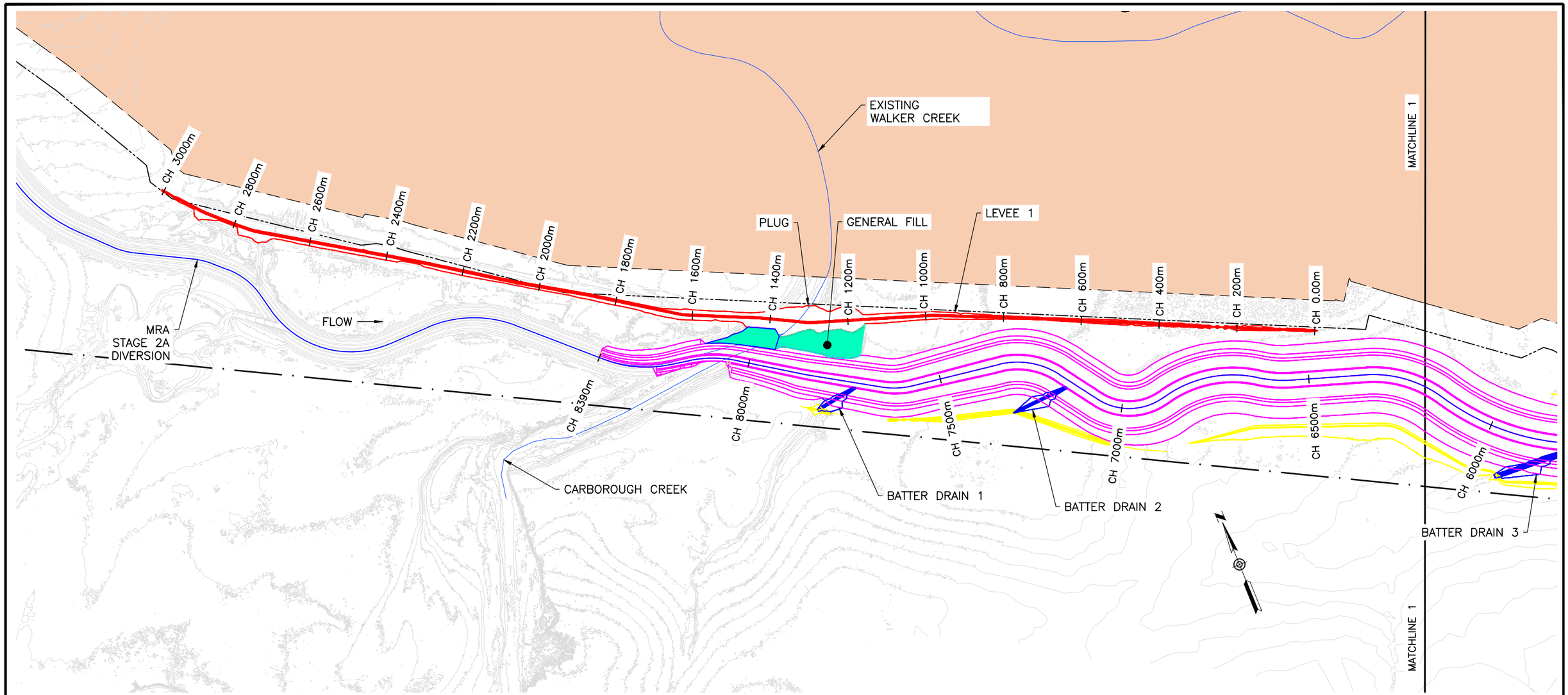

LEGEND	
FEATURE	LINETYPE/COLOUR
MAIN DIVERSION	
LEVEE	
BATTER DRAIN	
OVERLAND FLOW BUND	
PROPOSED PIT EXTENSION	
MINING LEASE BOUNDARY	
PROPOSED PIT EXTENTS BOUNDARY	
70 METER OFFSET BOUNDARY	

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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	NAME	DATE
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DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A
B
C NOT TO SCALE

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

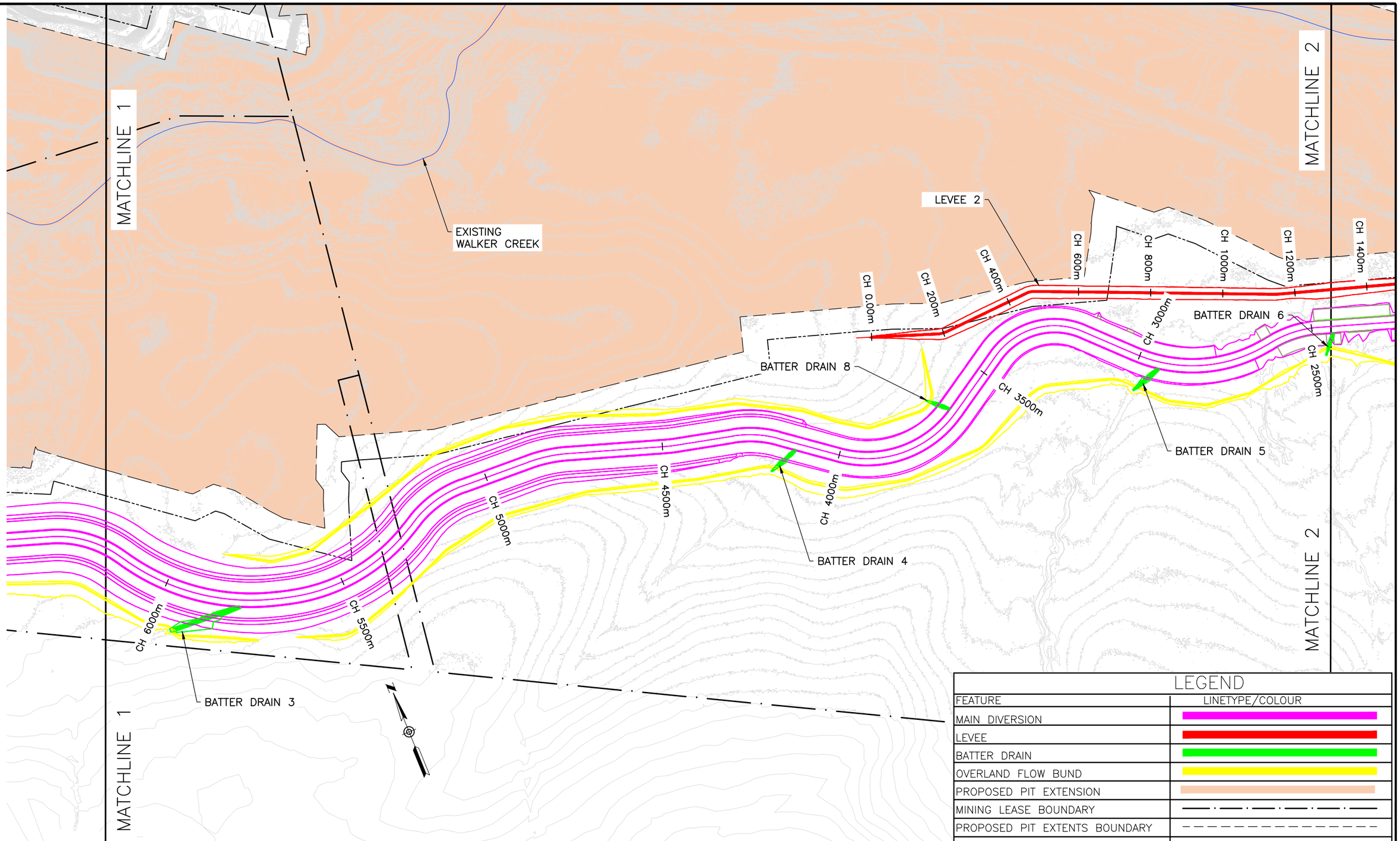
DETAIL PLAN 1 OF 3

Drawing No. P216009_002 Revision No. A

Sheet No. 2 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3



LEGEND	
FEATURE	LINETYPE/COLOUR
MAIN DIVERSION	
LEVEE	
BATTER DRAIN	
OVERLAND FLOW BUND	
PROPOSED PIT EXTENSION	
MINING LEASE BOUNDARY	
PROPOSED PIT EXTENTS BOUNDARY	
70 METER OFFSET BOUNDARY	

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

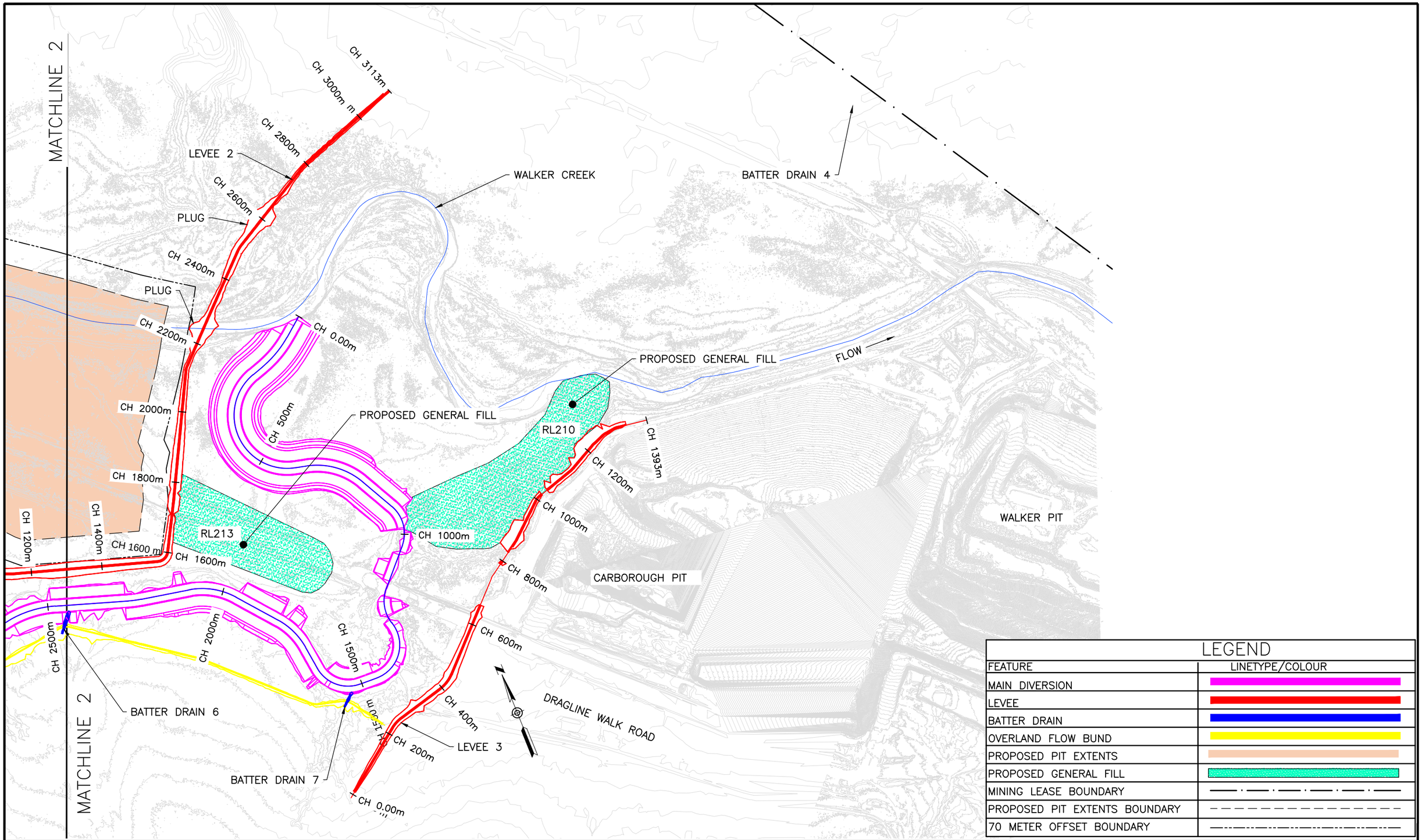
DETAIL PLAN 2 OF 3

Drawing No. P216009_003 Revision No. A

Sheet No. 3 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3



LEGEND	
FEATURE	LINETYPE/COLOUR
MAIN DIVERSION	
LEVEE	
BATTER DRAIN	
OVERLAND FLOW BUND	
PROPOSED PIT EXTENTS	
PROPOSED GENERAL FILL	
MINING LEASE BOUNDARY	
PROPOSED PIT EXTENTS BOUNDARY	
70 METER OFFSET BOUNDARY	

REV	DESCRIPTION	DATE	INTL
B	MINOR REVISION (PROPOSED GENERAL FILL)	19/07/16	MC
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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	NAME	DATE
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CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE
A
B
C
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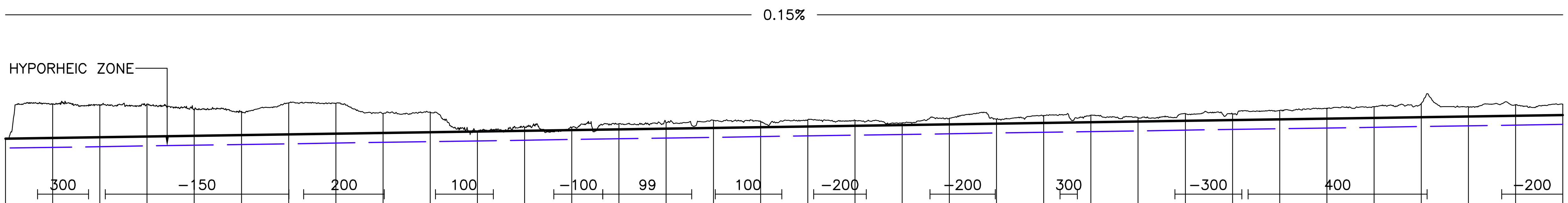
SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DETAIL PLAN 3 OF 3

Drawing No. P216009_004 Revision No. B
Sheet No. 4 File Name: P216009_001.dwg
 ABN 45 653 522 596
A3



DESIGN SURFACE	205.76	205.91	206.06	206.21	206.36	206.52	206.67	206.82	206.97	207.12	207.28	207.43	207.58	207.73	207.88	208.04	208.19
EXISTING SURFACE	205.64	213.14	212.95	213.10	211.87	211.44	213.33	213.24	211.05	211.38	207.32	208.03	208.09	208.91	209.13	209.65	209.42
DEPTH	−0.1	7.2	6.9	6.9	5.5	4.9	6.7	6.4	4.1	4.3	0	0.6	0.5	1.2	1.2	1.6	1.2
CHAINAGE	0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1100.00	1200.00	1300.00	1400.00	1500.00	1600.00

DESIGN SURFACE	208.34	208.49	208.64	208.80	208.95	209.10	209.25	209.40	209.56	209.71	209.86	210.01	210.16	210.32	210.47	210.62	210.77
EXISTING SURFACE	209.76	209.63	209.10	210.07	209.89	210.65	210.73	210.21	211.07	210.99	211.74	212.23	212.57	213.21	212.49	212.95	213.06
DEPTH	1.4	1.1	0.5	1.3	0.9	1.5	1.5	0.8	1.5	1.3	1.9	2.2	2.4	2.9	2	2.3	2.3
CHAINAGE	1700.00	1800.00	1900.00	2000.00	2100.00	2200.00	2300.00	2400.00	2500.00	2600.00	2700.00	2800.00	2900.00	3000.00	3100.00	3200.00	3300.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L.SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE
A 0 100 200 400
B 0 15 30 60
C

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION LONGITUDINAL SECTION 1 OF 3

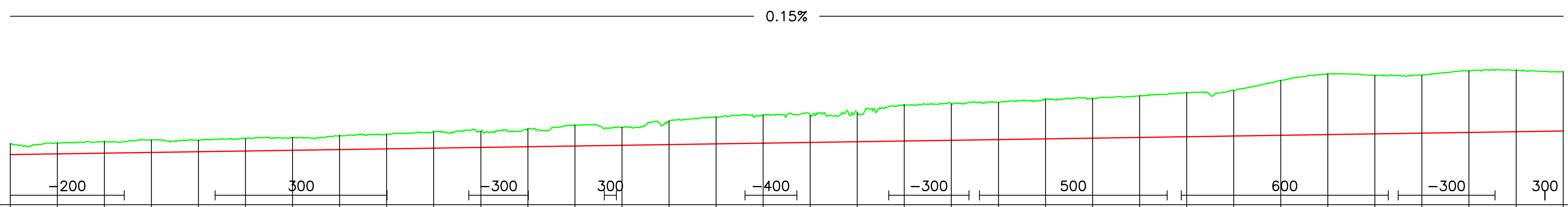
Drawing No. P216009_005 Revision No. A

Sheet No. 5 File Name: P216009_001-.dwg

 ABN 45 653 522 596 A3

NOTES

1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE



Datum RL 200

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE	DEPTH
3200.00	210.62	212.95	2.3
3300.00	210.77	213.06	2.3
3400.00	210.92	213.43	2.5
3500.00	211.08	213.75	2.7
3600.00	211.23	213.67	2.4
3700.00	211.38	214.04	2.7
3800.00	211.53	214.25	2.7
3900.00	211.68	214.73	3
4000.00	211.84	214.96	3.1
4100.00	211.99	215.54	3.6
4200.00	212.14	215.53	3.4
4300.00	212.29	216.12	3.8
4400.00	212.45	216.92	4.5
4500.00	212.60	216.44	3.8
4600.00	212.75	217.76	5
4700.00	212.90	218.64	5.7
4800.00	213.05	219.00	5.9
4900.00	213.21	218.98	5.8
5000.00	213.36	219.52	6.2
5100.00	213.51	221.22	7.7
5200.00	213.66	221.40	7.7
5300.00	213.81	221.67	7.9
5400.00	213.97	222.42	8.5
5500.00	214.12	222.51	8.4
5600.00	214.27	223.10	8.8
5700.00	214.42	223.80	9.4
5800.00	214.57	224.24	9.7
5900.00	214.73	226.39	11.7
6000.00	214.88	227.75	12.9
6100.00	215.03	227.42	12.4
6200.00	215.18	227.48	12.3
6300.00	215.33	228.38	13
6400.00	215.49	228.56	13.1
6500.00	215.64	228.24	12.6

REVISIONS

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE
A 0 100 200 400 m
B 0 15 30 60 m
C m

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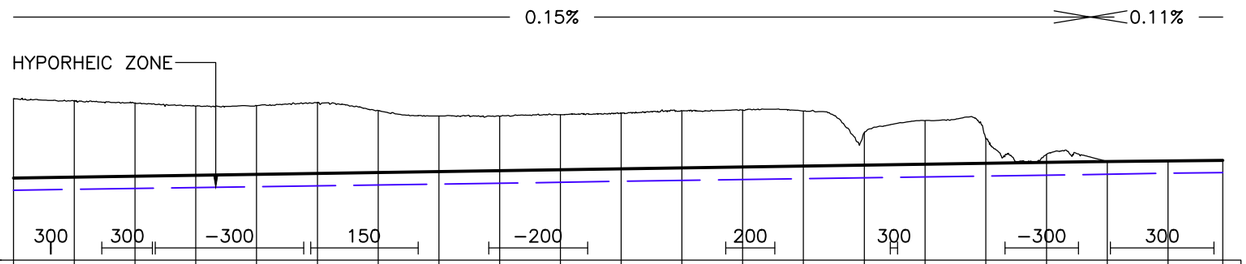
SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C
FUNCTIONAL DESIGN
DIVERSION LONGITUDINAL SECTION 2 OF 3

Drawing No. P216009_006 Revision No. A
Sheet No. 6 File Name: P216009_001-.dwg
 ABN 45 653 522 596
A3



Datum RL 202		300	300	−300	150		−200			200		300		−300	300							
DESIGN SURFACE	215.49	215.64	215.79	215.94	216.09	216.25	216.40	216.55	216.70	216.85	217.01	217.16	217.31	217.46	217.61	217.77	217.92	218.07	218.21	218.32	218.41	
EXISTING SURFACE	228.56	228.24	227.84	227.34	227.43	227.97	226.61	225.72	225.69	225.92	226.17	226.58	226.68	226.53	222.97	224.96	222.07	219.39	218.25	218.32	218.41	
DEPTH	13.1	12.6	12	11.4	11.3	11.7	10.2	9.2	9	9.1	9.2	9.4	9.4	9.1	5.4	7.2	4.2	1.3	0	0	0	
CHAINAGE	6400.00	6500.00	6600.00	6700.00	6800.00	6900.00	7000.00	7100.00	7200.00	7300.00	7400.00	7500.00	7600.00	7700.00	7800.00	7900.00	8000.00	8100.00	8200.00	8300.00	8390.00	

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
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DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	100	200	400
B	0	15	30	60
C				

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION LONGITUDINAL SECTION 3 OF 3

Drawing No. P216009_007 Revision No. A

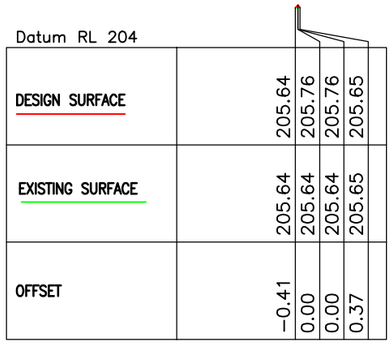
Sheet No. 7 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

