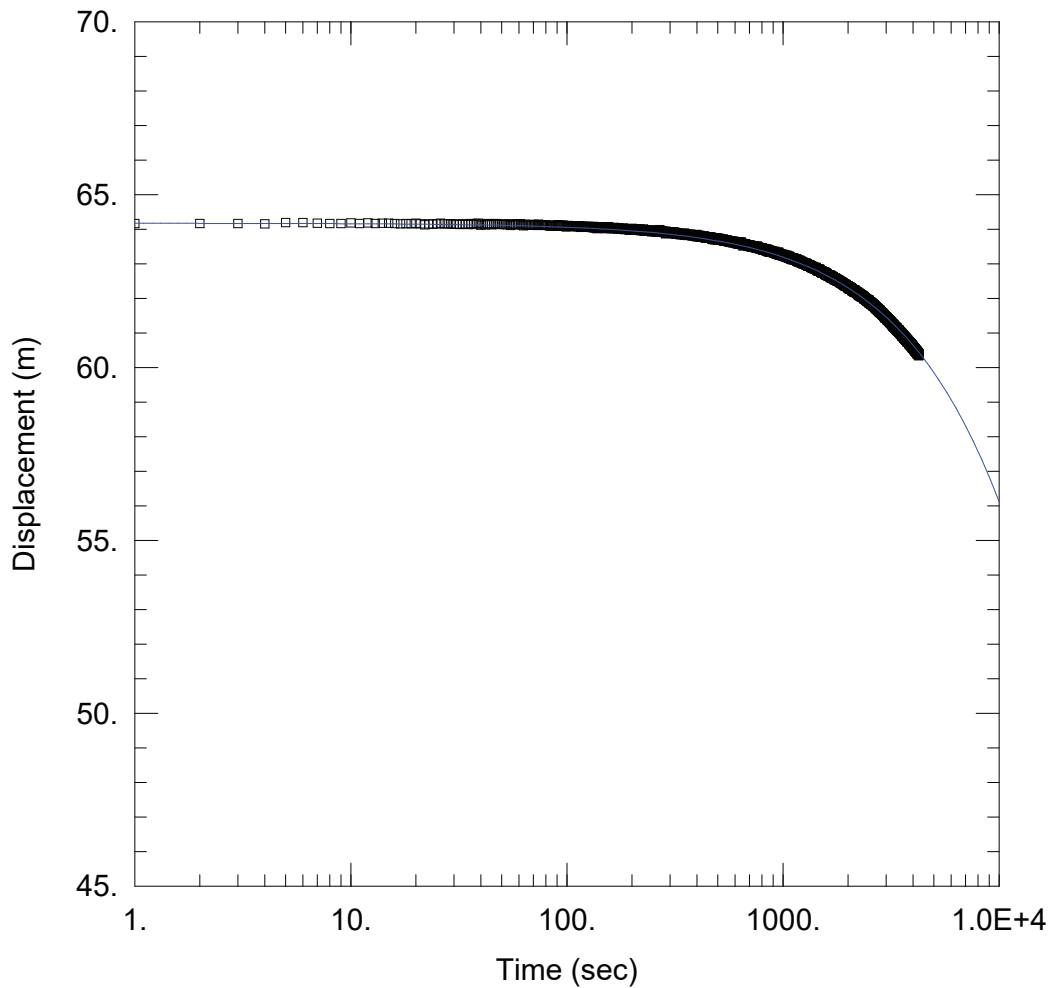
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 1.762E-8 m/sec

y0 = 64.17 m



320-01-BH2101 (FHT 74.0 M TO 79.0 M)

Data Set: V:\...\320-01-BH2101-Test6_KGS.aqt

Date: 12/13/18

Time: 15:41:34

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 20/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

WELL DATA (BH2101-Test6)

Initial Displacement: 64.17 m

Total Well Penetration Depth: 14.83 m

Casing Radius: 0.048 m

Static Water Column Height: 14.83 m

Screen Length: 5. m

Well Radius: 0.048 m

SOLUTION

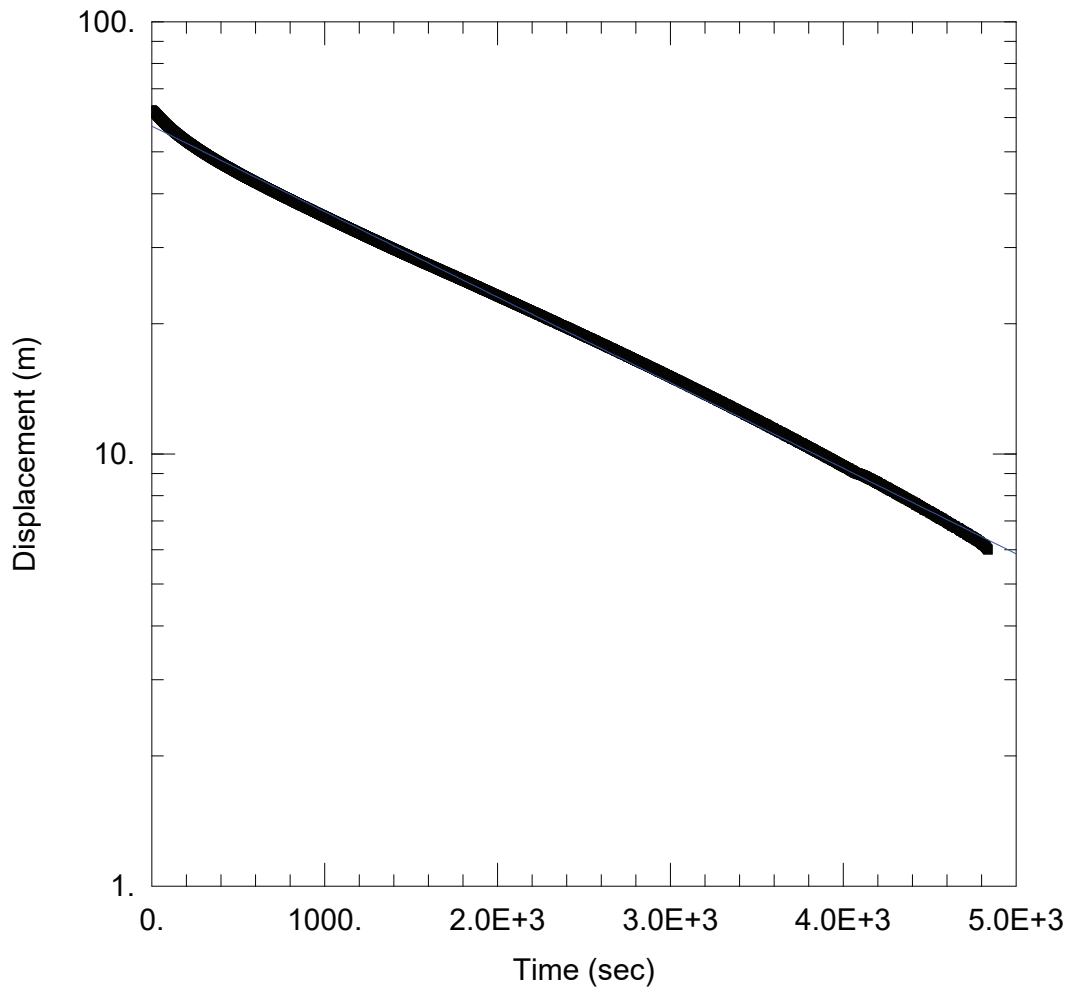
Aquifer Model: Confined

Kr = 2.823E-8 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.673E-9 m⁻¹



320-01-BH2101 (FHT 79.0 M TO 84.0 M)

Data Set: V:\...\320-01-BH2101-Test4_Hvor.aqt

Date: 12/13/18

Time: 15:39:25

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test4)

Initial Displacement: 62.44 m

Static Water Column Height: 20.16 m

Total Well Penetration Depth: 25.16 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

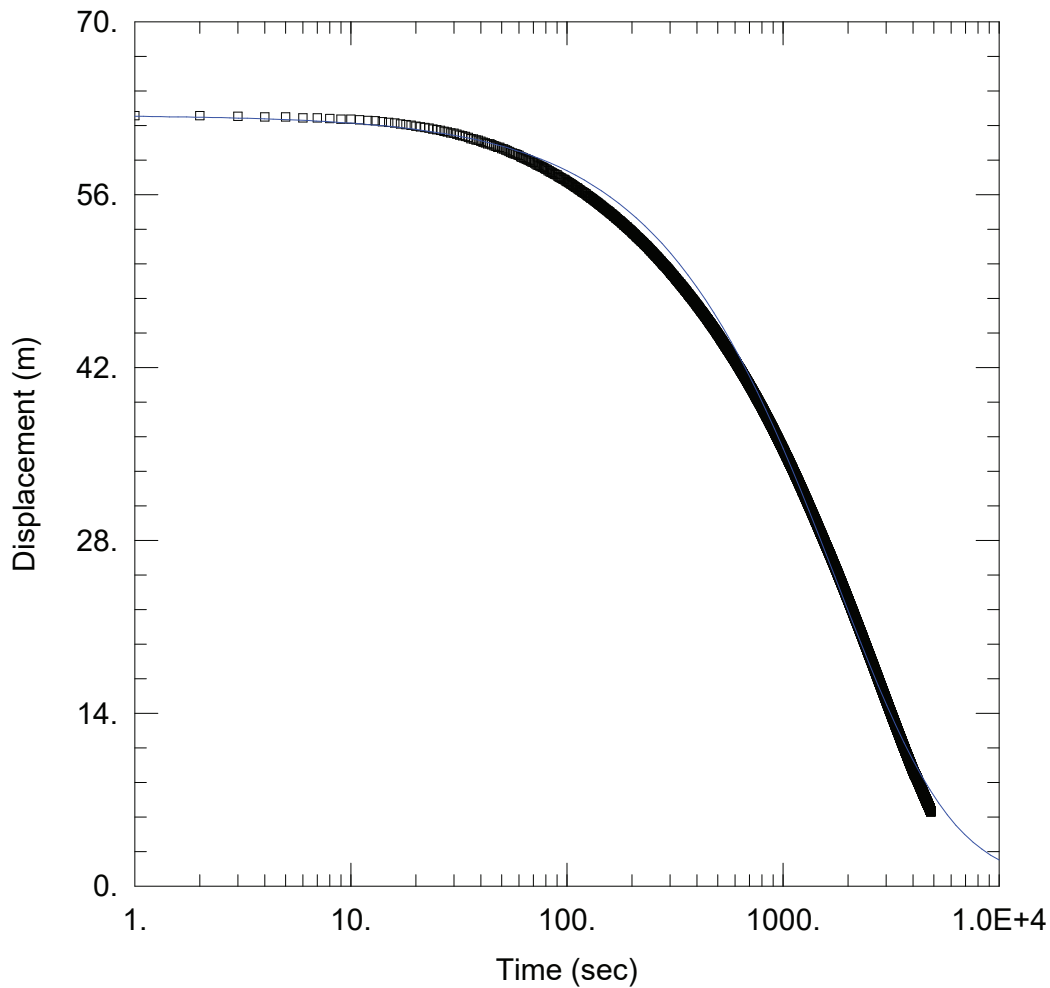
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 5.563E-7 m/sec

y0 = 57.33 m



320-01-BH2101 (FHT 79.0 M TO 84.0 M)

Data Set: V:\...\320-01-BH2101-Test4_KGS.aqt

Date: 12/13/18

Time: 15:40:00

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

WELL DATA (BH2101-Test4)

Initial Displacement: 62.44 m

Total Well Penetration Depth: 25.16 m

Casing Radius: 0.048 m

Static Water Column Height: 20.16 m

Screen Length: 5. m

Well Radius: 0.048 m

SOLUTION

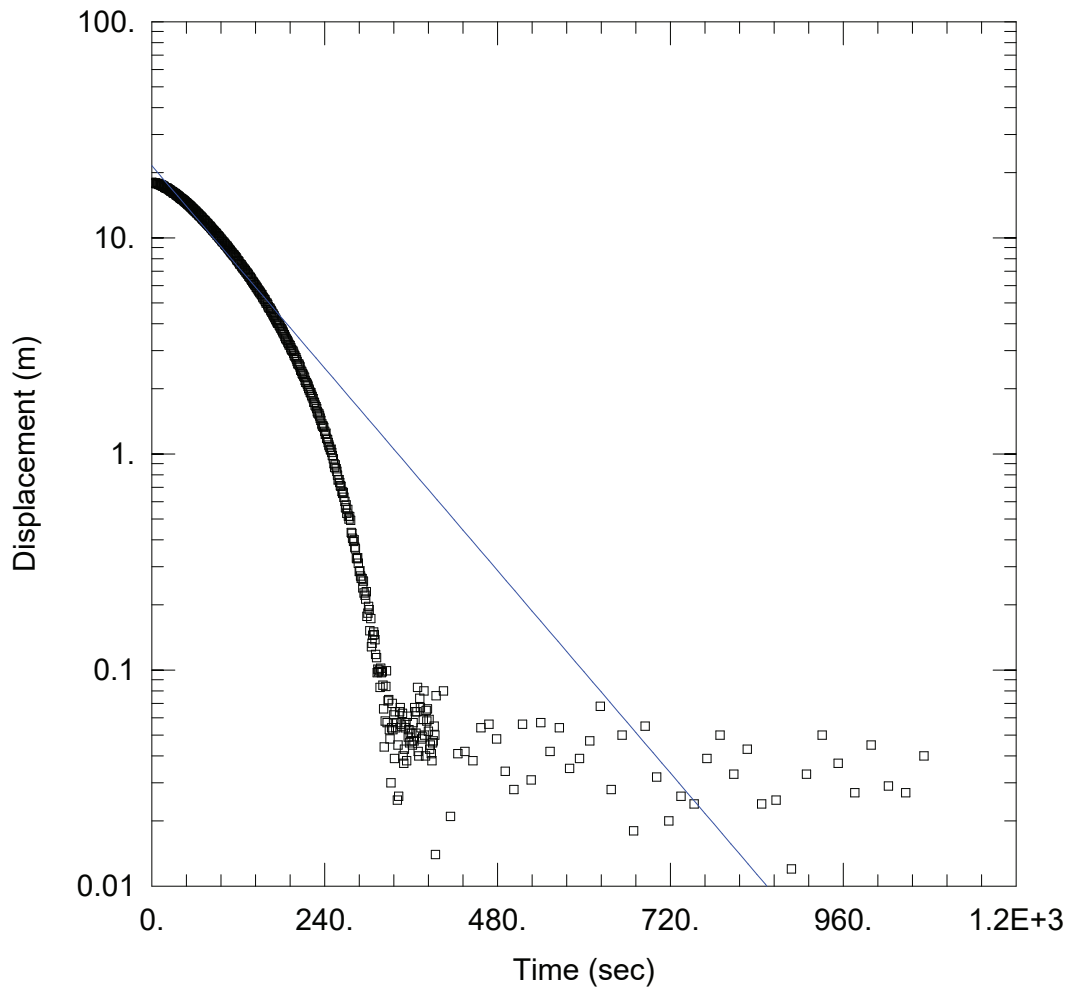
Aquifer Model: Confined

Kr = 6.801E-7 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.352E-5 m⁻¹



320-01-BH2101 (FHT 88.0 M TO 93.0 M)

Data Set: V:\...\320-01-BH2101-Test3A_Hvor_early.aqt

Date: 12/13/18

Time: 15:34:06

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test3A)

Initial Displacement: 18.05 m

Static Water Column Height: 28.95 m

Total Well Penetration Depth: 28.95 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

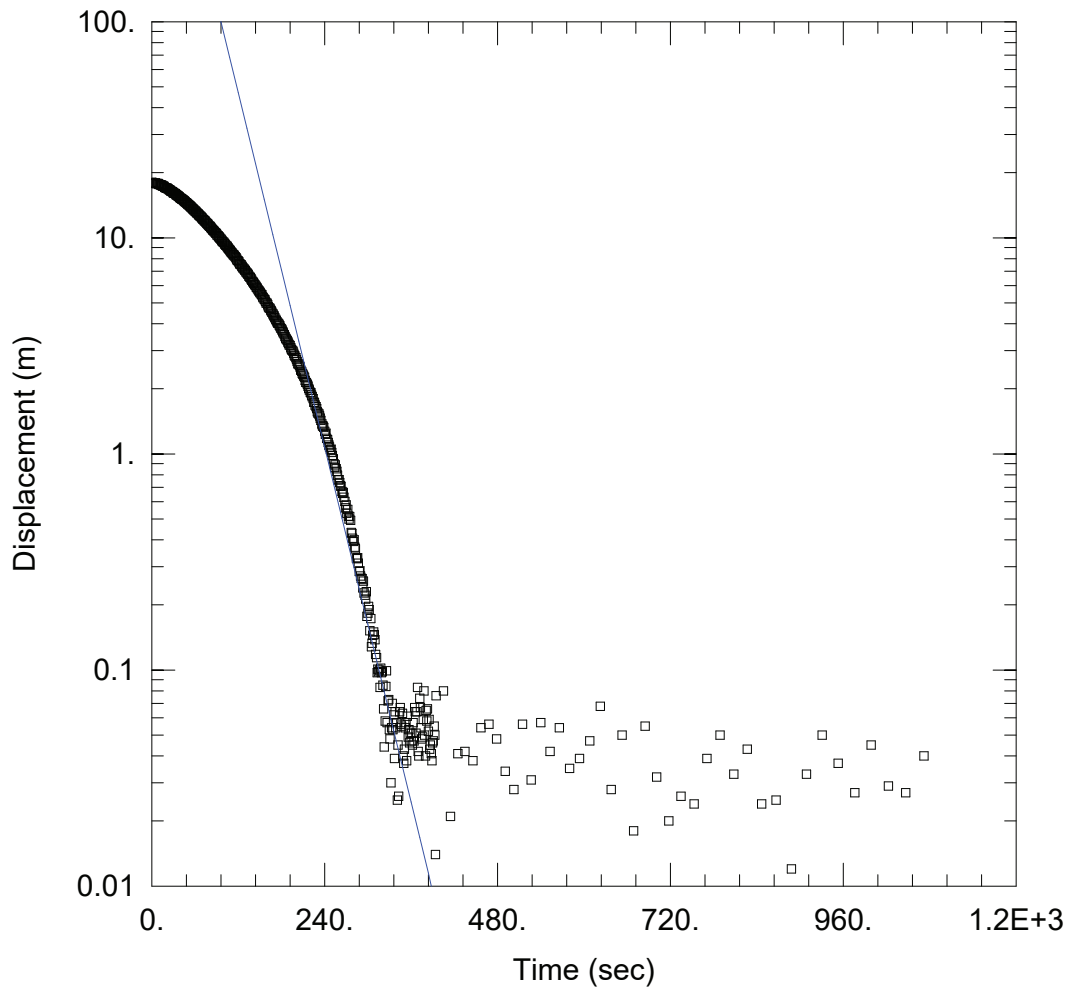
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 1.097E-5 m/sec

y0 = 21.55 m



320-01-BH2101 (FHT 88.0 M TO 93.0 M)

Data Set: V:\...\320-01-BH2101-Test3A_Hvor_Late.aqt

Date: 12/13/18

Time: 15:34:50

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test3A)

Initial Displacement: 18.05 m

Static Water Column Height: 28.95 m

Total Well Penetration Depth: 28.95 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

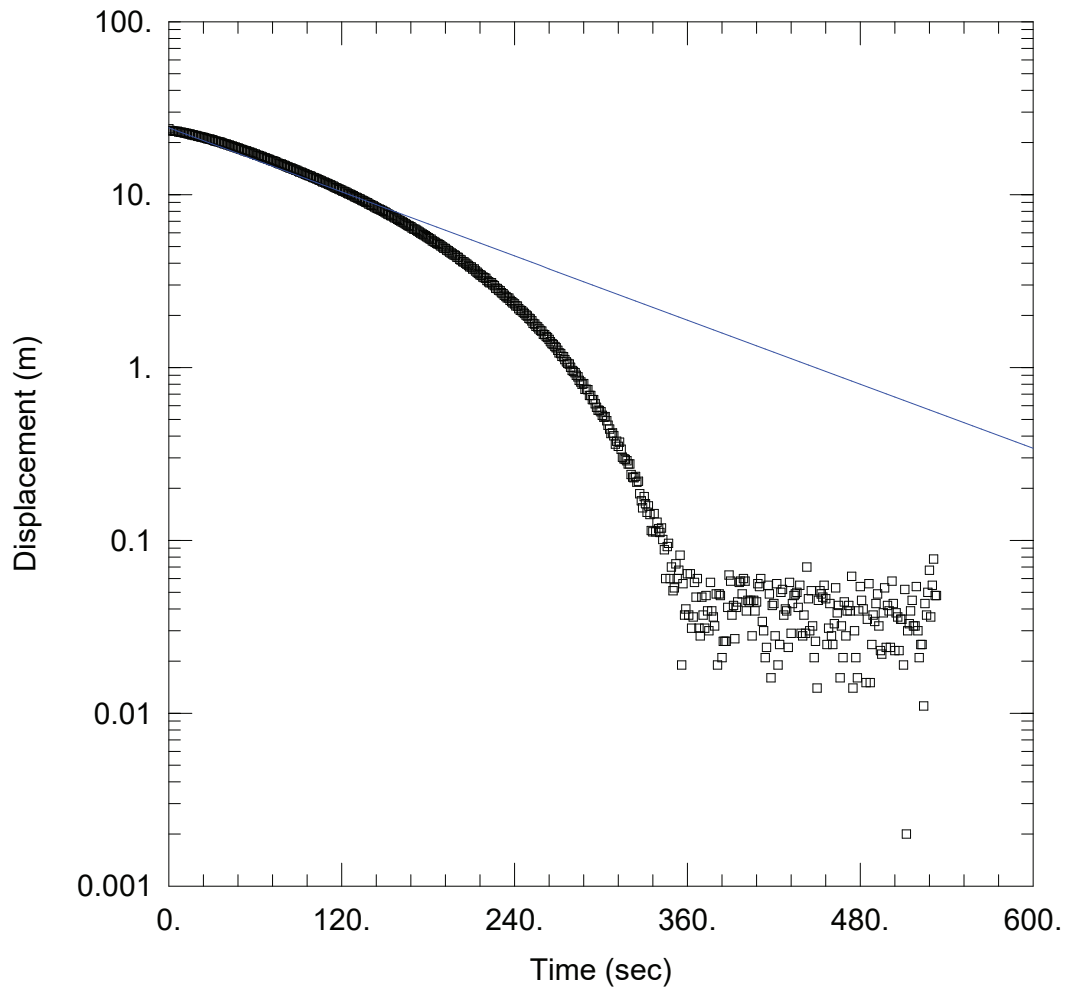
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 3.845E-5 m/sec

y0 = 2054.5 m



320-01-BH2101 (FALLING HEAD TEST 3B)

Data Set: V:\...\320-01-BH2101-Test3B_Hvor_early.aqt

Date: 12/13/18

Time: 15:14:10

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test3A)

Initial Displacement: 24. m

Static Water Column Height: 28.95 m

Total Well Penetration Depth: 28.95 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

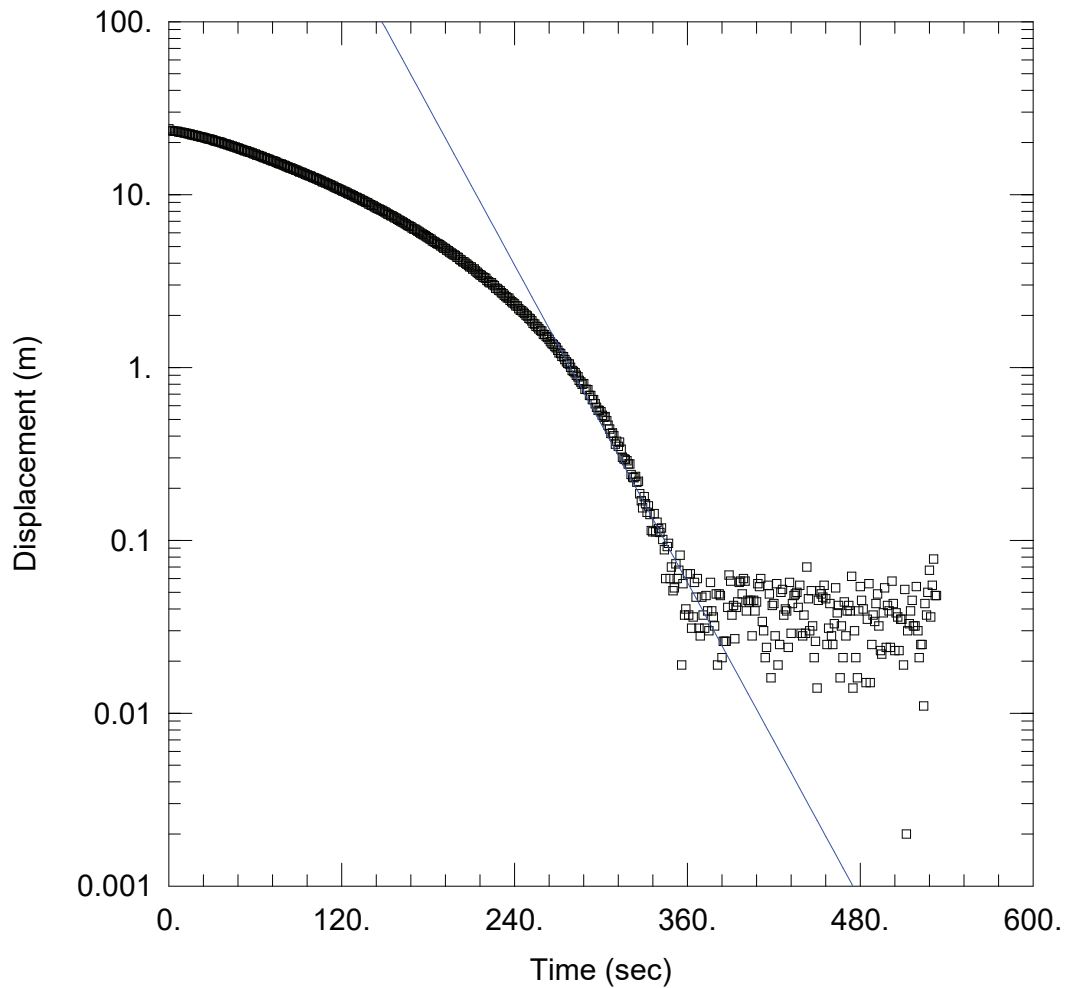
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 8.677E-6 m/sec

y0 = 24.28 m



320-01-BH2101 (FALLING HEAD TEST3B)

Data Set: V:\...\320-01-BH2101-Test3B_Hvor_Late.aqt

Date: 12/13/18

Time: 15:15:12

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test3A)

Initial Displacement: 24. m

Static Water Column Height: 28.95 m

Total Well Penetration Depth: 28.95 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

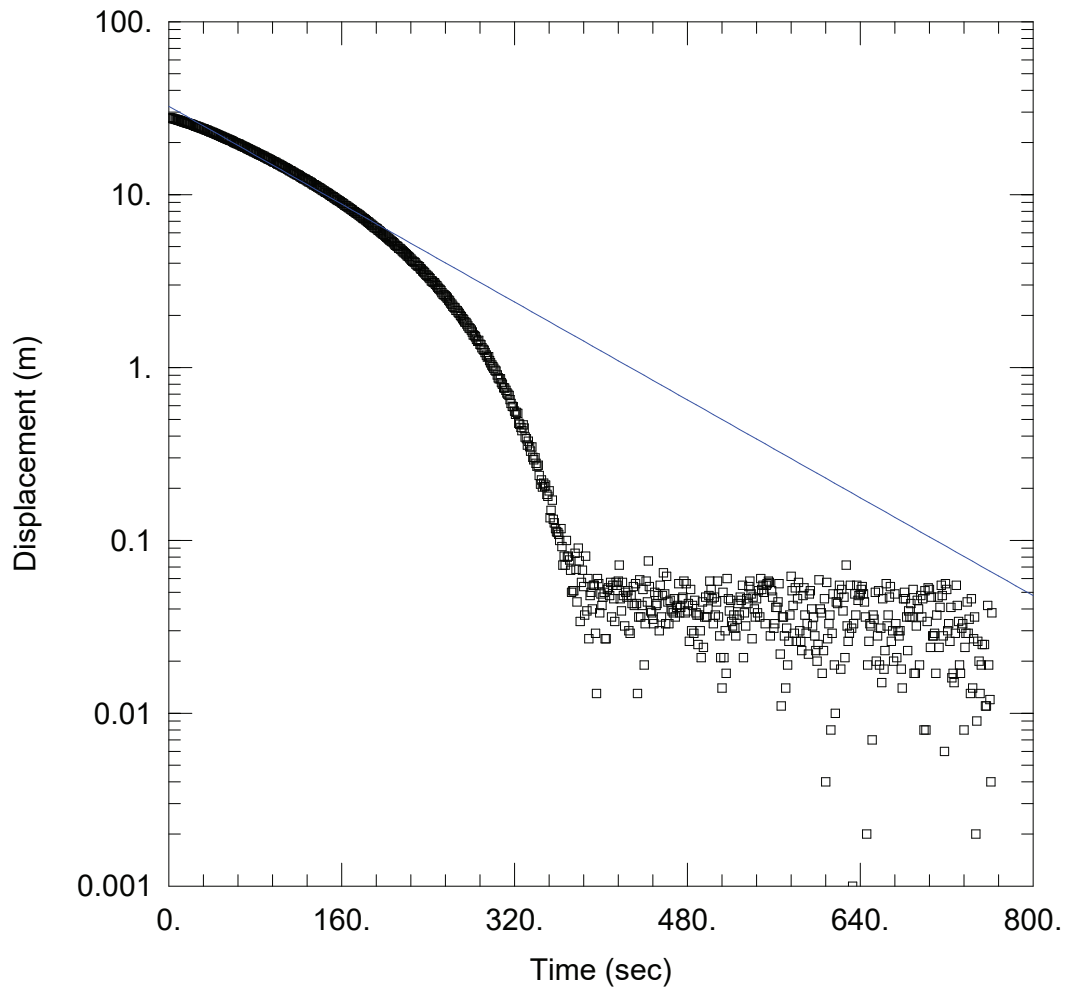
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 4.299E-5 m/sec

y0 = 1.834E+4 m



320-01-BH2101 (FHT 88.0 M TO 93.0 M)

Data Set: V:\...\320-01-BH2101-Test3C_Hvor_early.aqt

Date: 12/13/18

Time: 15:37:13

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test3C)

Initial Displacement: 27.9 m

Static Water Column Height: 28.95 m

Total Well Penetration Depth: 28.95 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

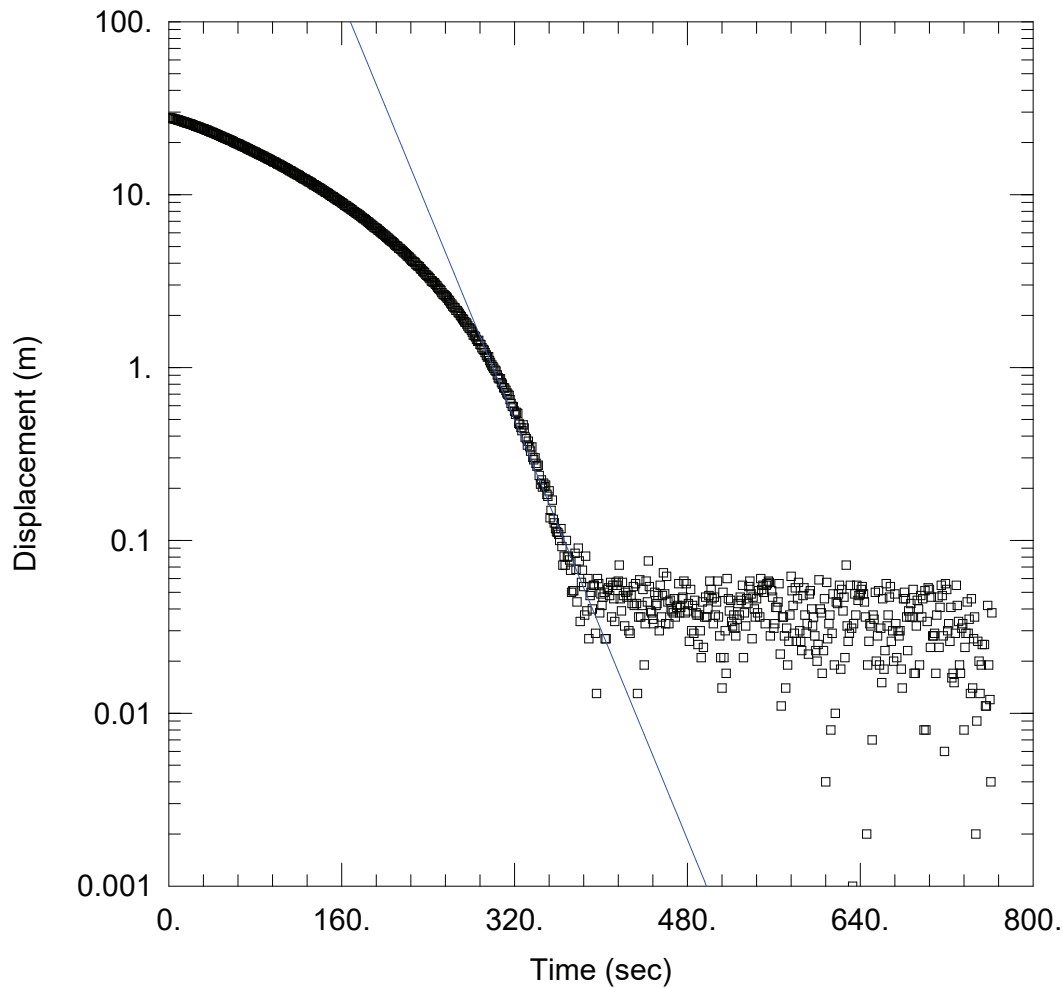
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 9.946E-6 m/sec

y0 = 32.42 m



320-01-BH2101 (FHT 88.0 M TO 93.0 M)

Data Set: V:\...\320-01-BH2101-Test3C_Hvor_late.aqt

Date: 12/13/18

Time: 15:37:48

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test3C)

Initial Displacement: 27.9 m

Static Water Column Height: 28.95 m

Total Well Penetration Depth: 28.95 m

Screen Length: 5. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

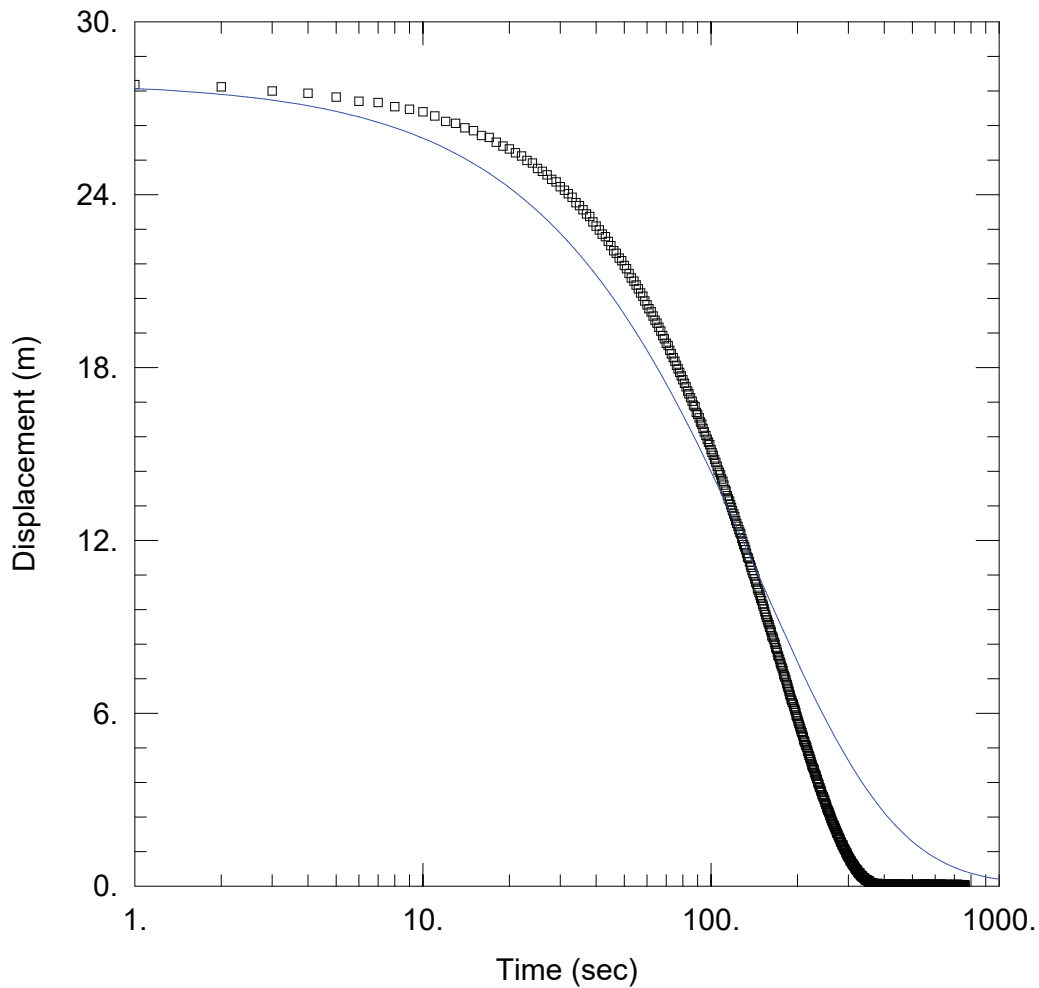
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 4.262E-5 m/sec

y0 = 3.532E+4 m



320-01-BH2101 (FHT 88.0 M TO 93.0 M)

Data Set: V:\...\320-01-BH2101-Test3C_KGS.aqt

Date: 12/13/18

Time: 15:38:25

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 5. m

WELL DATA (BH2101-Test3C)

Initial Displacement: 27.9 m

Total Well Penetration Depth: 28.95 m

Casing Radius: 0.048 m

Static Water Column Height: 28.95 m

Screen Length: 5. m

Well Radius: 0.048 m

SOLUTION

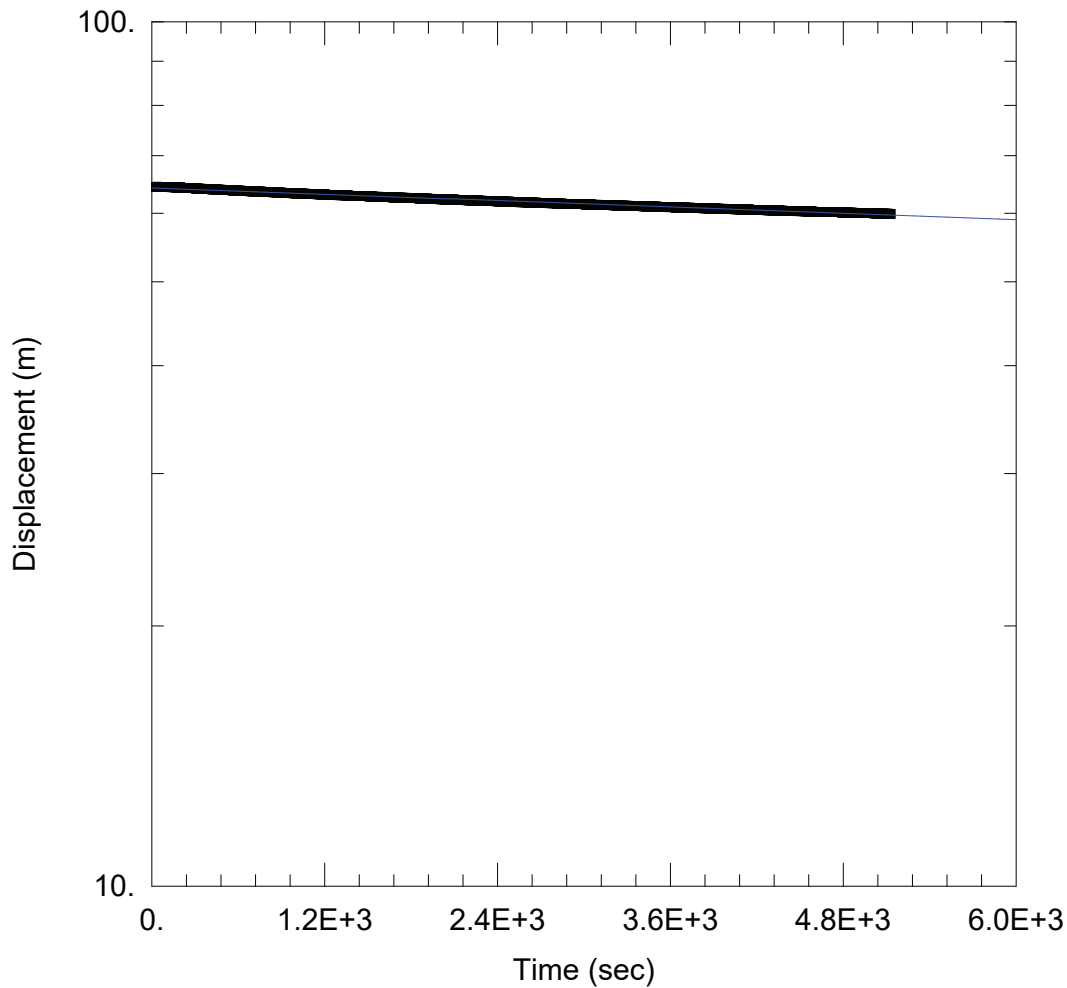
Aquifer Model: Confined

Kr = 2.414E-5 m/sec

Kz/Kr = 0.001

Solution Method: KGS Model

Ss = 5.929E-12 m⁻¹



320-01-BH2101 (FHT 103 M TO 107 M)

Data Set: V:\...\320-01-BH2101-Test2A_Hvor.aqt

Date: 12/13/18

Time: 15:30:46

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 4. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test2A)

Initial Displacement: 64.4 m

Static Water Column Height: 38.56 m

Total Well Penetration Depth: 68.4 m

Screen Length: 4. m

Casing Radius: 0.048 m

Well Radius: 0.048 m

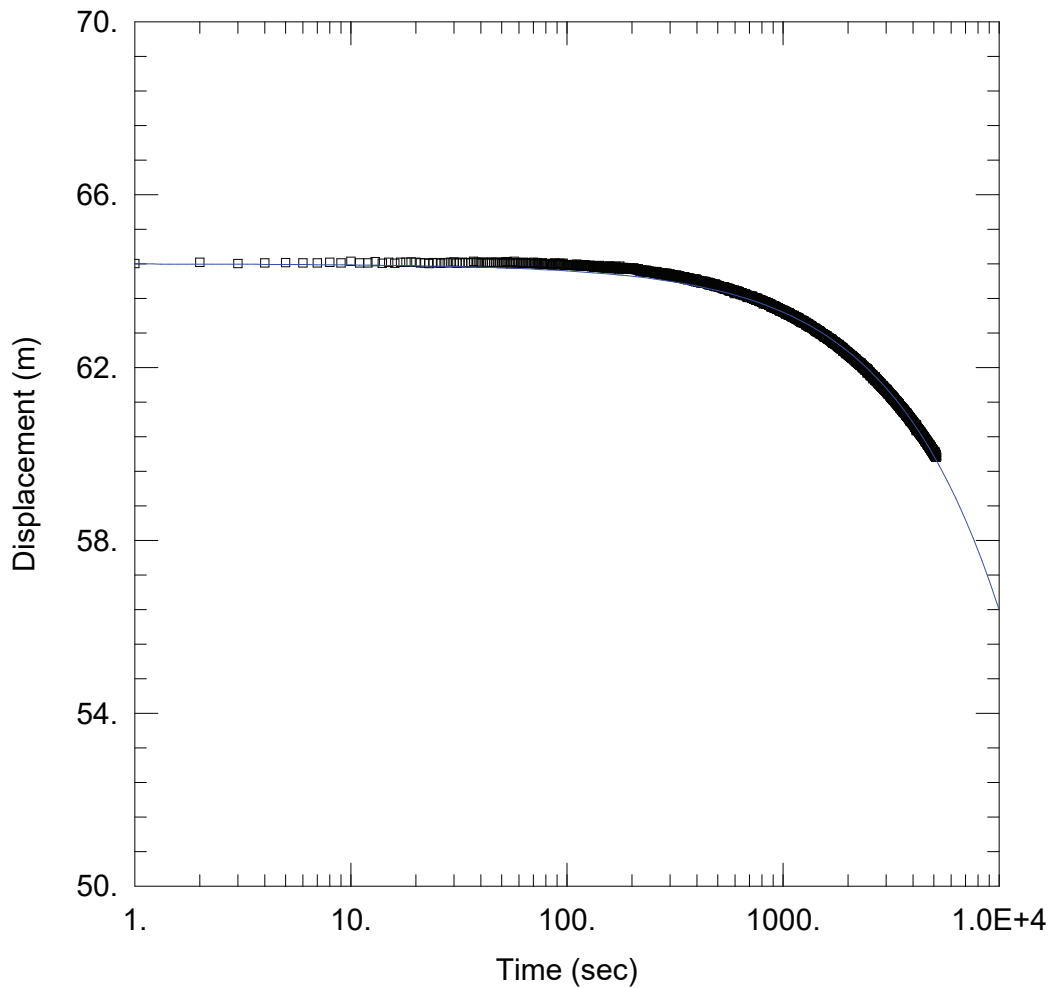
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 2.148E-8 m/sec

y0 = 64.22 m



320-01-BH2101 (FHT 103 M TO 107 M)

Data Set: V:\...\320-01-BH2101-Test2A_KGS.aqt

Date: 12/13/18

Time: 15:31:26

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 17/08/2018

AQUIFER DATA

Saturated Thickness: 4. m

WELL DATA (BH2101-Test2A)

Initial Displacement: 64.4 m

Total Well Penetration Depth: 68.4 m

Casing Radius: 0.048 m

Static Water Column Height: 38.56 m

Screen Length: 4. m

Well Radius: 0.048 m

SOLUTION

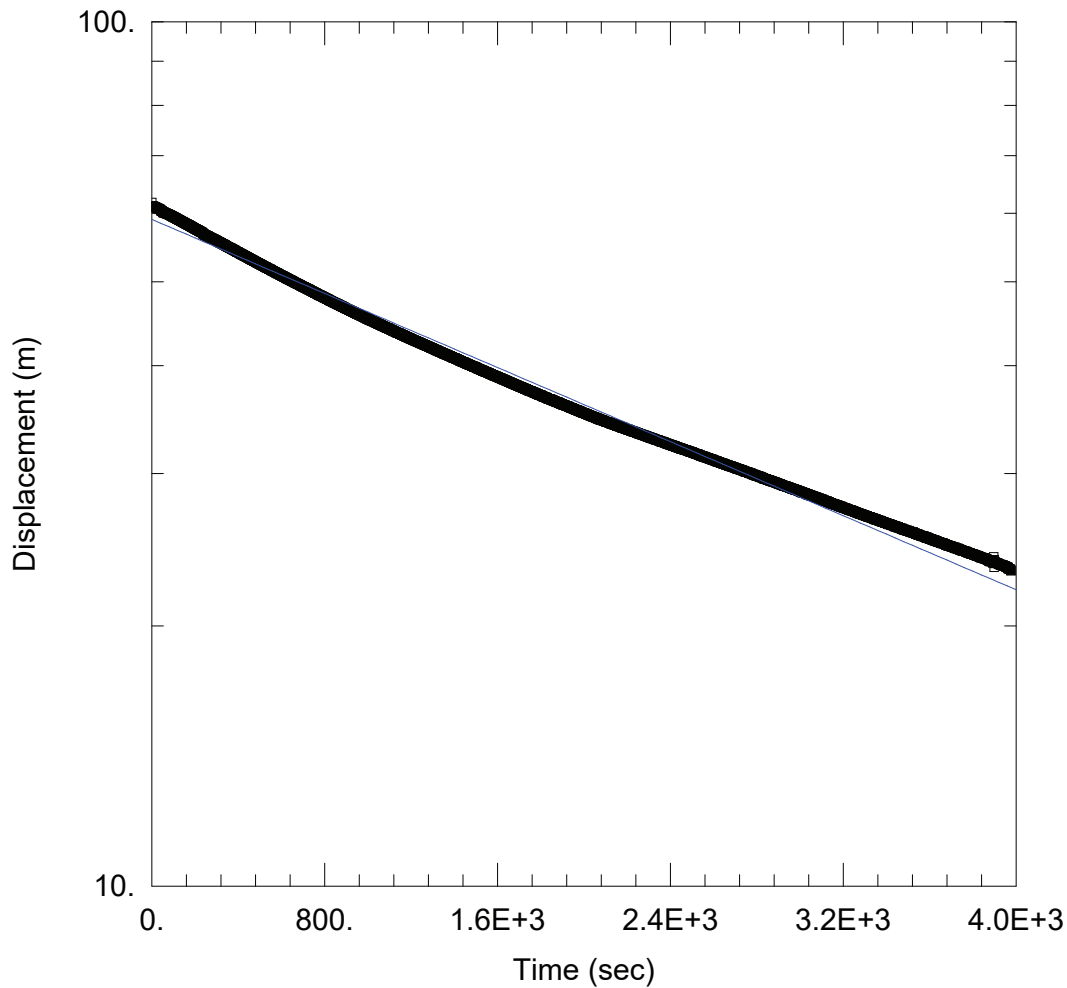
Aquifer Model: Confined

Kr = 1.862E-8 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.221E-5 m⁻¹



320-01-BH2101 (FHT 109.5 M TO 150 M)

Data Set: V:\...\320-01-BH2101-Test1_Hvor.aqt

Date: 12/13/18

Time: 15:28:14

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 16/08/2018

AQUIFER DATA

Saturated Thickness: 40.5 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH2101-Test1)

Initial Displacement: 61.8 m

Static Water Column Height: 88.84 m

Total Well Penetration Depth: 88.4 m

Screen Length: 40.5 m

Casing Radius: 0.048 m

Well Radius: 0.048 m

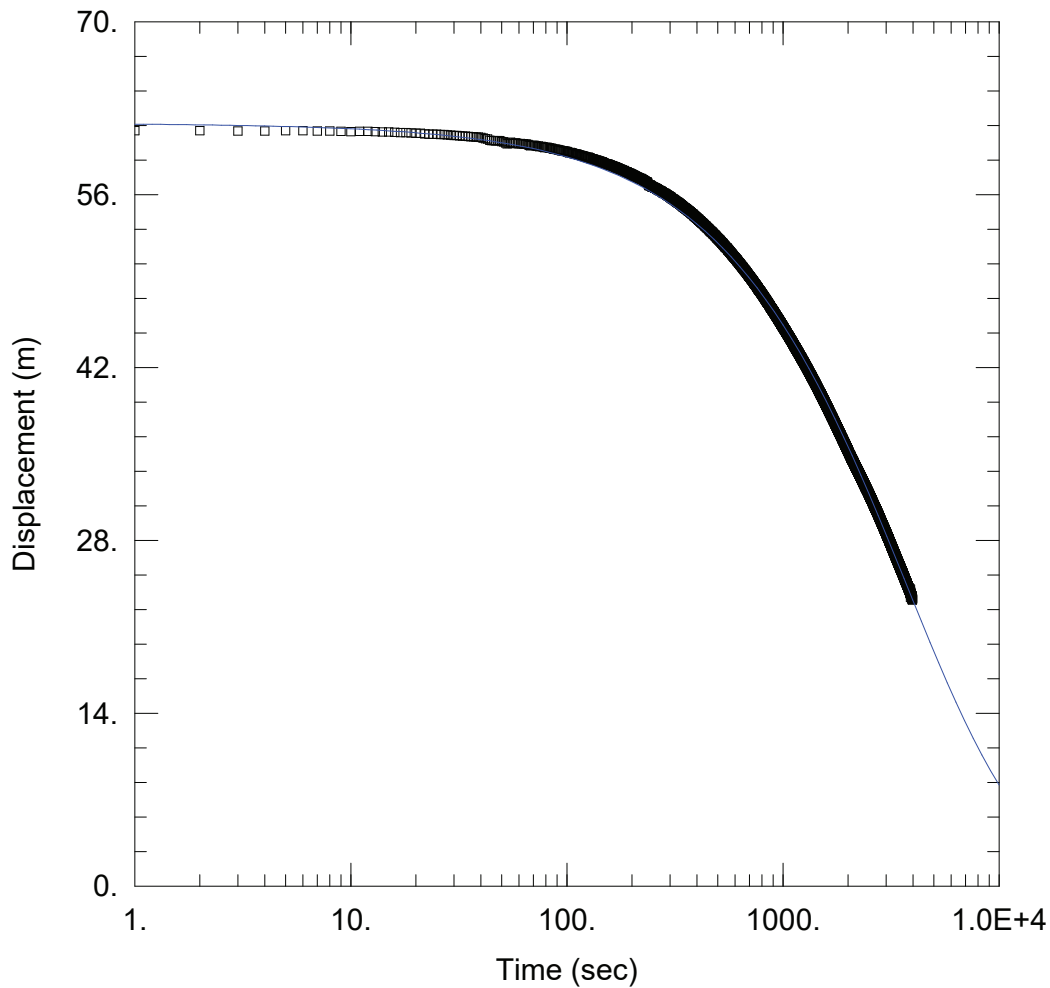
SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 3.717E-8 m/sec

y0 = 59.05 m



320-01-BH2101 (FHT 109.5 M TO 150 M)

Data Set: V:\...\320-01-BH2101-Test1_KGS.aqt

Date: 12/13/18

Time: 15:29:15

PROJECT INFORMATION

Company: Golder Associates Pty Ltd

Client: FFJV

Project: 1893795

Location: G to H

Test Well: 320-01-BH2101

Test Date: 16/08/2018

AQUIFER DATA

Saturated Thickness: 40.5 m

WELL DATA (BH2101-Test1)

Initial Displacement: 61.8 m

Total Well Penetration Depth: 88.4 m

Casing Radius: 0.048 m

Static Water Column Height: 88.84 m

Screen Length: 40.5 m

Well Radius: 0.048 m

SOLUTION

Aquifer Model: Confined

Kr = 4.253E-8 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 1.556E-5 m⁻¹

APPENDIX

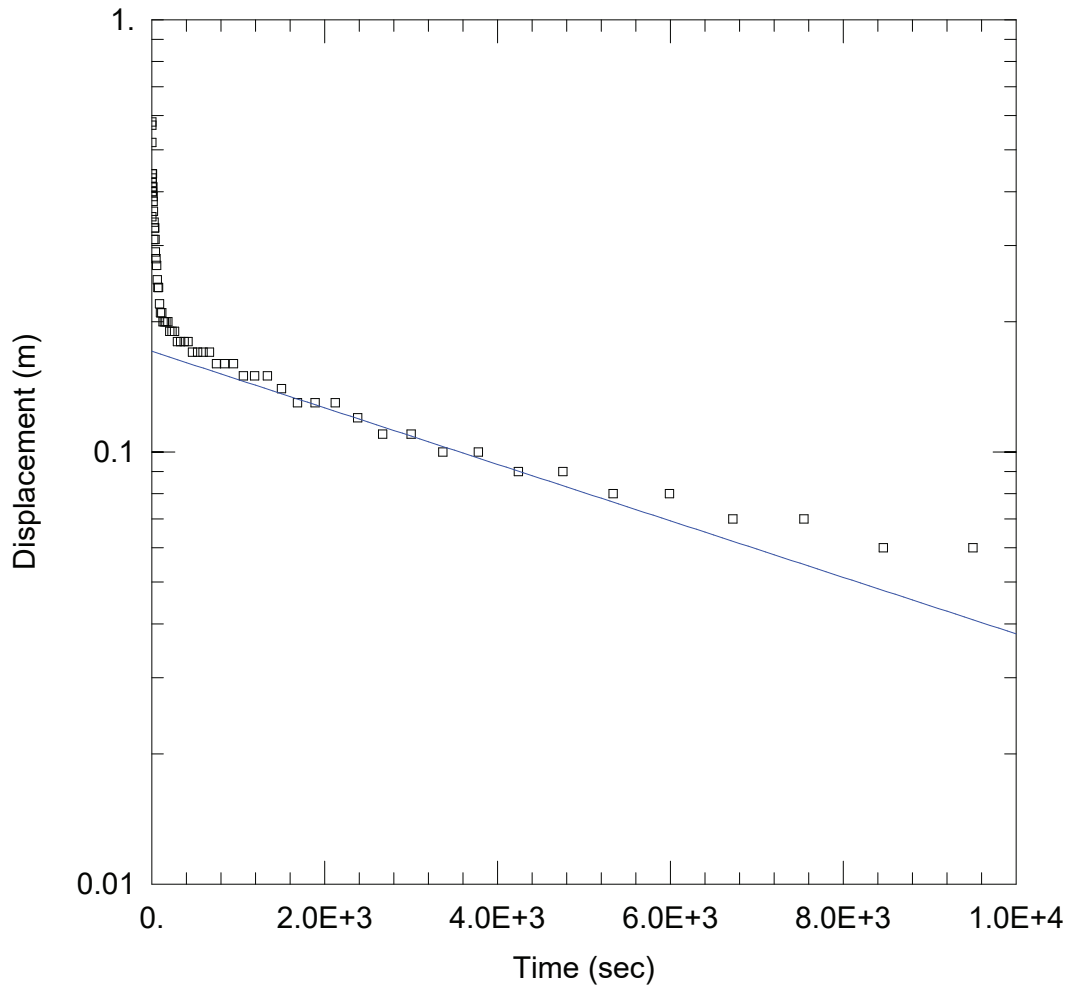
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Appendix F Slug testing
results

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320-01-BH2103 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2103 FHT_HVOR.aqt

Date: 03/12/19

Time: 10:32:58

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2103

Test Date: 20/11/2018

AQUIFER DATA

Saturated Thickness: 13.06 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2103)

Initial Displacement: 0.57 m

Static Water Column Height: 13.06 m

Total Well Penetration Depth: 13.06 m

Screen Length: 9. m

Casing Radius: 0.025 m

Well Radius: 0.048 m

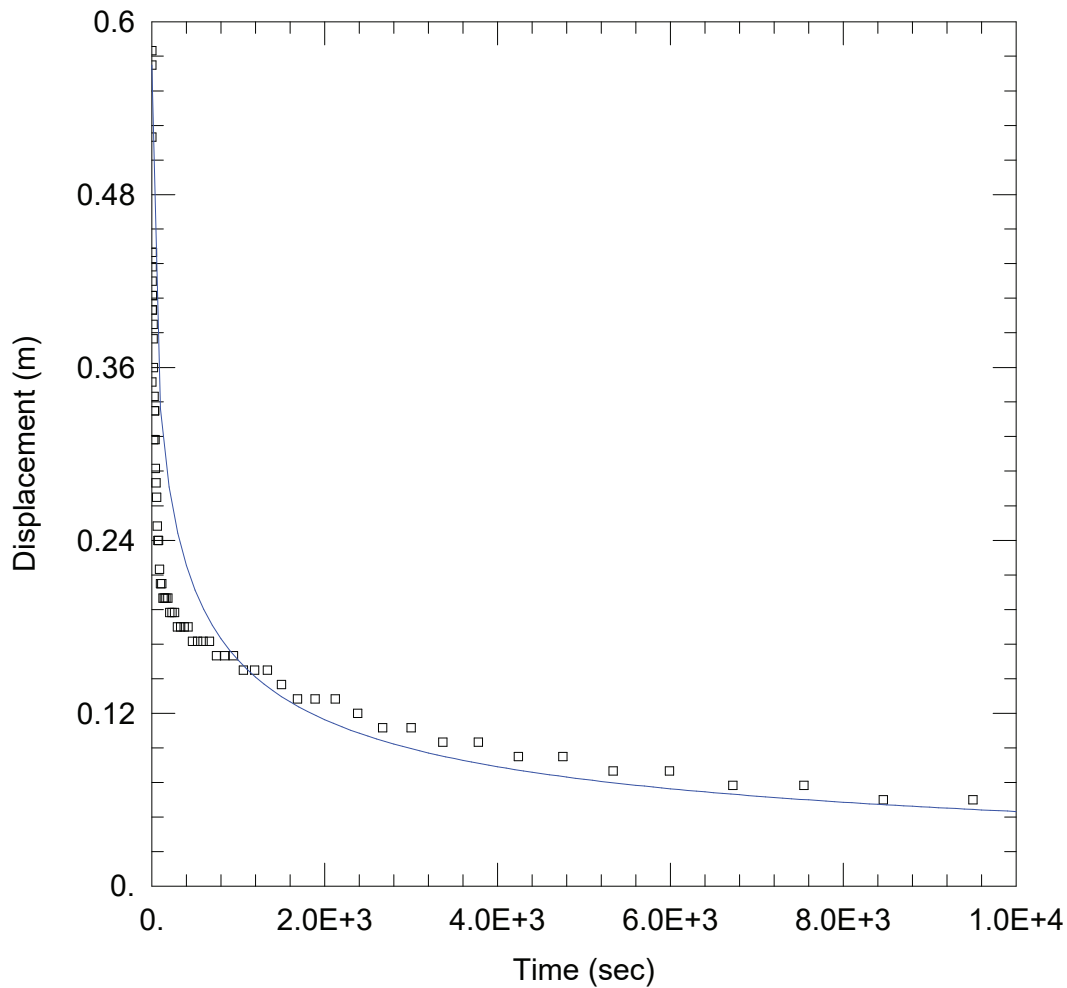
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 2.736E-8 m/sec

y0 = 0.1709 m



320-01-BH2103 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2103 FHT_KGS.aqt

Date: 03/12/19

Time: 10:33:50

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2103

Test Date: 20/11/2018

AQUIFER DATA

Saturated Thickness: 13.06 m

WELL DATA (320-01-BH2103)

Initial Displacement: 0.57 m

Total Well Penetration Depth: 13.06 m

Casing Radius: 0.025 m

Static Water Column Height: 13.06 m

Screen Length: 9. m

Well Radius: 10.05 m

SOLUTION

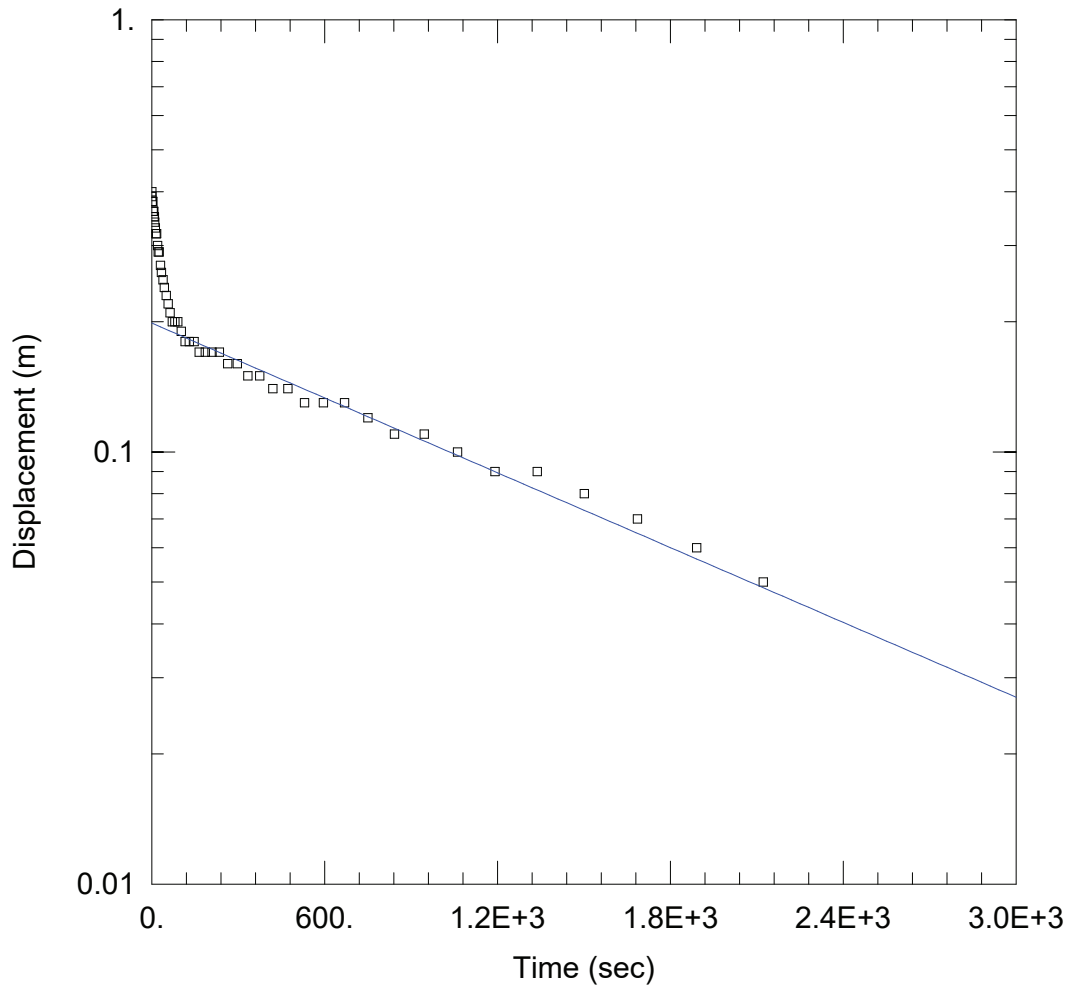
Aquifer Model: Unconfined

Kr = 1.217E-9 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 3.155E-5 m⁻¹



320-01-BH2103 (RISING HEAD TEST)