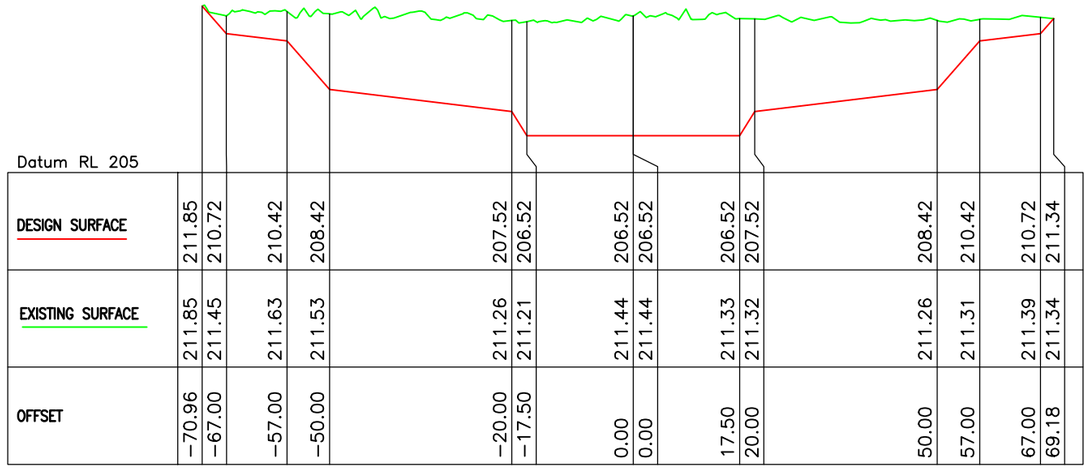
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 204

DESIGN SURFACE	205.64	205.76	205.76	205.65	
EXISTING SURFACE	205.64	205.64	205.64	205.65	
OFFSET	-0.41	0.00	0.00	0.37	

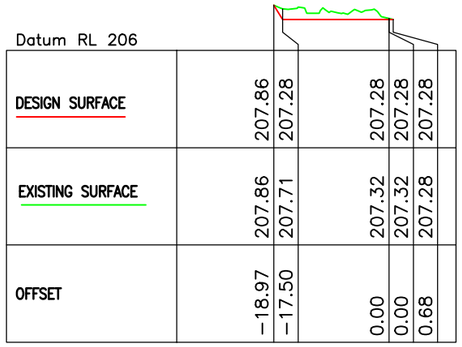
CH 0.00



Datum RL 205

DESIGN SURFACE	211.85	210.72	210.42	208.42	207.52	206.52	206.52	206.52	206.52	207.52	208.42	210.42	210.72	211.34	
EXISTING SURFACE	211.85	211.45	211.63	211.53	211.26	211.21	211.44	211.44	211.33	211.32	211.26	211.31	211.39	211.34	
OFFSET	-70.96	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	69.18	

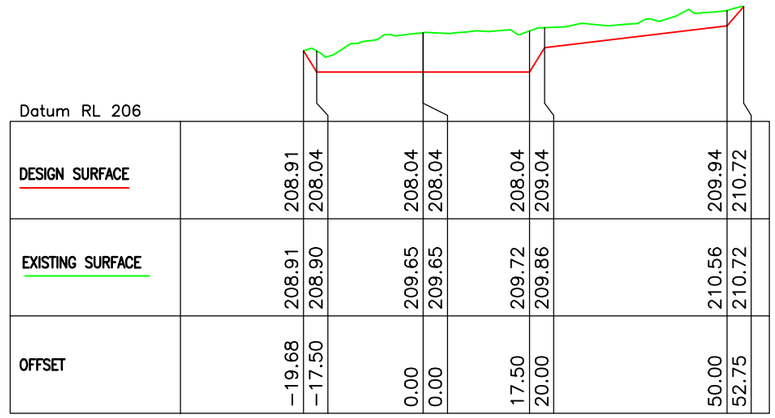
CH 500.00



Datum RL 206

DESIGN SURFACE	207.86	207.28	207.28	207.28	207.28	
EXISTING SURFACE	207.86	207.71	207.32	207.32	207.28	
OFFSET	-18.97	-17.50	0.00	0.00	0.68	

CH 1000.00



Datum RL 206

DESIGN SURFACE	208.91	208.04	208.04	208.04	208.04	209.04	209.94	210.72	
EXISTING SURFACE	208.91	208.90	209.65	209.65	209.72	209.86	210.56	210.72	
OFFSET	-19.68	-17.50	0.00	0.00	17.50	20.00	50.00	52.75	

CH 1500.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	10	20	40	mm
B	0	2.5	5	10	mm
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION CROSS SECTIONS 1 OF 6

Drawing No. P216009_008 Revision No. A

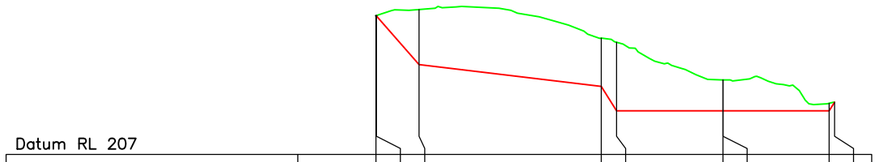
Sheet No. 8 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

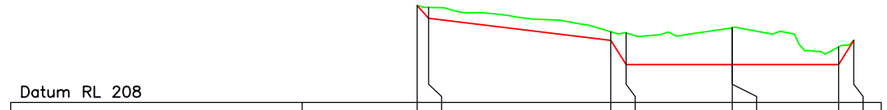
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 207

DESIGN SURFACE	212.70	212.70	210.70	209.80	208.80	208.80	208.80	208.80	209.15		
EXISTING SURFACE	212.70	212.71	212.96	211.78	211.61	210.07	210.07	209.10	209.15		
OFFSET	-57.08	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	18.38		

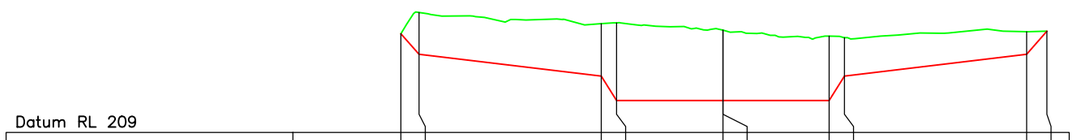
CH 2000.00



Datum RL 208

DESIGN SURFACE	211.99	211.46	210.56	209.56	209.56	209.56	209.56	209.56	210.55		
EXISTING SURFACE	211.99	211.91	210.91	210.87	211.07	211.07	210.28	210.55			
OFFSET	-51.85	-50.00	-20.00	-17.50	0.00	0.00	17.50	19.99			

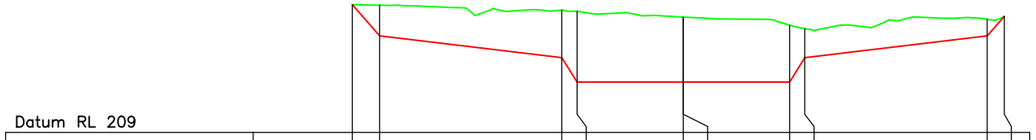
CH 2500.00



Datum RL 209

DESIGN SURFACE	213.07	212.22	211.32	210.32	210.32	210.32	211.32	212.22	213.17		
EXISTING SURFACE	213.07	213.94	213.47	213.51	213.21	213.21	212.97	212.91	213.15	213.17	
OFFSET	-52.97	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	53.34	

CH 3000.00



Datum RL 209

DESIGN SURFACE	214.26	212.98	212.08	211.08	211.08	211.08	211.08	212.08	212.98	213.78	
EXISTING SURFACE	214.26	214.23	214.03	213.99	213.75	213.75	213.42	213.27	213.66	213.78	
OFFSET	-54.47	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	52.81	

CH 3500.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	10	20	40	mm
B	0	2.5	5	10	
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION CROSS SECTIONS 2 OF 6

Drawing No. P216009_009 Revision No. A

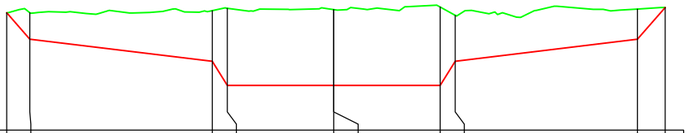
Sheet No. 9 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

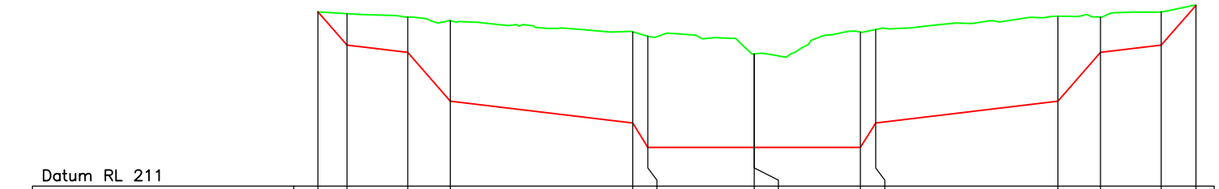
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 210

DESIGN SURFACE	214.83	213.74	212.84	211.84	211.84	211.84	211.84	212.84	213.74	215.04			
EXISTING SURFACE	214.83	214.83	214.91	215.02	214.96	214.96	215.07	214.72	214.98	215.04			
OFFSET	-53.82	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	54.57			

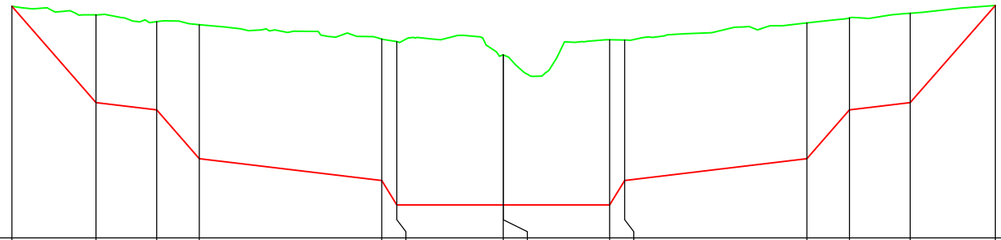
CH 4000.00



Datum RL 211

DESIGN SURFACE	218.16	216.80	216.50	214.50	213.60	212.60	212.60	212.60	212.60	213.60	214.50	216.50	216.80	218.43
EXISTING SURFACE	218.16	218.09	217.96	217.81	217.34	217.16	216.44	216.44	217.33	217.44	217.99	217.95	218.17	218.43
OFFSET	-71.77	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	72.71

CH 4500.00



Datum RL 212

DESIGN SURFACE	221.52	217.56	217.26	215.26	214.36	213.36	213.36	213.36	213.36	214.36	215.26	217.26	217.56	221.55
EXISTING SURFACE	221.52	221.17	220.89	220.77	220.17	220.07	219.52	219.52	220.15	220.13	220.84	221.04	221.24	221.55
OFFSET	-80.86	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	80.98

CH 5000.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	10	20	40	METRES
B	0	2.5	5	10	
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION CROSS SECTIONS 3 OF 6

Drawing No. P216009_010 Revision No. A

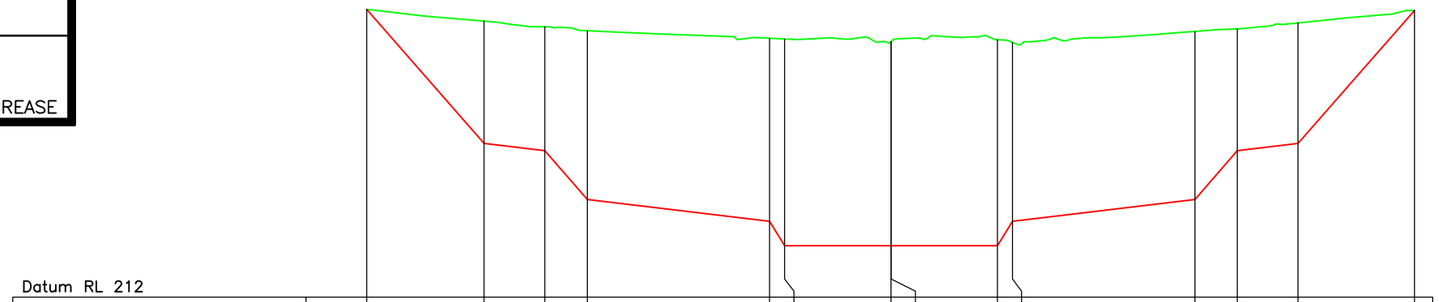
Sheet No. 10 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

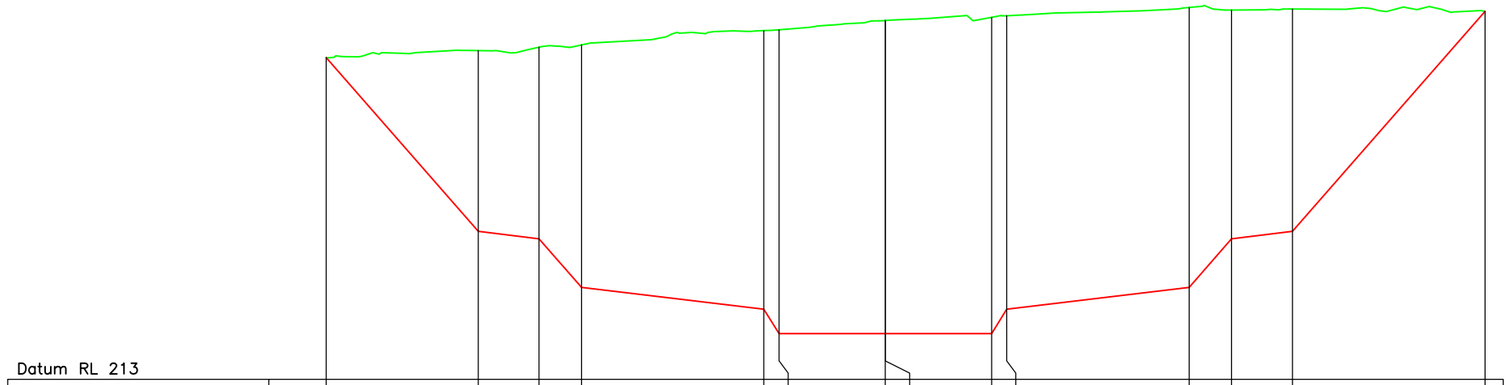
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 212

DESIGN SURFACE	223.83	218.32	218.02	216.02	215.12	214.12	214.12	214.12	214.12	214.12	215.12	216.02	218.02	218.32	223.79
EXISTING SURFACE	223.83	223.35	223.12	222.95	222.65	222.61	222.51	222.51	222.58	222.47	222.93	223.03	223.28	223.79
OFFSET	-86.30	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	86.15

CH 5500.00



Datum RL 213

DESIGN SURFACE	226.23	219.08	218.78	216.78	215.88	214.88	214.88	214.88	214.88	214.88	215.88	216.78	218.78	219.08	228.13
EXISTING SURFACE	226.23	226.52	226.66	226.75	227.34	227.37	227.75	227.75	227.89	227.95	228.29	228.19	228.22	228.13
OFFSET	-92.03	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	98.69

CH 6000.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A 0 10 20 40 mm
B 0 2.5 5 10 mm
C

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION CROSS SECTIONS 4 OF 6

Drawing No. P216009_011 Revision No. A

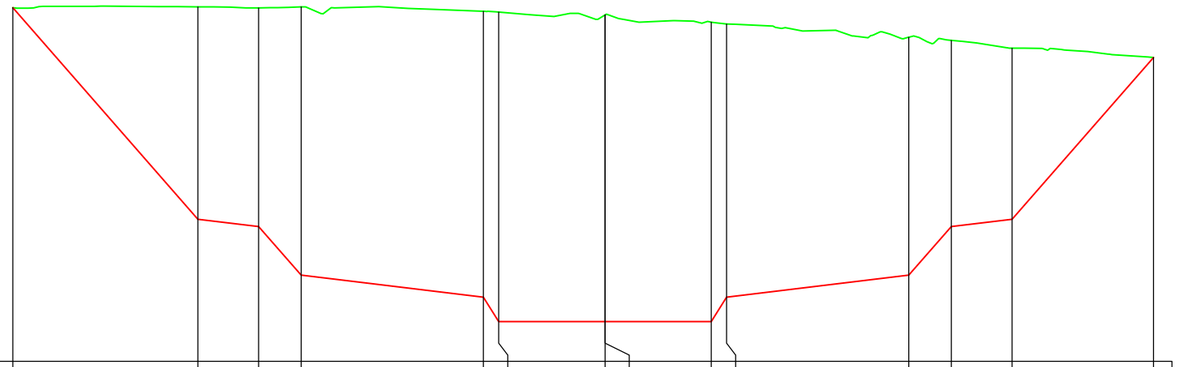
Sheet No. 11 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

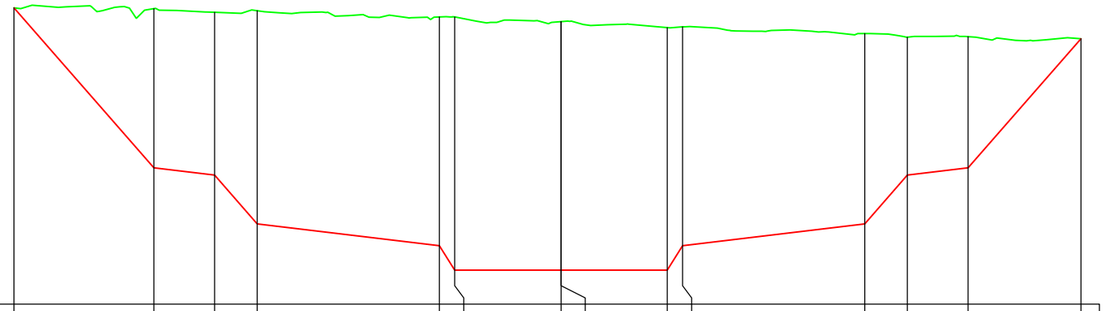
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 214

DESIGN SURFACE	228.54	219.84	219.54	217.54	216.64	215.64	215.64	215.64	215.64	216.64	217.54	219.54	219.84	226.49
EXISTING SURFACE	228.54	228.58	228.53	228.57	228.39	228.36	228.24	228.24	227.95	227.87	227.33	227.20	226.88	226.49
OFFSET	-97.45	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	90.29

CH 6500.00



Datum RL 215

DESIGN SURFACE	227.18	220.60	220.30	218.30	217.40	216.40	216.40	216.40	216.40	217.40	218.30	220.30	220.60	225.91
EXISTING SURFACE	227.18	227.15	227.00	227.06	226.80	226.81	226.61	226.61	226.37	226.40	226.12	225.98	226.00	225.91
OFFSET	-90.02	-67.00	-57.00	-50.00	-20.00	-17.50	0.00	0.00	17.50	20.00	50.00	57.00	67.00	85.59

CH 7000.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	10	20	40
B	0	2.5	5	10
C				

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

DIVERSION CROSS SECTIONS 5 OF 6

Drawing No. P216009_012 Revision No. A

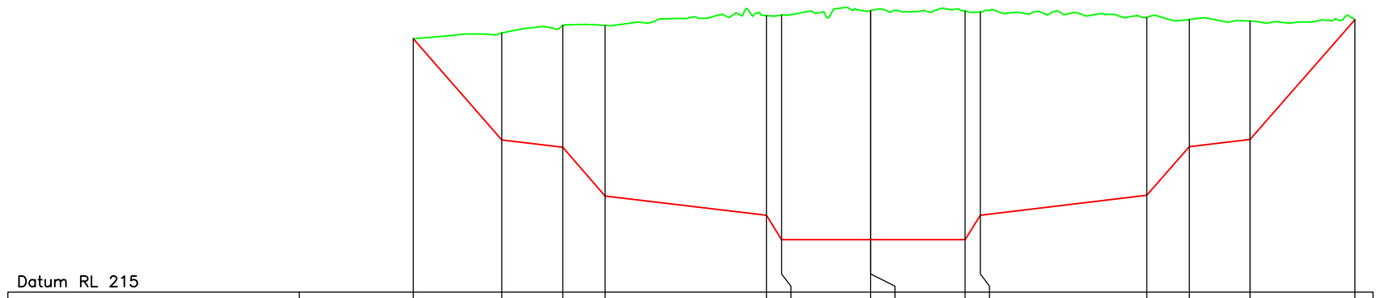
Sheet No. 12 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

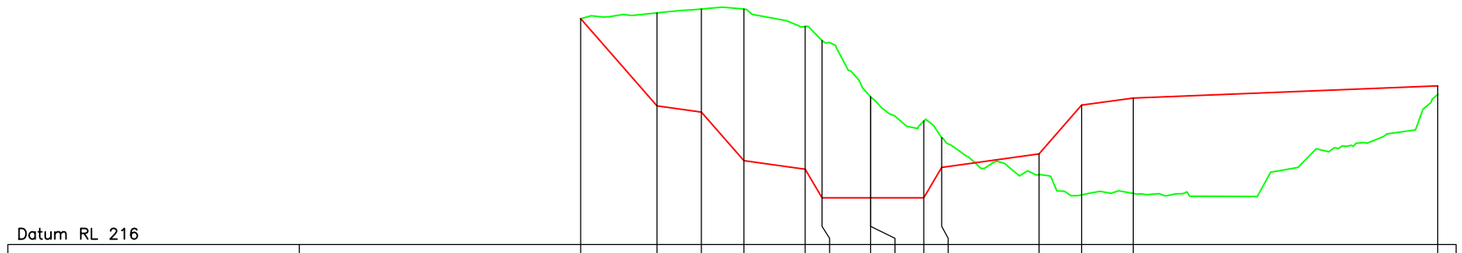
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 215

DESIGN SURFACE	225.42	221.26	220.96	218.96	218.16	217.16	217.16	217.16	217.16	218.16	218.98	220.98	221.28	226.21
EXISTING SURFACE	225.42	225.66	225.97	225.97	226.38	226.40	226.58	226.58	226.56	226.52	226.30	226.21	226.15	226.21
OFFSET	−75.29	−60.70	−50.70	−43.70	−17.15	−14.65	0.00	0.00	15.55	18.05	45.45	52.45	62.45	79.70

CH 7500.00



Datum RL 216

DESIGN SURFACE	225.29	221.70	221.45	219.45	219.09	217.92	217.92	217.92	217.92	219.17	219.73	221.73	222.03	222.53
EXISTING SURFACE	225.29	225.53	225.68	225.68	224.97	224.39	222.07	222.07	221.08	220.39	218.87	218.04	218.10	222.17
OFFSET	−47.74	−35.19	−27.88	−20.88	−10.79	−8.02	0.00	0.00	8.75	11.69	27.69	34.69	43.19	93.34

CH 8000.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	10	20	40	mm
B	0	2.5	5	10	
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

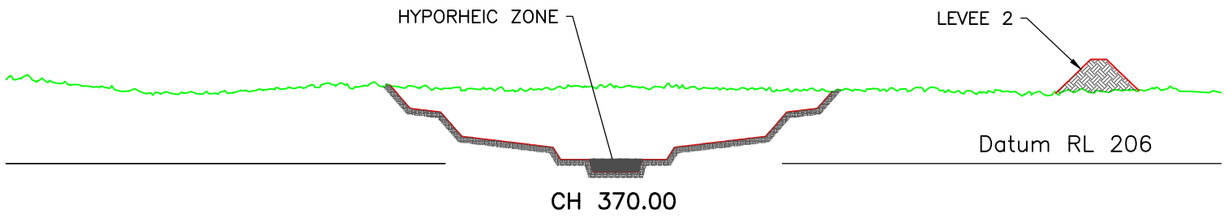
DIVERSION CROSS SECTIONS 6 OF 6

Drawing No. P216009_013 Revision No. A

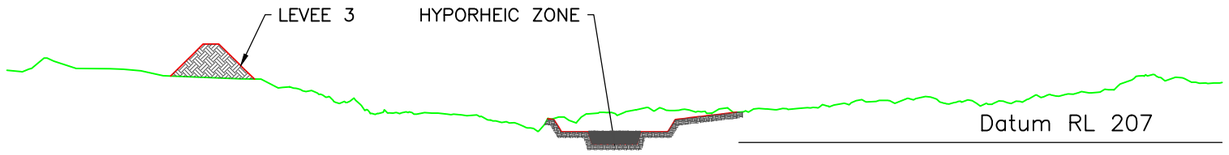
Sheet No. 13 File Name: P216009_001-.dwg

 ABN 45 653 522 596

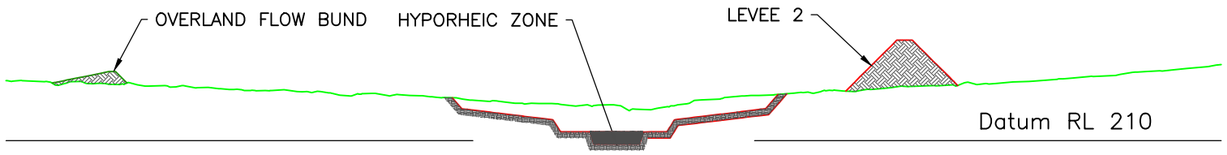
A3



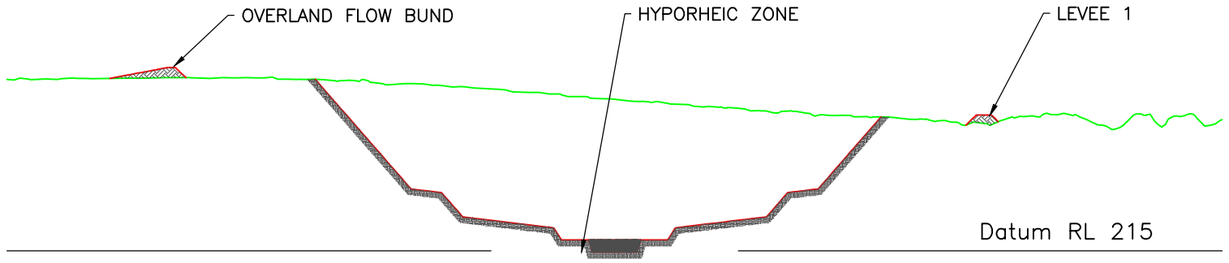
CH 370.00



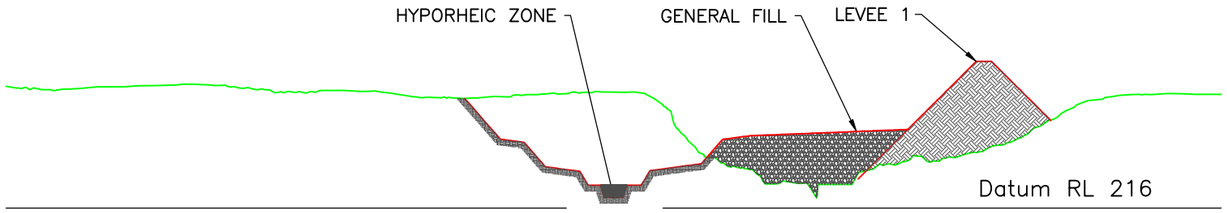
CH 1405.00



CH 3270.00



CH 6670.00



CH 7970.00

LEGEND

EXISTING SURFACE
DESIGN SURFACE

NOTE:
SECTIONS GIVEN LOOKING UPSTREAM

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE
A NOT TO SCALE
B
C

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

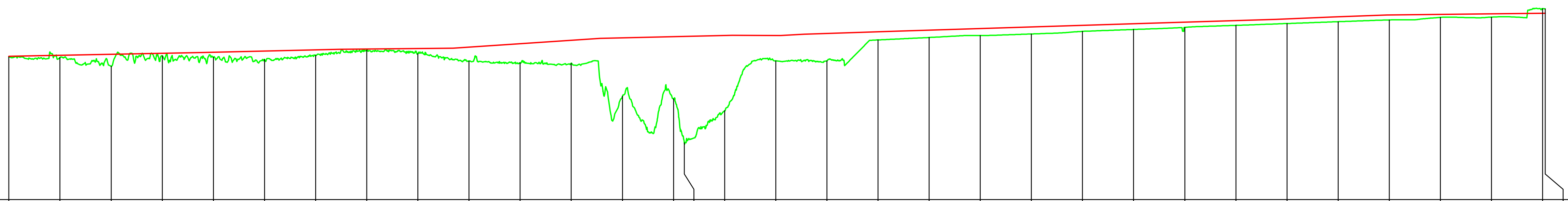
DIVERSION TYPICAL SECTIONS

Drawing No. P216009_014 Revision No. A
Sheet No. 14 File Name: P216009_001-.dwg
 ABN 45 653 522 596

A3

NOTES

1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE



Datum RL 212

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE	HEIGHT
0.00	226.01	225.95	0.1
100.00	226.11	225.88	0.2
200.00	226.21	225.03	1.2
300.00	226.31	226.05	0.3
400.00	226.42	225.91	0.5
500.00	226.53	225.69	0.8
600.00	226.64	226.09	0.5
700.00	226.72	226.61	0.1
800.00	226.77	226.27	0.5
900.00	226.91	225.55	1.4
1000.00	227.24	225.37	1.9
1100.00	227.57	225.32	2.3
1200.00	227.81	222.11	5.7
1300.00	227.93	221.86	6.1
1321.00	227.96	217.56	10.4
1400.00	228.05	220.70	7.3
1500.00	228.05	225.57	2.5
1600.00	228.24	225.56	2.7
1700.00	228.41	227.61	0.8
1800.00	228.57	227.85	0.7
1900.00	228.72	228.04	0.7
2000.00	228.88	228.19	0.7
2100.00	229.04	228.45	0.6
2200.00	229.20	228.63	0.6
2300.00	229.35	228.84	0.5
2400.00	229.50	229.04	0.5
2500.00	229.66	229.22	0.4
2600.00	229.87	229.40	0.5
2700.00	230.06	229.57	0.5
2800.00	230.11	229.82	0.3
2900.00	230.16	229.84	0.3
3000.00	230.22	230.67	0.4
3005.17		230.65	

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE
A 0 100 200 400 m
B 0 15 30 60 m
C m

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Client:
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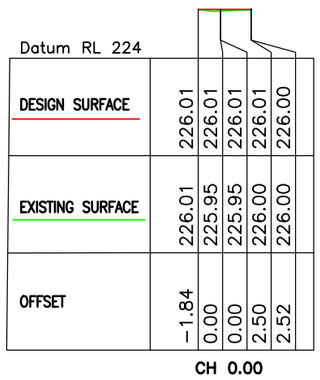
SOUTH WALKER CREEK MINE
MRA WALKER CREEK DIVERSION - STAGE 2C
FUNCTIONAL DESIGN
LEVEE 1 LONGITUDINAL SECTION

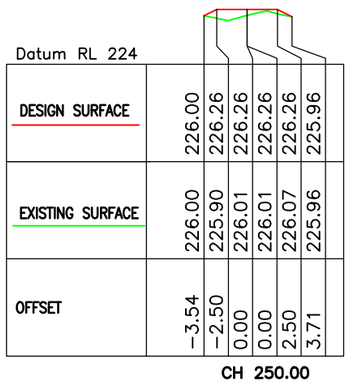
Drawing No. P216009_015 Revision No. A
Sheet No. 15 File Name: P216009_001-.dwg
 ABN 45 653 522 596
A3

NOTES

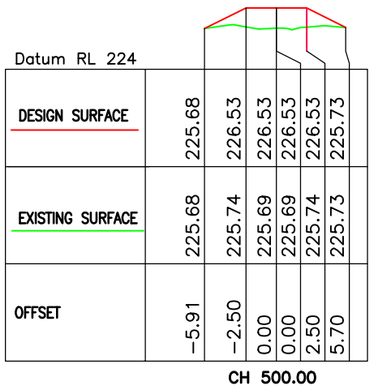
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



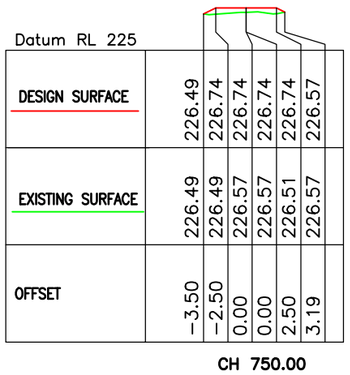
CH 0.00



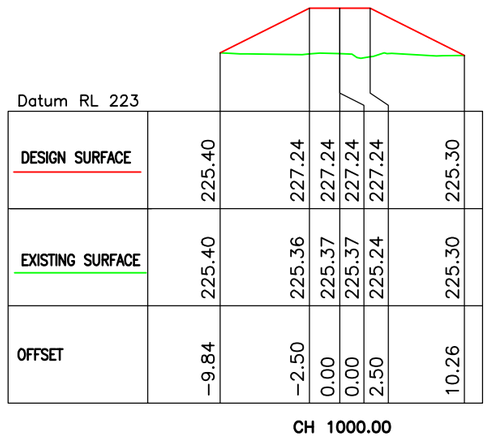
CH 250.00



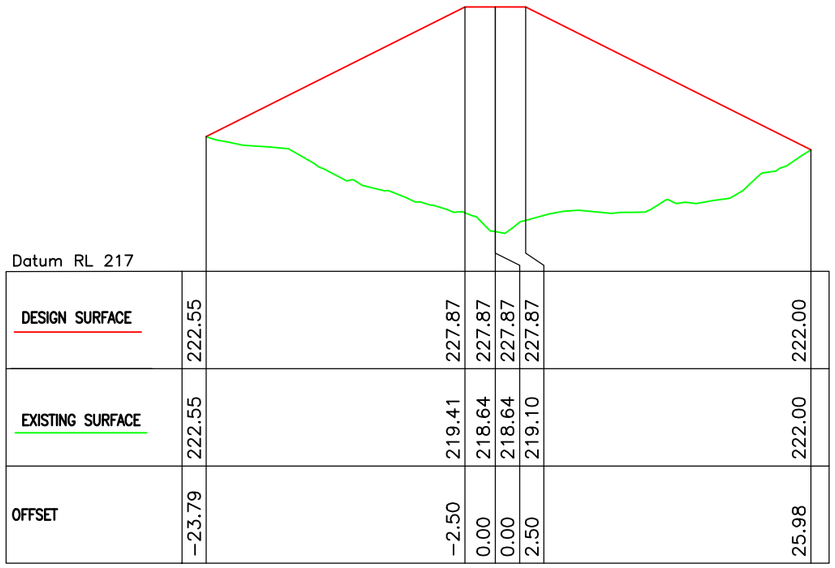
CH 500.00



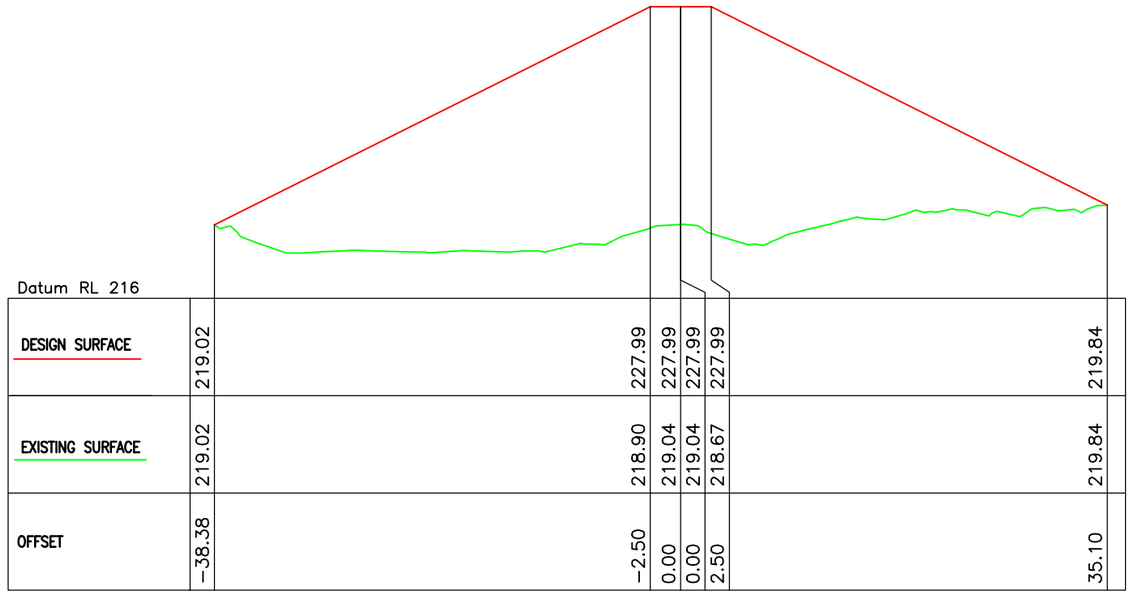
CH 750.00



CH 1000.00



CH 1250.00



CH 1350.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

	NAME	DATE
DESIGNED:	L. SUNNER	23/05/16
DRAWN:	M. COTTERALL	23/05/16
CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	5	10	20	m
B	0	2.5	5	10	m
C					

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Client: bhpbilliton resourcing the future

SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

LEVEE 1 CROSS SECTIONS 1 OF 2

Drawing No. P216009_016 Revision No. A

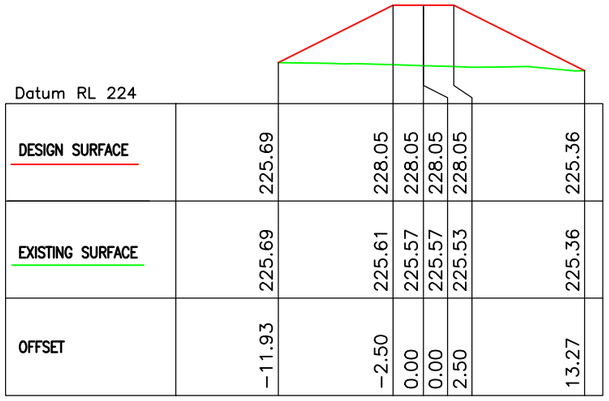
Sheet No. 16 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

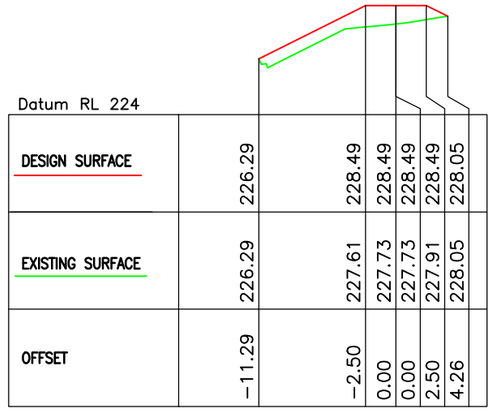
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



Datum RL 224

DESIGN SURFACE	225.69	228.05	228.05	228.05	228.05	225.36
EXISTING SURFACE	225.69	225.61	225.57	225.57	225.53	225.36
OFFSET	-11.93	-2.50	0.00	0.00	2.50	13.27

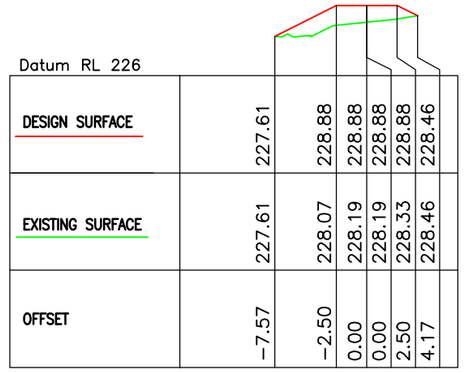
CH 1500.00



Datum RL 224

DESIGN SURFACE	226.29	228.49	228.49	228.49	228.49	228.05
EXISTING SURFACE	226.29	227.61	227.73	227.73	227.91	228.05
OFFSET	-11.29	-2.50	0.00	0.00	2.50	4.26

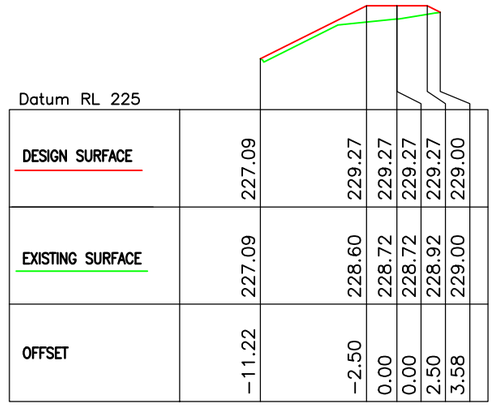
CH 1750.00



Datum RL 226

DESIGN SURFACE	227.61	228.88	228.88	228.88	228.88	228.46
EXISTING SURFACE	227.61	228.07	228.19	228.19	228.33	228.46
OFFSET	-7.57	-2.50	0.00	0.00	2.50	4.17

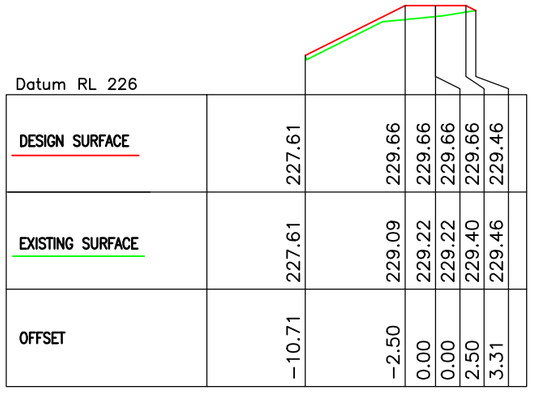
CH 2000.00



Datum RL 225

DESIGN SURFACE	227.09	229.27	229.27	229.27	229.27	229.00
EXISTING SURFACE	227.09	228.60	228.72	228.72	228.92	229.00
OFFSET	-11.22	-2.50	0.00	0.00	2.50	3.58