Data Set: V:\...\320-01-BH2103 RHT_HVOR.aqt

Date: 03/12/19

Time: 10:34:42

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2103

Test Date: 20/11/2018

AQUIFER DATA

Saturated Thickness: 13.06 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2103)

Initial Displacement: 0.4 m

Static Water Column Height: 13.06 m

Total Well Penetration Depth: 13.06 m

Screen Length: 9. m

Casing Radius: 0.025 m

Well Radius: 10.05 m

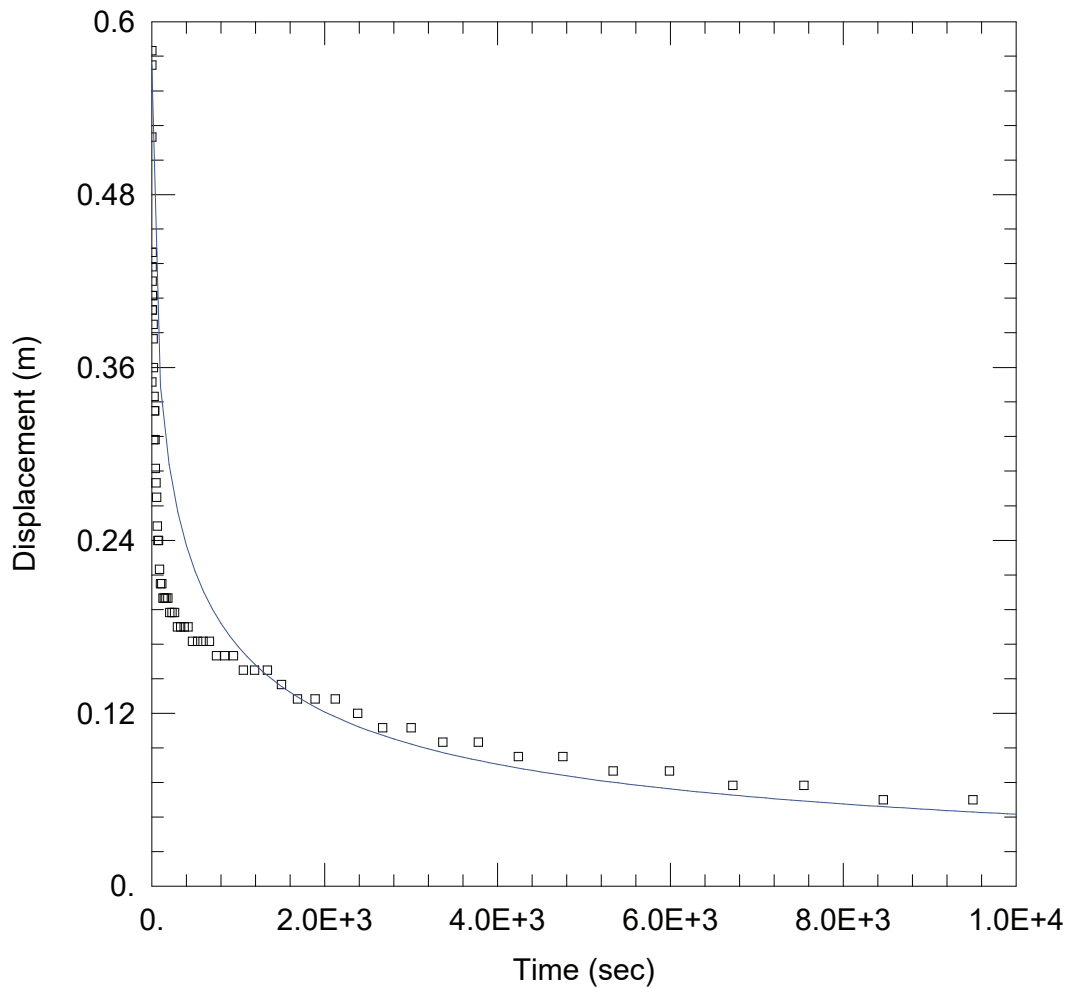
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 1.001E-8 m/sec

y0 = 0.1985 m



320-01-BH2103 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2103 RHT_KGS.aqt

Date: 03/12/19

Time: 10:36:29

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2103

Test Date: 20/11/2018

AQUIFER DATA

Saturated Thickness: 13.06 m

WELL DATA (320-01-BH2103)

Initial Displacement: 0.57 m

Total Well Penetration Depth: 13.06 m

Casing Radius: 0.025 m

Static Water Column Height: 13.06 m

Screen Length: 9. m

Well Radius: 0.048 m

SOLUTION

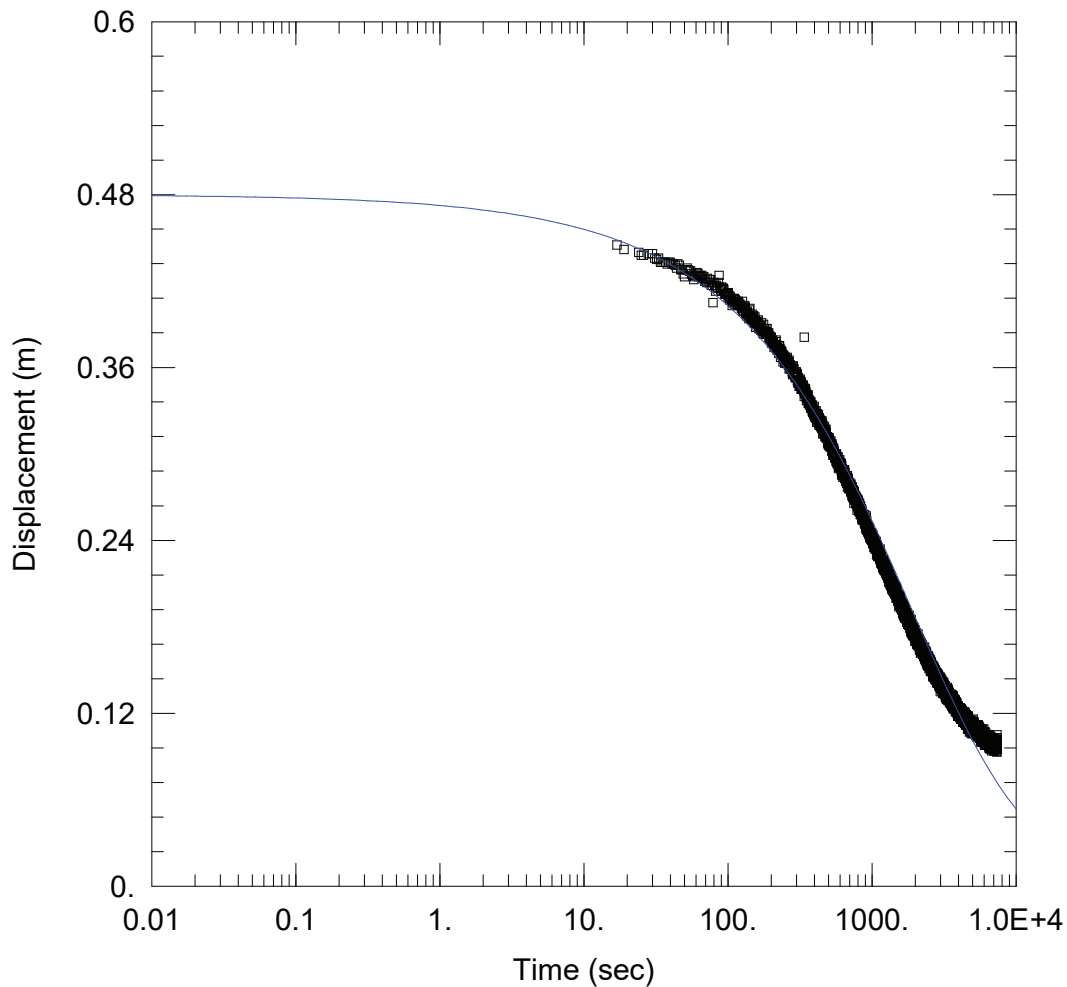
Aquifer Model: Unconfined

Kr = 6.181E-9 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.2148 m⁻¹



320-01-BH2201 FHT

Data Set: \...\320-01-BH2201 FHT_KGS_SK.aqt

Date: 11/15/18

Time: 15:30:23

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2201

AQUIFER DATA

Saturated Thickness: 13.32 m

WELL DATA (302-01-BH2201_FHT)

Initial Displacement: 0.48 m

Total Well Penetration Depth: 13.32 m

Casing Radius: 0.025 m

Static Water Column Height: 13.32 m

Screen Length: 6. m

Well Radius: 0.048 m

SOLUTION

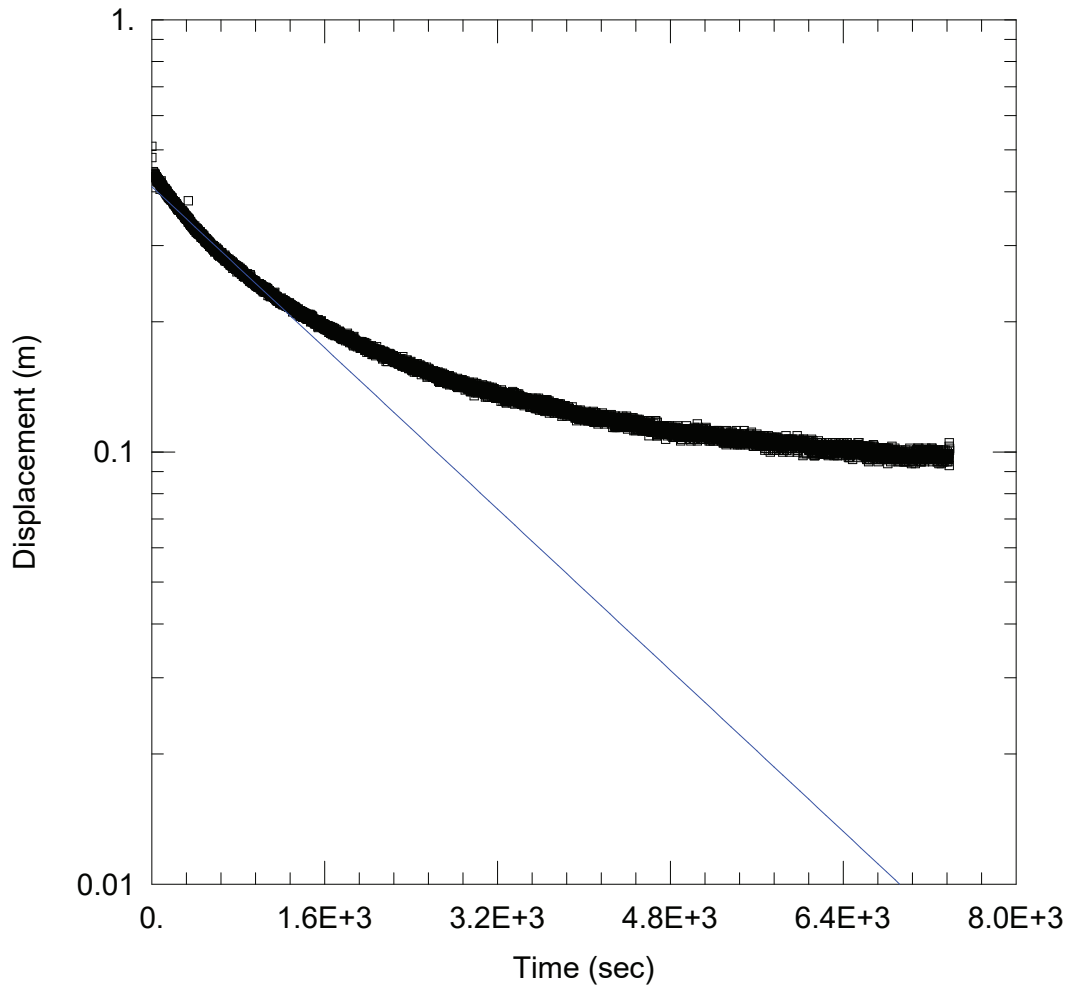
Aquifer Model: Unconfined

Kr = 2.987E-8 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.007508 m⁻¹



320-01-BH2201 FHT

Data Set: \...\320-01-BH2201 Slug in _HVOR.aqt

Date: 11/15/18

Time: 13:54:26

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2201

AQUIFER DATA

Saturated Thickness: 13.32 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (302-01-BH2201_FHT)

Initial Displacement: 0.48 m

Static Water Column Height: 13.32 m

Total Well Penetration Depth: 13.32 m

Screen Length: 6. m

Casing Radius: 0.025 m

Well Radius: 0.048 m

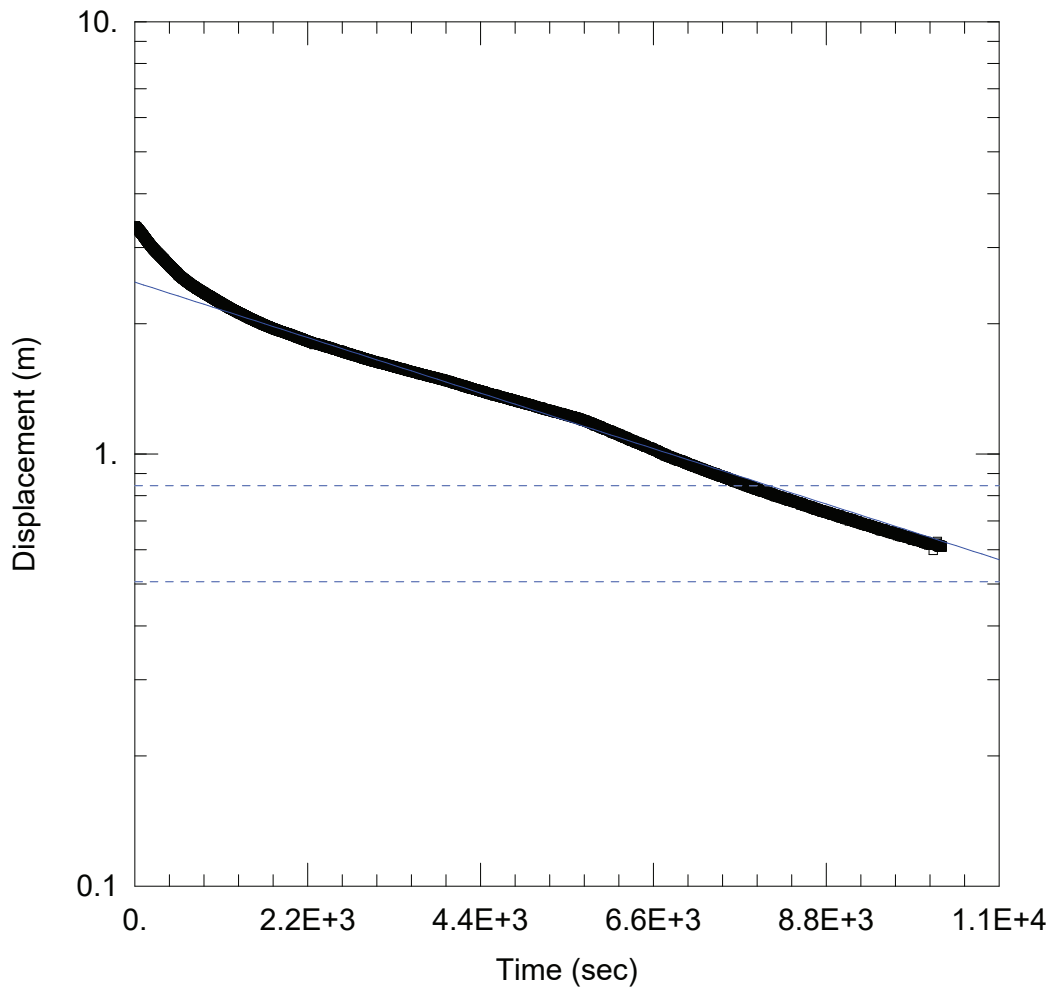
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 1.544E-7 m/sec

y0 = 0.411 m



320-01-BH2207 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2207 FHT_HVOR.aqt

Date: 04/10/19

Time: 13:08:55

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2207

Test Date: 11/02/2019

AQUIFER DATA

Saturated Thickness: 0.1 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2207)

Initial Displacement: 3.373 m

Static Water Column Height: 0.1 m

Total Well Penetration Depth: 0.1 m

Screen Length: 0.1 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

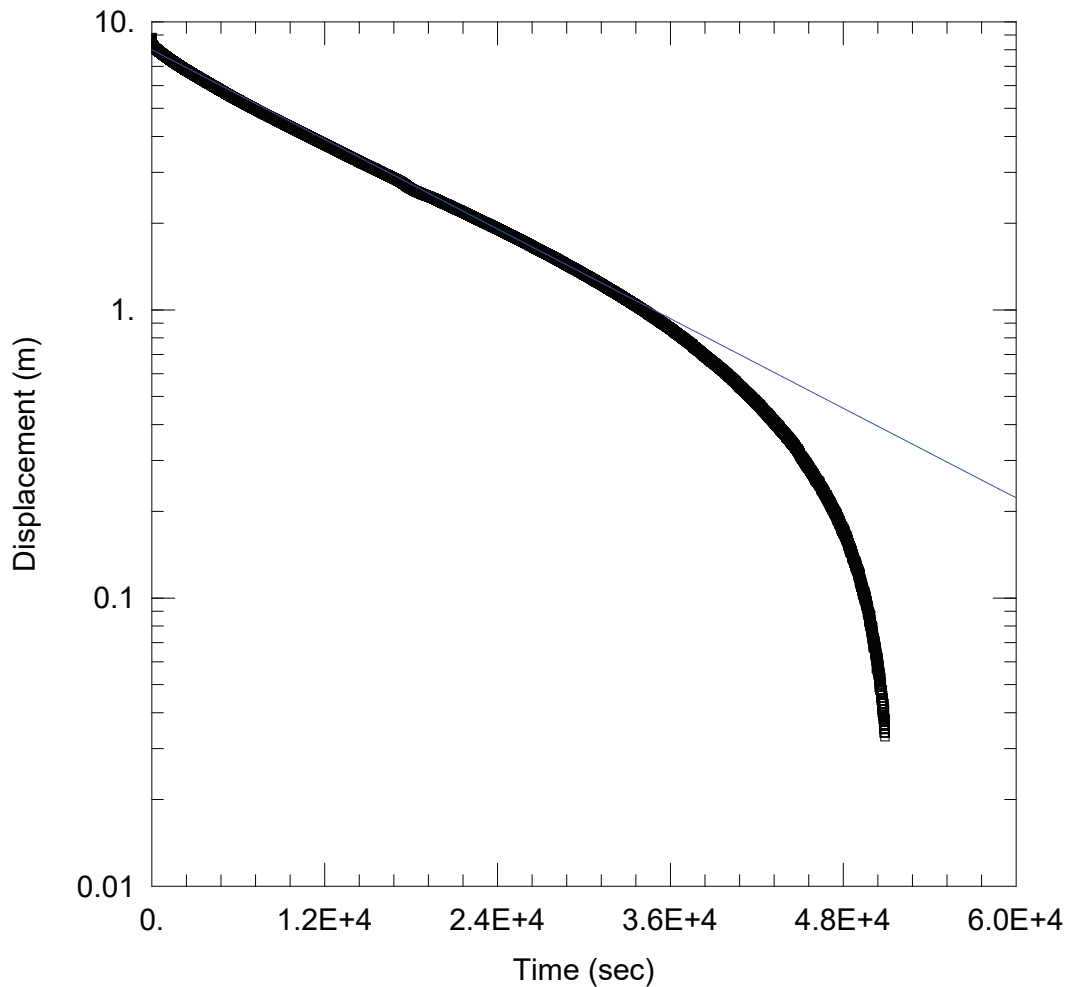
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 2.225E-6 m/sec

y0 = 2.497 m



320-01-BH2209 FHT

Data Set: \...\320-01-BH2209 FHT_HVOR.aqt

Date: 11/15/18

Time: 14:10:08

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2209

AQUIFER DATA

Saturated Thickness: 0.1 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2209)

Initial Displacement: 8.821 m

Static Water Column Height: 0. m

Total Well Penetration Depth: 1. m

Screen Length: 1. m

Casing Radius: 0.025 m

Well Radius: 0.048 m

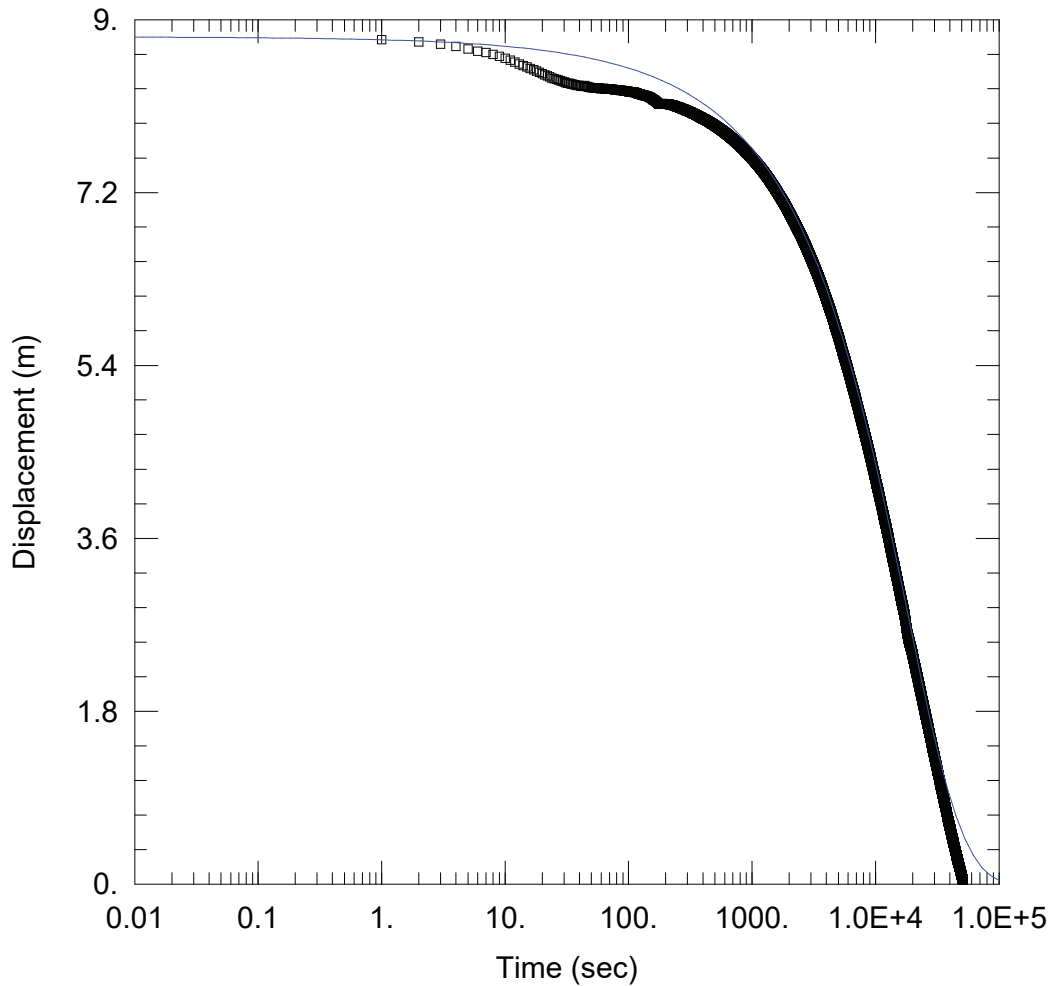
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 9.877E-7 m/sec

y0 = 7.985 m



WELL TEST ANALYSIS

Data Set: V:\...\320-01-BH2209 FHT_KGS.aqt

Date: 11/27/18

Time: 14:16:10

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2209

AQUIFER DATA

Saturated Thickness: 0.1 m

WELL DATA (320-01BH2209)

Initial Displacement: 8.821 m

Total Well Penetration Depth: 1. m

Casing Radius: 0.025 m

Static Water Column Height: 0. m

Screen Length: 1. m

Well Radius: 0.048 m

SOLUTION

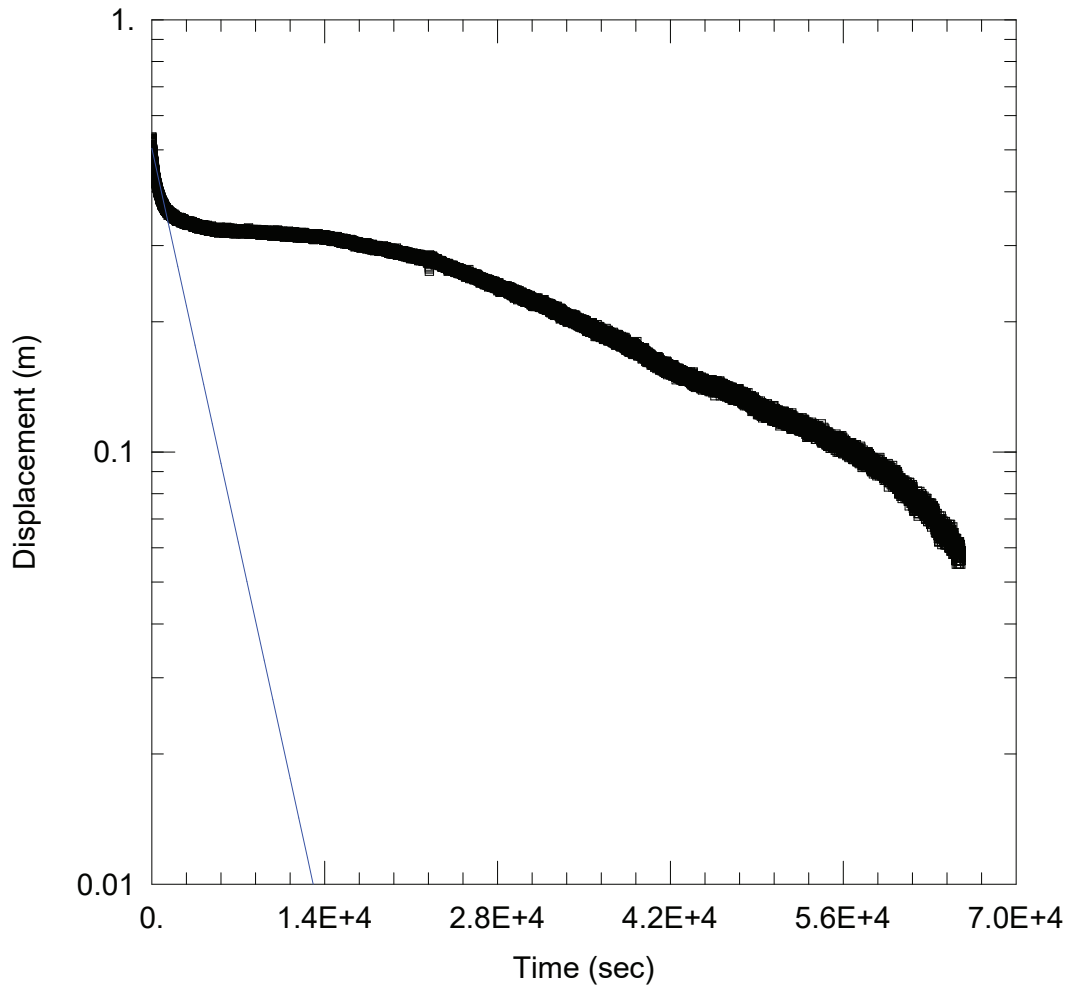
Aquifer Model: Unconfined

Kr = 1.431E-7 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.2735 m⁻¹



320-01-BH2212

Data Set: \...\320-01-BH2212 FHT_Hvor - SK.aqt

Date: 11/15/18

Time: 14:13:27

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2212

AQUIFER DATA

Saturated Thickness: 1. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2212)

Initial Displacement: 0.535 m

Static Water Column Height: 1. m

Total Well Penetration Depth: 1. m

Screen Length: 1. m

Casing Radius: 0.028 m

Well Radius: 0.048 m

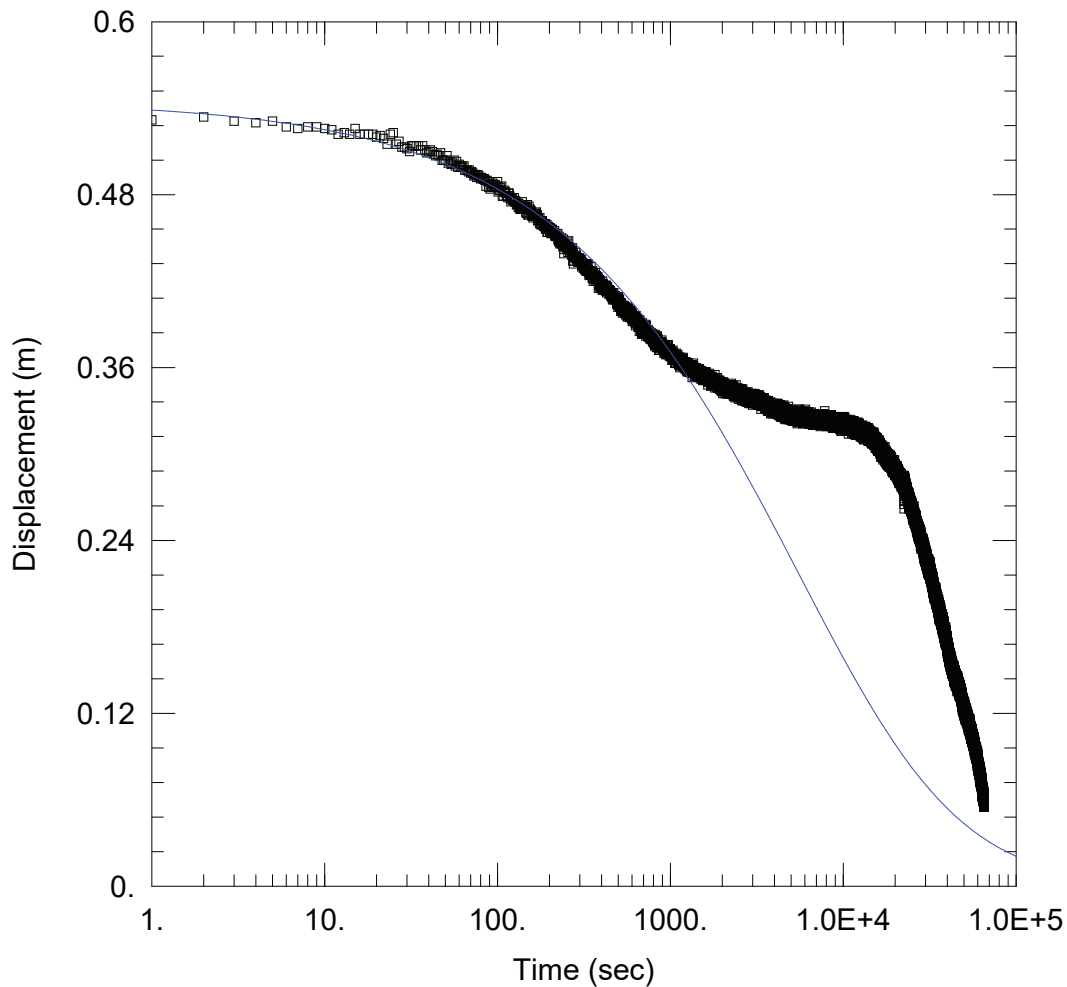
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 6.226E-7 m/sec

y0 = 0.5041 m



320-01-BH2212

Data Set: \...\320-01-BH2212 FHT_KGS - SK.aqt

Date: 11/15/18

Time: 14:17:22

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2212

AQUIFER DATA

Saturated Thickness: 1. m

WELL DATA (320-01-BH2212)