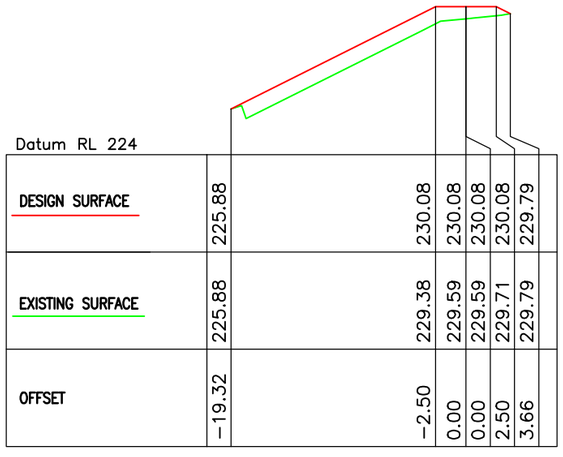
CH 2250.00



Datum RL 226

DESIGN SURFACE	227.61	229.66	229.66	229.66	229.66	229.46
EXISTING SURFACE	227.61	229.09	229.22	229.22	229.40	229.46
OFFSET	-10.71	-2.50	0.00	0.00	2.50	3.31

CH 2500.00



Datum RL 224

DESIGN SURFACE	225.88	230.08	230.08	230.08	230.08	229.79
EXISTING SURFACE	225.88	229.38	229.59	229.59	229.71	229.79
OFFSET	-19.32	-2.50	0.00	0.00	2.50	3.66

CH 2750.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	5	10	20	METRES
B	0	2.5	5	10	
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

LEVEE 1 CROSS SECTIONS 2 OF 2

Drawing No. P216009_017 Revision No. A

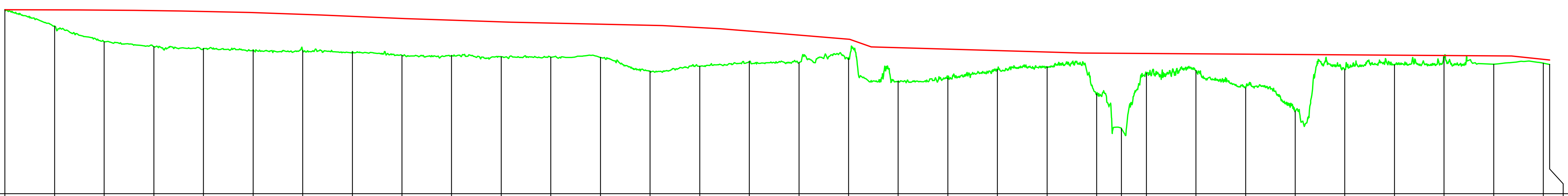
Sheet No. 17 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE



Datum RL 200

DESIGN SURFACE	218.57	218.55	218.52	218.47	218.39	218.29	218.11	217.90	217.68	217.52	217.34	217.21	217.10	216.99	216.76	216.42	216.01	215.59	214.74	214.59	214.45	214.31	214.20	214.18	214.16	214.13	214.09	214.06	214.02	213.99	213.95	213.92	213.56	
EXISTING SURFACE	218.54	216.91	215.33	214.84	214.64	214.50	214.46	214.33	213.97	213.94	213.82	213.77	213.76	212.35	212.85	213.34	213.22	213.63	211.36	211.65	212.52	212.82	210.08	206.57	212.15	212.43	210.68	208.32	212.52	212.99	213.81	213.06	213.17	213.04
HEIGHT	0	1.6	3.2	3.6	3.8	3.8	3.6	3.6	3.7	3.6	3.5	3.4	3.3	4.6	3.9	3.1	2.8	2	3.4	2.9	1.9	1.5	4.1	7.6	2	1.7	3.4	5.7	1.5	1	0.1	0.9	0.4	
CHAINAGE	0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1100.00	1200.00	1300.00	1400.00	1500.00	1600.00	1700.00	1800.00	1900.00	2000.00	2100.00	2200.00	2250.00	2300.00	2400.00	2500.00	2600.00	2700.00	2800.00	2900.00	3000.00	3100.00	3112.88

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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APPROVED:	R.LUCAS	23/05/16

SCALE
A 0 100 200 400 m
B 0 2 4 8 m
C m

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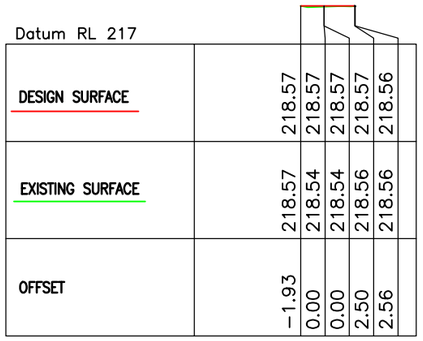
SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C
FUNCTIONAL DESIGN
LEVEE 2 LONGITUDINAL SECTION

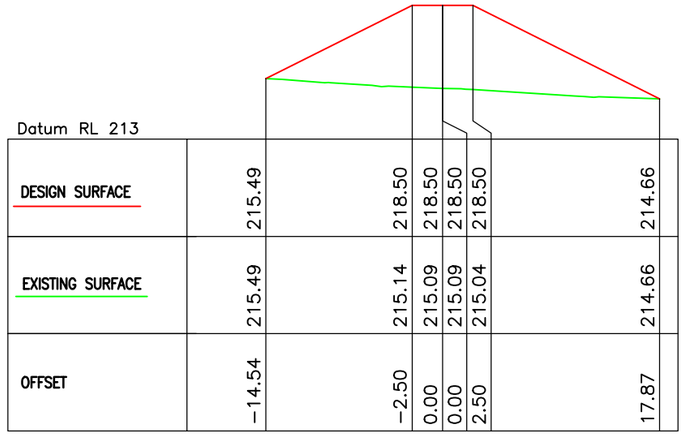
Drawing No. P216009_018 | Revision No. A
Sheet No. 18 | File Name: P216009_001-.dwg
©Alluvium Consulting Australia | ABN 45 653 522 596
A3

NOTES

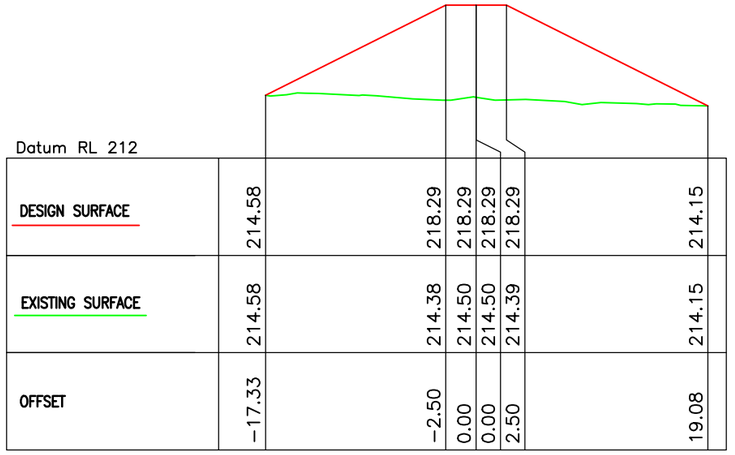
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



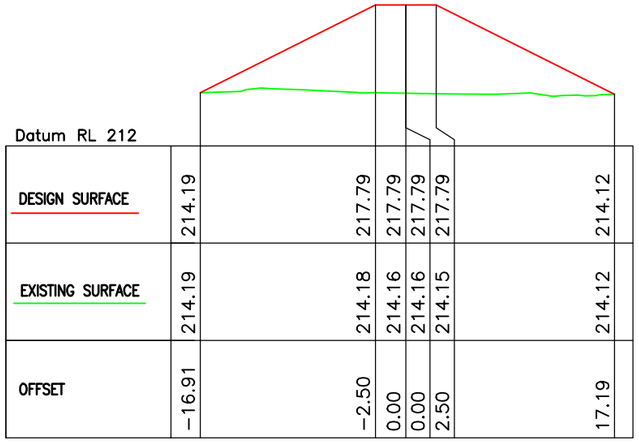
CH 0.00



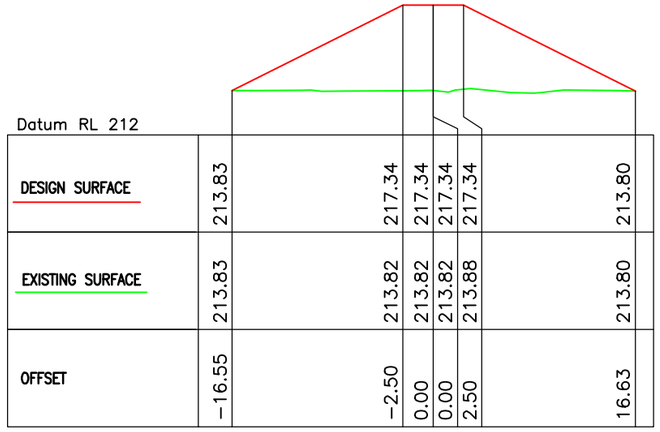
CH 250.00



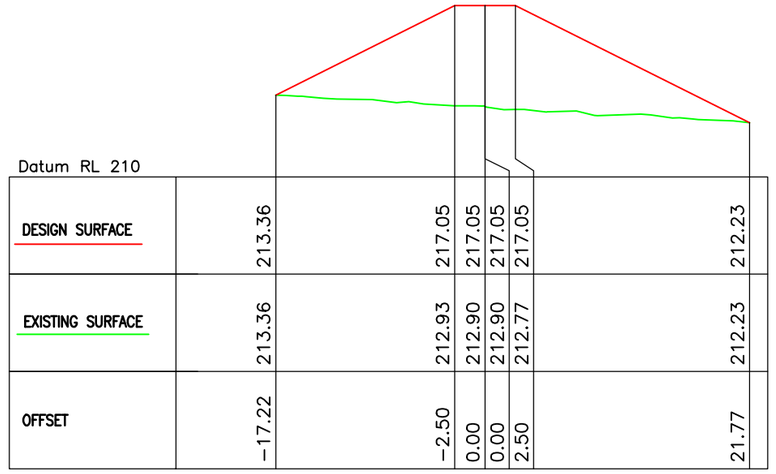
CH 500.00



CH 750.00



CH 1000.00



CH 1250.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

NOT FOR CONSTRUCTION

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CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	5	10	20	mm
B	0	6	12	24	mm
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

LEVEE 2 CROSS SECTIONS 1 OF 3

Drawing No. P216009_019 Revision No. A

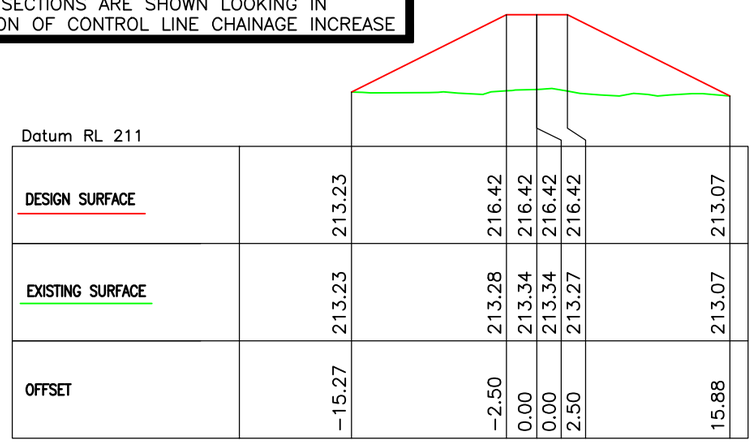
Sheet No. 19 File Name: P216009_001-.dwg

 ABN 45 653 522 596

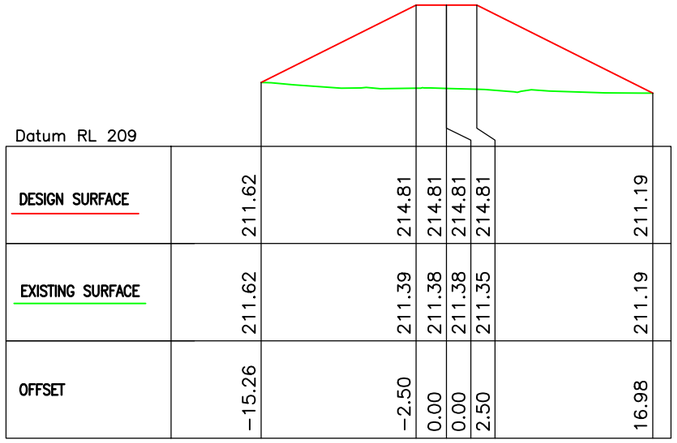
A3

NOTES

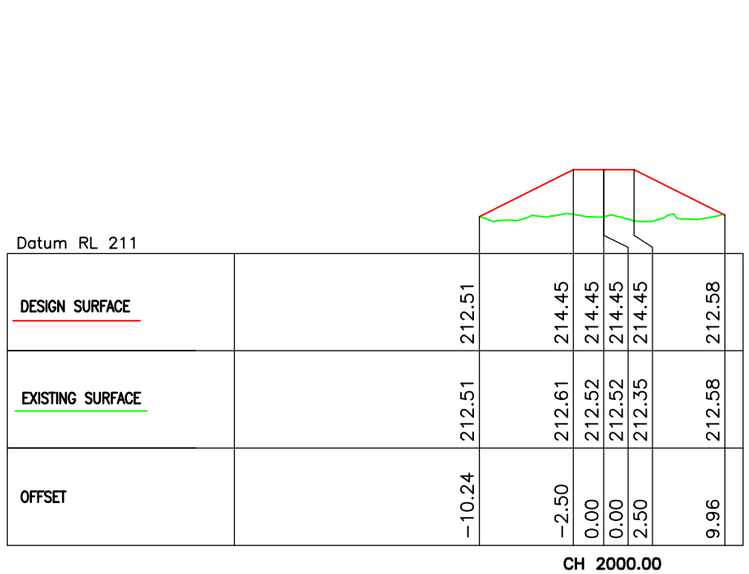
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



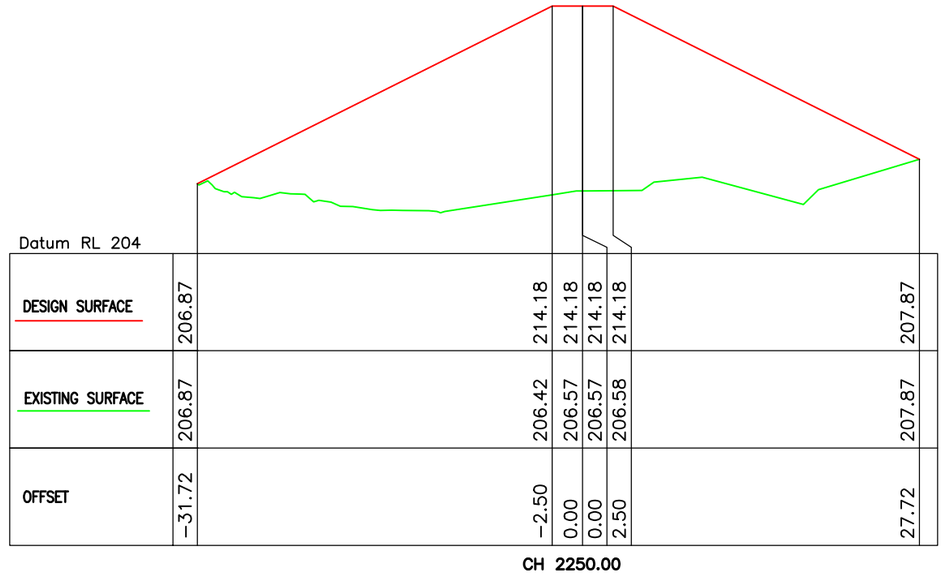
CH 1500.00



CH 1750.00



CH 2000.00



CH 2250.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	5	10	20	mm
B	0	6	12	24	
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

LEVEE 2 CROSS SECTIONS 2 OF 3

Drawing No. P216009_020 Revision No. A

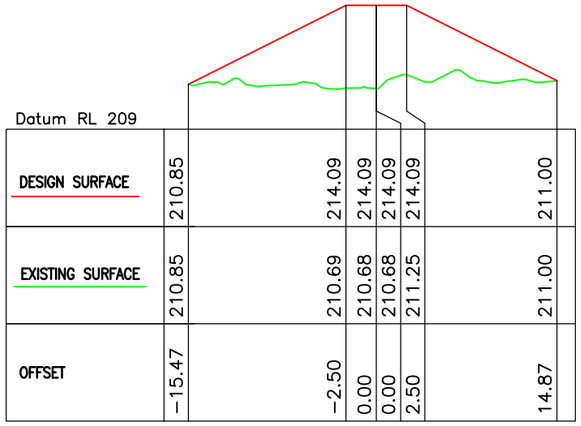
Sheet No. 20 File Name: P216009_001-.dwg

 ABN 45 653 522 596

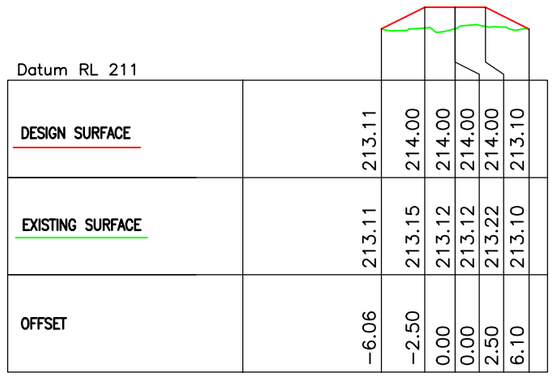
A3

NOTES

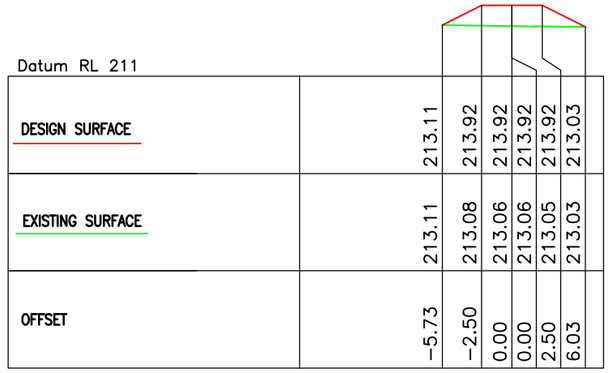
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



CH 2500.00



CH 2750.00



CH 3000.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	5	10	20	mm
B	0	6	12	24	mm
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

LEVEE 2 CROSS SECTIONS 3 OF 3

Drawing No. P216009_021 Revision No. A

Sheet No. 21 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

NOTES

1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE

Datum RL 202

DESIGN SURFACE	215.11	215.11	215.11	215.10	215.10	215.06	214.90	214.70	214.51	214.31	214.10	213.87	213.64	213.55	
EXISTING SURFACE	215.14	213.87	213.38	212.96	212.02	212.40	212.59	217.82	213.37	209.72	212.53	212.04	211.27	211.53	214.00
HEIGHT	−0	1.2	1.7	2.1	3.1	2.7	2.3	−3.1	1.1	4.6	1.6	1.8	2.4	2	
CHAINAGE	0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1100.00	1200.00	1300.00	1393.16

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

REVISIONS

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CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	100	200	400 mm
B	0	13	26	52
C				

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

LEVEE 3 LONGITUDINAL SECTION

Drawing No. P216009_022 Revision No. A

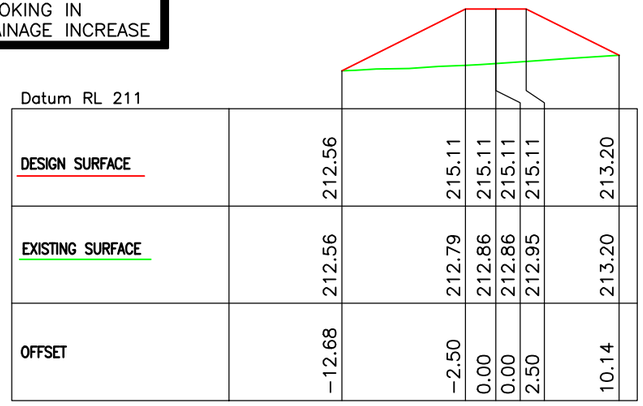
Sheet No. 22 File Name: P216009_001-.dwg