Initial Displacement: 0.545 m

Total Well Penetration Depth: 1. m

Casing Radius: 0.028 m

Static Water Column Height: 1. m

Screen Length: 1. m

Well Radius: 0.048 m

SOLUTION

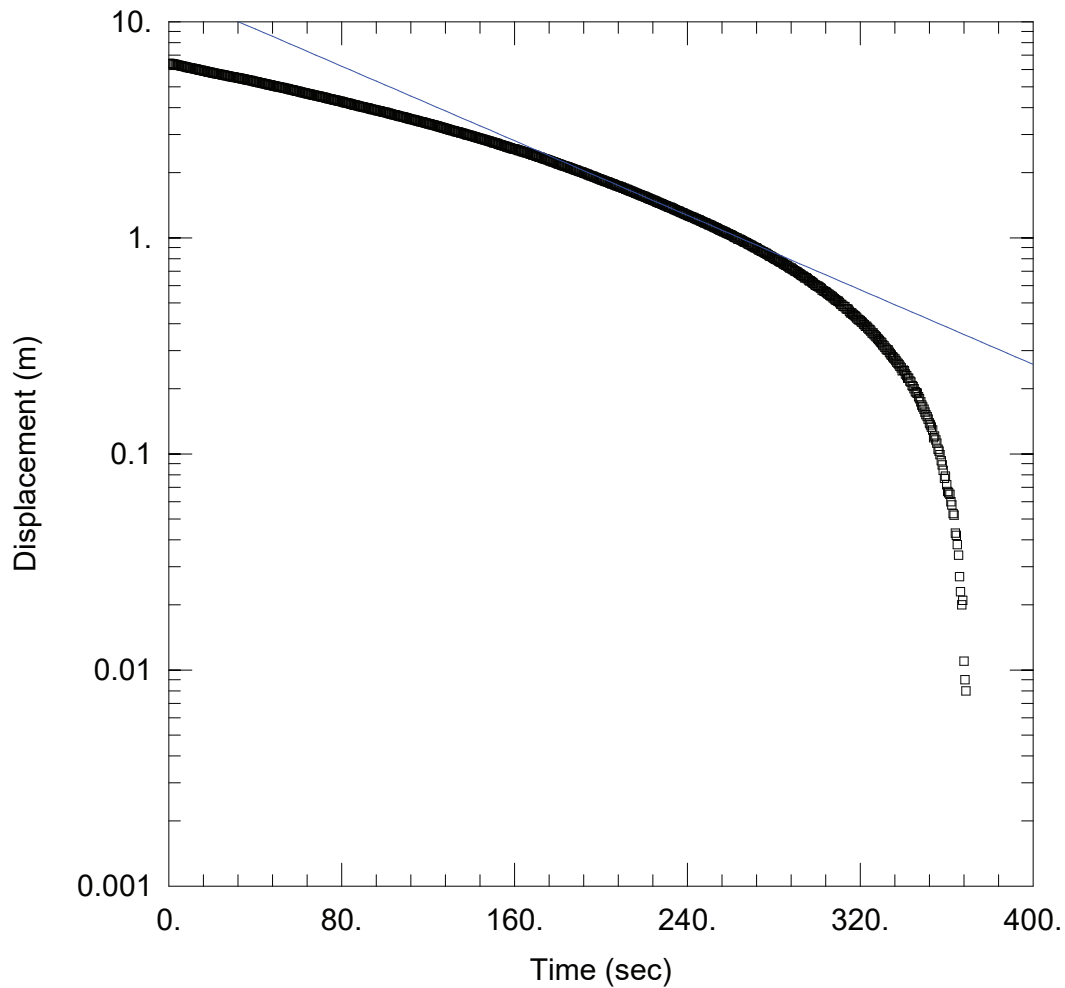
Aquifer Model: Unconfined

Kr = 4.509E-8 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.1578 m⁻¹



320-01-BH2215 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2215 FHT_HVOR.aqt

Date: 04/10/19

Time: 13:09:55

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2215

Test Date: 25/02/2019

AQUIFER DATA

Saturated Thickness: 0.2 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2215)

Initial Displacement: 6.41 m

Static Water Column Height: 0.2 m

Total Well Penetration Depth: 0.2 m

Screen Length: 0.2 m

Casing Radius: 0.025 m

Well Radius: 0.048 m

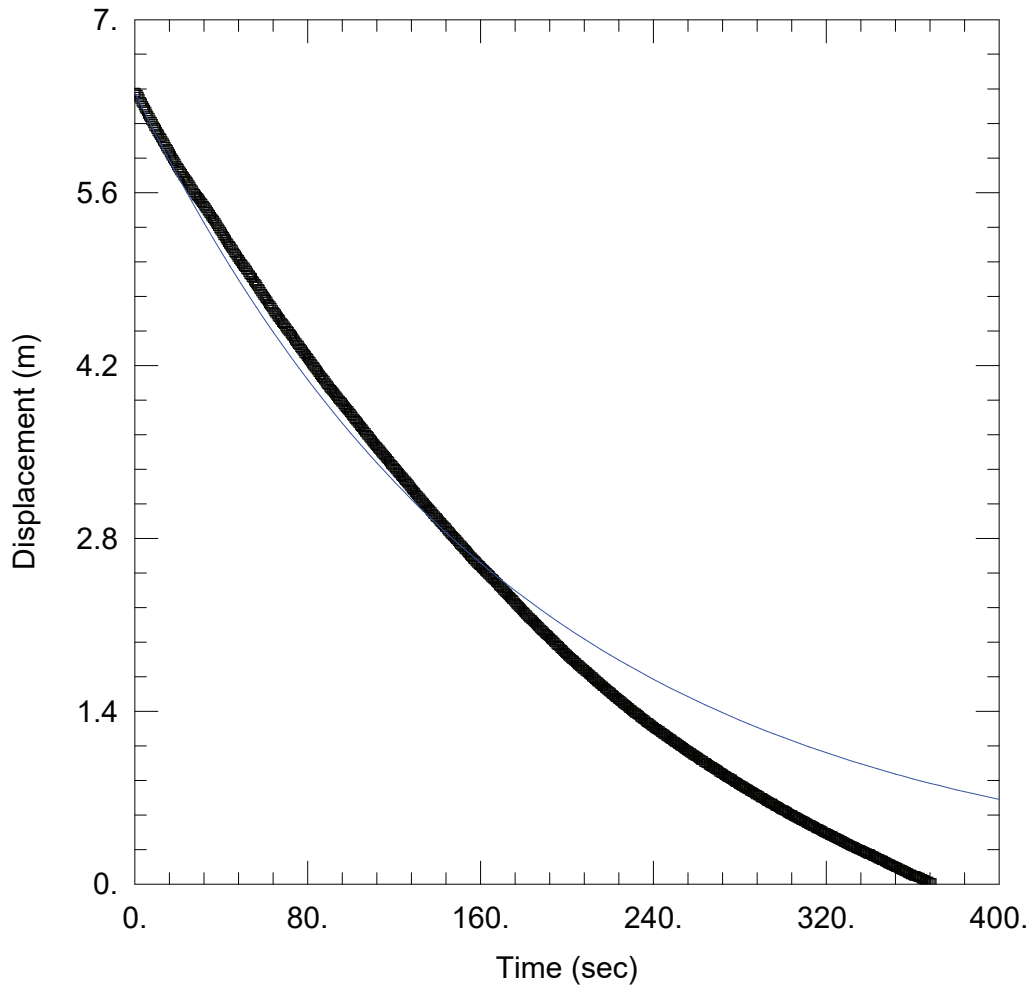
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 8.218E-5 m/sec

y0 = 13.77 m



320-01-BH2215 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2215 FHT_KGS.aqt

Date: 04/10/19

Time: 13:10:39

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2215

Test Date: 25/02/2019

AQUIFER DATA

Saturated Thickness: 0.2 m

WELL DATA (320-01-BH2215)

Initial Displacement: 6.41 m

Total Well Penetration Depth: 0.2 m

Casing Radius: 0.025 m

Static Water Column Height: 0.2 m

Screen Length: 0.2 m

Well Radius: 0.048 m

SOLUTION

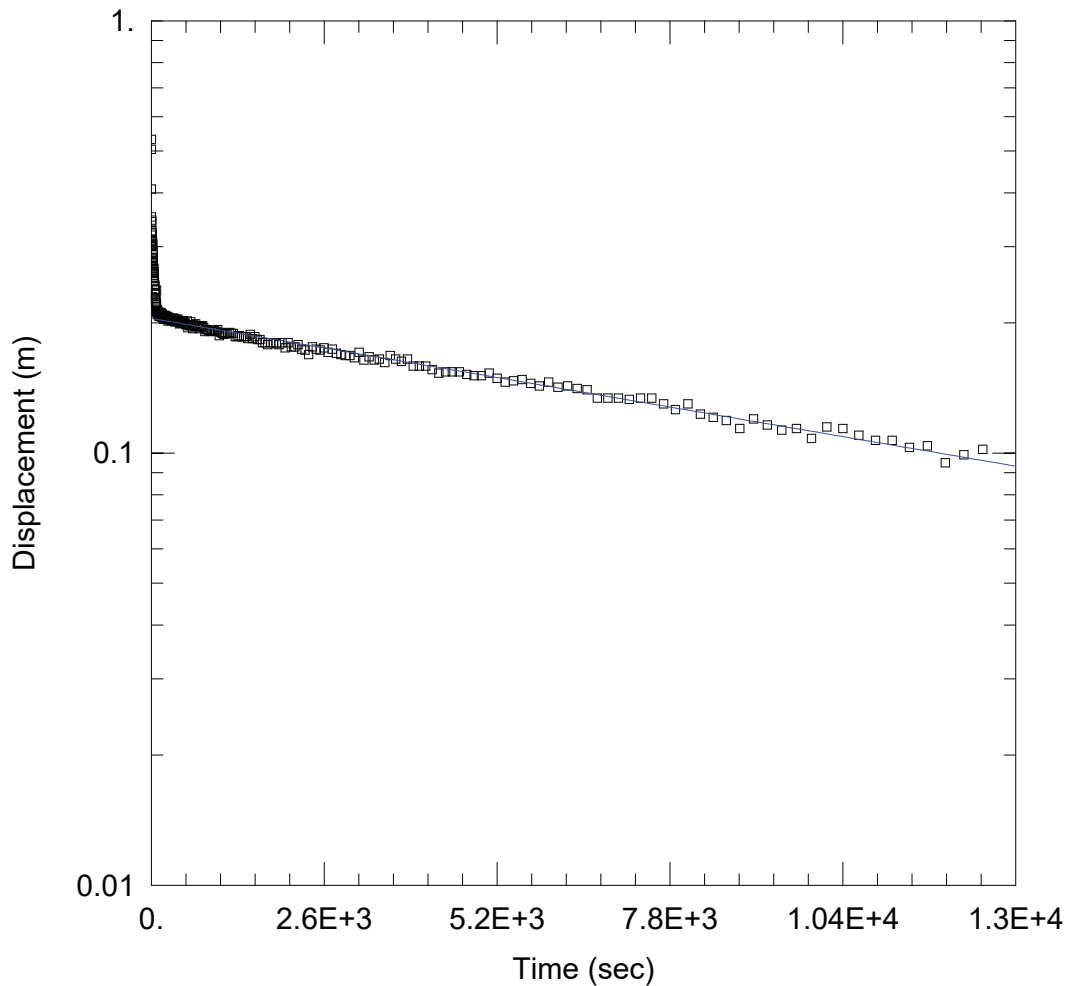
Aquifer Model: Unconfined

Kr = 1.014E-5 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 3.311E-7 m⁻¹



320-01-BH2216 (SLUG IN)

Data Set: V:\...\320-01-BH2216 FHT_HVOR.aqt

Date: 03/14/19

Time: 11:49:35

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2216

Test Date: 07/03/2019

AQUIFER DATA

Saturated Thickness: 6.6 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2216)

Initial Displacement: 0.532 m

Static Water Column Height: 6.6 m

Total Well Penetration Depth: 6.6 m

Screen Length: 6. m

Casing Radius: 0.025 m

Well Radius: 0.048 m

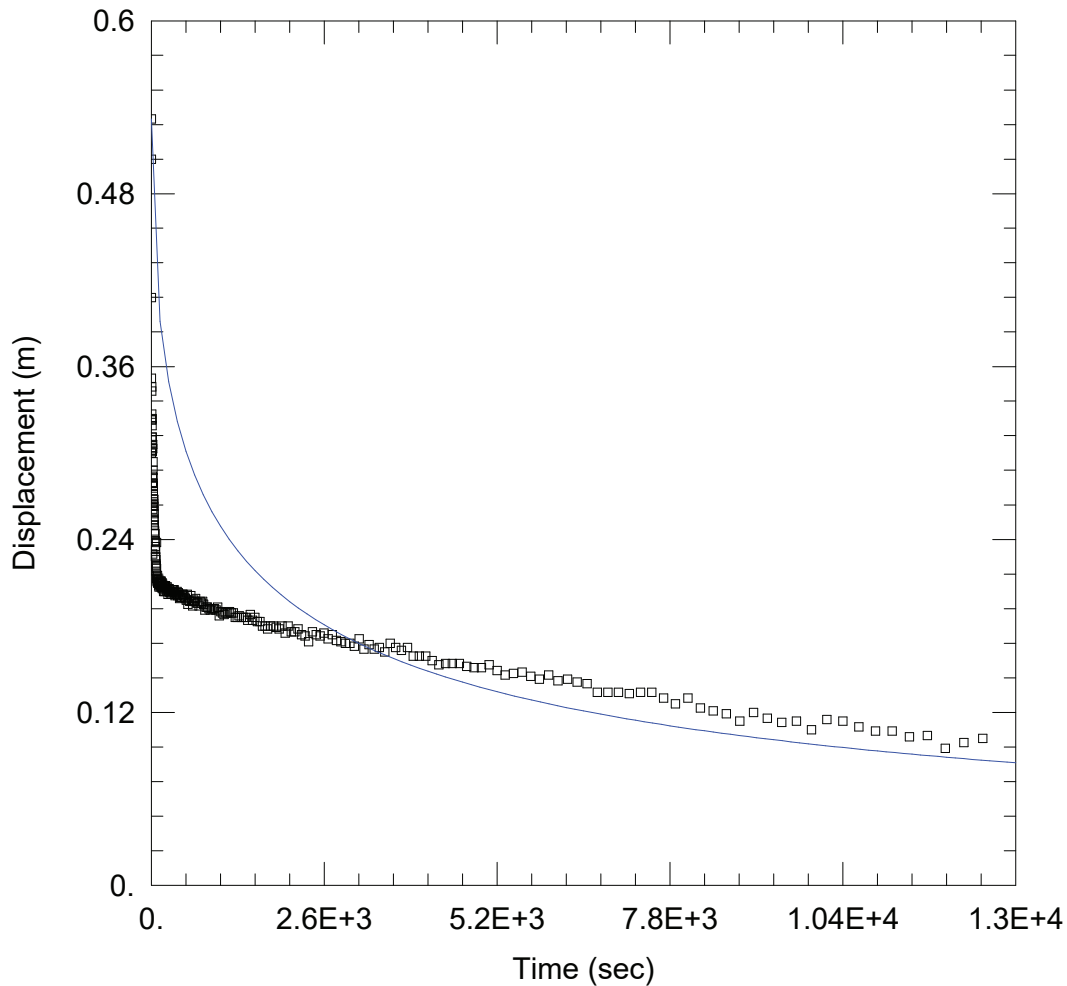
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 1.742E-8 m/sec

y0 = 0.2049 m



320-01-BH2216 (SLUG IN)

Data Set: V:\...\320-01-BH2216 FHT_KGS.aqt

Date: 03/14/19

Time: 11:50:53

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2216

Test Date: 07/03/2019

AQUIFER DATA

Saturated Thickness: 6.6 m

WELL DATA (320-01-BH2216)

Initial Displacement: 0.532 m

Total Well Penetration Depth: 6.6 m

Casing Radius: 0.025 m

Static Water Column Height: 6.6 m

Screen Length: 6. m

Well Radius: 0.048 m

SOLUTION

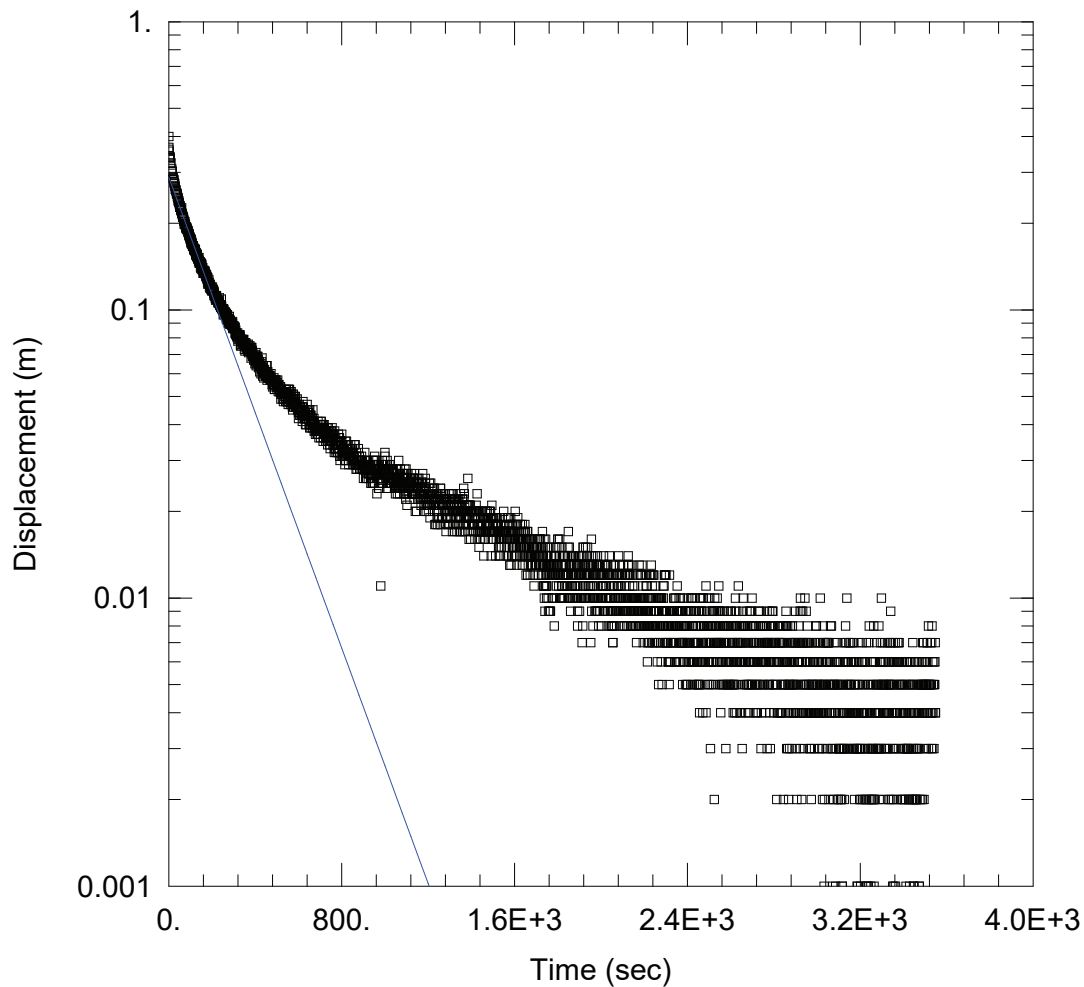
Aquifer Model: Unconfined

Kr = 2.675E-9 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.2932 m⁻¹



320-01-BH2217

Data Set: \...\320-01-BH2217 Slug in _HVOR.aqt

Date: 11/15/18

Time: 14:20:34

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2217

AQUIFER DATA

Saturated Thickness: 10.14 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (320-01-BH2217)

Initial Displacement: 0.4 m

Static Water Column Height: 10.14 m

Total Well Penetration Depth: 9. m

Screen Length: 9. m

Casing Radius: 0.025 m

Well Radius: 0.048 m

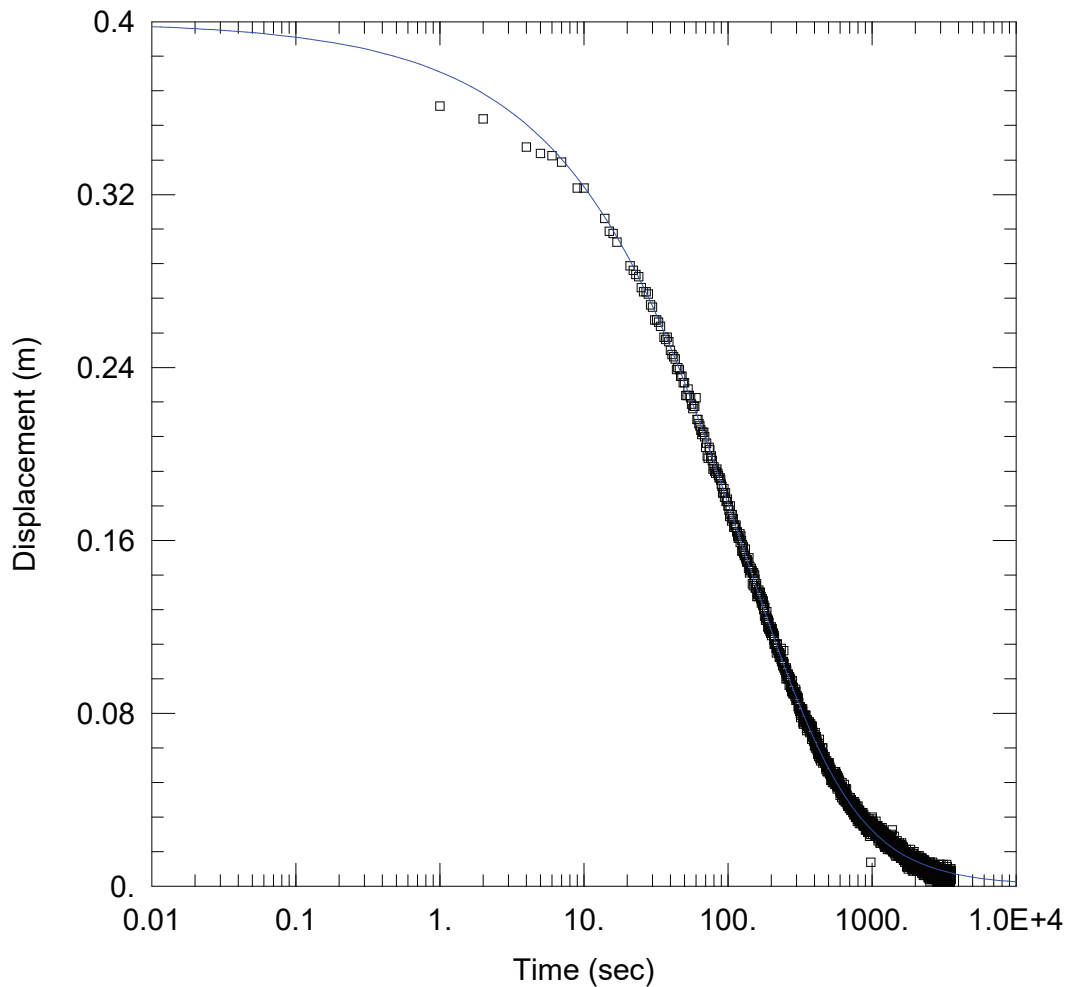
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

$K = 8.545E-7$ m/sec

$y_0 = 0.2883$ m



320-01-BH2217

Data Set: \...\320-01-BH2217 Slug in _KGS.aqt

Date: 11/15/18

Time: 14:22:48

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2217

AQUIFER DATA

Saturated Thickness: 10.14 m

WELL DATA (320-01-BH2217)

Initial Displacement: 0.4 m

Total Well Penetration Depth: 10.14 m

Casing Radius: 0.025 m

Static Water Column Height: 10.14 m

Screen Length: 9. m

Well Radius: 0.048 m

SOLUTION

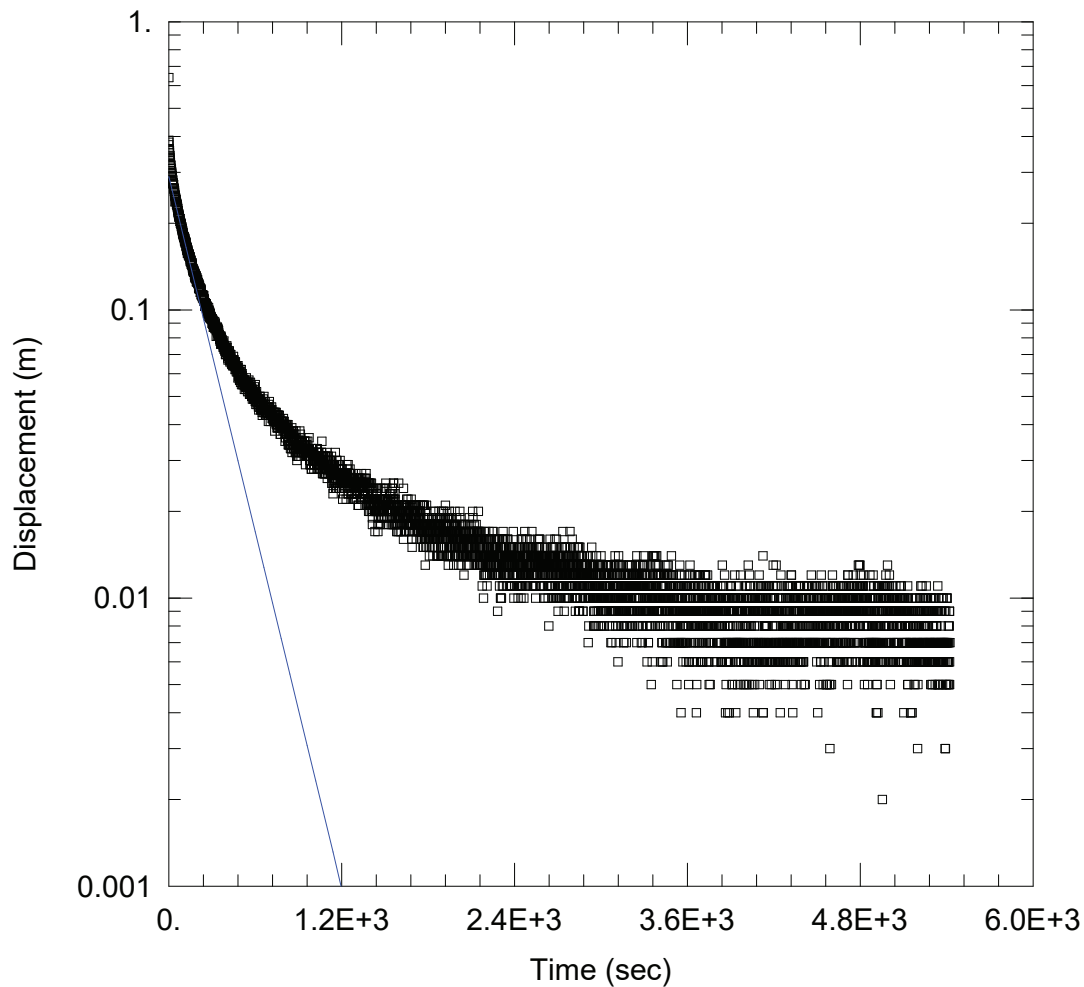
Aquifer Model: Unconfined

Kr = 3.513E-7 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 0.00363 m⁻¹



320-01-BH2217

Data Set: \...\320-01-BH2217 Slug out_HVOR.aqt

Date: 11/15/18

Time: 14:24:17

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2217

AQUIFER DATA

Saturated Thickness: 10.14 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (320-01-BH2217)

Initial Displacement: 0.64 m

Static Water Column Height: 10.14 m

Total Well Penetration Depth: 10.14 m

Screen Length: 9. m

Casing Radius: 0.025 m

Well Radius: 10.05 m

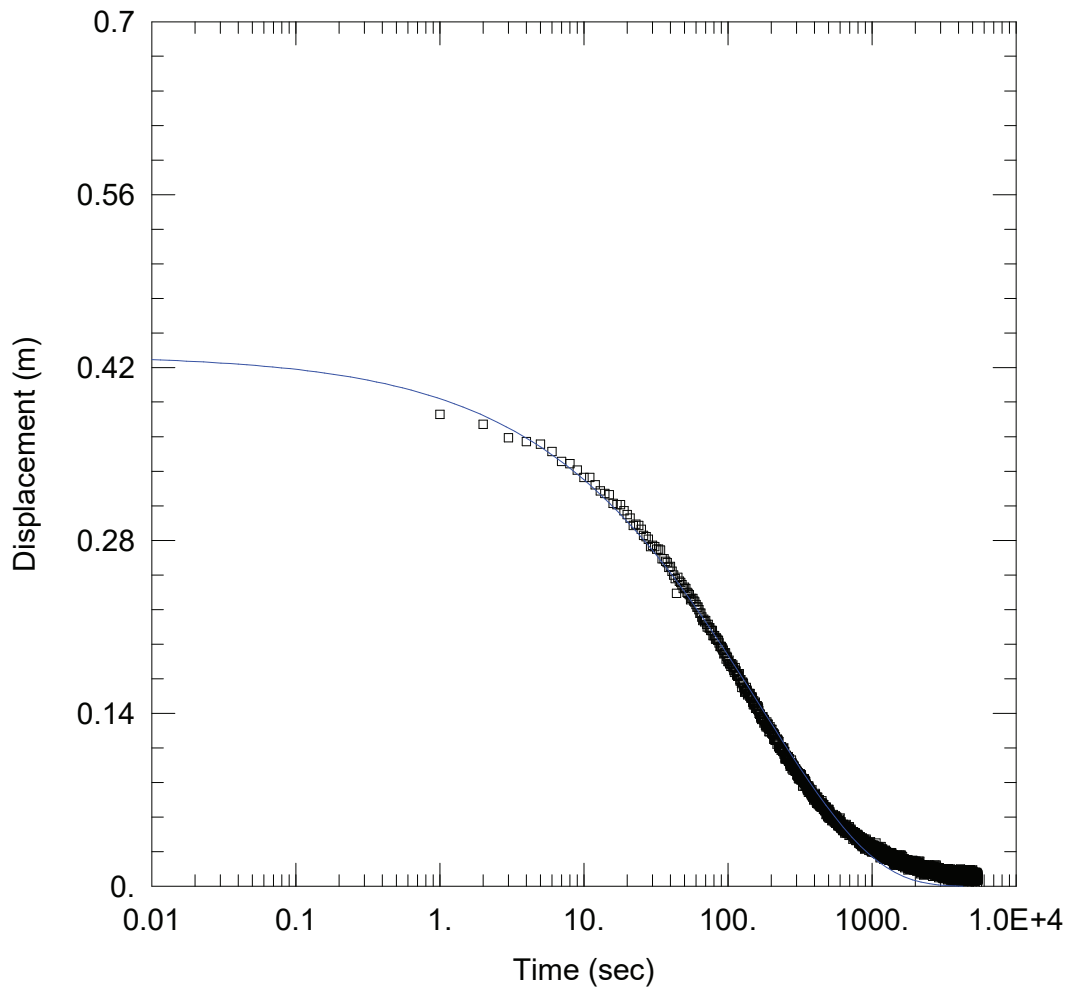
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

$K = 1.324E-7$ m/sec

$y_0 = 0.2901$ m



320-01-BH2217

Data Set: \...\320-01-BH2217 Slug out_KGS.aqt

Date: 11/15/18

Time: 14:26:37

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2217

AQUIFER DATA

Saturated Thickness: 10.14 m

WELL DATA (320-01-BH2217)

Initial Displacement: 0.43 m

Static Water Column Height: 10.14 m

Total Well Penetration Depth: 10.14 m

Screen Length: 9. m

Casing Radius: 0.025 m

Well Radius: 10.05 m

SOLUTION

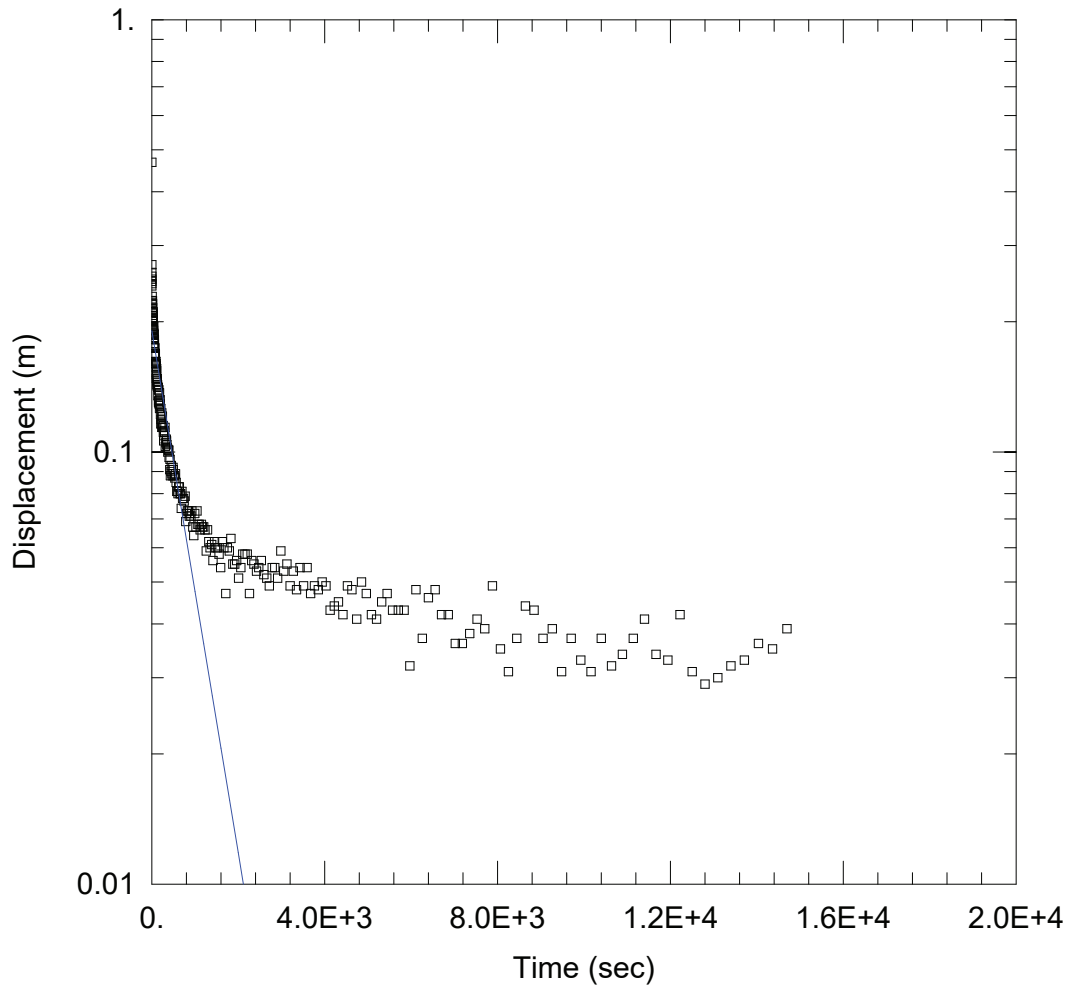
Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 6.741E-8 m/sec

Ss = 1.03E-6 m⁻¹

Kz/Kr = 1.