 ABN 45 653 522 596

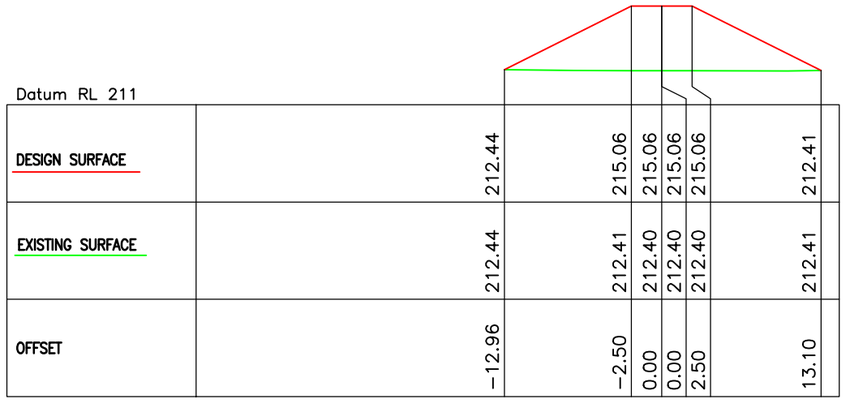
A3

NOTES

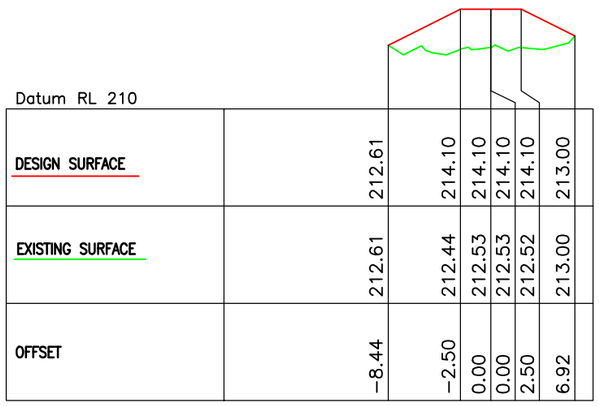
1. SCALE A IS THE HORIZONTAL SCALE
2. SCALE B IS THE VERTICAL SCALE
3. CROSS SECTIONS ARE SHOWN LOOKING IN DIRECTION OF CONTROL LINE CHAINAGE INCREASE



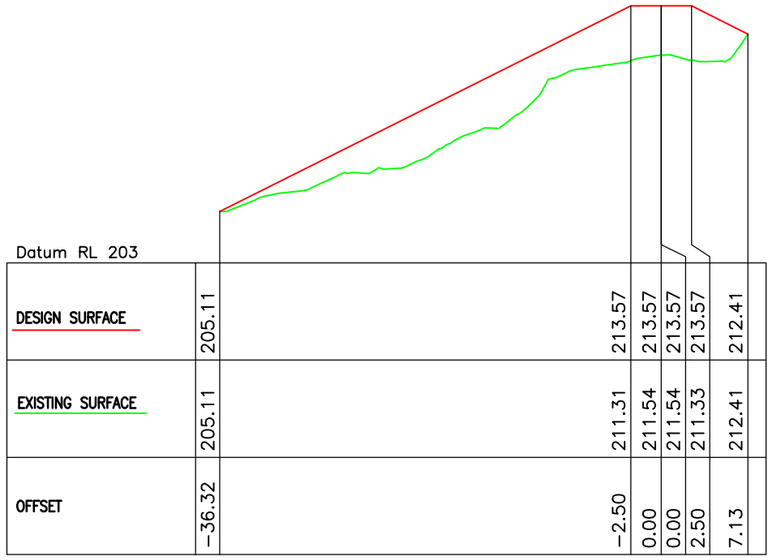
CH 250.00



CH 500.00



CH 1000.00



CH 1250.00

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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SCALE

A 0 5 10 20 mm
B 0 5 10 20 mm
C

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

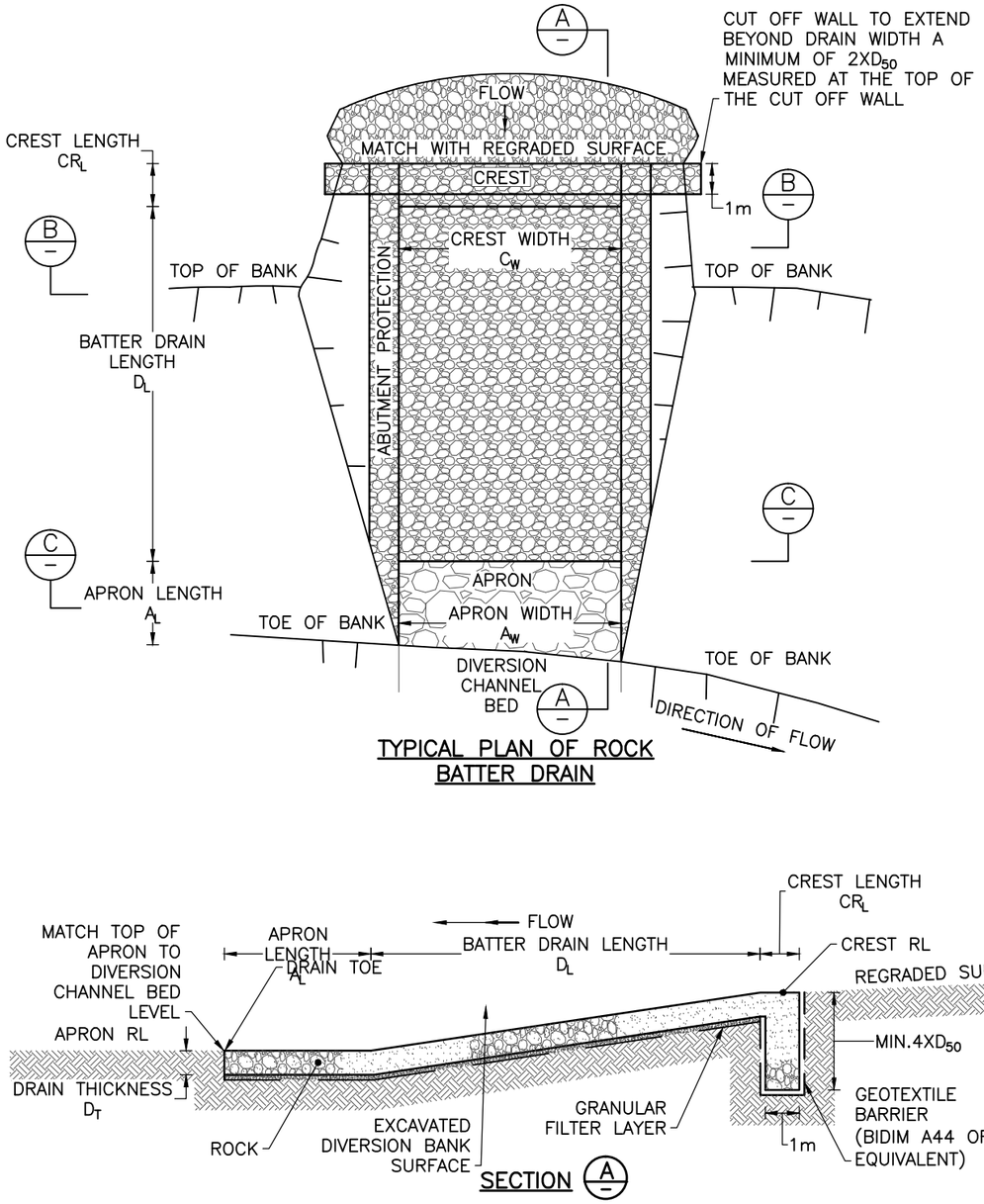
LEVEE 3 CROSS SECTIONS 1 OF 1

Drawing No. P216009_023 Revision No. A

Sheet No. 23 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

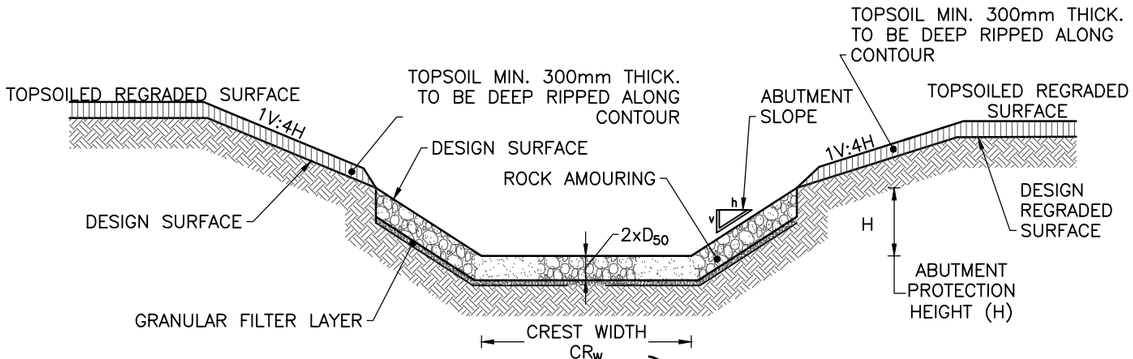


TYPICAL PLAN OF ROCK BATTER DRAIN

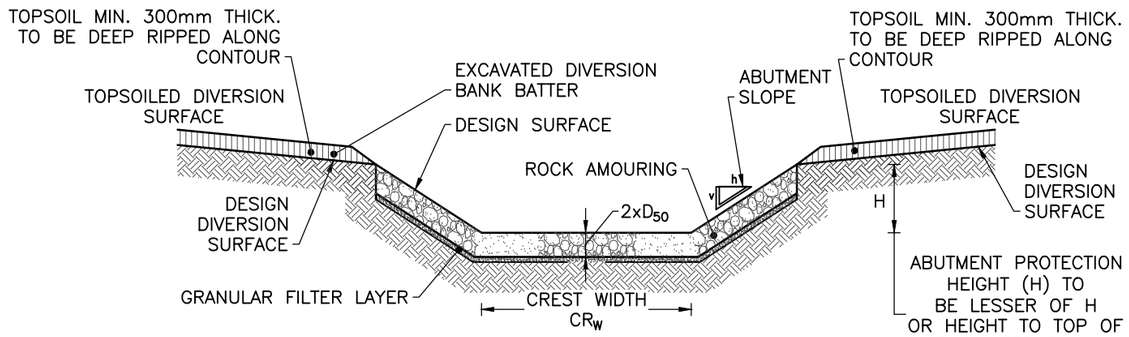
SECTION A

NOTES

1.	SUPPLY AND PLACEMENT OF GRANULAR FILTER MATERIAL, ROCK AND TOPSOIL TO BE IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS
2.	GEOTEXTILE SPECIFICATION TO BE IN ACCORDANCE WITH THIS DRAWING
3.	REFER TO DRAWING 216009-025 FOR BATTER DRAIN SPECIFICATIONS AND DIMENSIONS



SECTION B



SECTION C

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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APPROVED:	R.LUCAS	23/05/16

SCALE
A
B
C
NOT TO SCALE

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

BATTER DRAIN DETAILS

Drawing No. P216009_024 Revision No. A

Sheet No. 24 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

DRAIN ELEMENT	SYMBOL	UNITS	BATTER DRAIN 1	BATTER DRAIN 2	BATTER DRAIN 3	BATTER DRAIN 4	BATTER DRAIN 5	BATTER DRAIN 6	BATTER DRAIN 7	BATTER DRAIN 8
DRAIN LENGTH	CL	m	44.0	110.0	130.0	70.0	65.0	50.0	40.0	50.0
DRAIN DROP	CD	m	4.4	8.7	9.4	4.0	3.0	1.8	1.3	3.0
CREST RL (APPROX)	-	m	221.7	225.4	224.0	216.0	213.2	211.2	209.3	214.2
APRON RL (APPROX)	-	m	217.5	216.6	214.6	212.0	210.2	209.5	208.1	211.3
CREST LENGTH (MINIMUM)	CRL	m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CREST WIDTH	CRW	m	2.0	2.0	6.0	3.0	4.0	5.0	3.0	2.0
APRON LENGTH	AL	m	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
APRON WIDTH	AW	m	2.0	2.0	6.0	3.0	4.0	5.0	3.0	2.0
SIZE OF ROCK	D50	mm	300.0	200.0	350.0	350.0	350.0	300.0	300.0	200.0
DRAIN THICKNESS	CT	-	2xD50	2xD50	2xD50	2xD50	2xD50	2xD50	2xD50	2xD50
VOLUME OF ROCK	-	m^3	260	370	1130	490	510	385	270	190
ABUTMENT PROTECTION HEIGHT (MIN)	**H**	**m**	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ABUTMENT SLOPE	v:h	m/m	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5
GRANULAR FILTER THICKNESS	-	mm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GRANULAR FILTER MATERIAL SIZE	D50	mm	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
CREST COORDINATES (APPROX)			E: 643588	E: 644053	E: 645136	E: 646847	E: 647859	E: 648393	E: 649056	E: 647316
			N: 7593895	N: 7593699	N: 7593084	N: 7592869	N: 7592701	N: 7592590	N: 7592098	N: 7592891

REV	DESCRIPTION	DATE	INTL
A	ORIGINAL ISSUE	23/05/16	MC

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CHECKED:	L. SUNNER	23/05/16
APPROVED:	R.LUCAS	23/05/16

SCALE

A	0	5	10	20	mm
B	0	5	10	20	
C					

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SOUTH WALKER CREEK MINE

MRA WALKER CREEK DIVERSION - STAGE 2C

FUNCTIONAL DESIGN

BATTER DRAINS SPECIFICATIONS AND DIMENSIONS TABLE

Drawing No. P216009_025 Revision No. A

Sheet No. 25 File Name: P216009_001-.dwg

 ABN 45 653 522 596

A3

Attachment D

Water Licence Amendment

Client: 173074
File Ref: EMD0004

11 July 2017

Queensland Government

Department of
Natural Resources and Mines

BHP BILLITON MITSUI COAL PTY LTD
Attention: HEALTH, SAFETY AND ENVIRONMNET (HSE)
BHP BILLITON
GPO BOX 1389
BRISBANE QLD 4001

Dear Sir/Madam,

Re: Application for Amendment of Water Licence: reference 613491, Application reference 582179

Attached is an information notice, which is advice of the decision and the reasons for the decision for the abovementioned application and a Water Licence granted with conditions in accordance with the provisions of the *Water Act 2000*.

The chief executive has authorised this water licence to interfere by changing the course of flow in Walker Creek on the basis that the detailed design has been prepared to appropriate engineering standards by engineering consultants Alluvium Consulting Australia. The water licence does not authorise the levee works associated with this proposal as they do not constitute interference with the flow of water within a watercourse.

The proposed monitoring and maintenance plan must provide relevant information to identify that the diversion is progressing towards becoming a self-sustaining feature. This water licence has been granted with a monitoring condition that requires monitoring to be undertaken using the industry endorsed ACARP monitoring process specific to stream diversions within the Bowen Basin. The department would encourage that monitoring of flow events within the hillslope area and transition zones is undertaken to provide evidence that the diversion is performing as per the design intent.

From the information submitted with this application, it is acknowledged that the diversion has been designed to ensure that it will be a permanent feature of the landscape. However, the interference with the flow of water authorised by this water licence is considered to be temporary for the purpose of mining until the licensee negotiates acceptance from the Department of Natural Resources and Mines (or its successor) for the end of mine life rehabilitation of Walker Creek. The final rehabilitation of Walker Creek including the Stage 2C diversion will need to consider factors such as floodplain extents, adjoining landscape features including the location of final voids and surface and underground water interactions with the diversion.

Level 1, 22-30 Wood Street
PO Box 63, Mackay
Queensland 4740 Australia
Telephone+ 61 1800 822 100
Facsimile + 61 7 4999 6904
Website www.dnrm.qld.gov.au
ABN 59 020 847 551

Please note that this Water Licence does not negate the requirement to obtain any other approvals or to enter into other statutory arrangements.

If you have any further enquiries please call 1800 822 100 or email centralwaterservices@dnrm.qld.gov.au

Yours sincerely

Sandra Grinter
Project Officer

Information Notice

Application for Water Licence: application reference 582179

This information notice is given in accordance with *section 114* of the *Water Act 2000* ("the Act") in respect of the decision on the above application.

Background Matters

- The licensee applied under s216 of the *Water Act 2000* on 5 September 2016 to amend an existing water licence (613491). This application was made prior to an amendment of the *Water Act 2000* on 6 December 2016.
- Under transitional provisions including s1268 (2) of the current *Water Act 2000*, if this Act provides for an equivalent application, the application is taken to have been made, and may be dealt with, under the corresponding provisions of this Act.
- Pursuant to section 121 of the *Water Act 2000*, the licensee may apply under section 122 of the *Water Act 2000* to amend a water licence.
- Event 582179 seeks to amend an existing water licence 613491 that authorises the interference with the flow of water in Walker Creek by changing the course of flow on Mining Lease 4750.

Decision

I am an officer of the Department of Natural Resources and Mines delegated by the chief executive to exercise the power of the chief executive under section 114 of the Act. I have decided to grant with conditions the above application and provide the following information about my decision.

This information notice is advice of my decision and the reasons for the decision.

Evidence or other material on which the findings are based

In making findings of fact in relation to this decision, I considered the following evidence or other material:

- The application to amend a licence submitted by the licensee of water licence 613491 (BHP Billiton Mitsui Coal Pty Ltd) was considered properly made on 8 September 2016;
- The additional information provided by BHP Billiton Mitsui Coal Pty Ltd which was given in relation to this application;
    - Functional Design report entitled "Mulgrave Resource Access Walker Creek Diversion – Stage 2C", P216009_R01_v4.0, Alluvium, May 2016.
    - Function design plan, notes and drawings, Alluvium, May 2016.
    - Monitoring Program report: Mulgrave Resource Access Walker Creek Diversion Stage 2C Functional Design, P216009_R03_v2.0, Alluvium, June 2016.
    - Revegetation plan report entitled "Mulgrave Resources Access Walker Creek Diversion – Stage 2C Revegetation plan", P216009_R02v2.0, Alluvium, July 2016 plus revegetation plans.
- The public notice of the application in the Daily Mercury on 15 October 2016;
- The Water Plan (Fitzroy Basin) 2011;

- The Fitzroy Basin Resource Operations Plan 2014;
- Report entitled “Mulgrave Resources Access Walker Creek Diversion – Stage 2C Detailed Design”, P216043_R02_v02, Alluvium, February 2017.
- Detailed Design Drawings, P216009_001 and 004, Alluvium, July 2016.
- Detailed Design Drawings, P216009_002, 003 and 005-025, Alluvium, May 2016.
- Report entitled: “Monitoring Program: Mulgrave Resource Access Walker Creek Diversion Stage 2C”, P216043_R04_v02, Alluvium, February 2017.
- Report entitled: “Technical specification – Revegetation and Soils: Mulgrave Resource Access Walker Creek Diversion - Stage 2C”, P216043_R13V01, Alluvium, February 2017.
- “South Walker Creek Mine MRA 2C Project – Geotechnical Report”, H351964-00000-229-223-0001, Hatch, October 2016.
- The departmental guideline entitled ‘Guideline: Works that interfere with water in a watercourse – watercourse diversions, September 2014;
- The following Australian Coal Association Research Program (ACARP) reports:
    - Project C8030 Maintenance of Geomorphic Processes in the Bowen Basin River Diversions, dated May 2000;
    - Project C9068 Monitoring and Evaluation Program for Bowen Basin River Diversions, dated February 2001; and
    - Project C9068 Design and Rehabilitation Criteria for Bowen Basin Diversions, dated July 2002.
- The departmental investigation which is dated 28 June 2017;
- Sections 111, 112, 113, 114, 1268 and 1273 of the *Water Act 2000;* and
- Environmental Authority EPML00712313.

Findings on material questions of fact

My findings of fact in this matter are:-

- The application was considered to be properly made under the *Water Act 2000* on 8 September 2016;
- Economic justification for the diversion was provided;
- The application was considered to be properly published under the provisions of the *Water Act 2000*;
- The grant of the amended water licence is in accordance with the provisions of the *Water Plan (Fitzroy Basin) 2011* and the *Fitzroy Basin Resource Operations Plan 2014*;
- The report entitled “Mulgrave Resources Access Walker Creek Diversion – Stage 2C Detailed Design”, P216043_R02_v02, Alluvium, February 2017 has formed the basis for the grant of this water licence;
- The departmental guideline entitled ‘Guideline: Works that interfere with water in a watercourse – watercourse diversions, September 2014 has been considered in the development of the diversion design by the proponent;
- No take or impoundment of water is authorised by the water licence;
- Sections 113 and 114 of *Water Act 2000* have been considered; and
- Environmental Authority EPML00712313 authorises the mining of coal and in order to access the resource, Walker Creek requires diverting.

Reasons for the decision
Having regard to the material and findings referred to above, I have decided that the granting of this authority, subject to the attached conditions, will not have a significant long-term impact upon:

- the physical integrity of the watercourse
- the entitlement of existing licensees, permittees and riparian landowners
- the sustainable management of the local water and associated natural ecosystems
- the community uses of the water in Walker Creek.

If you are dissatisfied, you may apply for a review of the decision. This application and a subsequent appeal must be in accordance with *sections 851,861* to *863* and *878* of the *Water Act 2000*. Copies of these sections of the Act are enclosed. The application form must be supported by enough information to enable the reviewer to decide the application. An application for an internal review must be received at the office within 30 business days from the date you receive this notice.