320-01-BH2218 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2218 FHT_HVOR.aqt

Date: 11/27/18

Time: 14:23:56

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2218

Test Date: 20/11/2018

AQUIFER DATA

Saturated Thickness: 7.5 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (320-01-BH2218)

Initial Displacement: 0.468 m

Static Water Column Height: 7.5 m

Total Well Penetration Depth: 7.5 m

Screen Length: 6. m

Casing Radius: 0.025 m

Well Radius: 10.05 m

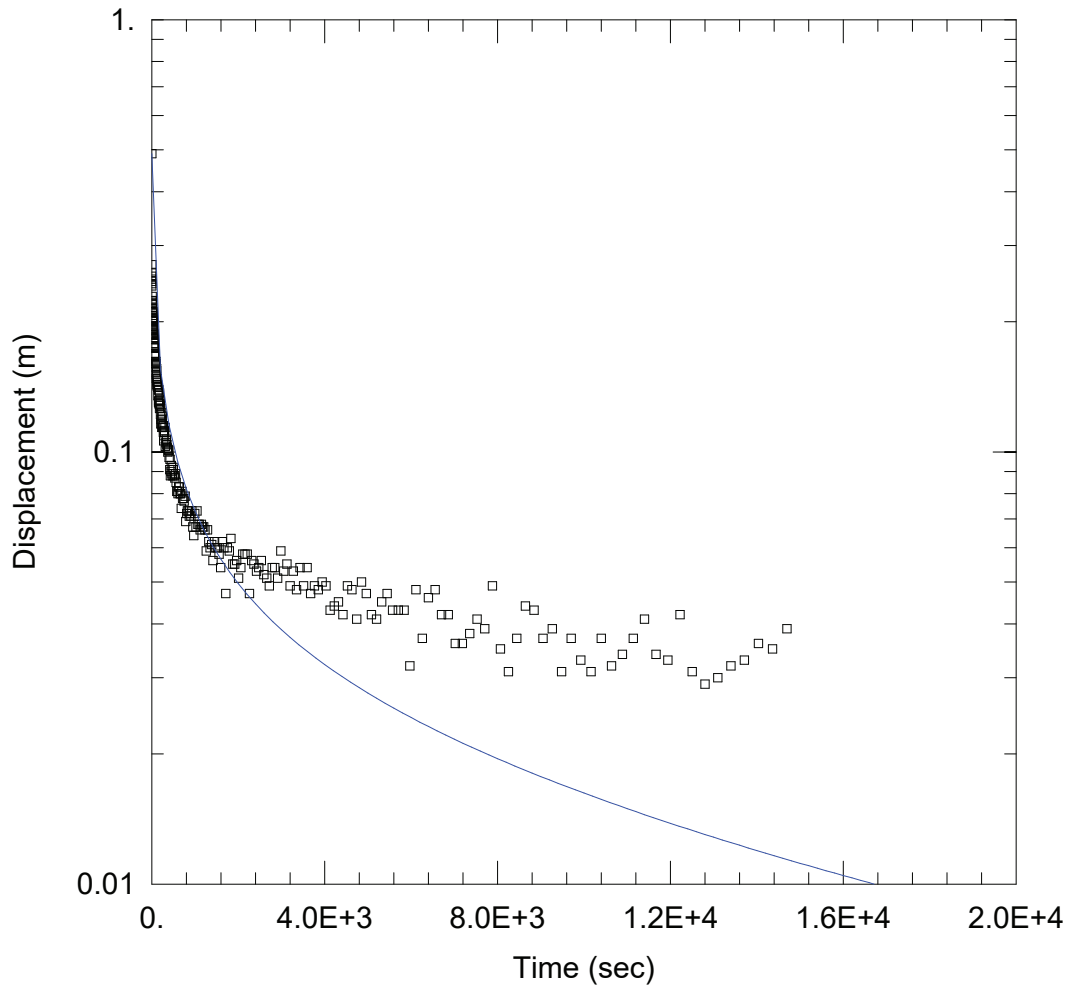
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 4.102E-8 m/sec

y0 = 0.1908 m



320-01-BH2218 (FALLING HEAD TEST)

Data Set: V:\...\320-01-BH2218 FHT_KGS.aqt

Date: 11/27/18

Time: 14:26:44

PROJECT INFORMATION

Company: Golder Associates

Client: FFJV

Project: 1893802

Test Well: 320-01-BH2218

Test Date: 20/11/2018

AQUIFER DATA

Saturated Thickness: 7.5 m

WELL DATA (320-01-BH2218)

Initial Displacement: 0.49 m

Total Well Penetration Depth: 7.5 m

Casing Radius: 0.025 m

Static Water Column Height: 7.5 m

Screen Length: 6. m

Well Radius: 10.05 m

SOLUTION

Aquifer Model: Unconfined

Kr = 1.334E-8 m/sec

Kz/Kr = 1.

Solution Method: KGS Model

Ss = 2.162E-5 m⁻¹

APPENDIX

W

Geotechnical

Appendix G Vibrating wire piezometer
calibration sheets

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT



VW Piezometer Calibration Certificate

Serial #: 1803844
 Range : 3500 kPa
 Cable Length: 140 m
 Date of Calibration: 11/14/2018

Part #: 52611050
 Cable Part # : 50613824
 Calibrated by: KB
 Note:

ABC Calibration Factors

	A	B	C
kPa	-6.044013E-4	-9.569014E-1	8.311351E+3
psi	-8.766100E-5	-1.387868E-1	1.205460E+3

Pressure in kPa/psi = (A x Hz²) + (B x Hz) + C, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	8.296855E+3	-9.511214E-1	6.037635E-1	-6.055243E-4	6.070409E-6	-9.885988E-3
psi	1.203315E+3	-1.379436E-1	8.756541E-2	-8.782078E-5	8.804074E-7	-1.433791E-3

Pressure in kPa/psi = C0 + (C1 x Hz) + (C2 x T) + (C3 x Hz²) + (C4 x Hz x T) + (C5 x T²)

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.

TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.

Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.2 °C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2999.9	1.5	0.22	-0.04
350.0	50.76	2922.8	351.3	50.95	-0.04
700.0	101.53	2844.6	698.7	101.34	0.04
1050.0	152.29	2764.3	1047.7	151.96	0.06
1400.0	203.05	2681.8	1398.2	202.80	0.05
1750.0	253.82	2597.1	1749.5	253.75	0.01
2100.0	304.58	2510.2	2100.9	304.72	-0.03
2450.0	355.34	2421.1	2451.8	355.60	-0.05
2800.0	406.11	2329.6	2802.1	406.40	-0.06
3150.0	456.87	2235.6	3151.4	457.07	-0.04
3500.0	507.63	2139.5	3497.4	507.28	0.07

VW Piezometer Calibration Certificate

Serial #: 1803845
 Range : 3500 kPa
 Cable Length: 280 m
 Date of Calibration: 11/14/2018

Part #: 52611050
 Cable Part #: 50613824
 Calibrated by: KB
 Note:

ABC Calibration Factors

	A	B	C
kPa	-8.314060E-4	4.733899E-1	5.682691E+3
psi	-1.205853E-4	6.865940E-2	8.242047E+2

Pressure in kPa/psi = (A x Hz²) + (B x Hz) + C, where Hz is frequency in Hertz.

TI Calibration Factors

	C0	C1	C2	C3	C4	C5
kPa	5.676418E+3	4.702452E-1	8.042299E-1	-8.306168E-4	-3.364994E-5	-7.939171E-3
psi	8.232658E+2	6.820090E-2	1.166396E-1	-1.204665E-4	-4.880339E-6	-1.151439E-3

Pressure in kPa/psi = C0 + (C1 x Hz) + (C2 x T) + (C3 x Hz²) + (C4 x Hz x T) + (C5 x T²)

Where Hz is the frequency reading in Hertz and T is the Thermistor reading in degrees C.
 TI factors are calculated from temperatures at 5.0, 15.0 and 25.0 degrees C.
 Applied pressure and temperature are NIST traceable.

Summary of Test Results at 15°C

Thermistor reading is 15.3°C.

Applied Pressure is referenced to 1 atm. Calculated Pressure uses ABC Calibration factors.

Applied (kPa)	Equivalent (psi)	Frequency (Hz)	Calculated (kPa)	Calculated (psi)	Error (%FS)
0.0	0.00	2914.6	-0.3	-0.04	0.01
350.0	50.76	2833.0	351.0	50.91	-0.03
700.0	101.53	2749.3	699.9	101.51	0.00
1050.0	152.29	2662.5	1049.3	152.19	0.02
1400.0	203.05	2572.3	1399.2	202.94	0.02
1750.0	253.82	2478.2	1749.8	253.79	0.01
2100.0	304.58	2380.0	2099.9	304.57	0.00
2450.0	355.34	2276.9	2450.3	355.39	-0.01
2800.0	406.11	2168.1	2800.9	406.23	-0.03
3150.0	456.87	2053.0	3150.3	456.92	-0.01
3500.0	507.63	1930.1	3499.2	507.51	0.02

SLOPE INDICATOR

Calibration Record

V-Logger



Part Number: 52615140

Serial Number: 1832651

Specification

Frequency Accuracy: \pm (0.002% of Reading +0.04Hz)
Temperature Accuracy: \pm .5 °C

Frequency Generator

Calibration Standard: <u>Agilent 33210A</u>	Serial Number: <u>20-78-SI</u>
Calibrator Re-Certification Due: <u>Feb. 9th, 2019</u>	

Temperature Resistance

Calibration Standard: <u>Shallcross Decade</u>	Serial Number: <u>20-15-SI</u>
Calibrator Re-Certification Due: <u>Feb. 15th, 2020</u>	

	<i>INPUT (Hz)</i>	<i>ACCEPTABLE RESPONSE (Hz)</i>	<i>ACTUAL RESPONSE (Hz)</i>	
FREQUENCY	450.000	449.951 to 450.049	449.998	
	1000.000	999.940 to 1000.060	999.991	
	2000.000	1999.920 to 2000.080	1999.976	
	3000.000	2999.900 to 3000.100	2999.964	
	4000.000	3999.880 to 4000.120	3999.952	
	5000.000	4999.860 to 5000.140	4999.943	
	6000.000	5999.840 to 6000.160	5999.927	
	<i>INPUT (Ω)</i>	<i>IDEAL RESPONSE (°C)</i>	<i>ACCEPTABLE RESPONSE (°C)</i>	<i>ACTUAL RESPONSE (°C)</i>
TEMPERATURE RTD	1715	-20.0	-20.5 to -19.5	-19.9
	2076	30.0	29.5 to 30.5	30.3
	2482	80.0	79.5 to 80.5	80.2
THERMISTOR	29142	-20.0	-20.5 to -19.5	-20.1
	2416	30.0	29.5 to 30.5	29.9
	377	80.0	79.5 to 80.5	80.0

This Certificate confirms that the equipment listed above has been calibrated in accordance with the manufacturer's specifications with calibration standards that are traceable to the National Institute of Standards and Technology (NIST).

Calibrated By: TQL

Date: November 8th, 2018

APPENDIX

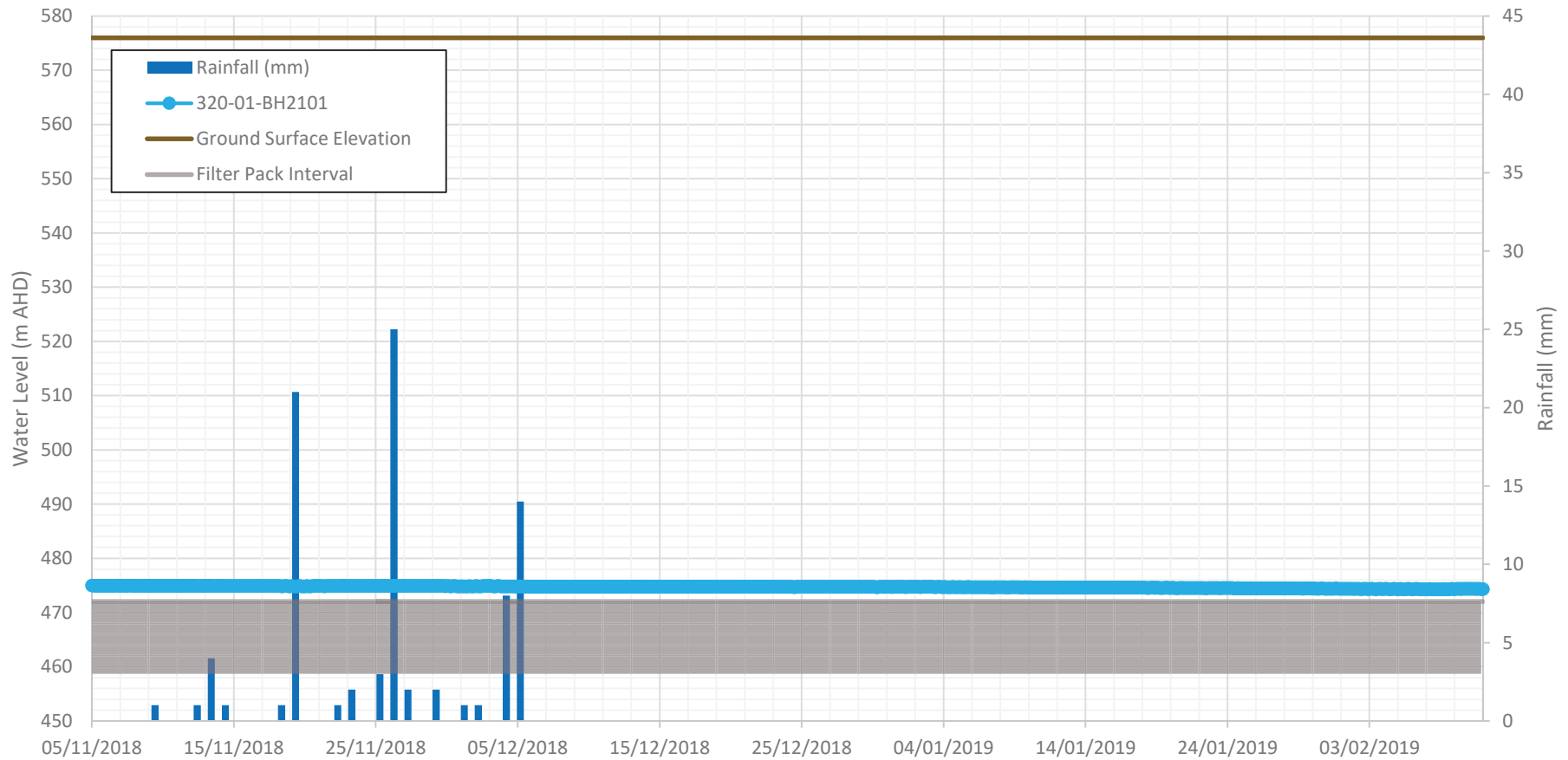
W

Geotechnical

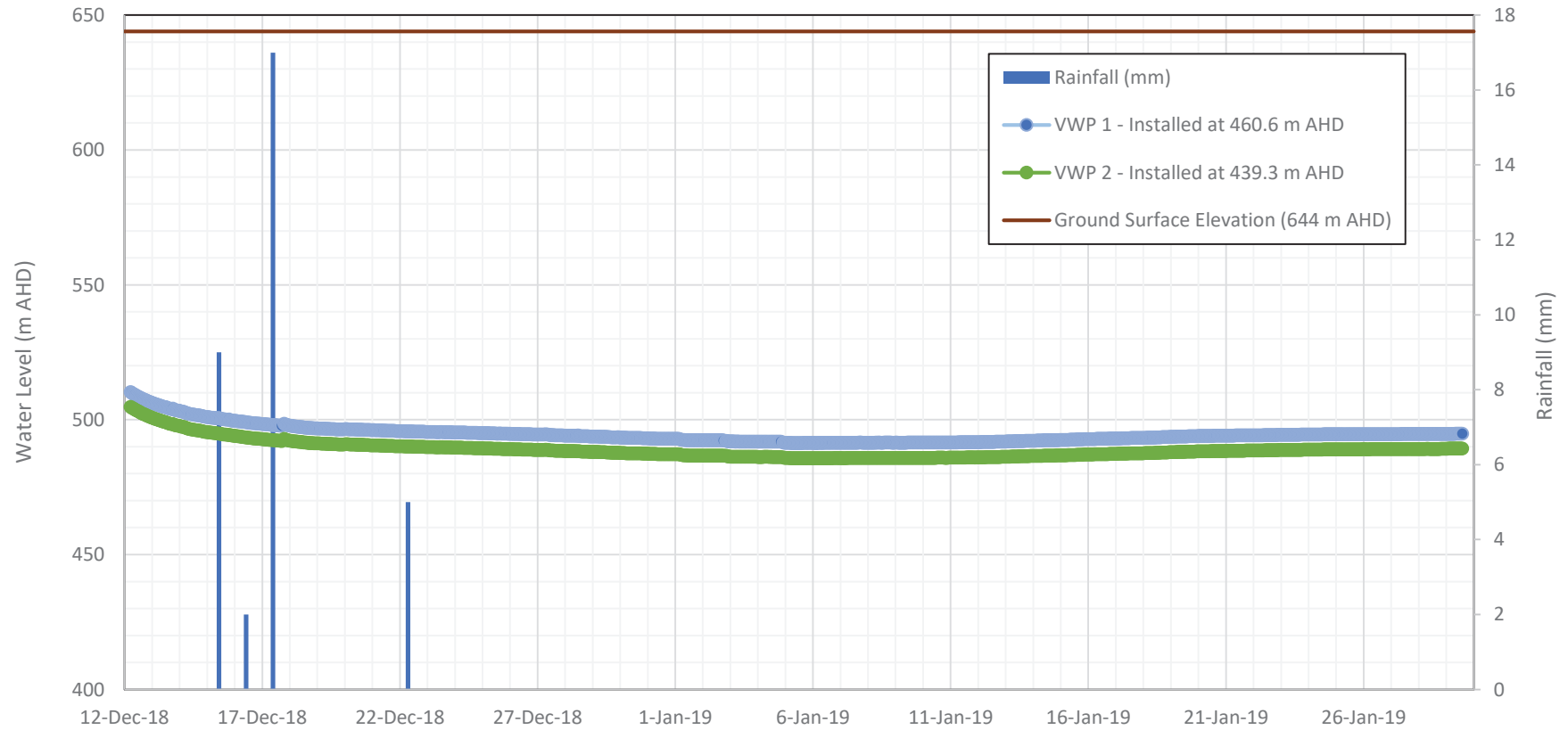
Appendix H Hydrographs

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT

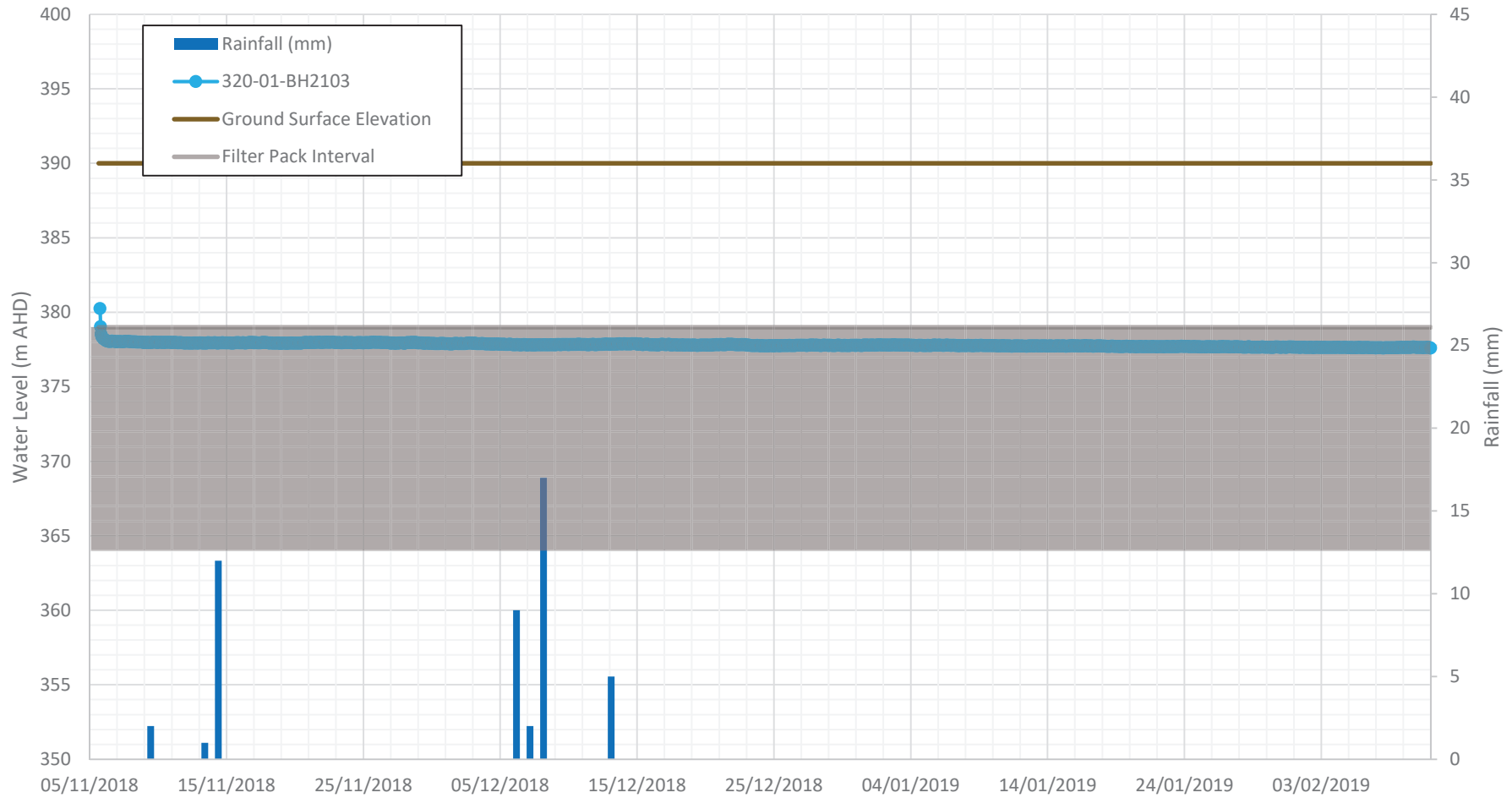




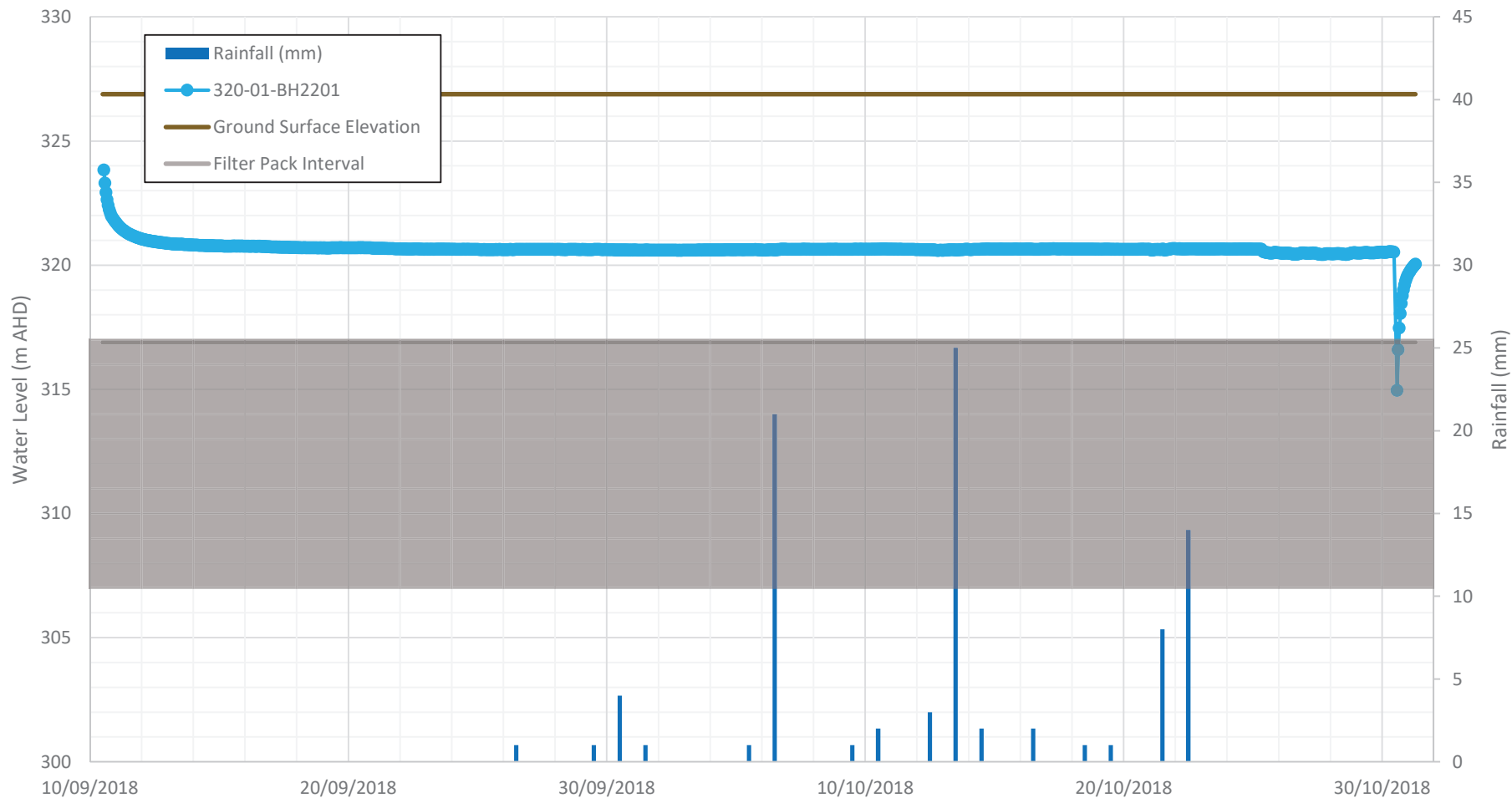
CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2101 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.1	REV No 3	A4



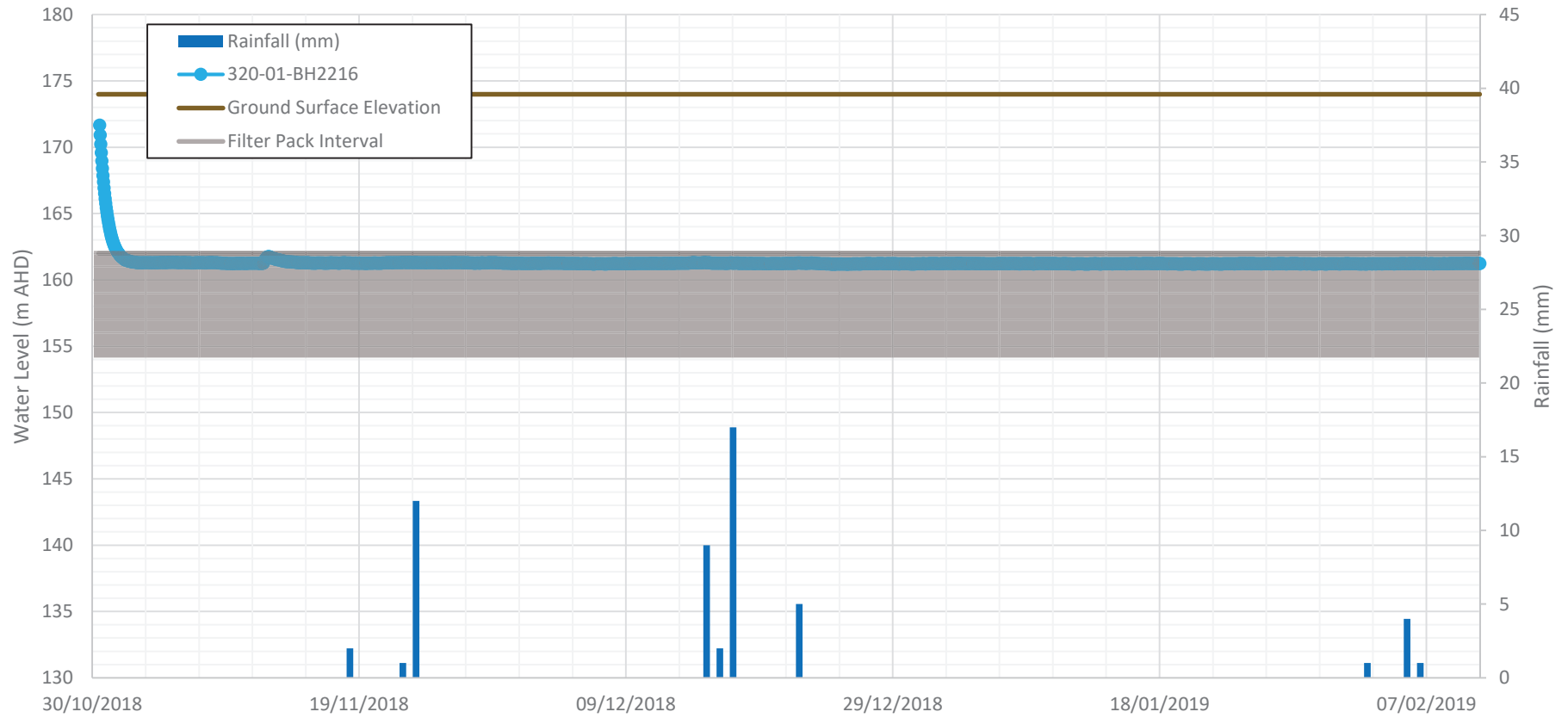
CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2102 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.2	REV No 3	A4