Sandra Grinter
Project Officer

WATER LICENCE
Water Act 2000

Queensland Government

Reference	613491	**Expiry Date**	30/06/2111
Licensee	BHP BILLITON MITSUI COAL PTY LTD		
Authorised Activity	Interfere with the flow of water in Walker Creek by changing the course of flow on or adjoining land described as Mining Lease 4750. Interference with the flow of water for a total length of 11,840m. Walker Creek Diversion.		
Authorised Purpose	Diverting the Flow of Water		

This water licence is subject to the conditions endorsed hereon or attached hereto.

Given at Mackay this TWELFTH day of JULY 2017.

Delegate of the Chief Executive
Department of Natural Resources and Mines

Water Licence: 613491
Expiry Date: 30/06/2111

Conditions: Schedule B

Refer to Schedule B attachment

1. **Interference**

The interference with flow authorised by this water licence is the interference that is described in the following document(s):

- Report entitled “Summary Design Report: Mulgrave Resource Access Walker Creek Diversion Stage 2A Design Report”, Alluvium, April 2014
- Detailed Design Drawings, P214003_000-037v1, Alluvium, September 2014
- Report entitled “Revegetation Plan Report: Mulgrave Resources Access Walker Creek Diversion Stage 2A Detailed Design”, P214003_R11v2.0, Alluvium, April 2014
- Report entitled “Mulgrave Resources Access Walker Creek Diversion – Stage 2C Detailed Design”, P216043_R02_v02, Alluvium, February 2017.
- Detailed Design Drawings, P216009_001 and 004, Alluvium, July 2016.
- Detailed Design Drawings, P216009_002, 003 and 005-025, Alluvium, May 2016.
- Report entitled: “Monitoring Program: Mulgrave Resource Access Walker Creek Diversion Stage 2C”, P216043_R04_v02, Alluvium, February 2017.
- Report entitled: “Technical specification – Revegetation and Soils: Mulgrave Resource Access Walker Creek Diversion - Stage 2C”, P216043_R13V01, Alluvium, February 2017.

2. Monitoring

a) The licensee must:
   - maintain and implement a monitoring and evaluation program that quantifies that the outcomes of the approved design of the interference authorised under this water licence are being achieved; or
   - maintain and implement a monitoring and evaluation program that quantifies that the interference authorised under this water licence is meeting or progressing towards achieving the following outcomes:
     - Developing features (including geomorphic and vegetation) present in the landscape and in local watercourses.
     - The watercourse diversion maintains a sediment transport regime that allows the diversion to be self-sustaining and not directly impact on upstream and downstream reaches.
     - The watercourse diversion and associated structures maintain equilibrium and functionality and do not require ongoing maintenance.

b) The monitoring and evaluation program must include recommendations as per ACARP Project C9068 "Monitoring and Evaluation Program for Bowen Basin River Diversions".

c) An electronic copy of the monitoring and evaluation report, prepared by a registered professional engineer (RPEQ), must be provided to the chief executive on request.

d) The report required under Schedule B condition 2. c) must include an evaluation of monitoring activities between reporting periods that demonstrates the diversion is meeting the outcomes of the approved design, or meeting or progressing towards achieving the outcomes in Schedule B condition 2. a). If the diversion is not meeting these outcomes, appropriate measures must be implemented and

monitored to ensure that the development of the diversion will meet these outcomes, and the report must detail these including a timetable for completing the proposed measures.

3. As Built Plans

The licensee must within 90 business days after constructing the diversion, provide the Chief Executive with an electronic copy of "as built" plans in the same scale and line form as the approved design drawings.

4. Maintenance

The licensee must maintain to the satisfaction of the chief executive, maintain the diversion in accordance with the conditions of the licence and must carry out any activities or make any alteration deemed necessary by the chief executive, after discussion and consultation with the licence holder, for the protection and proper maintenance of the diversion.

5. Modification

Where the operation of the diversion channel in the opinion of the chief executive has demonstrated that channel equilibrium cannot be achieved the chief executive may direct the licensee to take whatever measures and modifications are mutually agreed as necessary, over a time period agreed to by the licence holder, for the protection and proper maintenance of the diversion.

6. Relinquishment

Relinquishment of this water licence can only occur when it is deemed by the chief executive to satisfy the outcomes in Schedule B condition 2. a). Any request for relinquishment will be negotiated with the chief executive and will require the submission of a final monitoring and evaluation report prepared and certified by a RPEQ. The report must contain an evaluation of operational and relinquishment monitoring information that demonstrate that the diversion has been subjected to a suitable range of flow events determined by the certifier and has achieved the outcomes in Schedule B condition 2. a).

Attachment E

Diversion Monitoring Program

alluvium

MONITORING PROGRAM:

Mulgrave Resource Access Walker Creek Diversion Stage 2C

February 2017

bhpbilliton
resourcing the future

Document history

Revision:

Revision no.	2.0
Author/s	Luke Sunner
Checked	Michael Bain
Approved	Michael Bain

Revision no.	1.0
Author/s	Luke Sunner Rohan Lucas
Checked	Michael Bain
Approved	Rohan Lucas (RPEQ)

Distribution:

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Issue date	16 February 2017
Issued to	Rob Reeson (BMC)
Description:	Final

Revision no.	1.0
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Issued to	Rob Reeson (BMC)
Description:	Original issue

Citation:

Alluvium (2017). Mulgrave Resource Access Walker Creek Diversion Stage 2C - Monitoring Program, by Alluvium Consulting Australia for BHP Billiton Mitsui Coal Pty Ltd.

Ref: R:\Projects\2016\Townsville Projects\P216043_BHP MRA St 2C DD Diversion\1_Deliverables\P216043_R04_V02_Diversion_Monitoring_Program.docx

Contents

Figures

Tables

Abbreviations

ACARP	Australian Coal Association Research Program
Alluvium	Alluvium Consulting Australia Pty Ltd
BMC	BHP Billiton Mitsui Coal
IDC	Index of Diversion Condition
MRA	Mulgrave Resource Access
RPEQ	Registered Professional Engineer of Queensland
SWCM	South Walker Creek Mine

1 Introduction

BHP Billiton Mitsui Coal at South Walker Creek Mine (SWCM) proposes to divert Walker Creek. Currently Walker Creek through the SWCM lease includes two existing operational diversions: the Walker Pit diversion (downstream) and the MRA2A diversion (upstream) as shown on Figure 2-1.

The proposed new diversion is required to allow for further progression of the Mulgrave pit and is called the Mulgrave Resource Access (MRA) Walker Creek Diversion Stage 2C.

A monitoring program is an essential component of the complete design, construction and operational performance evaluation process for creek diversions and is required as part of the regulatory process. A monitoring program is already in place for the existing Walker Pit and Mulgrave Pit diversions and will require amendment to incorporate the proposed MRA Walker Creek Diversion Stage 2C.

1.1 Location

SWCM is located approximately 35km west of the Nebo Township in the geologic Bowen Basin, approximately 125km south-west of Mackay in Central Queensland as shown in Figure 1-1.

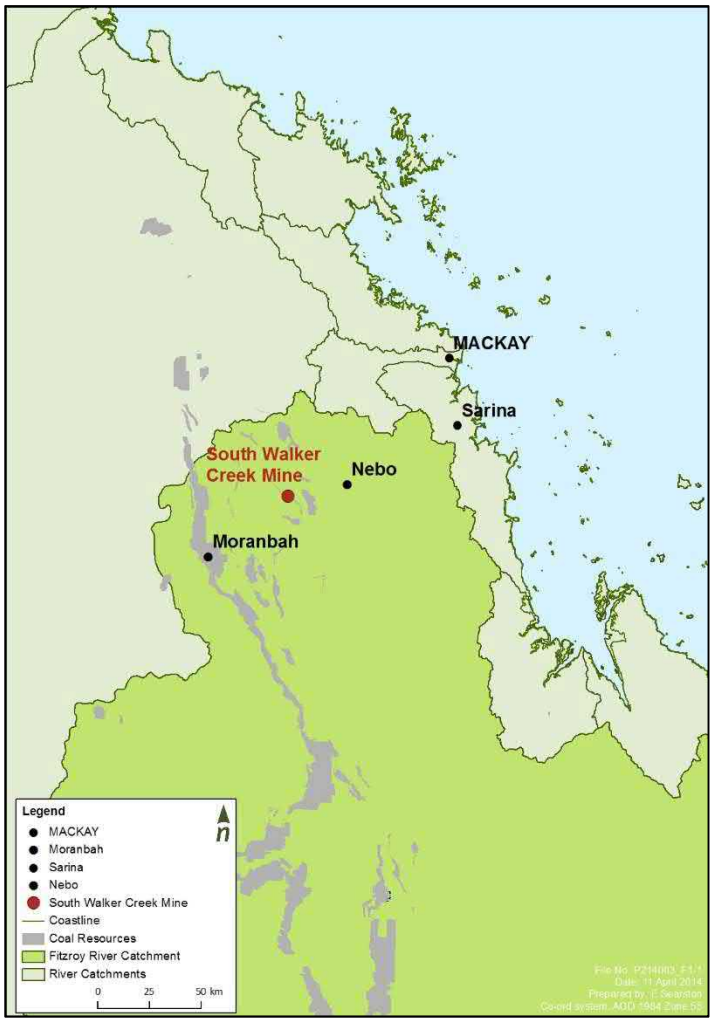


Figure 1-1. SWCM location map

2 Monitoring overview

Monitoring programs are an essential component of establishing, operating and relinquishing watercourse diversions and are required as part of the regulatory process for watercourse diversions in Queensland. Monitoring programs provide a mechanism to evaluate performance over time and inform management decisions and relinquishment applications.

2.1 Existing monitoring

A monitoring program is currently in place for the existing diversions. Location of monitoring points and reaches are shown on Figure 2-1. The existing monitoring program meets the intent of the requirements of the diversion licence conditions that are likely to be required for the proposed MRA Walker Creek Diversion Stage 2C; although some geographical adjustments to the programs will be required.

It is a requirement in the approvals conditions that diversion monitoring be undertaken by experienced and appropriately qualified waterway management professionals (including a Registered Professional Engineer Queensland (RPEQ)). This allows for qualitative assessment over and above the quantitative assessment in the Australian Coal Association Research Program (ACARP, project C9068) methodology that informs management of diversions in the long term to ensure a condition trajectory that will allow for timely relinquishment of approvals.

The outputs of the existing monitoring program are presented in the form of an Index of Diversion Condition (IDC) graph, an example of which is shown as Figure 2-2.

The existing and proposed monitoring program is based upon the "Monitoring and Evaluation Program for Bowen Basin Diversions" (ID&A, 2000) undertaken for ACARP. The total monitoring package for diversions through their lifetime from pre-construction to licence relinquishment comprises 4 components as shown in Table 2-1.

Table 2-1. Diversion monitoring package components

Monitoring Package COMPONENTS	Objective
1: Baseline monitoring	To establish a baseline data set that can be used for comparison when applying for approval renewals and relinquishment.
2: Construction monitoring	To demonstrate works have been undertaken to specification.
3: Operations monitoring	To maintain channel condition and reduce risk to mining infrastructure and the environment. Used in licence renewals if required.
4: Relinquishment monitoring	To demonstrate the diversion is operating as a waterway in equilibrium and not adversely impacting on adjoining reaches allowing for approvals relinquishment.

Details of these monitoring components as they are presently structured in the ACARP monitoring methodology are provided in section 2.2.

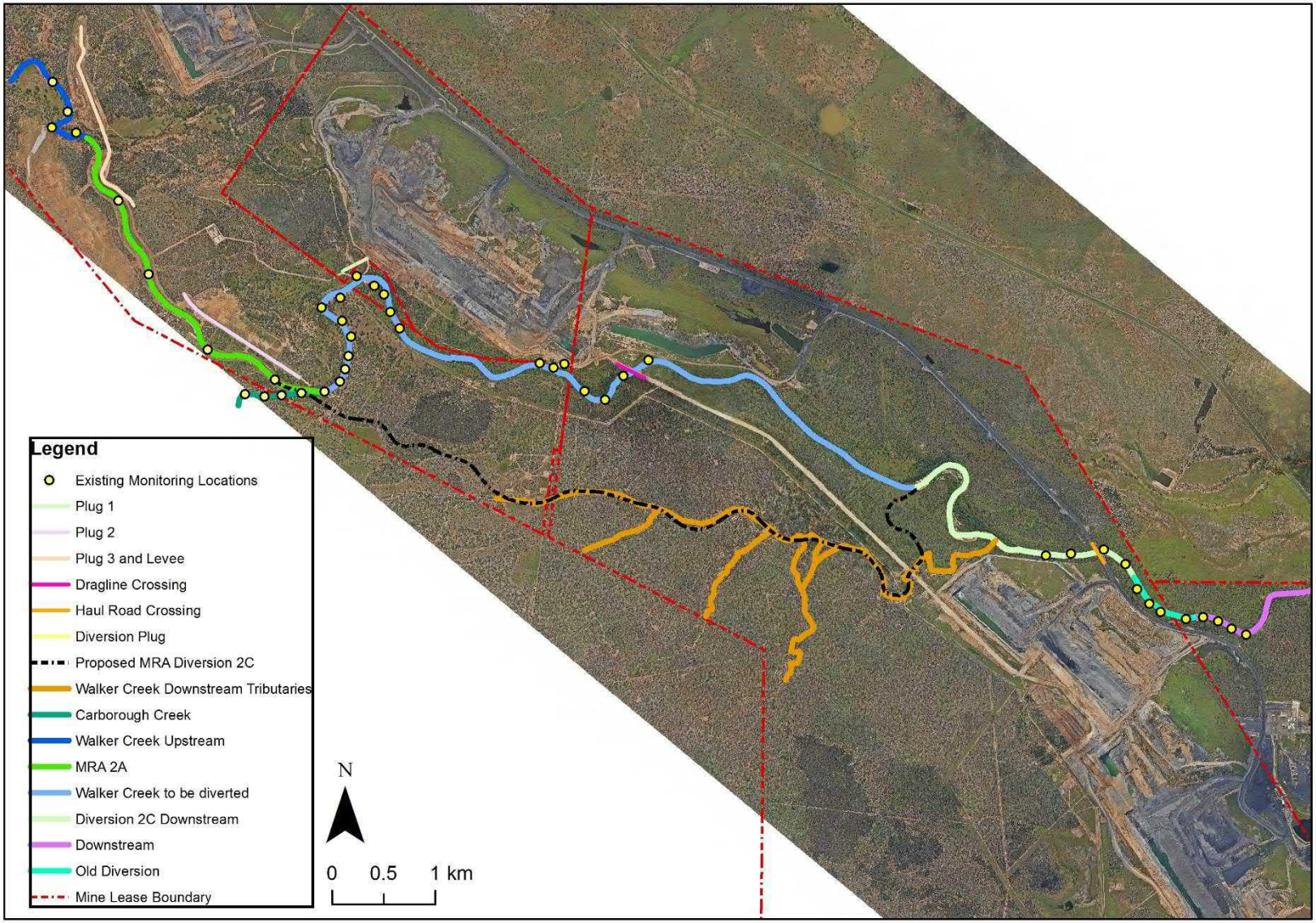


Figure 2-1. *Existing Walker Creek diversion monitoring program*

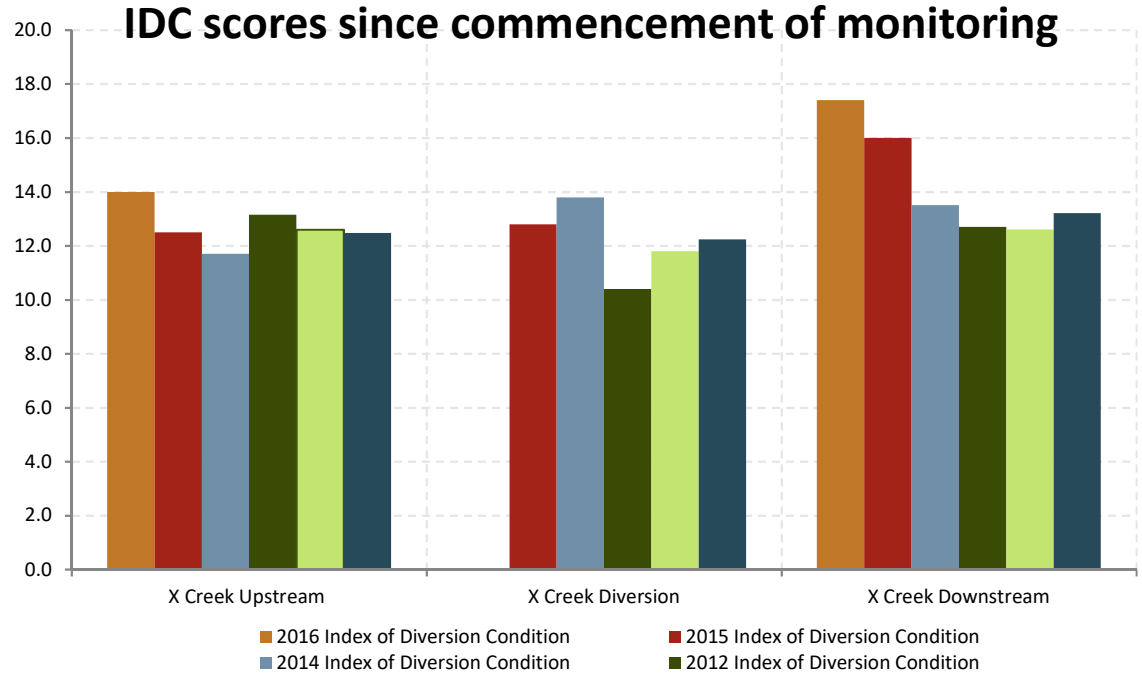


Figure 2-2. *Generic example of IDC graph.*

2.2 MRA2C Monitoring Program

The existing monitoring program will be augmented such that monitoring reaches containing four monitoring points are established upstream and downstream of all diversions, within the diversions themselves, and at key impact mitigation/monitoring locations along the waterways. Existing and proposed monitoring locations are presented in Figure 2-3.

Monitoring should be undertaken prior to diversion construction and would include operations monitoring methodology (described below) for existing monitoring locations and baseline monitoring methodology for proposed new locations.

Construction monitoring will be required once construction of the proposed diversion commences. Following completion of construction, operations monitoring should continue at all non-redundant monitoring locations.

The location of flow gauging stations that have been installed on Walker and Carborough Creeks for the existing diversion arrangements will require review for the operation of the MRA2C to ensure appropriate data capture.

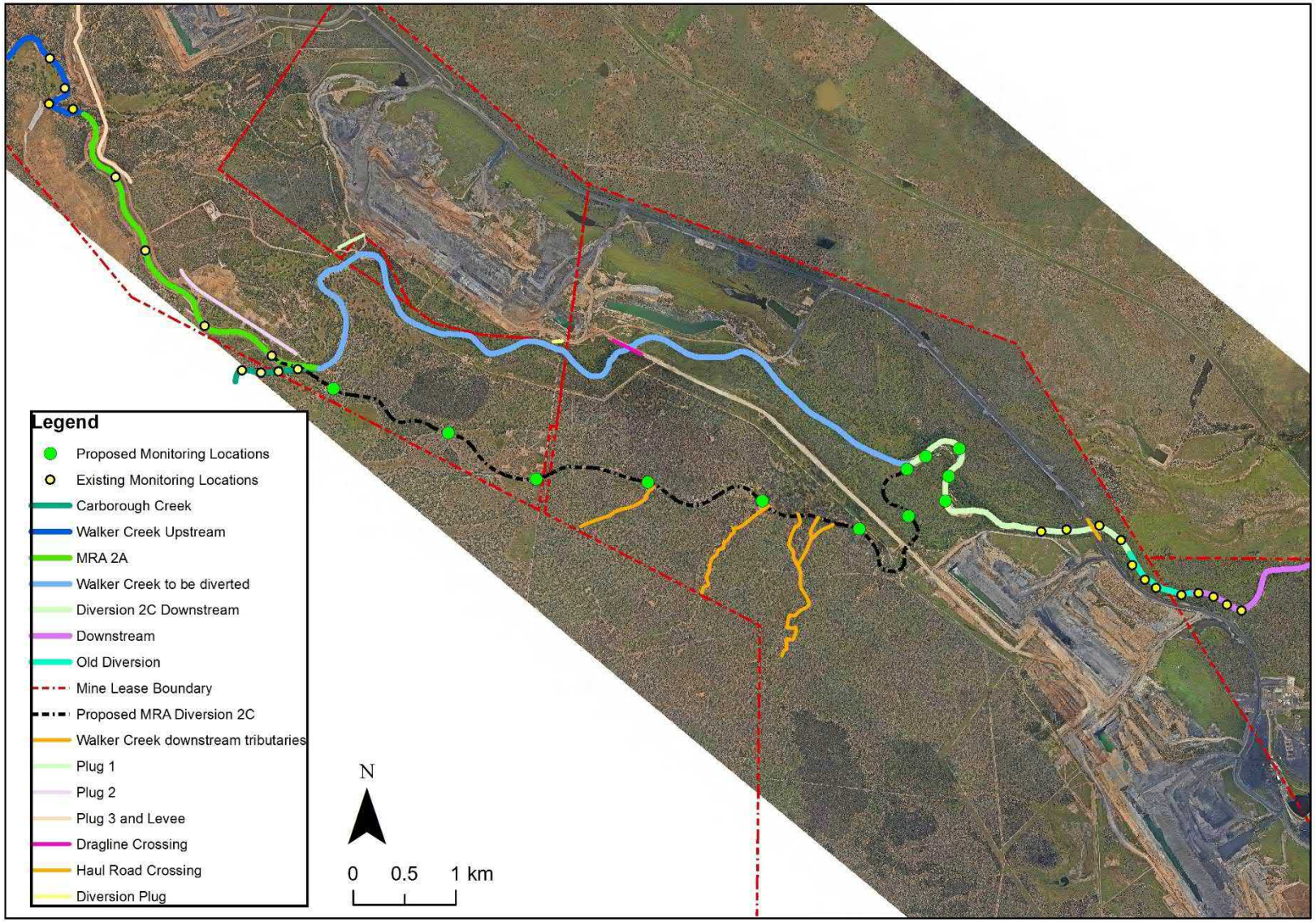


Figure 2-3. *Proposed monitoring locations*

Baseline monitoring
Baseline monitoring is undertaken to:

- establish a baseline data set of the condition of the pre-diversion waterway that can be used for comparison when applying for licence renewal and relinquishment, and
- compare the performance of the diversion during its operation over time to both itself and adjacent reaches.