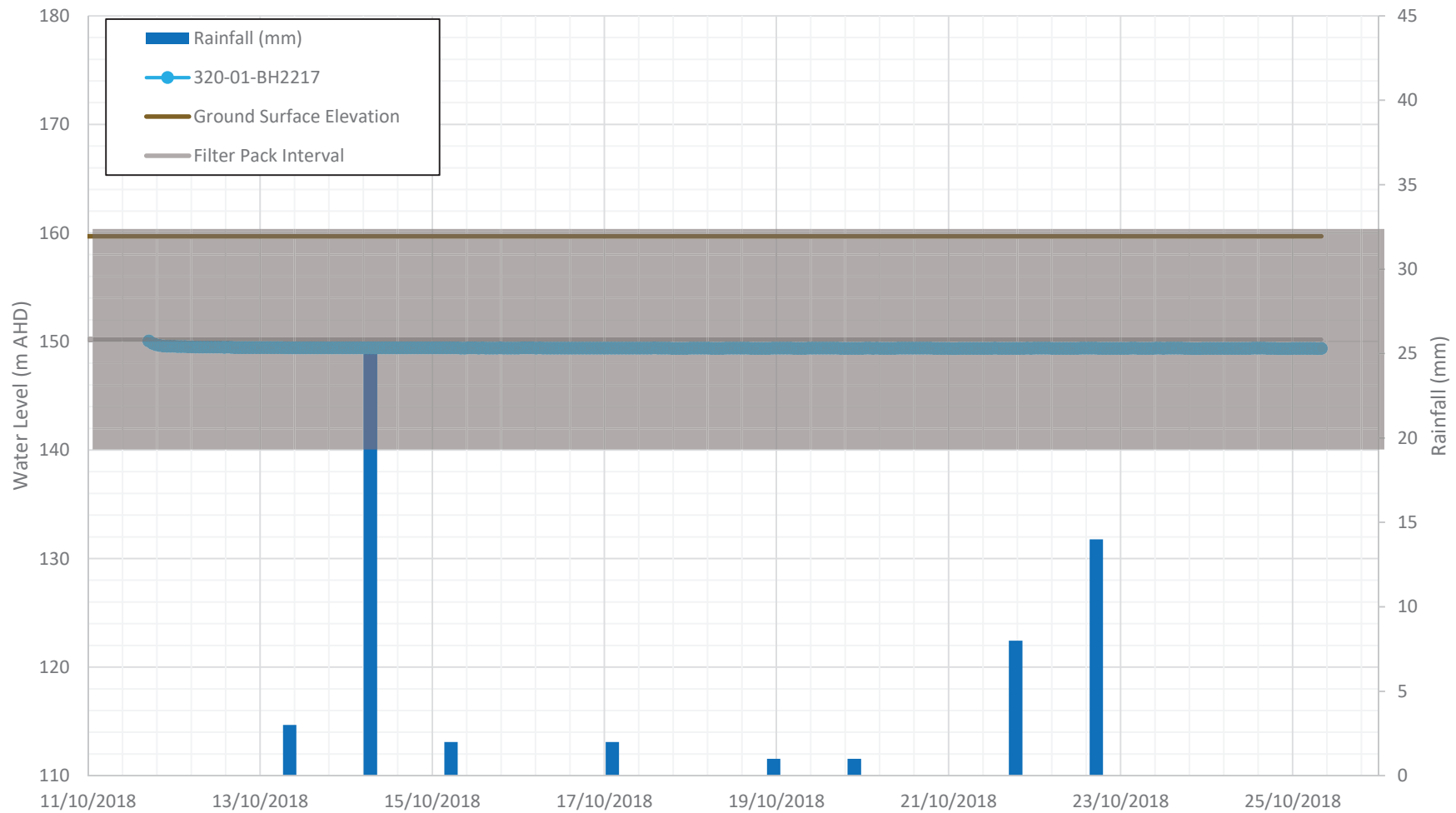
CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2103 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.3	REV No 3	A4



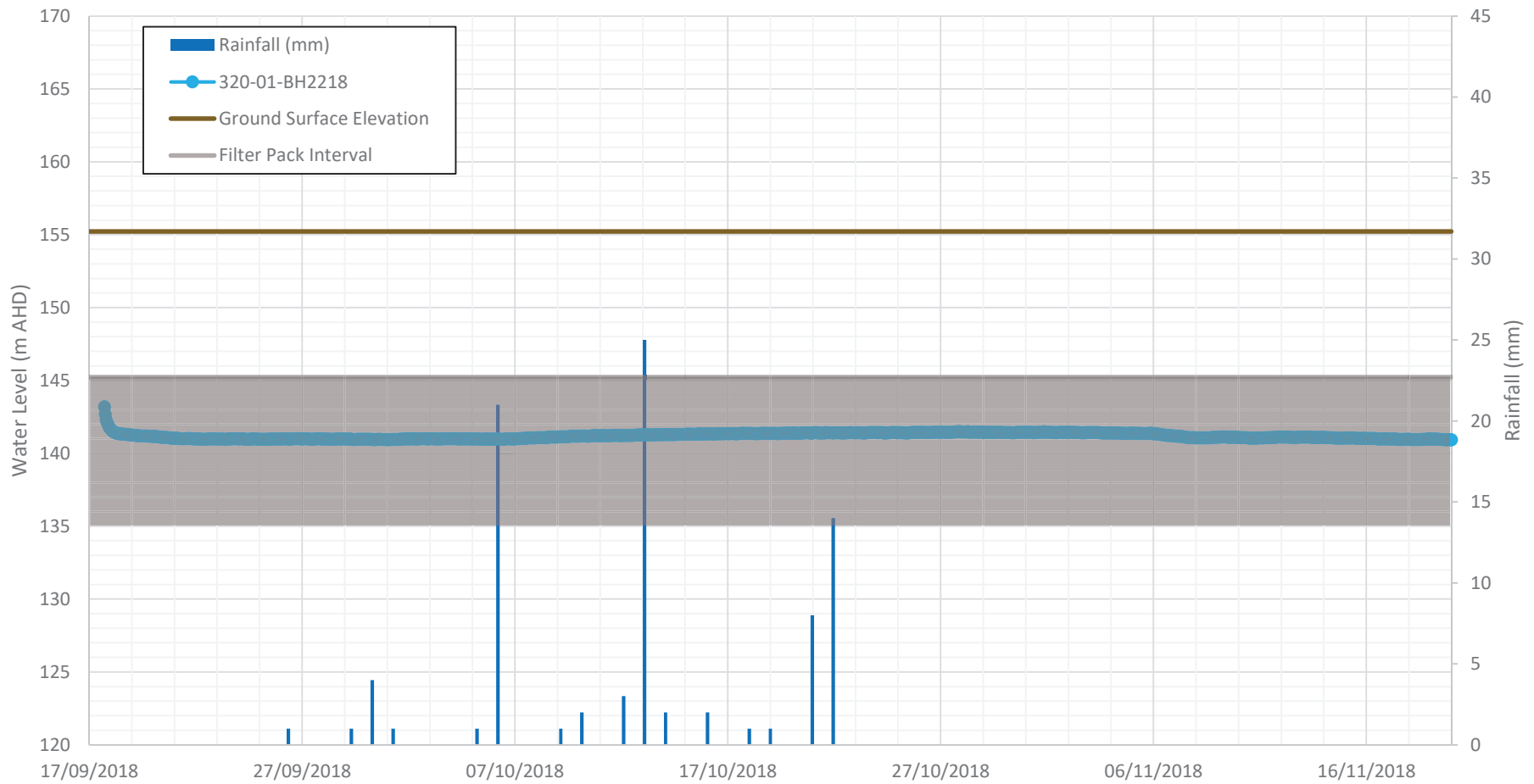
CLIENT	FFJV		PROJECT	Inland Rail – G2H					
DRAWN	SK	DATE	12/03/19	TITLE 320-01-BH2201 Hydrograph					
CHECKED	DB	DATE	12/03/19						
SCALE	Not to Scale		PROJECT No	1893795	FIGURE No	H1.4	REV No	3	A4



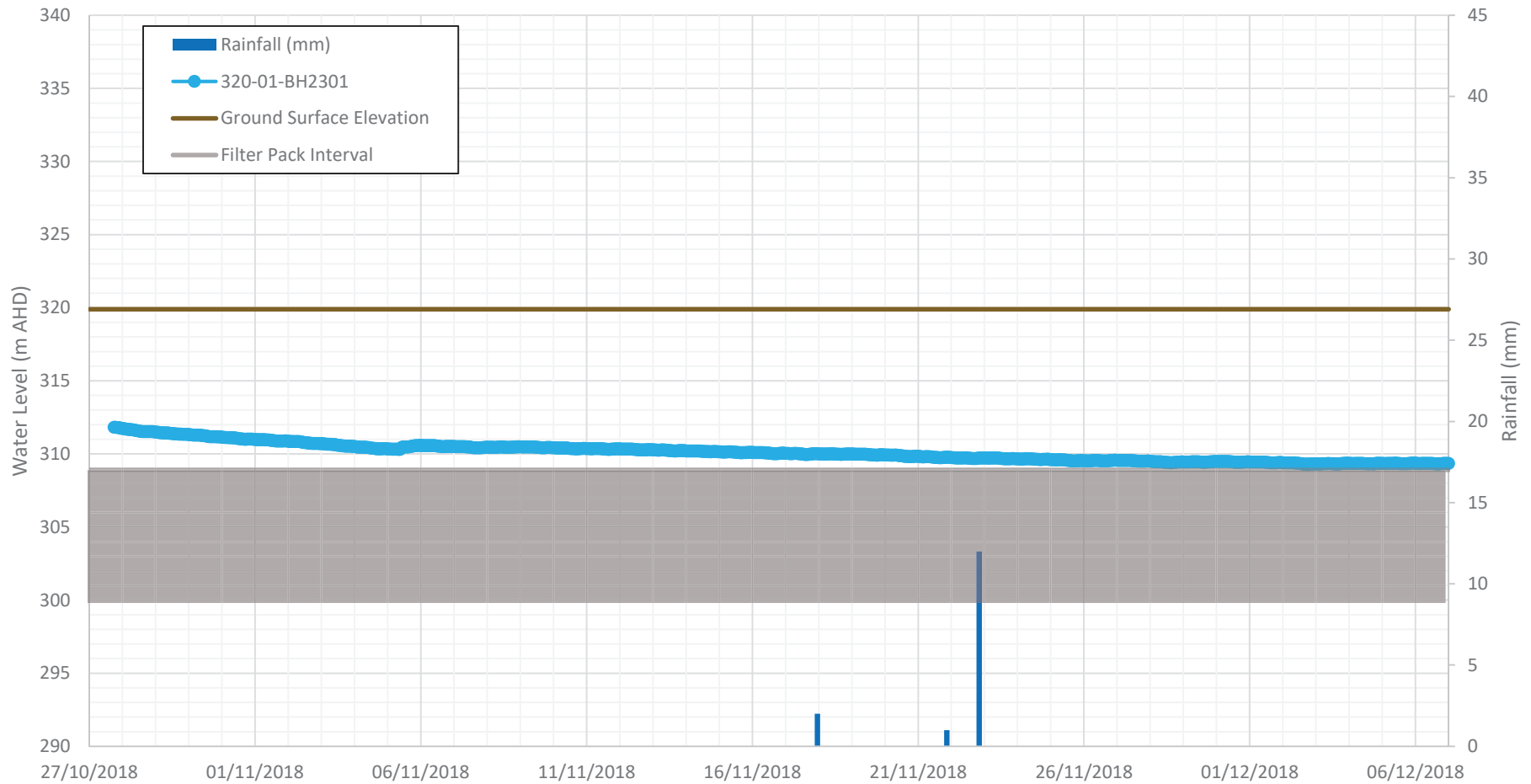
CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2216 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.5	REV No 3	A4



CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2217 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.6	REV No 3	A4



CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2218 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.7	REV No 3	A4



CLIENT FFJV		PROJECT Inland Rail – G2H			
DRAWN SK	DATE 12/03/19	TITLE 320-01-BH2301 Hydrograph			
CHECKED DB	DATE 12/03/19				
SCALE Not to Scale		PROJECT No 1893795	FIGURE No H1.8	REV No 3	A4

APPENDIX

W

Geotechnical

Appendix I Groundwater
laboratory reports

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT





		Heavy Metals																			
		Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium	Chromium (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL		0.001	0.001	0.001	0.001	0.001	0.001	0.05	0.05	0.0001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.05	0.05	0.001	0.001
Borehole ID	Sampled Date	0.004	0.003	0.756	0.748	<0.001	<0.001	<0.05	0.06	0.0001	<0.0001	0.003	0.003	<0.001	<0.001	0.003	0.002	0.31	0.17	<0.001	<0.001
320-01-BH2101	13/09/2018	0.001	0.001	0.145	0.111	<0.001	<0.001	<0.05	<0.05	<0.0001	<0.0001	0.002	<0.001	0.005	0.004	0.002	<0.001	1.42	0.11	<0.001	<0.001
320-01-BH2103	11/02/2019	0.007	0.005	0.314	0.238	<0.001	<0.001	0.22	0.22	<0.0001	<0.0001	0.005	<0.001	0.005	<0.001	0.008	<0.001	6.72	0.76	0.005	<0.001
320-01-BH2201	30/10/2018	0.01	0.007	0.625	0.488	<0.001	<0.001	0.29	0.31	<0.0001	<0.0001	0.006	<0.001	0.009	0.002	0.01	<0.001	4.08	<0.05	0.008	<0.001
320-01-BH2216	26/02/2019	0.036	0.035	0.383	0.309	<0.001	<0.001	0.42	0.42	<0.0001	<0.0001	0.005	<0.001	0.028	0.017	0.043	<0.001	2.24	0.34	0.012	<0.001
320-01-BH2217	30/10/2018	0.028	0.004	0.611	0.182	0.009	0.002	0.39	0.4	0.0005	<0.0001	0.113	0.008	0.126	0.005	0.288	0.004	-	-	0.172	0.007
320-01-BH2218	22/11/2018	0.685	0.003	28.3	0.124	0.1	<0.001	0.4	0.08	0.0564	<0.0001	0.488	<0.001	1.7	0.002	-	-	2020	<0.05	2.31	<0.001
320-01-BH2301	07/12/2018																				



													Other								
Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)	Sodium Absorption Ratio	Sodium Absorption Ratio (Filtered)	Electrical Conductivity @ 25°C	pH (Lab)	Total Dissolved Solids @180°C	Sodium (Filtered)	Potassium (Filtered)	Calcium (Filtered)		
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	-	-	uS/cm	pH Units	mg/L	mg/L	mg/L	mg/L		
EQL	0.001	0.001	0.0001	0.0001	0.001	0.01	0.01	0.01	0.01	0.005	0.005	0.01	0.01	1	0.01	10					
Borehole ID	Sampled Date																				
320-01-BH2101	13/09/2018	0.002	<0.001	<0.0001	<0.0001	0.003	0.002	<0.01	<0.01	0.04	0.04	<0.005	0.005	3.58	-	3040	12	985	174	58	178
320-01-BH2103	11/02/2019	0.493	0.467	<0.0001	<0.0001	0.005	0.005	<0.01	<0.01	<0.01	<0.01	0.009	0.01	-	1.77	1460	7.72	921	94	1	78
320-01-BH2201	30/10/2018	0.101	0.029	<0.0001	<0.0001	0.015	0.009	<0.01	<0.01	<0.01	<0.01	0.023	<0.005	-	9.81	2640	8.04	1570	442	7	101
320-01-BH2216	26/02/2019	0.11	0.031	<0.0001	<0.0001	0.01	0.006	<0.01	<0.01	<0.01	<0.01	0.027	<0.005	-	25.1	2800	7.78	1770	612	18	22
320-01-BH2217	30/10/2018	0.077	0.054	<0.0001	<0.0001	0.029	0.018	<0.01	<0.01	0.01	<0.01	0.044	0.01	-	21.7	2080	7.72	1300	461	19	21
320-01-BH2218	22/11/2018	0.458	0.04	<0.0001	<0.0001	0.169	0.008	<0.01	<0.01	0.28	0.02	0.423	0.054	-	21.4	1210	7.17	1160	257	12	6
320-01-BH2301	07/12/2018	70.9	0.073	<0.001	<0.0001	1.71	0.003	<0.1	<0.01	1.24	<0.01	12.2	0.014	-	23.7	5690	8.22	3420	974	12	83



Sample Quality Parameters																				
Magnesium (Filtered)	Chloride	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Ammonia (as N)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Total)	Fluoride	Reactive Phosphorus (as P)	Total Phosphorus (as P)	Total Anions	Total Cations	Ionic Balance (Lab)	Hardness (as CaCO3) (Filtered)	
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	mg/L	
EQL	1		1	1	1	1	0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.01	0.01	0.01	0.01	0.01	0.01	

Borehole ID	Sampled Date	<1	87	77	<1	92	562	654	0.02	<0.01	0.02	4.59	4.5	4.5	0.3	<0.01	0.02	17.1	17.9	2.31	444
320-01-BH2101	13/09/2018	<1	87	77	<1	92	562	654	0.02	<0.01	0.02	4.59	4.5	4.5	0.3	<0.01	0.02	17.1	17.9	2.31	444
320-01-BH2103	11/02/2019	82	229	34	430	<1	<1	430	0.08	<0.01	0.08	0.89	9.1	9.2	0.2	0.01	0.02	15.8	14.8	3.29	532
320-01-BH2201	30/10/2018	32	403	18	830	<1	<1	830	<0.01	<0.01	<0.01	0.43	1.1	1.1	0.4	<0.01	0.09	28.3	27.1	2.25	384
320-01-BH2216	26/02/2019	14	321	4	1020	<1	<1	1020	0.06	<0.01	0.06	0.21	0.7	0.8	-	<0.01	0.14	29.5	29.3	0.32	-
320-01-BH2217	30/10/2018	8	164	7	893	<1	<1	893	<0.01	<0.01	<0.01	0.06	0.2	0.2	1.8	0.01	0.17	22.6	22.2	0.82	85
320-01-BH2218	22/11/2018	3	126	2	421	<1	<1	421	0.16	<0.01	0.16	0.24	3	3.2	0.8	<0.01	2.41	12	12	0.1	27
320-01-BH2301	07/12/2018	27	1450	323	209	<1	<1	209	0.07	<0.01	0.07	0.68	49.3	49.4	-	<0.01	127	51.8	49	2.74	-



CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5065
Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 48 Callemondah Drive Gladstone QLD 4680
Ph: 07 4978 7944 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171
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Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

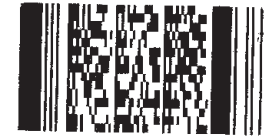
TOWNSVILLE 14-15 Desma Court Bohle QLD 4818

ALS logo

Environmental Division
Brisbane

Work Order Reference
EB1826458

N/A
N/A



Telephone : + 61-7-3243 7222

CLIENT: **GOLDER ASSOCIATES PTY LTD** TURNAROUND REQUIREMENTS: Standard TAT (List due date): Non Standard or urgent TAT (List due date):

OFFICE: **BRISBANE** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)

PROJECT: **INLAND RAIL (PIZ)** PROJECT NO.: **1829** ALS QUOTE NO.: _____

ORDER NUMBER: _____ PURCHASE ORDER NO: **1893196** COUNTRY OF ORIGIN: _____

PROJECT MANAGER: **MITCH MCGINNIS** CONTACT PH: _____

SAMPLER: **ROB CUPPER** SAMPLER MOBILE: **0448 611 113** RELINQUISHED BY: _____ RECEIVED BY: **DARLEK**

COC Emailed to ALS? (YES / NO) EDD FORMAT (or default): _____ DATE/TIME: _____

Email Reports to (will default to PM if no other addresses are listed): **skumarapeli@golder.com.au** DATE/TIME: **11/11/18 1500**

Email Invoice to (will default to PM if no other addresses are listed): _____

FOR LAB: _____
Custody Seal: _____
Free ice / fro receipt?: _____
Random Sar: _____
Other comm: _____

RELINQUISHED: _____
DATE/TIME: _____

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price)							Additional Information				
	LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	When Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										
							Anions / Cations	Co, Mg, Na, Cl, F	SO ₄ , Alkalinity, Hardness	EC, pH, TDS	Total Dissolved	As, B, Ba, Be, Cd, Cr, Cu, Mn, Ni, Pb, Se, V, Zn, Hg	Nitrite, Nitrate, Nitrite, Ammonia	Reactive Phosphorus	Total P, N, TKN	Sodium, Absorption ratio	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	320-01-BH2217	30/10/18 3:00pm	W	N, SP	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
2	320-01-BH2201	30/10/18 1:00pm	W	N, SP	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
						TOTAL											

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

QADELAIDE 3/1 Burma Road Pooraka SA 5095
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Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

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Ph: 07 4978 7944 E: gladstone@alsglobal.com

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QNOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 02 4423 2063 E: nowra@alsglobal.com

QPERTH 10 Hod Way Malaga WA 6090
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QSYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

QTOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

QWOLLONGONG 1/19-21 Ralph Black Drive, Nth Wollongong NSW 2500
Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: GOLDER ASSOCIATES	TURNAROUND REQUIREMENTS: <input type="checkbox"/> Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: GOLDER-BRISBANE	<input checked="" type="checkbox"/> Non Standard or urgent TAT (List due date): 48 hrs	
PROJECT: INLAND RAIL P12	PROJECT NO.: 193795	Custody Seal Intact? Yes No N/A Free Ice / frozen ice bricks present upon receipt? Yes No N/A Random Sample Temperature on Receipt: °C Other comment:
ORDER NUMBER:	PURCHASE ORDER NO.:	COC SEQUENCE NUMBER (Circle)
PROJECT MANAGER: Mitch McGinnis	CONTACT PH:	COC: 1 2 3 4 5 6 7
SAMPLER: C. VINCENT SUSANTHA KUMARAPELI	SAMPLER MOBILE: 0410023462	OF: 1 2 3 4 5 6 7
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RECEIVED BY: KYLIE
Email Reports to (will default to PM if no other addresses are listed): Skumarapeli@golder.com.au	RELINQUISHED BY: C. VINCENT	RECEIVED BY: _____
Email Invoice to (will default to PM if no other addresses are listed):	DATE/TIME: 22/11/18	DATE/TIME: 22/11/18 8:35

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) <small>When Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).</small>										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE <small>(refer to codes below)</small>	TOTAL BOTTLES	Anions / Cations Ca, Mg, Na, K, Cl, F, SO ₄ , Alkalinity, Hardness	EE, PH, TDS	Total Dissolved As, B, Ba, Be, Cd, Cr, Co, Cu, Mn, Fe, Ni	Pb, Se, V, Zn, Hg	Nutrients Nitrate, Nitrite, Ammonia	Reactive Phosphorus	Total P _{IN} TAN	Sodium Adsorption Ratio			
1	320-01-BH2218	21/11/18 0930	W	N, SP	4	✓	✓	✓	✓	✓	✓	✓	✓			
					TOTAL											

Environmental Division
Brisbane
Work Order Reference
EB1828548



Telephone : +61-7-3243 7222

URGENT

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

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Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 5555 E: samples.sydney@alsglobal.com

Environmental Division
Brisbane
Work Order Reference
EB1830099

W 2500

N/A
N/A

CLIENT: GOLDER ASSOCIATES PTY LTD	TURNAROUND REQUIREMENTS: <input checked="" type="checkbox"/> Standard TAT (List due date): 48 hrs	FOR Cust Free recep Rank Other
OFFICE: GOLDER - BRISBANE	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT (List due date):	
PROJECT: INLAND RAIL (P12)	PROJECT NO.:	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OP: 1 2 3 4 5 6 7
ORDER NUMBER:	ALQS QUOTE NO.:	
PURCHASE ORDER NO.: 1893795	COUNTRY OF ORIGIN:	RECEIVED BY: DANE K DATE/TIME: 19/10 7/12/13
PROJECT MANAGER: MIRIAM GINNIS	CONTACT PH:	
SAMPLER: HANNAH GROVES	SAMPLER MOBILE: 0405 046 250	RELINQUISHED BY: DATE/TIME: 7/12/13
COC Emailed to ALS? (YES / NO) NO	EDD FORMAT (or default):	
Email Reports to (will default to PM if no other addresses are listed): SKUMARAPALI@GOLDER.COM	DATE/TIME: 7/12/13	RELINQUISHED BY: DATE/TIME: 7/12/13
Email Invoice to (will default to PM if no other addresses are listed): AU	DATE/TIME: 7/12/13	



Telephone : + 61-7-3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) <small>When Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).</small>							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	ANIONS / CATIONS Ca, Mg, Na, Cl, F, SO ₄ , Alkalinity, Hardness	EL, PH, TDS	TOTAL DISSOLVED As, B, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Fe, Ni, Pb, Se, V, Zn, (Hg)	NITRATES, NITRITE, AMMONIA	REACTIVE PHOSPHORUS	TOTAL P/N, TKN	SODIUM ADSORPTION RATIO	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	320-01-BH2301	7/12/13	W	N, SP	4	✓	✓	✓	✓	✓	✓	✓	
TOTAL					4								

HT

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 Y = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.



CHAIN OF CUSTODY

ALS Laboratory, please tick →

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Ph 07 4796 0600 E townsville.enwork@alsglobal.com

WOLLONGONG 1/19-21 Ralph Black Drive Nth Wollongong NSW 2500
Ph 02 4225 3125 E wollongong@alsglobal.com

CLIENT: Golder Associates Pty Ltd		TURNAROUND REQUIREMENTS: <input type="checkbox"/> Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle)	
OFFICE: Golder - Brisbane		Standard TAT may be longer for some tests e.g. Ultra Trace Organics		Custody Seal Intact? Yes No N/A	
PROJECT: Inland Rail (Pkg 1)		PROJECT NO: 1893795		Free Ice / frozen ice bricks present upon receipt? Yes No N/A	
ORDER NUMBER:		PURCHASE ORDER NO.:		COC SEQUENCE NUMBER (Circle)	
PROJECT MANAGER: Mitch McGinnis		CONTACT PH: 0448611113		COC: 1 2 3 4 5 6 7	
SAMPLER: Hannah Groves / Ying Zhang		SAMPLER MOBILE: 0405 648 280		OF: 1 2 3 4 5 6 7	
COC Emailed to ALS? (YES / NO)		EDD FORMAT (or default):		RECEIVED BY: Bianca C	
Email Reports to (will default to PM if no other addresses are listed): skumarapeli@golder.com.au		Email Reports to (will default to PM if no other addresses are listed): hgroves@golder.com.au		DATE/TIME: 13/2/19 1:51pm	
Email Invoice to (will default to PM if no other addresses are listed):		RELINQUISHED BY:		RECEIVED BY:	
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:		DATE/TIME:		DATE/TIME:	

ALS USE ONLY	SAMPLE DETAILS			CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price)							Additional Information
	LAB ID	SAMPLE ID	DATE / TIME		Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (held filtered bottle required)							
	MATRIX: Solid(S) Water(W)			TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Anions/Cations: Ca, Mg, Na, Cl, F, SO4 Alkalinity, Hardness	EC, pH, TDS	Total/Dissolved Metals: As, B, Ba, Be, Cd, Cr, Co, Cu, Cd, Mn, Fe, Ni, Pb, Se, V, Zn, Hg	Nutrients: Nitrate, Nitrite, Ammonia	Reactive Phosphorus, Total P, Total N, TKN	Sodium Adsorption Ratio	
1	320-01-242103	11-2-19	2.30		4	X	X	X	X	X	X	Comments on key contaminant levels dilutions or samples requiring specific QC analysis etc.
					TOTAL							



Environmental Division
Brisbane
Work Order Reference
EB1903588



Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Specialisation bottle; SP = Sulfuric Preserved Plastic;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles



CHAIN OF CUSTODY

ALS Laboratory, please tick →

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PERTH 10 Hod Way Maraga WA 6090
Ph 08 9209 7655 E samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2154
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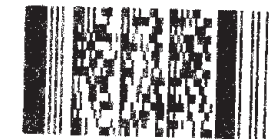
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Ph 07 4796 0600 E townsville.environments@alsglobal.com

WOLLONGONG 1/19-21 Ralph Black Drive Nith Wollongong NSW 2500
Ph 02 4225 3125 E wollongong@alsglobal.com

CLIENT: Golder Associates Pty Ltd		TURNAROUND REQUIREMENTS: <input type="checkbox"/> Standard TAT (List due date):		FOR LABORATORY USE ONLY (Circle)	
OFFICE: Golder - Brisbane		Standard TAT may be longer for some tests <input checked="" type="checkbox"/> Non Standard or urgent TAT (List due date): 48 hours.		Custody Seal Intact? Yes No N/A	
PROJECT: Inland Rail (Pkg 44) P12		PROJECT NO.: 189595		Free Ice / frozen ice bricks present upon receipt? Yes No N/A	
ORDER NUMBER:		PURCHASE ORDER NO.:		Random Sample Temperature on Receipt °C	
PROJECT MANAGER: Mitch McGinnis		CONTACT PH: 0448611113		Other comment	
SAMPLER: Hannah Groves / Ying Zhang		SAMPLER MOBILE: 0405 046 250		RECEIVED BY: ROBERT WIPPEN	
COC Emailed to ALS? (YES / NO)		ADD FORMAT (or default):		RELINQUISHED BY:	
Email Reports to (will default to PM if no other addresses are listed): skumarapelli@golder.com.au, hgroves@golder.com.au		DATE/TIME: 22/2/19 12:00		DATE/TIME: 22/2/19 14:55	
Email Invoice to (will default to PM if no other addresses are listed):		DATE/TIME:		DATE/TIME:	
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:					

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required)							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Anions/Cations: Ca, Mg, Na, Cl, F, SO4 Alkalinity, Hardness	EC, pH, TDS	Total/Dissolved Metals: As, B, Ba, Be, Cd, Cr, Co, Cu, Cd, Mn, Fe, Ni, Pb, Se, V, Zn, Hg	Nutrients: Nitrate, Nitrite, Ammonia	Reactive Phosphorus, Total P, Total N, TKN	Sodium Adsorption Ratio	Comments on likely contaminant levels dilutions, or samples requiring specific QC analysis etc
	320-01-BH2216	26-02-2019 8.20 am	W		4	✓	✓	✓	✓	✓		
URGENT												
					TOTAL	4						

Environmental Division
Brisbane
Work Order Reference
EB1904979



Telephone : + 61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic, N = Nitric Preserved Plastic, ORC = Nitric Preserved ORC, SH = Sodium Hydroxide/Cd Preserved, S = Sodium Hydroxide Preserved Plastic, AG = Amber Glass Unpreserved, AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved, VB = VOA Vial Sodium Bisulphate Preserved, VS = VOA Vial Sulfuric Preserved, AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass, H = HCl preserved Plastic, HS = HCl preserved Speciation bottle, SP = Sulfuric Preserved Plastic, F = Fumaldehyde Preserved Glass,
 Z = Zinc Acetate Preserved Bottle, E = EDTA Preserved Bottles, ST = Sterile Bottle, ASS = Plastic Bag for Acid Sulphate Soils, B = Unpreserved Bag, LI = Lugols Iodine Preserved Bottles, STT = Sterile Sodium Thiosulfate Preserved Bottles

CERTIFICATE OF ANALYSIS

Work Order : EB1826458 Client : GOLDER ASSOCIATES Contact : MR MITCH McGINNIS Address : P O BOX 1734 MILTON QLD, AUSTRALIA 4064 Telephone : +61 07 3721 5400 Project : 1893795 Order number : 17893795 C-O-C number : ---- Sampler : ROBERT CUPPER Site : INLAND RAIL (P12) Quote number : EN/002/18 National BQ No. of samples received : 2 No. of samples analysed : 2	Page : 1 of 5 Laboratory : Environmental Division Brisbane Contact : Andrew Epps Address : 2 Byth Street Stafford QLD Australia 4053 Telephone : +61 7 3552 8639 Date Samples Received : 01-Nov-2018 15:00 Date Analysis Commenced : 01-Nov-2018 Issue Date : 06-Nov-2018 17:32
--	--



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. -

Where moisture determination has been performed, results are reported on a dry weight basis. -