The Baseline Monitoring Program is based upon the "Monitoring and Evaluation Program for Bowen Basin River Diversions" (ID&A, 2001) undertaken for the Australian Coal Association Research Program and consists of:

- index of diversion condition (including the establishment of photo points)
- aerial photograph prior to construction
- survey (cross sections and long section)
- vegetation information recorded as part of Index of Diversion Condition (IDC) assessment and
- flow event information.

Further details are provided in Table 2-2.

Table 2-2. Baseline Monitoring Components

	Baseline monitoring undertaken
Index of diversion condition (IDC)	IDC will be undertaken for each of the reaches; upstream reach and downstream reach. As part of the IDC assessment, photographs will be taken to record the condition of Walker Creek and Carborough Creek before diversion construction. Photographs will be taken of the upstream reach and the downstream reach. The photographs will be taken from fixed points along the upstream and downstream reaches to allow future comparisons.
Aerial photographs	An aerial photograph displaying the existing condition of the creek and also the location of the new diversion has to be taken prior to works beginning. This is added to the baseline monitoring database.
Survey	Detailed topographic survey of the monitoring reaches must be undertaken by BMC prior to construction. This information is included in the monitoring database for comparison against future survey. This information will be used as part of the quantitative assessment of the performance of the diversion during its operation and contribute to relinquishment monitoring to demonstrate the diversion has had no adverse impacts on upstream and downstream reaches. The cross-sections generated from the survey need to include changes in bank shape. Cross-sections are located on meanders and straight sections to monitor horizontal and vertical displacement of the channel.
Vegetation	The associations and condition of vegetation in each of the reaches is assessed as a record of its pre diversion state.
Flow events	Collection of flow data to understand the magnitude of event to which the diversion has been subjected to is required. This may occur at commencement of operations or at baseline.

Riparian vegetation monitoring
In addition to the Riparian Index assessment, riparian and terrestrial vegetation will be assessed in all reaches using detailed site assessment and Regional Ecosystem mapping. This will allow for future comparison of upstream and downstream reaches with the diverted reach to identify key species that may be absent from the diversion reach but present in the adjoining reaches. It will also help to determine the success of the revegetation plan, which aims to re-create a healthy functioning reach of waterway that will be self-sustaining over the long term. The method has been utilised at the existing monitoring sites in the past and should be continued, consistent with the vegetation condition trajectory method in ACARP project C23030 (Alluvium, 2016).

Operations monitoring

The purpose of this monitoring is to maintain channel condition and reduce risk to mining infrastructure and the environment while also facilitating licence renewal (if required). The operations monitoring requirements are detailed in Table 2-3.

Table 2-3. Operations monitoring requirements

	Construction monitoring requirements	
Survival of works	The survival of instream structures and works such as riprap and vegetation should be assessed during this phase of monitoring. Early detection of damage is likely to increase the options for remedial action.	
Photographs	Photographs should continue to be taken from fixed photopoints in the upstream reach and downstream reach set up during the baseline monitoring. The diversion reach fixed photopoints established as part of the construction monitoring should also be repeated during IDC assessment.	
Aerial photographs	Aerial photographs of the upstream reach, diversion reach and downstream reach should be taken on an annual basis.	
Visual assessment	The upstream reach, diversion reach and downstream reach should be visually assessed using the IDC, which should be repeated in each of the years identified in Table 2-6 . This inspection would include assessment of:	
IDC	• bank condition • piping • bed condition • recovery • proximity of spoil piles from bank	• stability of instream structures • structural intactness of vegetation • regeneration of vegetation • longitudinal continuity of vegetation

The field data should be transferred into the IDC spreadsheet and added to the database established during baseline monitoring. The data can then be used to assist with comparing any changes.

Construction monitoring

Construction monitoring should be undertaken during and immediately after construction. The purpose of this stage is to demonstrate that works have been undertaken to specification and explain any variations that may occur during construction. Provision of an As Constructed report within 90 business days of completion of works is usually a requirement of the approvals for the diversion. The construction monitoring requirements are detailed in Table 2-4.

Table 2-4. Construction monitoring requirements

	Construction monitoring requirements
Execution outputs	An execution output database should be established to record descriptions of the construction activities completed. The date of activity completion should be noted along with details of any accompanying photographs. Construction activities not completed to specification should be recorded in the database along with an explanation and details of the modified design.
Photographs	Photographs should be taken during construction and immediately after the work is finished. Certain features of the diversion such as instream structures should have several photographs depicting different stages of their construction. Photographs should be taken from fixed photo points where possible and details such as date, time and weather conditions should accompany the photographs.
Aerial photographs	If practical, an aerial photo should be taken immediately after diversion construction or rehabilitation has been completed. These photographs would accurately display the extent of change and provide a baseline reference for changes that may occur in the future.

Relinquishment monitoring

The objective of this phase is to demonstrate that the diversion is operating as a waterway in equilibrium and not having an adverse impact on adjoining reaches. Relinquishment monitoring can be undertaken prior to mine closure if operations monitoring is showing the diversion to be operating in dynamic equilibrium. However, the diversion should have been operating for a minimum of 10 years and had flow events of sufficient frequency and magnitude to test the design.

The relinquishment monitoring requirements are detailed in Table 2-5.

Table 2-5. Relinquishment monitoring requirements

	Relinquishment monitoring requirements
Survey 1	Long-section and cross-section survey should be conducted during the first year of relinquishment monitoring. The survey should include the control reach, diversion reach and downstream reach. This survey will then be able to be compared to the 'as built' long-section to assess the change in bed elevation.
Stage 1 evaluation	Survey data from baseline and operations monitoring should be compared with data from relinquishment monitoring. Rates of change for channel top width, cross-section area, horizontal and vertical displacement can then be calculated.
Vegetation assessment	Detailed vegetation assessment should be conducted during the first year of relinquishment monitoring to determine key species absent from the diversion reach but present in control reach where this is appropriate. However, this must also take into account the fact that the diversion may be constructed in ground higher than the lower lying floodplain, which as a consequence will contain large flows in channel rather than engaging with an adjacent floodplain. The diversion reach may therefore have different geomorphic and ecological characteristics than the pre-existing reach.
Photographs	Photographs should be taken from the fixed photo points in the control, diversion and downstream reaches.
Aerial photographs	Aerial photos of diversion and control, diversion and downstream reaches should continue to be taken on an annual basis.
Survey 2	A final long-section and cross-section survey should be conducted prior to application for licence relinquishment.
Stage 2 evaluation	All data should be evaluated and photographs collated for presentation in a report to regulators.
Survey	Long-section and cross-section surveys should be conducted in the control reach, diversion reach and downstream reach. These surveys should be repeated a minimum of every 2 years or after a major flood event (e.g. 10 year ARI event).
Flow events	Flow events should be monitored to determine the size of events the diversion has been subjected to.

Table 2-6. Indicative timetable for future monitoring

Monitoring package	Monitoring activity	Prior to construction of diversion	During construction	First year of diversion operation	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Baseline monitoring	Photographs																						
	Aerial photographs																						
	Survey																						
	Vegetation																						
	Flow events																						
Construction monitoring	Execution outputs																						
	Photographs																						
	Aerial photographs																						
Operations monitoring	Survival of works																						
	Photographs																						
	Aerial Photographs																						
	Index of diversion condition																						
	Survey																						
	Flow events																						

Monitoring package	Monitoring activity	Prior to construction of diversion	During construction	First year of diversion operation	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Relinquishment monitoring	Survey 1																						
	Stage 1 evaluation																						
	Vegetation assessment																						
	Photographs																						
	Aerial photographs																						
	Survey 2																						
	Stage 2 evaluation																						

3 References

Alluvium, 2015. *Collaborative Performance Trajectories for Diversion Approvals Relinquishment* (C23030). Report by Alluvium for Australian Coal Association Research Program (ACARP).

ID&A, 2001.*Monitoring and Evaluation Program for Bowen Basin River Diversions*, Australian Coal Association Research Program, project C9068.

Attachment F

REMP Design Report 2016

South Walker Creek

Receiving Environment Monitoring Program Design

Prepared for:

BMC South Walker Creek Mine

frc environmental

PO Box 2363, Wellington Point QLD 4160
Telephone: + 61 3286 3850
Facsimile: + 61 3821 7936

frc reference: 150404

freshwater estuarine marine

Document Control Summary

Project No.:	150404
Status:	Draft Report
Project Director:	Carol Conacher
Project Manager:	Nirvana Searle
Title:	South Walker Creek Receiving Environment Monitoring Program Design
Project Team:	C. Chargulaf, C. Conacher, C. Forward and N. Searle
Client:	BMC South Walker Creek Mine
Client Contact:	Natalie Poole
Date:	September 2016
Edition:	150404Riii
Checked by:	Carol Conacher _____
Issued by:	Nirvana Searle _____

Distribution Record

BMC:	As .pdf

Contents

Figures

Tables

Maps

1 Introduction

1.1 Background

South Walker Creek Mine, managed by BHP Billiton Mitsui Coal Pty. Ltd (BMC), is located 25 km west of Nebo in Central Queensland. The mine is an open cut coal operation that produces PCI coal for the domestic and international market. As part of the mining operation, South Walker Creek Mine operates a processing plant where mined coal is screened, washed and blended to meet marketing demand specifications. Following processing, coal product is transported by rail to the BMA owned Hay Point Terminal south of Mackay, where it is distributed for use in both domestic and international steel production.

The mine encompasses two leases, which are authorised under Environmental Authority (EA) EPML00712313 (South Walker Creek Mine). The mining leases are ML4750 and ML70131. The preparation and implementation of a receiving environment monitoring program (REMP) is required under this EA.

The REMP for South Walker Creek Mine has been developed to monitor and record the effects of released mine-affected water on the receiving environment. It aims to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to any releases of mine-affected water.

This report presents the design of the REMP for South Walker Creek Mine. The scope of this design document is guided by the 'Receiving Environment Monitoring Program Guideline – for use with Environmentally Relevant Activities under the Environmental Protection Act (1994)' (EHP 2014), and includes:

- a description of the release characteristics, including quality and quantity of the release
- a description of the receiving environment attributes, including
  - a description of the spatial extent of the receiving waters
  - catchment area and surrounding land use, hydrology, geomorphology, aquatic habitats, background water and sediment quality, and key aquatic communities of waterways in the receiving environment
  - applicable environmental values (EVs), including hydrology, water quality objectives (WQOs) and biological objectives applicable to the receiving environment
- spatial context, including the location of monitoring sites

- temporal context of the REMP, including the timing and frequency of sampling, and
- the monitoring program design.

2 Description of the Activity

Mining operations at South Walker Creek Mine commenced in 1996. Mining is carried out along strips that are approximately 55 m wide and roughly follow the dip of the coal seam in a westerly direction. All pits are situated on ML4750 and ML70131, with operational pits currently extending over a strike length of 20 km. Pre-strip mining is a substantial component of the mining operation. Mined coal is hauled from the pit to the coal preparation plant ROM or to designated stockpiles in diesel powered rear dump haul-trucks.

The projected life of the mine under current mine planning scenarios extends operations for another 30 years. The ultimate life of the mine will be determined by the full extraction of marketable reserves.

The relevant activity for the REMP is the release of mine-affected water from South Walker Creek Mine to the receiving environment. The characteristics of the release and the mine-affected water are described below.

2.1 Release Characteristics and Potential Risks

Water Quality

A review of potential contaminants associated with South Walker Creek Mine and the risks to water quality is required to determine the primary types and sources of contaminants. A review of the previous REMP design document (which was revised in 2012), and a brief assessment of potential contaminants for the 2014 REMP monitoring report (frc environmental 2015) identified the following potential contaminants at South Walker Creek Mine:

- metals and metalloids (aluminium, copper, iron, chromium, lead, manganese, nickel, uranium, vanadium and zinc)
- turbidity
- total suspended solids
- electrical conductivity, and
- pH.

Water quality parameters that may represent a potential risk to the receiving environment were also identified in the EA. In addition to the parameters above, these included:

- sulphate
- metals and metalloids (arsenic, boron, cadmium, cobalt, mercury, molybdenum and selenium)
- ammonia and nitrate
- fluoride and sodium, and
- total petroleum hydrocarbons.

To update the REMP design, water quality monitoring data collected by South Walker Creek Mine between 2012 and 2015 was summarised and compared with the EA contaminant release trigger levels and background data (where available) (Table 2.1). This data included physical-chemical parameters and contaminants measured in the mine-affected water storage dams, at downstream sites (WCDS, SCDS and BCDS) and at upstream sites (WCUS, SCUS and BCUS).

Where the median and / or mean and the 95th percentile values both exceeded the EA contaminant release trigger levels in sediment dam water, parameters were classified as high risk. These high risk parameters are:

- electrical conductivity
- sulfate
- aluminium, and
- iron.

Where the mean or median *or* 95th percentile values exceeded the EA contaminant release trigger levels in sediment dam water, parameters were classified as moderate risk. These moderate risk parameters are:

- pH
- turbidity
- nitrate
- arsenic
- chromium
- copper

- molybdenum
- zinc, and
- total petroleum hydrocarbons (C6-C9 fraction.

Where parameters *did not* exceed the EA contaminant release trigger levels in the sediment dam water, or there is no available guideline, they were classified a low risk. The low risk parameters are:

- total suspended solids
- total dissolved solids
- sodium
- fluoride
- ammonia
- nitrite
- oxides of nitrogen
- boron
- cadmium
- cobalt
- lead
- manganese
- mercury
- nickel
- selenium
- silver
- uranium
- vanadium
- all BTEX
- total petroleum hydrocarbons (C10–C14, C15–C28 and C29–C36), and
- cyanobacteria.

Water levels in the receiving environment can potentially be affected by releases of mine-affected water and may lead to changes to the natural flow regime. As Walker and Sandy Creeks have previously been determined to have limited ecological value (BMT WBM 2011), releases from South Walker Creek Mine into Walker or Sandy Creeks are authorised to occur when natural flow in Bee Creek has exceeded 3.5 m^3/s, irrespective of flows in either of those creeks. Discharge flow rates have been scientifically calculated to have minimal effect upon flows in Bee Creek, with discharges commencing at equivalently very low rates and increasing as natural flows in Bee Creek increase. . As such, the water level is unlikely to change significantly in Bee Creek, and any change is likely to be within the range of seasonal variation in flow. An assessment undertaken by BMT WBM (2011) determined that the risk to Sandy Creek when there is no natural flow was low, as there is only a short distance (1.5 km) between the release point and the confluence with Bee Creek. The distance between the discharge point on Walker Creek and the confluence with Bee Creek is 8.1 km; therefore, if releases occur when there is no natural flow, there is potential for mine releases to influence the water levels and flow over a greater distance in Walker Creek .

Table 2.1 Summary of water quality measured by water quality loggers between January 2012 and April 2015.

Parameter	Units	Contaminant Release Trigger Level	Receiving Waters Contaminant Trigger Level	Background Sites					Mine-affected Water Storage Dams					Receiving Environment Sites				
				Median	Mean	20th Percentile	80th Percentile	95th Percentile	Median	Mean	20th Percentile	80th Percentile	95th Percentile	Median	Mean	20th Percentile	80th Percentile	95th Percentile
Physical and Chemical																		
temperature	° C	–	–	–	–	–	–	–	27.155	26.7	23.62	30.206	32.975	24.8	24.5	24.7	25.8	28.4
electrical conductivity (in situ)	µS/cm	700	1000	***10***	87	4	31	646	***3393***	***3057***	***1264***	***4246***	***5452***	***70***	433	11	1162	***1647***
electrical conductivity (laboratory)	µS/cm	700	1000	***305***	434	190	554	1440	***2900***	***2809***	***936***	4066	***5509***	***317***	455	200	652	1100
pH (in situ)	pH Unit	6.5 – 9.2	6.5 – 8.5	***7.6***	7.6	6.9	8.3	8.8	***8.9***	***8.7***	***8.1***	9.2	***9.6***	***7.2***	7.2	6.7	7.9	8.2
pH (laboratory)	pH Unit	6.5 – 9.2	6.5 – 8.5	***8.0***	8.0	7.7	8.2	8.5	***8.9***	***8.7***	***8.2***	9.2	***9.3***	***7.9***	7.9	7.6	8.2	8.5
turbidity (in situ)	NTU	500	750	***6***	95	2	120	389	***56***	204	17	257	1225	***2***	105	0	156	537
turbidity (laboratory)	NTU	500	750	***475***	1016	***166***	1382	***2785***	40	63	16	86	186	***610***	939	***96***	1896	***2346***
suspended solids	mg/L	–	–	295	721	126	1000	2540	26	45	13	51	159	420	832	68	1560	2822
dissolved solids	mg/L	–	–	213	378	100	608	1102	697	1600	31	2828	3850	175	325	82	481	1051
Major Cations and Anions																		
sodium	µg/L	–	–	45	4489	22	212	28850	749	295898	212	817600	1137500	56	10332	25	248	40400
fluoride	µg/L	2000	–	160	203	<10	312	546	470	442	244	600	855	180	162	108	212	305
sulfate	mg/L	250	250	3	11	2	14	30	***315***	***312***	***153***	406	***654***	12	27	3	37	131
Nutrients																		
ammonia as N	µg/L	900	–	20	62	<5	65	231	40	61	8.6	74	206	24	42	9	75	112
nitrate as N	mg/L	1100	–	34	284	<5	190	1170	70	681	5	730	4042	63	102	6	130	296
nitrite as N	µg/L	–	–	–	–	–	–	–	<10	31	<10	44	134	<10	<10	<10	<10	<10
oxides of nitrogen	µg/L	–	–	–	–	–	–	–	80	655	5	696	3805	100	123	100	136	177
Total Metals and Metalloids																		
aluminium	µg/L	55	–	5700	10065	2240	17400	24750	400	637	188	906	2000	11000	12844	1940	21560	33620
arsenic	µg/L	13	–	3	3	2	3	5	4	6	2	8	15	2	3	2	3	6
boron	µg/L	370	–	52	69	<50	91	138	150	148	84.8	180	240	78	94	<50	144	262
cadmium	µg/L	0.2	–	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1
chromium	µg/L	1	–	7	11	2	18	26	<1	1	<1	2	3	10	12	2	19	32
cobalt	µg/L	90	–	5	8	<1	15	21	<1	<1	<1	<1	2	7	10	2	18	31
copper	µg/L	2	–	17	16	5	25	34	2	3	1	4	8	14	20	6	35	50
iron	µg/L	300	–	6100	11919	2000	21280	30720	390	630	188	938	1885	12000	14185	1740	22560	39410
lead	µg/L	4	–	5	9	2	15	23	<1	<1	<1	<1	2	6	10	3	15	31
manganese	µg/L	1900	–	400	525	90	894	1220	14	29	6	48	103	445	755	184	1384	2098

Parameter	Units	Contaminant Release Trigger Level	Receiving Waters Contaminant Trigger Level	Background Sites					Mine-affected Water Storage Dams					Receiving Environment Sites				
				Median	Mean	20th Percentile	80th Percentile	95th Percentile	Median	Mean	20th Percentile	80th Percentile	95th Percentile	Median	Mean	20th Percentile	80th Percentile	95th Percentile
mercury	µg/L	0.2	–	<0.05	<0.05	<0.05	<0.05	0.1	0.05	<0.05	<0.05	0.05	0.1	<0.05	<0.05	<0.05	0.1	0.1
molybdenum	µg/L	34	–	<1	3	<1	2	17	12	23	8.4	44	70	<1	1	<1	2	7
nickel	µg/L	11	–	10	16	3	29	37	2	2	<1	4	6	12	17	3	30	47
selenium	µg/L	10	–	<1	1	<1	1	5	5	4	2	5	6	<1	2	<1	5	5
silver	µg/L	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
uranium	µg/L	–	–	1	1	<0.5	2	3	4	4	2	6	10	1	1	1	2	2
vanadium	µg/L	–	–	27	25	8	37	51	5	5	5	5	8	24	29	9	52	70
zinc	µg/L	8	–	48	61	10	124	146	3	13	3	12	71	26	46	8	81	145
Dissolved Metals and Metalloids																		
aluminium	µg/L	55	–	90	445	<10	470	2050	<10	23	<10	20	107	150	733	<10	628	3611
arsenic	µg/L	13	–	1	1	<1	2	3	4	5	2	8	13	<1	<1	<1	1	2
boron	µg/L	370	–	65	97	<50	128	245	150	144	90	180	210	72	83	<50	120	160
cadmium	µg/L	0.2	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
chromium	µg/L	1	–	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2
cobalt	µg/L	90	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
copper	µg/L	2	–	3	3	2	4	5	1	1	<1	2	3	2	3	2	4	8
iron	µg/L	300	–	220	370	23	516	1220	25	36	14	25	100	210	497	19	784	2038
lead	µg/L	4	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
manganese	µg/L	1900	–	<5	15	<5	10	62	<5	5	<5	<5	15	6	104	<5	40	654
mercury	µg/L	0.2	–	<0.05	<0.05	<0.05	<0.05	0.1	0.05	0.1	<0.05	0.05	0.1	<0.05	<0.05	<0.05	0.1	0.1
molybdenum	µg/L	34	–	1	4	<1	3	19	11	22	7	42	67	1	2	<1	2	7
nickel	µg/L	11	–	1	1	<1	2	3	1	1	<1	2	3	1	1	<1	2	3
selenium	µg/L	10	–	<1	2	<1	2	5	5	4	2	5	6	<1	2	<1	5	5
silver	µg/L	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.85	<1	<1	<1	<1	<1
uranium	µg/L	–	–	<0.5	1	<0.5	1	2	4	4	2	6	10	1	1	<0.5	1	2
vanadium	µg/L	–	–	4	5	3	5	11	5	5	3	5	10	5	5	3	5	13
zinc	µg/L	8	–	3	15	<1	23	49	3	7	2.5	9	18	3	10	<1	15	30
BTEX																		
benzene	µg/L	–	–	–	–	–	–	–	<1	2	<1	<1	10	<1	<1	<1	<1	<1
toluene	µg/L	–	–	–	–	–	–	–	<2	4	<2	<2	25	<2	<2	<2	<2	<2
ethylbenzene	µg/L	–	–	–	–	–	–	–	<2	8	<2	<2	50	<2	<2	<2	<2	<2
meta- & para-xylene	µg/L	–	–	–	–	–	–	–	<2	4	<2	<2	25	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	–	–	–	–	–	–	–	<2	4	<2	<2	25	<2	<2	<2	<2	<2

Parameter	Units	Contaminant Release Trigger Level	Receiving Waters Contaminant Trigger Level	Background Sites					Mine-affected Water Storage Dams					Receiving Environment Sites				
				Median	Mean	20th Percentile	80th Percentile	95th Percentile	Median	Mean	20th Percentile	80th Percentile	95th Percentile	Median	Mean	20th Percentile	80th Percentile	95th Percentile
total xylenes	µg/L	–	–	–	–	–	–	–	<2	2	<2	<2	10	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	–	–	–	–	–	–	–	<1	2	<1	<1	10	<1	<1	<1	<1	<1
Hydrocarbons																		
TPH C6 - C9 fraction	µg/L	20	–	<10	<10	<10	<10	10	10	12	<10	10	50	<10	<10	<10	10	10
TPH C10 - C14 fraction	µg/L	–	–	<50	<50	<50	<50	<50	<50	<50	<50	<50	50	<50	<50	<50	<50	<50
TPH C15 - C28 fraction	µg/L	–	–	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36 fraction	µg/L	–	–	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C10 - C36 fraction	µg/L	100	–	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
naphthalene	µg/L	–	–	–	–	–	–	–	<5	9	<5	<5	50	<5	<5	<5	<5	<5
Biological																		
cyanobacteria	cells/ml	–	–	–	–	–	–	–	29760	48020	7880	72136	139512	–	–	–	–	–

Grey shading indicates a value does not comply with the contaminant release trigger level and is outside the 20–80th percentile range of data from background sites.

Bold italics indicate a value does not comply with the receiving waters contaminant trigger level and is outside the 20–80th percentile range of data from background sites.

Timing of Releases

Under the Environmental Authority, the release of mine-affected water is authorised only during periods of natural flow in Bee Creek and must be in accordance with the receiving water flow criteria for discharge detailed in Table 2.2. Given that release points direct flow into Walker Creek or Sandy Creek this means that the immediate receiving waters may have no flow.

As releases of mine-affected water in Bee Creek can only occur during natural flow events, when the water released from the mine will be diluted by, and mix with, the natural flow, the ecological risk to Bee Creek associated with the timing of authorised releases is considered low. Walker Creek and Sandy Creek have been categorised as having limited environmental value (BMT WBM 2011). The risk to Sandy Creek when there is no natural flow is likely to be low, as there is only limited environmental value present in the short distance (1.5 km) between the release point and the confluence with Bee Creek. Similarly, the risk to Walker Creek is also low because of the limited environmental values present, however the length of stream that will potentially receive mine-affected during periods of no flow is longer (8.1km) which slightly increases the risk compared to Sandy Creek because it provides a greater area of sediment that may absorb contaminants. ;

Table 2.2 Mine affected water release allowed during flow events.

Receiving water flow criteria for discharge	Maximum release rate (for all combined release point flows)
low flow <3.5 m^3/s for a period of 28 days after natural flow events that exceed 3.5 m^3/s	<1.5 m^3/s
medium flow (low) >3.5 m^3/s	between <0.4 and 1.3 m^3/s [a]
medium flow (high) >10 m^3/s	between <1.1 and 3.6 m^3/s [a]
high flow >24.2 m^3/s	between <1.2 and 8.8 m^3/s [a]
very high flow >121 m^3/s	<8.2 m^3/s

[a] release rate is dependent on the electrical conductivity and sulphate concentrations of the release waters

Potential Risks to Environmental Values

The release of mine-affected water may:

- directly influence some water quality parameters within the receiving environment
- directly influence some sediment quality parameters within the receiving environment
- directly influence flow within the receiving environment
- directly influence aquatic habitat, including bank stability, presence of benthic or filamentous algae, and suitability of habitat for aquatic fauna, and
- indirectly influence biological communities (i.e. aquatic flora and fauna) within the receiving environment.

A conceptual model of the risks associated with the release of mine-affected water to the environmental values (EV) of the receiving environment is shown in Figure 2.1. The risk to flow, sediment quality, aquatic ecology and macroinvertebrates is:

- low when releases occur during natural flow in Bee Creek, Walker Creek and Sandy Creek, and
- moderate when there is no natural flow in Walker Creek and Sandy Creek.

The risk to water quality ranges from low to high, depending on the water quality parameter, when releases occur during natural flow and from moderate to high when there is no natural flow. Few parameters represent a potential high risk to the receiving

environment of SWC Mine, and an evaluation undertaken by BMT WBM in 2011 found that releases of mine-affected water from SWC Mine are unlikely to have a significant impact on the environmental values of the waterways that form the receiving environment.

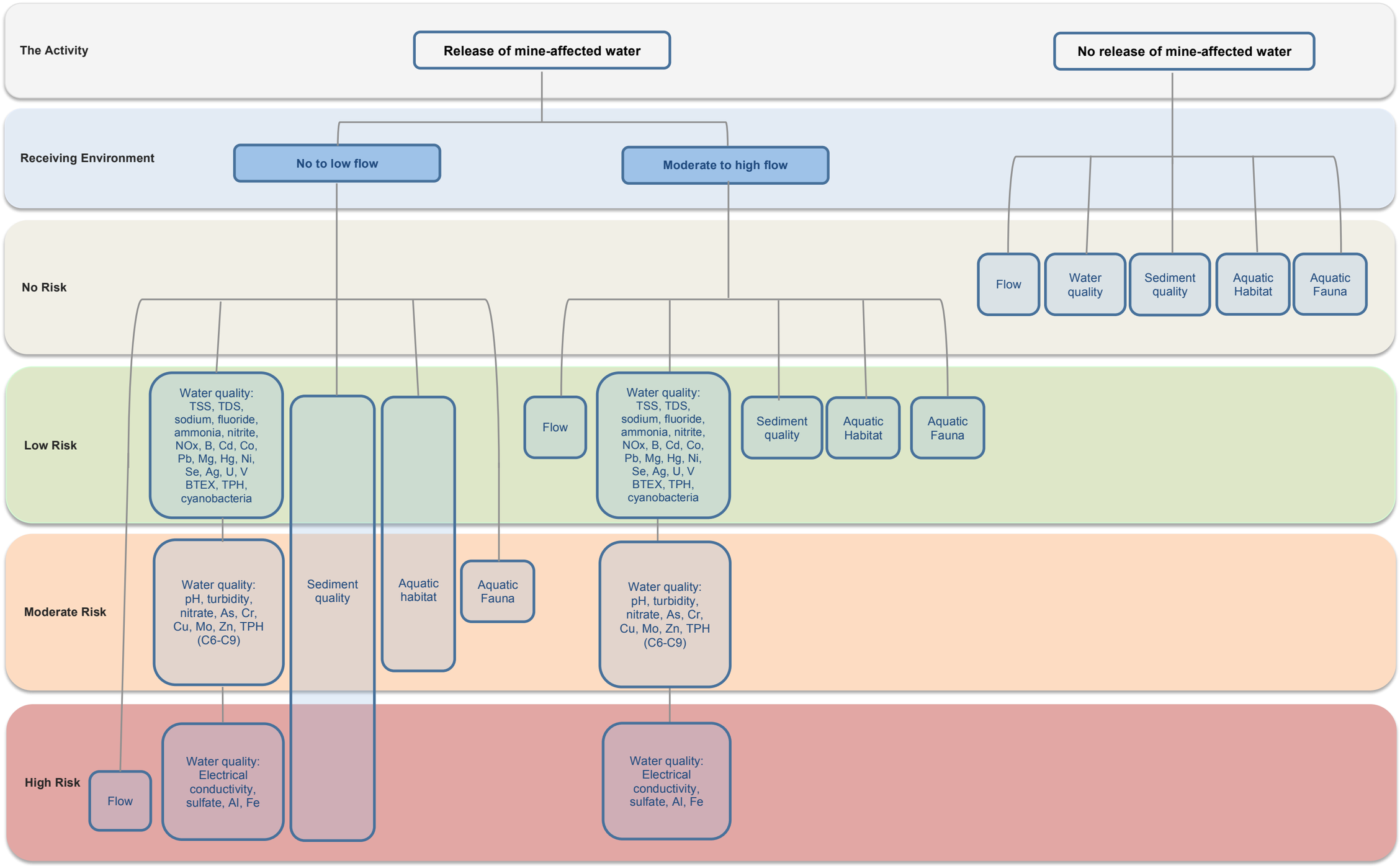


Figure 2.1 Conceptual model of risks to the EVs of the South Walker Creek Mine receiving environment associated with the release of mine-affected water.

3 Description of the Receiving Environment Attributes

3.1 Spatial Extent of the Receiving Environment

The receiving environment for South Walker Creek Mine is defined in the EA as Bee Creek and connected or surrounding waterways within 15 km downstream of the release. The connected and surrounding waterways comprise Walker Creek, Carborough Creek, Sandy Creek and Kemmis Creek. Carborough Creek joins Walker Creek to the west of the active mine area. Walker Creek, Kemmis Creek and Sandy Creek flow directly into Bee Creek, which then flows into the Connors River. The Connors River then meets the Isaac River, which is a major sub-catchment of the Fitzroy Basin that eventually drains to the Great Barrier Reef.

Kemmis Creek is north of the mine site and is currently not affected by mine water releases; however, there is a mine-affected water storage dam that flows into a tributary of Kemmis Creek when it overflows in accordance with the SWC Sediment and Erosion Management Plan. Additionally, SWC is currently pursuing approvals to progress mining activity that will occur within the Kemmis Creek catchment. Whilst there are no plans to release mine-affected water into the Kemmis Creek catchment, a greater volume of stormwater will be generated which will be allowed to flow into tributaries of Kemmis Creek. Therefore this REMP includes the addition of two new monitoring points to establish baseline conditions for the proposed future development.

3.2 Current Condition of the Receiving Environment

Previous Surveys

Water quality and aquatic ecology within South Walker Creek Mine leases and surrounding environment (including the downstream receiving environment) were assessed for the Environmental Impact Statement (EIS) for the mine, in previous versions of the REMP design, in annual REMP monitoring since 2008, and in an environmental values and salt assimilation assessment (BMT WBM 2011). Where possible, information from these studies has been used to summarise the current condition of the receiving environment.

Catchment Area, Surrounding Land Use and Riverine Development

The Isaac River sub-basin covers an area of approximately 22 365 km^2 this includes rivers and natural and artificial wetlands (EHP 2015). The waterways that comprise the SWC Mine receiving environments (i.e. Walker Creek, Sandy Creek, Carborough Creek

and Bee Creek) are in the Isaac River sub-basin, which is in the Fitzroy Basin. Kemmis Creek and Harrybrandt Creek, which are connected to the receiving environment creeks are also in the Fitzroy Basin.

The nearest town is Nebo, which is approximately 25 km east of South Walker Creek Mine. The surrounding areas have supported mining activity since the 1970s. In general, the surrounding area is used for low intensity cattle grazing, minerals exploration and mining. However, downstream of the receiving environment other land uses such as cropping, grazing, mining, rail and road infrastructure, sewage treatment plants, and industrial and various residential activities are also present. Approximately 20 km downstream of South Walker Creek Mine, Bee Creek runs along the western border of Dipperu National Park, which is of high environmental value.

Hydrology

There are no naturally occurring permanent water bodies (i.e. perennial rivers, lakes or wetlands) in the vicinity of South Walker Creek Mine, and the area is drained by ephemeral waterways. Most creeks in the area only flow after substantial rainfall.

The pattern of stream flow in Bee Creek reflects the pattern of rainfall at South Walker Creek Mine (Figure 3.1). Flow in Bee Creek was characterised by high flow events in the late 2014 wet season (February to April 2014) and in the 2014–2015 wet season (December 2014 to February 2015) (DNRM 2015). There was little to no flow at other times in the year, which is typical of ephemeral creek systems.

Discharge from South Walker Creek Mine in February 2014 and January 2015 represented a small proportion of the flow in Bee Creek, with daily flow at Bee Creek upstream (Bee Creek at Strathfield Road) substantially higher than the total volume of mine-affected water discharged during each flow event (Figure 3.1) (BMC 2014, BMC 2015a, BMC 2015b, BMC 2015c).

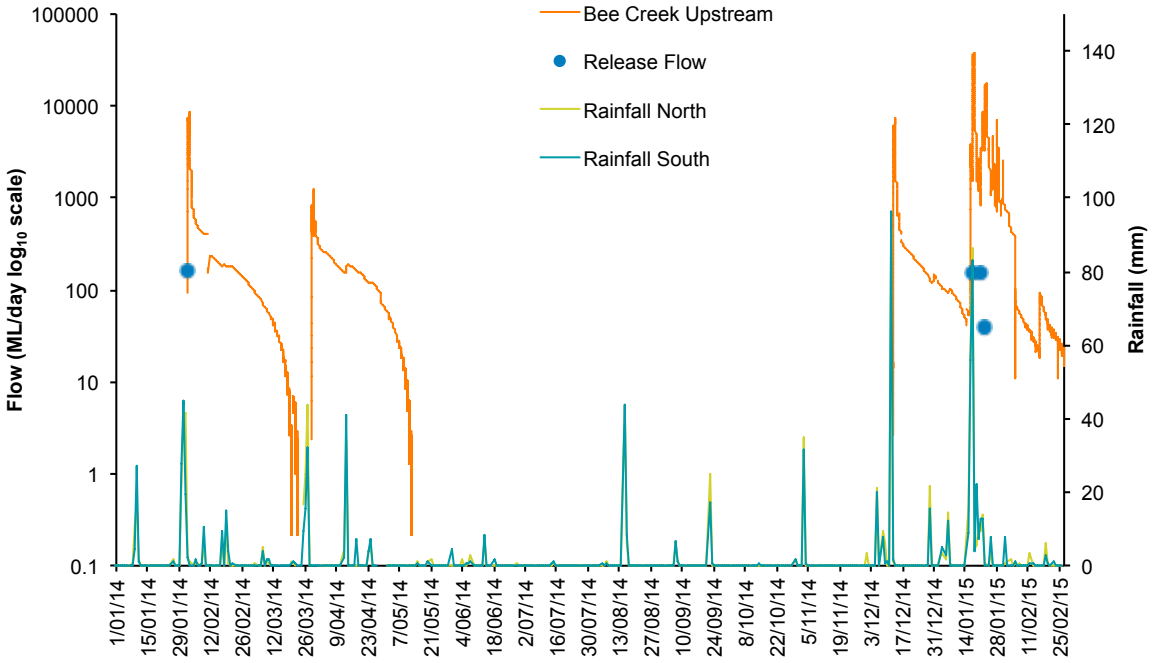


Figure 3.1 Daily rainfall (mm) at South Walker Creek Mine and daily flow (ML/day) in Bee Creek, from 1 January 2014 to 25 February 2015.

Geomorphology

Waterways of the receiving environment are in unconfined valleys (i.e. without constrictions imposed by bedrock or other rock-dominated geologies), with substrates generally composed of a combination of cobble, pebbles, gravel, sand and silt. The waterways have low sinuosity and occasional meanders, and the bed gradient is low, with the surrounding topography undulating to relatively flat.

Aquatic Habitat Features

Aquatic habitat in the region is moderately impacted by human activities (other than the mine discharge), and ranges from poor to moderate condition, reflecting the ephemeral nature of the waterways and harsh environmental conditions. Land-use is dominated by cattle grazing on native and improved pastures, and there has been some historical clearing of riparian vegetation, although large trees still grow on the creek banks in many locations, in particular at sites on higher order streams. Riparian vegetation is dominated by native species, such as eucalypts (e.g. river redgum, *Eucalyptus camaldulensis)*, she-oaks (e.g. *Casuarina* spp.) and grasses, although exotic grasses are also widespread. In the State of the River survey, weeds were common and land use was predominantly grazing on moderately to highly cleared land (Van Manen 2005).

There is some bank erosion across the area, which is generally associated with partial clearing of vegetation for cattle grazing, cattle access to water and water scouring during periods of high flow.

Previous surveys have shown that in-stream habitat diversity in Walker, Sandy and Carborough Creeks is low, typically comprising small isolated pools except after high rainfall events. Substrates in these creeks are dominated by highly mobile fine sediments, with areas of extensive deposition (frc environmental 2015).

Water Quality

Previous studies in the South Walker Creek Mine area have indicated that water quality is generally typical of ephemeral systems, and the surrounding geology (frc environmental 2015). It was found that:

- the concentrations of some metals in water, in particular aluminium, copper, iron and uranium, do not comply with the ANZECC (2000) trigger values for the 95% protection of aquatic species, and sometimes exceed the limits for livestock drinking water, but that the concentrations of dissolved metals were generally much lower than total concentrations
- the concentrations of some metals were higher at receiving environment sites that at background sites
- water quality was similar at background and receiving environment, but:
  - median electrical conductivity did not comply with the relevant guidelines at background sites, and
  - 95th percentile concentrations of nutrients (i.e. total nitrogen, total phosphorus, and phosphate) did not comply with relevant guidelines across all sites.

The results from the 2015 REMP indicated that for some parameters that are consistently below the laboratory limit of reporting at receiving environment sites (e.g. petroleum hydrocarbons and some metals and metalloids) and which are not identified as a potential risk may need to be reviewed and excluded from future monitoring.

In other surveys of Bee Creek, the concentrations of several parameters were above WQOs, which were:

- electrical conductivity
- total suspended solids
- phosphorous

- sodium
- total nitrogen, and
- some metals and metalloids (aluminium, arsenic, boron, iron and vanadium) (frc unpublished data).

High concentrations of nitrogen and phosphorous were likely to be due to access by livestock to the waterway.

In-stream Sediment Quality

The concentrations of metals and metalloids in sediment were generally below the sediment quality guideline (SQG) trigger values (where available) at both reference and receiving environment sites. The concentration of ammonia in sediment was slightly above the trigger value at receiving environment site SCDS (Sandy Creek downstream). The concentration of nickel in sediment was above the trigger value (but below the SQG-high value) at both reference sites in Cooper