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. -

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference. -

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes. -

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details. -

Key : - CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		310-01-BH2217	310-01-BH2201	----	----	----
Client sampling date / time		30-Oct-2018 15:00		30-Oct-2018 13:00		----	----	----
Compound	CAS Number	LOR	Unit	EB1826458-001	EB1826458-002	-----	-----	-----
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.72	8.04	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	2080	2640	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	1300	1570	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	893	830	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	893	830	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	7	18	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	164	403	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	21	101	----	----	----
Magnesium	7439-95-4	1	mg/L	8	32	----	----	----
Sodium	7440-23-5	1	mg/L	461	442	----	----	----
Potassium	7440-09-7	1	mg/L	19	7	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	85	384	----	----	----
^ Sodium Adsorption Ratio	----	0.01	-	21.7	9.81	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.035	0.005	----	----	----
Boron	7440-42-8	0.05	mg/L	0.42	0.22	----	----	----
Barium	7440-39-3	0.001	mg/L	0.309	0.238	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Cobalt	7440-48-4	0.001	mg/L	0.017	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	0.054	0.029	----	----	----
Nickel	7440-02-0	0.001	mg/L	0.018	0.009	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	310-01-BH2217	310-01-BH2201	----	----	----
Client sampling date / time				30-Oct-2018 15:00	30-Oct-2018 13:00	----	----	----	
Compound	CAS Number	LOR	Unit	EB1826458-001	EB1826458-002	-----	-----	-----	
				Result	Result	---	---	---	
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.010	<0.005	----	----	----	
Iron	7439-89-6	0.05	mg/L	0.34	0.76	----	----	----	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.036	0.007	----	----	----	
Boron	7440-42-8	0.05	mg/L	0.42	0.22	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.383	0.314	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.028	0.005	----	----	----	
Chromium	7440-47-3	0.001	mg/L	0.005	0.005	----	----	----	
Copper	7440-50-8	0.001	mg/L	0.043	0.008	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.077	0.101	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.029	0.015	----	----	----	
Lead	7439-92-1	0.001	mg/L	0.012	0.005	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	0.01	<0.01	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.044	0.023	----	----	----	
Iron	7439-89-6	0.05	mg/L	2.24	6.72	----	----	----	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	1.8	0.4	----	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.06	0.43	----	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	310-01-BH2217	310-01-BH2201	----	----	----
Client sampling date / time				30-Oct-2018 15:00	30-Oct-2018 13:00	----	----	----	
Compound	CAS Number	LOR	Unit	EB1826458-001	EB1826458-002	-----	-----	-----	
				Result	Result	----	----	----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	1.1	----	----	----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	0.2	1.1	----	----	----	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.17	0.09	----	----	----	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.01	<0.01	----	----	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	22.6	28.3	----	----	----	
Total Cations	----	0.01	meq/L	22.2	27.1	----	----	----	
Ionic Balance	----	0.01	%	0.82	2.25	----	----	----	

CERTIFICATE OF ANALYSIS

Work Order : EB1828548 Client : GOLDER ASSOCIATES Contact : MR MITCH McGINNIS Address : P O BOX 1734 MILTON QLD, AUSTRALIA 4064 Telephone : +61 07 3721 5400 Project : 1893795 INLAND RAIL P12 Order number : C-O-C number : ---- Sampler : SUSANTHA KUMARAPELI Site : ---- Quote number : EN/002/18 National BQ No. of samples received : 1 No. of samples analysed : 1	Page : 1 of 5 Laboratory : Environmental Division Brisbane Contact : Andrew Epps Address : 2 Byth Street Stafford QLD Australia 4053 Telephone : +61 7 3552 8639 Date Samples Received : 22-Nov-2018 08:35 Date Analysis Commenced : 22-Nov-2018 Issue Date : 26-Nov-2018 14:46
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Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. -

Where moisture determination has been performed, results are reported on a dry weight basis. -

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. -

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference. -

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes. -

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details. -

Key : - CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

∅ = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for sample EB1828548-001(320-01-BH2218). However, the difference is within experimental variation of the methods.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID			320-01-BH2218	----	----	----	----
Client sampling date / time		22-Nov-2018 00:00			----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1828548-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit	7.17	----	----	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	1210	----	----	----	----	
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L	1160	----	----	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	421	----	----	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	421	----	----	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	----	----	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	126	----	----	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	6	----	----	----	----	
Magnesium	7439-95-4	1	mg/L	3	----	----	----	----	
Sodium	7440-23-5	1	mg/L	257	----	----	----	----	
Potassium	7440-09-7	1	mg/L	12	----	----	----	----	
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	27	----	----	----	----	
^ Sodium Adsorption Ratio	----	0.01	-	21.4	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.004	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	0.40	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.182	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	0.002	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.005	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	0.008	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	0.004	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.040	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.008	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	0.007	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	320-01-BH2218	----	----	----	----
Client sampling date / time				22-Nov-2018 00:00	----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1828548-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	0.02	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.054	----	----	----	----	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.028	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	0.39	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.611	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	0.009	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	0.0005	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.126	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	0.113	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	0.288	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.458	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.169	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	0.172	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	0.28	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.423	----	----	----	----	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.8	----	----	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.24	----	----	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.16	----	----	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.16	----	----	----	----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.0	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		320-01-BH2218	----	----	----	----
Client sampling date / time		22-Nov-2018 00:00		----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1828548-001	-----	-----	-----	-----
				Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	3.2	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	2.41	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	12.0	----	----	----	----
Total Cations	----	0.01	meq/L	12.0	----	----	----	----
Ionic Balance	----	0.01	%	0.10	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order : **EB1830099**
Client : **GOLDER ASSOCIATES**
Contact : MR SUSANTHA KUMARAPELI
Address : P O BOX 1734
 MILTON QLD, AUSTRALIA 4064
Telephone : +61 07 3721 5400
Project : 1893795 INLAND RAIL P12
Order number :
C-O-C number : ----
Sampler : HANNAH GROVES
Site : ----
Quote number : EN/002/18 National BQ
No. of samples received : 1
No. of samples analysed : 1

Page : 1 of 5
Laboratory : Environmental Division Brisbane
Contact : Andrew Epps
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : +61 7 3552 8639
Date Samples Received : 07-Dec-2018 19:20
Date Analysis Commenced : 08-Dec-2018
Issue Date : 12-Dec-2018 08:39



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. -

Where moisture determination has been performed, results are reported on a dry weight basis. -

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. -

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference. -

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes. -

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details. -

Key : - CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020T (Total Metals by ICP-MS): Limit of reporting raised for sample EB1830099-001(320-01-BH2301) due to matrix interference.
- TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- -EG035T (Total Mercury): Sample EB1830099-001(320-01-BH2301) diluted due to matrix interference. LOR adjusted accordingly.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID			320-01-BH2301	----	----	----	----
Client sampling date / time		07-Dec-2018 00:00			----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1830099-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit	8.22	----	----	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	5690	----	----	----	----	
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L	3420	----	----	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	209	----	----	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	209	----	----	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	323	----	----	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	1450	----	----	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	83	----	----	----	----	
Magnesium	7439-95-4	1	mg/L	27	----	----	----	----	
Sodium	7440-23-5	1	mg/L	974	----	----	----	----	
Potassium	7440-09-7	1	mg/L	12	----	----	----	----	
ED093F: SAR and Hardness Calculations									
^ Sodium Adsorption Ratio	----	0.01	-	23.7	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.003	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.124	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.002	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.073	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.003	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.014	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	320-01-BH2301	----	----	----	----
Client sampling date / time				07-Dec-2018 00:00	----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1830099-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L	0.08	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.685	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	0.100	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	28.3	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	0.0564	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	0.488	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	1.70	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	2.31	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	70.9	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	1.71	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.10	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	1.24	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	12.2	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	0.40	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	2020	----	----	----	----	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0010	----	----	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.68	----	----	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.07	----	----	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.07	----	----	----	----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	49.3	----	----	----	----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	49.4	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	320-01-BH2301	----	----	----	----
			Client sampling date / time	07-Dec-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1830099-001	-----	-----	-----	-----
				Result	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	127	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	51.8	----	----	----	----
Total Cations	----	0.01	meq/L	49.0	----	----	----	----
Ionic Balance	----	0.01	%	2.74	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order : EB1903588 Client : GOLDER ASSOCIATES Contact : MR MITCH McGINNIS Address : 32 SHAND STREET BRISBANE QLD, AUSTRALIA 4053 Telephone : +61 07 3721 5400 Project : 1893795 Inland Rail (Pkg 12) Order number : C-O-C number : ---- Sampler : ROBERT CUPPER Site : ---- Quote number : EN/002/18 National BQ No. of samples received : 1 No. of samples analysed : 1	Page : 1 of 5 Laboratory : Environmental Division Brisbane Contact : Andrew Epps Address : 2 Byth Street Stafford QLD Australia 4053 Telephone : +61 7 3552 8639 Date Samples Received : 13-Feb-2019 13:51 Date Analysis Commenced : 13-Feb-2019 Issue Date : 20-Feb-2019 16:34
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Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. -

Where moisture determination has been performed, results are reported on a dry weight basis. -

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. -

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference. -

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes. -

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details. -

Key : - CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS). However, the difference is within experimental variation of the methods.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID			320-01-BH2103	----	----	----	----
Client sampling date / time		11-Feb-2019 02:30			----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1903588-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit	7.72	----	----	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	1460	----	----	----	----	
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L	921	----	----	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	430	----	----	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	430	----	----	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	34	----	----	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	229	----	----	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	78	----	----	----	----	
Magnesium	7439-95-4	1	mg/L	82	----	----	----	----	
Sodium	7440-23-5	1	mg/L	94	----	----	----	----	
Potassium	7440-09-7	1	mg/L	1	----	----	----	----	
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	532	----	----	----	----	
^ Sodium Adsorption Ratio	----	0.01	-	1.77	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.001	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.111	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.004	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.467	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.005	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	320-01-BH2103	----	----	----	----
Client sampling date / time				11-Feb-2019 02:30	----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1903588-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.010	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	0.11	----	----	----	----	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.001	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.145	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.005	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	0.002	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	0.002	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.493	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.005	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.009	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	1.42	----	----	----	----	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.2	----	----	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.89	----	----	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.08	----	----	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.08	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID			320-01-BH2103	----	----	----	----
Client sampling date / time		11-Feb-2019 02:30			----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1903588-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	9.1	----	----	----	----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	9.2	----	----	----	----	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.02	----	----	----	----	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.01	----	----	----	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	15.8	----	----	----	----	
Total Cations	----	0.01	meq/L	14.8	----	----	----	----	
Ionic Balance	----	0.01	%	3.29	----	----	----	----	

CERTIFICATE OF ANALYSIS

Work Order	: EB1904979	Page	: 1 of 5
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR SUSANTHA KUMARAPELI	Contact	: Andrew Epps
Address	: C/- GOLDING CONTRACTORS PTY LTD LEVEL 3 8 GARDNER CLOSE MILTON QLD 4064	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3721 5400	Telephone	: +61 7 3552 8639
Project	: 1893795 Inland Rail P/2	Date Samples Received	: 27-Feb-2019 14:55
Order number	:	Date Analysis Commenced	: 27-Feb-2019
C-O-C number	: ----	Issue Date	: 04-Mar-2019 09:43
Sampler	: ROBERT CUPPER		
Site	: ----		
Quote number	: EN/002/18 National BQ		
No. of samples received	: 1		
No. of samples analysed	: 1		



Accreditation No. 825
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- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

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- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID			320-01-BH2216	----	----	----	----
		Client sampling date / time			26-Feb-2019 08:20	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1904979-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit	7.78	----	----	----	----	
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm	2800	----	----	----	----	
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L	1770	----	----	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1020	----	----	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	1020	----	----	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	----	----	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	321	----	----	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	22	----	----	----	----	
Magnesium	7439-95-4	1	mg/L	14	----	----	----	----	
Sodium	7440-23-5	1	mg/L	612	----	----	----	----	
Potassium	7440-09-7	1	mg/L	18	----	----	----	----	
ED093F: SAR and Hardness Calculations									
^ Sodium Adsorption Ratio	----	0.01	-	25.1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.007	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.488	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.002	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.031	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.006	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	320-01-BH2216	----	----	----	----
Client sampling date / time				26-Feb-2019 08:20	----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1904979-001	-----	-----	-----	-----	
				Result	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	0.31	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	0.010	----	----	----	----	
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----	
Barium	7440-39-3	0.001	mg/L	0.625	----	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	0.006	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	0.009	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	0.010	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	0.008	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	0.110	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	0.010	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	0.027	----	----	----	----	
Boron	7440-42-8	0.05	mg/L	0.29	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	4.08	----	----	----	----	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.21	----	----	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.06	----	----	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.06	----	----	----	----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	----	----	----	----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		320-01-BH2216	----	----	----	----
Client sampling date / time		26-Feb-2019 08:20		----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1904979-001	-----	-----	-----	-----
				Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued								
^ Total Nitrogen as N	----	0.1	mg/L	0.8	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.14	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	29.5	----	----	----	----
Total Cations	----	0.01	meq/L	29.3	----	----	----	----
Ionic Balance	----	0.01	%	0.32	----	----	----	----

QUALITY CONTROL REPORT

Work Order : EB1826458 Client : GOLDER ASSOCIATES Contact : MR MITCH McGINNIS Address : P O BOX 1734 MILTON QLD, AUSTRALIA 4064 Telephone : +61 07 3721 5400 Project : 1893795 Order number : 17893795 C-O-C number : ---- Sampler : ROBERT CUPPER Site : INLAND RAIL (P12) Quote number : EN/002/18 National BQ No. of samples received : 2 No. of samples analysed : 2	Page : 1 of 8 Laboratory : Environmental Division Brisbane Contact : Andrew Epps Address : 2 Byth Street Stafford QLD Australia 4053 Telephone : +61 7 3552 8639 Date Samples Received : 01-Nov-2018 Date Analysis Commenced : 01-Nov-2018 Issue Date : 06-Nov-2018
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Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 2015212)									
EB1826453-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.81	7.80	0.128	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2015213)									
EB1826453-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1020	1020	0.498	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 2015717)									
EB1826453-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	724	774	6.76	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2015211)									
EB1826453-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	381	380	0.278	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	381	380	0.278	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2015251)									
EB1826477-004	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	305	307	0.534	0% - 20%
EB1826453-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	4	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 2015252)									
EB1826477-004	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	463	461	0.486	0% - 20%
EB1826453-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	113	114	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2015721)									
EB1826406-006	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	9	10	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	6	6	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	28	28	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit
EB1826295-015	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	381	382	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	258	256	0.443	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	2030	1990	1.90	0% - 20%



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2015721) - continued									
EB1826295-015	Anonymous	ED093F: Potassium	7440-09-7	1	mg/L	9	9	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2015722)									
EB1826295-015	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.154	0.148	3.69	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.295	0.293	0.604	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-F: Boron	7440-42-8	0.05	mg/L	0.54	0.52	3.20	0% - 50%		
EG020A-F: Iron	7439-89-6	0.05	mg/L	0.78	0.76	2.59	0% - 50%		
EG020T: Total Metals by ICP-MS (QC Lot: 2015714)									
EB1826414-002	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.1 µg/L	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	2 µg/L	0.002	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.074	0.074	0.00	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<1 µg/L	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<1 µg/L	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	2 µg/L	0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<1 µg/L	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	24 µg/L	0.021	14.0	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	2 µg/L	0.002	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<5 µg/L	<0.005	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<10 µg/L	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<10 µg/L	<0.01	0.00	No Limit
EG020A-T: Boron	7440-42-8	0.05	mg/L	130 µg/L	0.14	0.00	No Limit		
EG020A-T: Iron	7439-89-6	0.05	mg/L	320 µg/L	0.24	31.6	No Limit		
EB1826295-015	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0004	<0.0001	114	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.175	0.172	2.17	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.002	0.001	0.00	No Limit

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 Work Order : EB1826458
 Client : GOLDER ASSOCIATES
 Project : 1893795



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2015714) - continued									
EB1826295-015	Anonymous	EG020A-T: Lead	7439-92-1	0.001	mg/L	0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.339	0.322	5.24	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.006	<0.005	21.2	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.54	0.52	4.50	0% - 50%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	1.85	1.86	0.00	0% - 20%
EG035F: Dissolved Mercury by FIMS (QC Lot: 2015723)									
EB1826295-015	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2015712)									
EB1826295-015	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 2015210)									
EB1826453-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2015264)									
EB1826453-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.09	0.12	25.0	0% - 50%
EB1826477-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.08	0.09	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2015253)									
EB1826477-004	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1826453-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2015265)									
EB1826453-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.08	0.08	0.00	No Limit
EB1826477-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2015244)									
EB1826453-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	23.2	24.3	4.75	0% - 20%
EB1826477-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	10.8	10.7	0.00	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2015243)									
EB1826453-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.30	0.30	0.00	0% - 20%
EB1826477-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.67	0.66	0.00	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2015250)									
EB1826453-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.10	0.10	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA005P: pH by PC Titrator (QCLot: 2015212)									
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	99.2	98	102	
				----	7 pH Unit	100	98	102	
EA010P: Conductivity by PC Titrator (QCLot: 2015213)									
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2100 µS/cm	100	91	107	
				<1	12890 µS/cm	99.3	91	107	
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 2015717)									
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	103	88	112	
				<10	2000 mg/L	101	88	112	
ED037P: Alkalinity by PC Titrator (QCLot: 2015211)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	93.4	80	120	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2015251)									
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	103	85	118	
				<1	100 mg/L	102	85	118	
ED045G: Chloride by Discrete Analyser (QCLot: 2015252)									
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	107	90	115	
				<1	1000 mg/L	104	90	115	
ED093F: Dissolved Major Cations (QCLot: 2015721)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2015722)									
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	96.0	88	116	
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	87.2	81	117	
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	88.8	70	130	
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	92.1	88	108	
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	109	87	113	
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	94.8	86	112	
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	108	88	114	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	96.0	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	96.5	89	120	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	92.8	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	94.8	83	112	
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	111	88	114	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike	Spike Recovery (%)		Recovery Limits (%)	
					Concentration	LCS	Low	High	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2015722) - continued									
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	94.9	87	113	
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	99.0	81	125	
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	96.7	82	114	
EG020T: Total Metals by ICP-MS (QCLot: 2015714)									
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	98.0	88	112	
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	85.8	81	119	
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	95.6	70	130	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.6	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	103	89	115	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	105	88	116	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	93.5	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	104	88	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.8	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	96.2	79	111	
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	113	87	114	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	94.4	84	114	
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	97.4	82	128	
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	98.6	82	118	
EG035F: Dissolved Mercury by FIMS (QCLot: 2015723)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	86.2	84	118	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2015712)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	84.9	84	118	
EK040P: Fluoride by PC Titrator (QCLot: 2015210)									
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	106	80	117	
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2015264)									
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	97.0	86	112	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2015253)									
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	98.9	90	110	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2015265)									
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	98.7	89	115	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2015244)									
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	99.9	70	111	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2015243)									
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	94.8	77	109	
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2015250)									
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	92.6	88	115	



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	Spike Recovery(%) MS	Recovery Limits (%)	
						Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2015251)							
EB1826453-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	108	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 2015252)							
EB1826453-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	108	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 2015722)							
EB1826467-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.1 mg/L	99.6	70	130
		EG020A-F: Beryllium	7440-41-7	0.1 mg/L	94.0	70	130
		EG020A-F: Barium	7440-39-3	0.5 mg/L	90.8	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	94.8	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	109	70	130
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	94.8	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	107	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	102	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	94.3	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	94.7	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	99.7	70	130
		EG020A-F: Vanadium	7440-62-2	0.1 mg/L	102	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	99.8	70	130
		EG020A-F: Boron	7440-42-8	0.5 mg/L	98.5	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2015714)							
EB1826406-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	102	70	130
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	88.7	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	105	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	102	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	91.6	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	90.8	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	92.8	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	92.8	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	88.9	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	91.1	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	96.6	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	90.6	70	130
		EG035F: Dissolved Mercury by FIMS (QCLot: 2015723)					
EB1826295-015	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	78.0	70	130



Sub-Matrix: WATER

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2015712)							
EB1826414-001	Anonymous	EG035T: Mercury	7439-97-6	0.05 mg/L	84.3	70	130
EK040P: Fluoride by PC Titrator (QCLot: 2015210)							
EB1826453-002	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	101	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2015264)							
EB1826453-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	82.0	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2015253)							
EB1826453-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	101	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2015265)							
EB1826453-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	100	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2015244)							
EB1826453-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	97.5	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2015243)							
EB1826453-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	112	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2015250)							
EB1826453-002	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.4 mg/L	101	70	130

QUALITY CONTROL REPORT

Work Order	: EB1828548	Page	: 1 of 8
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR MITCH McGINNIS	Contact	: Andrew Epps
Address	: P O BOX 1734 MILTON QLD, AUSTRALIA 4064	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3721 5400	Telephone	: +61 7 3552 8639
Project	: 1893795 INLAND RAIL P12	Date Samples Received	: 22-Nov-2018
Order number	:	Date Analysis Commenced	: 22-Nov-2018
C-O-C number	: ----	Issue Date	: 26-Nov-2018
Sampler	: SUSANTHA KUMARAPELI		
Site	: ----		
Quote number	: EN/002/18 National BQ		
No. of samples received	: 1		
No. of samples analysed	: 1		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 2051941)									
EB1828142-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.68	7.74	0.778	0% - 20%
EB1828180-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.57	7.64	0.920	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2051943)									
EB1828142-003	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	404	404	0.00	0% - 20%
EB1828180-003	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	16800	16800	0.482	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 2052371)									
EB1828018-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1590	1580	0.883	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2051942)									
EB1828142-003	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	87	86	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	87	86	0.00	0% - 20%
EB1828180-003	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	637	642	0.699	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	637	642	0.699	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2052011)									
EB1827988-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	11	11	0.00	0% - 50%
EB1828167-005	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	1	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 2052012)									
EB1827988-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	153	154	0.00	0% - 20%
EB1828167-005	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	744	740	0.540	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2053078)									
EB1828548-001	320-01-BH2218	ED093F: Calcium	7440-70-2	1	mg/L	6	6	0.00	No Limit



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2053078) - continued									
EB1828548-001	320-01-BH2218	ED093F: Magnesium	7439-95-4	1	mg/L	3	3	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	257	259	0.827	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	12	12	0.00	0% - 50%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2053080)									
EB1828548-001	320-01-BH2218	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.182	0.191	4.88	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.008	0.007	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.005	0.006	18.1	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.004	0.003	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.040	0.040	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.008	0.006	26.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.054	0.050	7.93	0% - 50%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	0.02	0.02	0.00	No Limit
EG020A-F: Boron	7440-42-8	0.05	mg/L	0.40	0.40	0.00	No Limit		
EG020T: Total Metals by ICP-MS (QC Lot: 2053085)									
EB1828168-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.113	0.114	1.47	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.385	0.384	0.00	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.006	0.006	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.007	0.006	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Boron	7440-42-8	0.05	mg/L	0.14	0.14	0.00	No Limit		
EG035F: Dissolved Mercury by FIMS (QC Lot: 2053079)									
EB1828548-001	320-01-BH2218	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2053088)									
EB1828168-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 2051944)									
EB1828142-003	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.1	0.00	No Limit

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 Work Order : EB1828548
 Client : GOLDER ASSOCIATES
 Project : 1893795 INLAND RAIL P12



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK040P: Fluoride by PC Titrator (QC Lot: 2051944) - continued									
EB1828180-003	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2052027)									
EB1828540-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.05	81.1	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2052014)									
EB1828548-001	320-01-BH2218	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2052026)									
EB1828540-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.06	0.07	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2052364)									
EB1828147-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.6	2.7	4.48	0% - 20%
EB1828540-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	0.5	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2052363)									
EB1828147-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.38	0.37	0.00	0% - 20%
EB1828540-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2052015)									
EB1828548-001	320-01-BH2218	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA005P: pH by PC Titrator (QCLot: 2051941)									
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98	102	
				----	7 pH Unit	100	98	102	
EA010P: Conductivity by PC Titrator (QCLot: 2051943)									
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2100 µS/cm	96.6	91	107	
				<1	24800 µS/cm	99.5	91	107	
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 2052371)									
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	99.6	88	112	
				<10	2000 mg/L	99.8	88	112	
ED037P: Alkalinity by PC Titrator (QCLot: 2051942)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	103	80	120	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2052011)									
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	104	85	118	
				<1	100 mg/L	98.3	85	118	
ED045G: Chloride by Discrete Analyser (QCLot: 2052012)									
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	99.4	90	115	
				<1	1000 mg/L	105	90	115	
ED093F: Dissolved Major Cations (QCLot: 2053078)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2053080)									
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	97.1	88	116	
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	101	81	117	
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	95.1	70	130	
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	91.0	88	108	
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	91.8	87	113	
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	92.5	86	112	
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	96.9	88	114	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.7	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	92.7	89	120	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	95.6	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	94.3	83	112	
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	95.7	88	114	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike	Spike Recovery (%)		Recovery Limits (%)	
					Concentration	LCS	Low	High	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2053080) - continued									
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	96.7	87	113	
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	99.4	81	125	
EG020T: Total Metals by ICP-MS (QCLot: 2053085)									
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	97.8	88	112	
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	92.7	81	119	
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	93.8	70	130	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	90.6	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	97.5	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	98.3	89	115	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	102	88	116	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.4	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	104	88	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.1	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	94.4	79	111	
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	110	87	114	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	94.2	84	114	
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	96.6	82	128	
EG035F: Dissolved Mercury by FIMS (QCLot: 2053079)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	90.3	84	118	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2053088)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	89.5	84	118	
EK040P: Fluoride by PC Titrator (QCLot: 2051944)									
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	93.6	80	117	
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2052027)									
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	95.7	86	112	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2052014)									
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	102	90	110	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2052026)									
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	102	89	115	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2052364)									
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	1 mg/L	83.8	70	108	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2052363)									
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.442 mg/L	93.4	79	105	
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2052015)									
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	95.2	88	115	



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

				Matrix Spike (MS) Report					
				Spike	SpikeRecovery(%)	Recovery Limits (%)			
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High		
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2052011)									
EB1828101-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	# Not Determined	70	130		
ED045G: Chloride by Discrete Analyser (QCLot: 2052012)									
EB1828101-001	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	81.9	70	130		
EG020F: Dissolved Metals by ICP-MS (QCLot: 2053080)									
EB1828572-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.1 mg/L	99.1	70	130		
		EG020A-F: Beryllium	7440-41-7	0.1 mg/L	94.5	70	130		
		EG020A-F: Barium	7440-39-3	0.5 mg/L	100	70	130		
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	91.1	70	130		
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	85.8	70	130		
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	88.8	70	130		
		EG020A-F: Copper	7440-50-8	0.2 mg/L	90.3	70	130		
		EG020A-F: Lead	7439-92-1	0.1 mg/L	86.4	70	130		
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	87.3	70	130		
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	88.2	70	130		
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	98.9	70	130		
		EG020A-F: Vanadium	7440-62-2	0.1 mg/L	94.2	70	130		
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	89.5	70	130		
		EG020A-F: Boron	7440-42-8	0.5 mg/L	89.2	70	130		
EG020T: Total Metals by ICP-MS (QCLot: 2053085)									
EB1828168-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	88.2	70	130		
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	90.8	70	130		
		EG020A-T: Barium	7440-39-3	1 mg/L	90.4	70	130		
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	93.3	70	130		
		EG020A-T: Chromium	7440-47-3	1 mg/L	90.9	70	130		
		EG020A-T: Cobalt	7440-48-4	1 mg/L	88.1	70	130		
		EG020A-T: Copper	7440-50-8	1 mg/L	93.9	70	130		
		EG020A-T: Lead	7439-92-1	1 mg/L	88.3	70	130		
		EG020A-T: Manganese	7439-96-5	1 mg/L	89.9	70	130		
		EG020A-T: Nickel	7440-02-0	1 mg/L	90.9	70	130		
		EG020A-T: Vanadium	7440-62-2	1 mg/L	86.2	70	130		
		EG020A-T: Zinc	7440-66-6	1 mg/L	88.0	70	130		
		EG035F: Dissolved Mercury by FIMS (QCLot: 2053079)							
		EB1828572-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	80.2	70	130



Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2053088)							
EB1828168-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	81.7	70	130
EK040P: Fluoride by PC Titrator (QCLot: 2051944)							
EB1828142-004	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	90.4	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2052027)							
EB1828548-001	320-01-BH2218	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	86.8	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2052026)							
EB1828548-001	320-01-BH2218	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	94.9	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2052364)							
EB1828148-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	96.1	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2052363)							
EB1828148-001	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	94.5	70	130

QUALITY CONTROL REPORT

Work Order	: EB1830099	Page	: 1 of 7
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR SUSANTHA KUMARAPELI	Contact	: Andrew Epps
Address	: P O BOX 1734 MILTON QLD, AUSTRALIA 4064	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3721 5400	Telephone	: +61 7 3552 8639
Project	: 1893795 INLAND RAIL P12	Date Samples Received	: 07-Dec-2018
Order number	:	Date Analysis Commenced	: 08-Dec-2018
C-O-C number	: ----	Issue Date	: 12-Dec-2018
Sampler	: HANNAH GROVES		
Site	: ----		
Quote number	: EN/002/18 National BQ		
No. of samples received	: 1		
No. of samples analysed	: 1		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 2082923)									
EB1829787-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	8.84	8.92	0.901	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2082922)									
EB1829787-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	5280	5250	0.575	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 2083184)									
EB1830080-004	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	5140	5220	1.54	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2082925)									
EB1830028-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	161	167	3.96	0% - 20%
		ED037-P: Total Alkalinity as CaCO ₃	----	1	mg/L	161	167	3.96	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA (QC Lot: 2083109)									
EB1830063-007	Anonymous	ED041G: Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	8	8	0.00	No Limit
EB1830002-001	Anonymous	ED041G: Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	100	100	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 2083112)									
EB1830063-007	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	95	97	1.49	0% - 20%
EB1830002-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	900	901	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2083837)									
EB1830099-001	320-01-BH2301	ED093F: Calcium	7440-70-2	1	mg/L	83	84	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	27	28	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	974	972	0.165	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	12	12	0.00	0% - 50%
EB1829556-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	87	86	1.52	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	65	64	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	356	350	1.55	0% - 20%



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2083837) - continued									
EB1829556-001	Anonymous	ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2083841)									
EB1830099-001	320-01-BH2301	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.124	0.123	0.00	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.073	0.073	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.014	0.014	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.08	0.08	0.00	No Limit
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EG020T: Total Metals by ICP-MS (QC Lot: 2083997)									
EB1830098-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.166	0.162	2.30	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.078	0.076	2.83	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.014	0.014	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.20	0.13	42.2	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	3.31	3.15	5.05	0% - 20%		
EB1829787-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0002	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.006	0.006	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.287	0.292	1.56	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.038	0.038	0.00	0% - 20%
EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.060	0.063	4.50	0% - 20%		

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 Work Order : EB1830099
 Client : GOLDER ASSOCIATES
 Project : 1893795 INLAND RAIL P12



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2083997) - continued									
EB1829787-001	Anonymous	EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.037	0.037	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	1.54	1.83	17.3	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	2.62	2.68	2.08	0% - 20%
EG035F: Dissolved Mercury by FIMS (QC Lot: 2083838)									
EB1830022-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1829556-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2083995)									
EB1830028-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	0.0705	0.0745	5.52	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2087612)									
EB1830099-001	320-01-BH2301	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.68	0.68	0.00	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2083111)									
EB1830063-007	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1830002-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2087613)									
EB1830099-001	320-01-BH2301	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.07	0.06	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2084226)									
EB1829364-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.7	2.8	0.00	0% - 20%
EB1830099-001	320-01-BH2301	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	49.3	55.1	11.1	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2084225)									
EB1829364-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.39	0.38	3.38	0% - 20%
EB1830099-001	320-01-BH2301	EK067G: Total Phosphorus as P	----	0.01	mg/L	127	125	2.10	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2083110)									
EB1830002-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.05	0.05	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA005P: pH by PC Titrator (QCLot: 2082923)									
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98	102	
				----	7 pH Unit	100	98	102	
EA010P: Conductivity by PC Titrator (QCLot: 2082922)									
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	220 µS/cm	103	91	107	
				<1	12890 µS/cm	98.9	91	107	
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 2083184)									
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	102	88	112	
				<10	2000 mg/L	98.0	88	112	
ED037P: Alkalinity by PC Titrator (QCLot: 2082925)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	107	80	120	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2083109)									
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	101	85	118	
				<1	100 mg/L	95.5	85	118	
ED045G: Chloride by Discrete Analyser (QCLot: 2083112)									
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	103	90	115	
				<1	1000 mg/L	102	90	115	
ED093F: Dissolved Major Cations (QCLot: 2083837)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2083841)									
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	91.9	88	116	
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	95.1	81	117	
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	104	70	130	
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.0	88	108	
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	88.0	87	113	
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	92.3	86	112	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.1	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	92.6	89	120	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	90.0	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	95.6	83	112	
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	101	88	114	
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	89.8	87	113	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2083841) - continued									
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	102	81	125	
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	95.0	82	114	
EG020T: Total Metals by ICP-MS (QCLot: 2083997)									
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.8	88	112	
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	87.4	81	119	
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	93.4	70	130	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	91.0	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	99.9	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	104	89	115	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	95.6	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	97.7	88	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	100	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	98.2	79	111	
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	87	114	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	104	84	114	
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	93.8	82	128	
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	96.3	82	118	
EG035F: Dissolved Mercury by FIMS (QCLot: 2083838)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	99.3	84	118	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2083995)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	97.6	84	118	
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2087612)									
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	101	86	112	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2083111)									
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	101	90	110	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2087613)									
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	95.5	89	115	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2084226)									
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	95.1	70	108	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2084225)									
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	89.9	79	105	
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2083110)									
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	96.3	88	115	

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.



Sub-Matrix: WATER

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2083109)							
EB1830002-004	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	112	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 2083112)							
EB1830002-004	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	98.1	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2083997)							
EB1829787-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	98.6	70	130
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	83.5	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	98.3	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	89.8	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	94.6	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	94.2	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	88.2	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	88.0	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	90.6	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	95.8	70	130
EG020A-T: Zinc	7440-66-6	1 mg/L	96.5	70	130		
EG035F: Dissolved Mercury by FIMS (QCLot: 2083838)							
EB1829556-002	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	87.2	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2083995)							
EB1830098-001	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	83.0	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2083111)							
EB1830002-004	Anonymous	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	107	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2084226)							
EB1829364-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	108	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2084225)							
EB1829364-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	107	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2083110)							
EB1830002-004	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.4 mg/L	101	70	130

QUALITY CONTROL REPORT

Work Order	: EB1903588	Page	: 1 of 9
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR MITCH McGINNIS	Contact	: Andrew Epps
Address	: 32 SHAND STREET BRISBANE QLD, AUSTRALIA 4053	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3721 5400	Telephone	: +61 7 3552 8639
Project	: 1893795 Inland Rail (Pkg 12)	Date Samples Received	: 13-Feb-2019
Order number	:	Date Analysis Commenced	: 13-Feb-2019
C-O-C number	: ----	Issue Date	: 20-Feb-2019
Sampler	: ROBERT CUPPER		
Site	: ----		
Quote number	: EN/002/18 National BQ		
No. of samples received	: 1		
No. of samples analysed	: 1		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 2189174)									
EB1903588-001	320-01-BH2103	EA005-P: pH Value	----	0.01	pH Unit	7.72	7.76	0.517	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2189173)									
EB1903588-001	320-01-BH2103	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1460	1440	0.820	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 2184942)									
EB1903487-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1230	1190	3.77	0% - 20%
EB1903545-002	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	693	671	3.13	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2189172)									
EB1903001-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	168	150	11.1	0% - 20%
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	532	551	3.56	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	700	701	0.221	0% - 20%
EB1903588-001	320-01-BH2103	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	430	432	0.432	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	430	432	0.432	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2184260)									
EB1903541-022	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	282	278	1.66	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 2184259)									
EB1903541-022	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	374	373	0.305	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2184561)									
EB1903549-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	48	50	3.58	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	20	20	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	19	20	0.00	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2184561) - continued									
EB1903588-001	320-01-BH2103	ED093F: Calcium	7440-70-2	1	mg/L	78	78	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	82	84	1.49	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	94	94	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2184563)									
EB1903584-005	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.161	0.160	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.007	0.008	16.2	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.05	0.05	0.00	No Limit
EG020A-F: Iron	7439-89-6	0.05	mg/L	1.21	1.22	0.00	0% - 20%		
EB1903588-001	320-01-BH2103	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.111	0.112	0.00	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.467	0.471	0.925	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.010	0.009	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020A-F: Iron	7439-89-6	0.05	mg/L	0.11	0.12	0.00	No Limit		
EG020T: Total Metals by ICP-MS (QC Lot: 2184657)									
EB1903541-071	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.1 µg/L	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	2 µg/L	0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	85 µg/L	0.082	2.68	0% - 20%



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2184657) - continued									
EB1903541-071	Anonymous	EG020A-T: Chromium	7440-47-3	0.001	mg/L	2 µg/L	0.002	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	3 µg/L	0.003	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<1 µg/L	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	36 µg/L	0.035	3.38	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	3 µg/L	0.004	27.7	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	32 µg/L	0.032	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<10 µg/L	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<50 µg/L	<0.05	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	1370 µg/L	1.39	1.75	0% - 20%		
EB1903581-002	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.167	0.173	3.15	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.023	0.024	0.00	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.004	0.003	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.30	0.32	8.10	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	0.10	0.06	52.4	No Limit		
EG035F: Dissolved Mercury by FIMS (QC Lot: 2184562)									
EB1903563-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2184654)									
EB1903541-071	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.1 µg/L	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 2189171)									
EB1903001-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.3	0.3	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2186057)									
EB1903588-001	320-01-BH2103	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.89	0.82	7.73	0% - 20%
EB1903620-010	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.05	<0.01	133	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2184257)									
EB1903541-007	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1903588-001	320-01-BH2103	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2186058)									

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 Work Order : EB1903588
 Client : GOLDER ASSOCIATES
 Project : 1893795 Inland Rail (Pkg 12)



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2186058) - continued									
EB1903588-001	320-01-BH2103	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.08	0.08	0.00	No Limit
EB1903620-010	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2187209)									
EB1903370-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	4.0	3.9	0.00	No Limit
EB1903566-004	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.0	1.0	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2187208)									
EB1903370-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.85	0.80	5.39	0% - 50%
EB1903566-004	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2184261)									
EB1903588-001	320-01-BH2103	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.01	<0.01	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA005P: pH by PC Titrator (QCLot: 2189174)									
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98	102	
				----	7 pH Unit	100	98	102	
EA010P: Conductivity by PC Titrator (QCLot: 2189173)									
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2100 µS/cm	104	91	107	
				<1	24800 µS/cm	102	91	107	
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 2184942)									
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	107	88	112	
				<10	2000 mg/L	103	88	112	
ED037P: Alkalinity by PC Titrator (QCLot: 2189172)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	98.1	80	120	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2184260)									
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	103	85	118	
				<1	100 mg/L	98.7	85	118	
ED045G: Chloride by Discrete Analyser (QCLot: 2184259)									
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	106	90	115	
				<1	1000 mg/L	107	90	115	
ED093F: Dissolved Major Cations (QCLot: 2184561)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2184563)									
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	100	88	116	
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	100	81	117	
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	103	70	130	
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.8	88	108	
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	87	113	
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	101	86	112	
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	97.1	88	114	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	94.2	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	92.9	89	120	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.4	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	102	83	112	
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	88	114	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2184563) - continued									
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	96.4	87	113	
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	102	81	125	
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	106	82	114	
EG020T: Total Metals by ICP-MS (QCLot: 2184657)									
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	107	88	112	
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	100	81	119	
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	101	70	130	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	106	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	107	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	112	89	115	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	111	88	116	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	104	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	108	88	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	110	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	106	79	111	
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	108	87	114	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	108	84	114	
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	97.1	82	128	
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	108	82	118	
EG035F: Dissolved Mercury by FIMS (QCLot: 2184562)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	105	84	118	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2184654)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	93.7	84	118	
EK040P: Fluoride by PC Titrator (QCLot: 2189171)									
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	97.6	80	117	
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2186057)									
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	90.3	86	112	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2184257)									
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	101	90	110	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2186058)									
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.4	89	115	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2187209)									
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	1 mg/L	78.8	70	108	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2187208)									
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.442 mg/L	88.2	79	105	
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2184261)									
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	89.2	88	115	



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

				Matrix Spike (MS) Report					
				Spike	Spike Recovery(%)	Recovery Limits (%)			
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High		
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2184260)									
EB1903588-001	320-01-BH2103	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	97.9	70	130		
ED045G: Chloride by Discrete Analyser (QCLot: 2184259)									
EB1903588-001	320-01-BH2103	ED045G: Chloride	16887-00-6	400 mg/L	105	70	130		
EG020F: Dissolved Metals by ICP-MS (QCLot: 2184563)									
EB1903584-006	Anonymous	EG020A-F: Arsenic	7440-38-2	0.1 mg/L	105	70	130		
		EG020A-F: Beryllium	7440-41-7	0.1 mg/L	101	70	130		
		EG020A-F: Barium	7440-39-3	0.5 mg/L	106	70	130		
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	99.7	70	130		
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	101	70	130		
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	101	70	130		
		EG020A-F: Copper	7440-50-8	0.2 mg/L	98.8	70	130		
		EG020A-F: Lead	7439-92-1	0.1 mg/L	# Not Determined	70	130		
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	# Not Determined	70	130		
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	96.0	70	130		
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	102	70	130		
		EG020A-F: Vanadium	7440-62-2	0.1 mg/L	99.5	70	130		
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	98.0	70	130		
		EG020A-F: Boron	7440-42-8	0.5 mg/L	99.0	70	130		
EG020T: Total Metals by ICP-MS (QCLot: 2184657)									
EB1903541-074	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	102	70	130		
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	93.2	70	130		
		EG020A-T: Barium	7440-39-3	1 mg/L	93.6	70	130		
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	98.1	70	130		
		EG020A-T: Chromium	7440-47-3	1 mg/L	98.2	70	130		
		EG020A-T: Cobalt	7440-48-4	1 mg/L	97.2	70	130		
		EG020A-T: Copper	7440-50-8	1 mg/L	93.5	70	130		
		EG020A-T: Lead	7439-92-1	1 mg/L	93.7	70	130		
		EG020A-T: Manganese	7439-96-5	1 mg/L	92.5	70	130		
		EG020A-T: Nickel	7440-02-0	1 mg/L	97.4	70	130		
		EG020A-T: Vanadium	7440-62-2	1 mg/L	103	70	130		
		EG020A-T: Zinc	7440-66-6	1 mg/L	93.5	70	130		
		EG035F: Dissolved Mercury by FIMS (QCLot: 2184562)							

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 Work Order : EB1903588
 Client : GOLDER ASSOCIATES
 Project : 1893795 Inland Rail (Pkg 12)



Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035F: Dissolved Mercury by FIMS (QCLot: 2184562) - continued							
EB1903630-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	87.6	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2184654)							
EB1903541-074	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	87.6	70	130
EK040P: Fluoride by PC Titrator (QCLot: 2189171)							
EB1903001-003	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	87.2	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2186057)							
EB1903620-001	Anonymous	EK055G: Ammonia as N	7664-41-7	2 mg/L	80.8	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2184257)							
EB1903541-021	Anonymous	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	96.4	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2186058)							
EB1903620-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	94.0	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2187209)							
EB1903370-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	92.3	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2187208)							
EB1903370-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	98.6	70	130

QUALITY CONTROL REPORT

Work Order	: EB1904979	Page	: 1 of 9
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR SUSANTHA KUMARAPELI	Contact	: Andrew Epps
Address	: C/- GOLDING CONTRACTORS PTY LTD LEVEL 3 8 GARDNER CLOSE MILTON QLD 4064	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3721 5400	Telephone	: +61 7 3552 8639
Project	: 1893795 Inland Rail P/2	Date Samples Received	: 27-Feb-2019
Order number	:	Date Analysis Commenced	: 27-Feb-2019
C-O-C number	: ----	Issue Date	: 04-Mar-2019
Sampler	: ROBERT CUPPER		
Site	: ----		
Quote number	: EN/002/18 National BQ		
No. of samples received	: 1		
No. of samples analysed	: 1		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 2208558)									
EB1904665-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.08	7.10	0.282	0% - 20%
EB1904676-006	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.98	7.99	0.125	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2208557)									
EB1904665-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	30300	30200	0.331	0% - 20%
EB1904676-006	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	3460	3470	0.288	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 2209488)									
EB1902060-003	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	165	164	0.00	0% - 50%
ED037P: Alkalinity by PC Titrator (QC Lot: 2208556)									
EB1904407-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	12	15	26.5	0% - 50%
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	271	303	11.3	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	282	318	12.0	0% - 20%
EB1904676-006	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1220	1220	0.202	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	1220	1220	0.202	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2208937)									
EB1904971-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	367	374	1.90	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 2208934)									
EB1904948-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 2209254)									
EB1904819-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	15	15	0.00	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	8	8	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	29	29	0.00	0% - 20%



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2209254) - continued									
EB1904819-001	Anonymous	ED093F: Potassium	7440-09-7	1	mg/L	6	6	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2209256)									
EB1905027-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.097	0.099	1.68	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.27	0.26	0.00	No Limit
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EB1904909-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.510	0.513	0.490	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.014	0.014	0.00	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.040	0.040	0.00	0% - 20%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.059	0.058	0.00	0% - 50%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	1.64	1.72	5.26	0% - 20%
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EG020T: Total Metals by ICP-MS (QC Lot: 2209361)									
EB1904909-002	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.009	0.010	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.465	0.462	0.560	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	0.003	0.00	No Limit



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2209361) - continued									
EB1904909-002	Anonymous	EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.016	0.016	0.00	0% - 50%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.045	0.046	3.19	0% - 20%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.063	0.062	2.03	0% - 50%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	1.84	1.74	4.99	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.08	0.08	0.00	No Limit
EB1904909-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.010	0.010	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.565	0.584	3.28	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.001	0.002	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.006	0.007	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.026	0.026	0.00	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.041	0.040	0.00	0% - 20%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.178	0.185	3.52	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	1.69	1.77	4.25	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	1.09	1.12	2.23	0% - 20%
		EG035F: Dissolved Mercury by FIMS (QC Lot: 2209257)							
EB1904979-001	320-01-BH2216	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2209365)									
EB1904979-001	320-01-BH2216	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1905049-003	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2209285)									
EB1904909-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	2.77	2.92	5.35	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2208938)									
EB1904971-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2209286)									
EB1904909-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2209188)									
EB1904902-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.4	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2209187)									
EB1904902-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.02	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2208935)									

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 Work Order : EB1904979
 Client : GOLDER ASSOCIATES
 Project : 1893795 Inland Rail P/2



Sub-Matrix: **WATER**

Laboratory Duplicate (DUP) Report

<i>Laboratory sample ID</i>	<i>Client sample ID</i>	<i>Method: Compound</i>	<i>CAS Number</i>	<i>LOR</i>	<i>Unit</i>	<i>Original Result</i>	<i>Duplicate Result</i>	<i>RPD (%)</i>	<i>Recovery Limits (%)</i>
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2208935) - continued									
EB1904948-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA005P: pH by PC Titrator (QCLot: 2208558)									
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98	102	
				----	7 pH Unit	100	98	102	
EA010P: Conductivity by PC Titrator (QCLot: 2208557)									
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	4000 µS/cm	103	91	107	
				<1	12890 µS/cm	99.4	91	107	
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 2209488)									
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	101	88	112	
				<10	2000 mg/L	100	88	112	
ED037P: Alkalinity by PC Titrator (QCLot: 2208556)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	90.1	80	120	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2208937)									
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	105	85	118	
				<1	100 mg/L	107	85	118	
ED045G: Chloride by Discrete Analyser (QCLot: 2208934)									
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	95.9	90	115	
				<1	1000 mg/L	103	90	115	
ED093F: Dissolved Major Cations (QCLot: 2209254)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS (QCLot: 2209256)									
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.9	88	116	
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	99.8	81	117	
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	103	70	130	
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	95.6	88	108	
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	96.0	87	113	
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	98.2	86	112	
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	106	88	114	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	96.8	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	102	89	120	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	100	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	104	83	112	
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	88	114	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
				Result	Spike	Spike Recovery (%)	Recovery Limits (%)	
					Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 2209256) - continued								
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	99.4	87	113
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	98.3	81	125
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	114
EG020T: Total Metals by ICP-MS (QCLot: 2209361)								
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.5	88	112
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	95.8	81	119
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	98.8	70	130
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	94.7	88	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	99.0	89	115
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	99.1	89	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	99.3	88	116
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.9	89	112
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.8	88	114
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	99.0	88	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	93.7	79	111
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	99.8	87	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	94.3	84	114
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	96.6	82	128
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	100	82	118
EG035F: Dissolved Mercury by FIMS (QCLot: 2209257)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	97.3	84	118
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2209365)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	84	118
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2209285)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	99.0	86	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2208938)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.2	90	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2209286)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.3	89	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2209188)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	1 mg/L	76.6	70	108
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2209187)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	0.442 mg/L	85.3	79	105
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2208935)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	104	88	115

Matrix Spike (MS) Report



The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report					
				Spike	SpikeRecovery(%)	Recovery Limits (%)			
				Concentration	MS	Low	High		
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2208937)									
EB1904963-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	# Not Determined	70	130		
ED045G: Chloride by Discrete Analyser (QCLot: 2208934)									
EB1904963-001	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	# Not Determined	70	130		
EG020F: Dissolved Metals by ICP-MS (QCLot: 2209256)									
EB1904909-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.1 mg/L	105	70	130		
		EG020A-F: Beryllium	7440-41-7	0.1 mg/L	103	70	130		
		EG020A-F: Barium	7440-39-3	0.5 mg/L	104	70	130		
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	96.4	70	130		
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	91.7	70	130		
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	93.1	70	130		
		EG020A-F: Copper	7440-50-8	0.2 mg/L	90.9	70	130		
		EG020A-F: Lead	7439-92-1	0.1 mg/L	91.5	70	130		
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	96.3	70	130		
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	92.0	70	130		
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	109	70	130		
		EG020A-F: Vanadium	7440-62-2	0.1 mg/L	99.1	70	130		
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	95.2	70	130		
		EG020A-F: Boron	7440-42-8	0.5 mg/L	99.4	70	130		
EG020T: Total Metals by ICP-MS (QCLot: 2209361)									
EB1904819-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	98.4	70	130		
		EG020A-T: Beryllium	7440-41-7	0.1 mg/L	98.1	70	130		
		EG020A-T: Barium	7440-39-3	1 mg/L	98.7	70	130		
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	94.7	70	130		
		EG020A-T: Chromium	7440-47-3	1 mg/L	97.0	70	130		
		EG020A-T: Cobalt	7440-48-4	1 mg/L	93.7	70	130		
		EG020A-T: Copper	7440-50-8	1 mg/L	95.4	70	130		
		EG020A-T: Lead	7439-92-1	1 mg/L	96.8	70	130		
		EG020A-T: Manganese	7439-96-5	1 mg/L	93.6	70	130		
		EG020A-T: Nickel	7440-02-0	1 mg/L	95.1	70	130		
		EG020A-T: Vanadium	7440-62-2	1 mg/L	96.3	70	130		
		EG020A-T: Zinc	7440-66-6	1 mg/L	93.2	70	130		
		EG035F: Dissolved Mercury by FIMS (QCLot: 2209257)							
		EB1905016-013	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	78.5	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2209365)									



Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2209365) - continued							
EB1905016-013	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	79.3	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2209285)							
EB1904909-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	103	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2208938)							
EB1904963-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	91.4	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2209286)							
EB1904909-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	94.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2209188)							
EB1904902-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	95.8	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2209187)							
EB1904902-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	95.9	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2208935)							
EB1904963-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.4 mg/L	92.7	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EB1826458	Page	: 1 of 8
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR MITCH MCGINNIS	Telephone	: +61 7 3552 8639
Project	: 1893795	Date Samples Received	: 01-Nov-2018
Site	: INLAND RAIL (P12)	Issue Date	: 06-Nov-2018
Sampler	: ROBERT CUPPER	No. of samples received	: 2
Order number	: 17893795	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- For all regular sample matrices, **NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**



Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis			
	Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural	310-01-BH2217, 310-01-BH2201	----	----	----	02-Nov-2018	30-Oct-2018	3

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER** Evaluation: ✘ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
		Container / Client Sample ID(s)	Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	30-Oct-2018	✘
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	27-Nov-2018	✔
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	06-Nov-2018	✔
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	13-Nov-2018	✔
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)	310-01-BH2201	30-Oct-2018	----	----	----	01-Nov-2018	27-Nov-2018	✔
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)	310-01-BH2201	30-Oct-2018	----	----	----	01-Nov-2018	27-Nov-2018	✔
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	27-Nov-2018	✔



Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED093F: SAR and Hardness Calculations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	27-Nov-2018	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	28-Apr-2019	✓
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	02-Nov-2018	28-Apr-2019	✓	02-Nov-2018	28-Apr-2019	✓
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	27-Nov-2018	✓
EG035T: Total Recoverable Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	27-Nov-2018	✓
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	02-Nov-2018	27-Nov-2018	✓
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	01-Nov-2018	27-Nov-2018	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	01-Nov-2018	01-Nov-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	01-Nov-2018	27-Nov-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK061G) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	01-Nov-2018	27-Nov-2018	✓	01-Nov-2018	27-Nov-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	01-Nov-2018	27-Nov-2018	✓	01-Nov-2018	27-Nov-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G) 310-01-BH2217,	310-01-BH2201	30-Oct-2018	----	----	----	01-Nov-2018	01-Nov-2018	✓



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	4	25.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO ₄ 2- by Discrete Analyser	ED041G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	10	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	4	25.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	10	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO ₄ 2- by Discrete Analyser	ED041G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	7	28.57	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Regular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	4	25.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	4	25.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.



Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO ₃ -. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
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Work Order : EB1826458
Client : GOLDER ASSOCIATES
Project : 1893795



<i>Preparation Methods</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EB1828548	Page	: 1 of 9
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR MITCH McGINNIS	Telephone	: +61 7 3552 8639
Project	: 1893795 INLAND RAIL P12	Date Samples Received	: 22-Nov-2018
Site	: ----	Issue Date	: 26-Nov-2018
Sampler	: SUSANTHA KUMARAPELI	No. of samples received	: 1
Order number	:	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- Matrix Spike outliers exist - please see following pages for full details.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers exist - please see following pages for full details.



Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EB1828101--001	Anonymous	Sulfate as SO4 - Turbidimetric	14808-79-8	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Matrix Spikes (MS)					
Nitrite as N by Discrete Analyser	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	22-Nov-2018	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	20-Dec-2018	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	29-Nov-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	06-Dec-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	20-Dec-2018	✓



Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	20-Dec-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2218	22-Nov-2018	----	----	----	23-Nov-2018	20-Dec-2018	✓
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2218	22-Nov-2018	----	----	----	23-Nov-2018	20-Dec-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 320-01-BH2218	22-Nov-2018	----	----	----	23-Nov-2018	21-May-2019	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) 320-01-BH2218	22-Nov-2018	23-Nov-2018	21-May-2019	✓	23-Nov-2018	21-May-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 320-01-BH2218	22-Nov-2018	----	----	----	23-Nov-2018	20-Dec-2018	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) 320-01-BH2218	22-Nov-2018	----	----	----	23-Nov-2018	20-Dec-2018	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	20-Dec-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	20-Dec-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	24-Nov-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	20-Dec-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) 320-01-BH2218	22-Nov-2018	23-Nov-2018	20-Dec-2018	✓	23-Nov-2018	20-Dec-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) 320-01-BH2218	22-Nov-2018	23-Nov-2018	20-Dec-2018	✓	23-Nov-2018	20-Dec-2018	✓

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 Work Order : EB1828548
 Client : GOLDER ASSOCIATES
 Project : 1893795 INLAND RAIL P12



Matrix: **WATER** Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method <i>Container / Client Sample ID(s)</i>	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) 320-01-BH2218	22-Nov-2018	----	----	----	22-Nov-2018	24-Nov-2018	✔



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	3	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	14	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	2	50.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	50.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	3	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	8	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	14	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	2	50.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	50.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	8	25.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Regular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	2	50.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	50.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	8	12.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	2	50.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	50.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	0	1	0.00	5.00	✗	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	0	1	0.00	5.00	✗	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.



Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO ₃ -. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO ₄ DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
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<i>Preparation Methods</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

QA/QC Compliance Assessment to assist with Quality Review

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Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR SUSANTHA KUMARAPALI	Telephone	: +61 7 3552 8639
Project	: 1893795 INLAND RAIL P12	Date Samples Received	: 07-Dec-2018
Site	: ----	Issue Date	: 12-Dec-2018
Sampler	: HANNAH GROVES	No. of samples received	: 1
Order number	:	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- For all regular sample matrices, **NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers exist - please see following pages for full details.



Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator Clear Plastic Bottle - Natural 320-01-BH2301	----	----	----	10-Dec-2018	08-Dec-2018	2

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Matrix Spikes (MS) Ammonia as N by Discrete analyser	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results. This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein. Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters. Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator Clear Plastic Bottle - Natural (EA005-P) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	08-Dec-2018	*
EA010P: Conductivity by PC Titrator Clear Plastic Bottle - Natural (EA010-P) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	04-Jan-2019	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C Clear Plastic Bottle - Natural (EA015H) 320-01-BH2301	07-Dec-2018	----	----	----	08-Dec-2018	14-Dec-2018	✓
ED037P: Alkalinity by PC Titrator Clear Plastic Bottle - Natural (ED037-P) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	21-Dec-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA Clear Plastic Bottle - Natural (ED041G) 320-01-BH2301	07-Dec-2018	----	----	----	08-Dec-2018	04-Jan-2019	✓



Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) 320-01-BH2301	07-Dec-2018	----	----	----	08-Dec-2018	04-Jan-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	04-Jan-2019	✓
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	04-Jan-2019	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	05-Jun-2019	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) 320-01-BH2301	07-Dec-2018	10-Dec-2018	05-Jun-2019	✓	10-Dec-2018	05-Jun-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	04-Jan-2019	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) 320-01-BH2301	07-Dec-2018	----	----	----	10-Dec-2018	04-Jan-2019	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) 320-01-BH2301	07-Dec-2018	----	----	----	11-Dec-2018	04-Jan-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) 320-01-BH2301	07-Dec-2018	----	----	----	08-Dec-2018	09-Dec-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) 320-01-BH2301	07-Dec-2018	----	----	----	11-Dec-2018	04-Jan-2019	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) 320-01-BH2301	07-Dec-2018	10-Dec-2018	04-Jan-2019	✓	10-Dec-2018	04-Jan-2019	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) 320-01-BH2301	07-Dec-2018	10-Dec-2018	04-Jan-2019	✓	10-Dec-2018	04-Jan-2019	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) 320-01-BH2301	07-Dec-2018	----	----	----	08-Dec-2018	09-Dec-2018	✓



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	1	3	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	8	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	1	8	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	6	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	3	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	8	25.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	15	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	8	25.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	6	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	3	33.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Regular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB) - Continued							
Chloride by Discrete Analyser	ED045G	1	15	6.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	8	12.50	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	16	6.25	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	1	100.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	11	9.09	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	1	100.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	15	6.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	15	6.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	6	16.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	13	7.69	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	3	33.33	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	11	9.09	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	5.56	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	0	1	0.00	5.00	✖	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	15	6.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	16	6.25	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	0	1	0.00	5.00	✖	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	0	1	0.00	5.00	✖	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	15	6.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	15	6.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	13	7.69	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	3	33.33	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	11	9.09	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	5.56	5.00	✔	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.



Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO ₃ -. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO ₄ DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

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Work Order : EB1830099
Client : GOLDER ASSOCIATES
Project : 1893795 INLAND RAIL P12



<i>Preparation Methods</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EB1903588	Page	: 1 of 9
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR MITCH McGINNIS	Telephone	: +61 7 3552 8639
Project	: 1893795 Inland Rail (Pkg 12)	Date Samples Received	: 13-Feb-2019
Site	: ----	Issue Date	: 20-Feb-2019
Sampler	: ROBERT CUPPER	No. of samples received	: 1
Order number	:	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- Matrix Spike outliers exist - please see following pages for full details.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers exist - please see following pages for full details.



Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020F: Dissolved Metals by ICP-MS	EB1903584--006	Anonymous	Lead	7439-92-1	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG020F: Dissolved Metals by ICP-MS	EB1903584--006	Anonymous	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis			
	Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural 320-01-BH2103		----	----	----	15-Feb-2019	11-Feb-2019	4

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Matrix Spikes (MS)					
Reactive Phosphorus as P-By Discrete Analyser	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
		Container / Client Sample ID(s)	Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P) 320-01-BH2103	11-Feb-2019		----	----	----	15-Feb-2019	11-Feb-2019	*
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P) 320-01-BH2103	11-Feb-2019		----	----	----	15-Feb-2019	11-Mar-2019	✓



Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) 320-01-BH2103	11-Feb-2019	----	----	----	14-Feb-2019	18-Feb-2019	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) 320-01-BH2103	11-Feb-2019	----	----	----	15-Feb-2019	25-Feb-2019	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) 320-01-BH2103	11-Feb-2019	----	----	----	13-Feb-2019	11-Mar-2019	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) 320-01-BH2103	11-Feb-2019	----	----	----	13-Feb-2019	11-Mar-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2103	11-Feb-2019	----	----	----	16-Feb-2019	11-Mar-2019	✓
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2103	11-Feb-2019	----	----	----	16-Feb-2019	11-Mar-2019	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 320-01-BH2103	11-Feb-2019	----	----	----	16-Feb-2019	10-Aug-2019	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) 320-01-BH2103	11-Feb-2019	16-Feb-2019	10-Aug-2019	✓	16-Feb-2019	10-Aug-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 320-01-BH2103	11-Feb-2019	----	----	----	16-Feb-2019	11-Mar-2019	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) 320-01-BH2103	11-Feb-2019	----	----	----	18-Feb-2019	11-Mar-2019	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) 320-01-BH2103	11-Feb-2019	----	----	----	15-Feb-2019	11-Mar-2019	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) 320-01-BH2103	11-Feb-2019	----	----	----	15-Feb-2019	11-Mar-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) 320-01-BH2103	11-Feb-2019	----	----	----	13-Feb-2019	13-Feb-2019	✓



Matrix: **WATER** Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) 320-01-BH2103	11-Feb-2019	----	----	----	15-Feb-2019	11-Mar-2019	✔
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) 320-01-BH2103	11-Feb-2019	15-Feb-2019	11-Mar-2019	✔	15-Feb-2019	11-Mar-2019	✔
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) 320-01-BH2103	11-Feb-2019	15-Feb-2019	11-Mar-2019	✔	15-Feb-2019	11-Mar-2019	✔
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) 320-01-BH2103	11-Feb-2019	----	----	----	13-Feb-2019	13-Feb-2019	✔



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	12	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	9	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	6	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	12	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	1	3	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	100.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	12	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	8	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	7	28.57	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	9	22.22	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	3	66.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	7	28.57	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	8	12.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Regular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	8	12.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	0	1	0.00	5.00	*	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	8	12.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	18	5.56	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.



Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO ₃ -. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
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Page : 9 of 9
Work Order : EB1903588
Client : GOLDER ASSOCIATES
Project : 1893795 Inland Rail (Pkg 12)



<i>Preparation Methods</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EB1904979	Page	: 1 of 9
Client	: GOLDER ASSOCIATES	Laboratory	: Environmental Division Brisbane
Contact	: MR SUSANTHA KUMARAPELI	Telephone	: +61 7 3552 8639
Project	: 1893795 Inland Rail P/2	Date Samples Received	: 27-Feb-2019
Site	: ----	Issue Date	: 04-Mar-2019
Sampler	: ROBERT CUPPER	No. of samples received	: 1
Order number	:	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- Matrix Spike outliers exist - please see following pages for full details.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**



Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EB1904963--001	Anonymous	Sulfate as SO4 - Turbidimetric	14808-79-8	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
ED045G: Chloride by Discrete Analyser	EB1904963--001	Anonymous	Chloride	16887-00-6	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural 320-01-BH2216	----	----	----	27-Feb-2019	26-Feb-2019	1

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results. This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein. Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters. Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	26-Feb-2019	*
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	26-Mar-2019	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	05-Mar-2019	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	12-Mar-2019	✓



Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	26-Mar-2019	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	26-Mar-2019	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	26-Mar-2019	✓
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	26-Mar-2019	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	25-Aug-2019	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) 320-01-BH2216	26-Feb-2019	28-Feb-2019	25-Aug-2019	✓	28-Feb-2019	25-Aug-2019	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	26-Mar-2019	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	26-Mar-2019	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	26-Mar-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	28-Feb-2019	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) 320-01-BH2216	26-Feb-2019	----	----	----	28-Feb-2019	26-Mar-2019	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) 320-01-BH2216	26-Feb-2019	28-Feb-2019	26-Mar-2019	✓	28-Feb-2019	26-Mar-2019	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) 320-01-BH2216	26-Feb-2019	28-Feb-2019	26-Mar-2019	✓	28-Feb-2019	26-Mar-2019	✓

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Matrix: **WATER** Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method <i>Container / Client Sample ID(s)</i>	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) 320-01-BH2216	26-Feb-2019	----	----	----	27-Feb-2019	28-Feb-2019	✔



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	12	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	4	25.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	5	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	14	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	13	7.69	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	7	28.57	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	5	40.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	7	28.57	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER**

Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Regular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB) - Continued							
Chloride by Discrete Analyser	ED045G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	4	25.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	5	20.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	6	16.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	5	20.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	7	14.29	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G. The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.



Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO ₃ -. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO ₄ DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

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<i>Preparation Methods</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

APPENDIX

W

Geotechnical

Appendix J Important
information

GOWRIE TO HELIDON ENVIRONMENTAL IMPACT STATEMENT



The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification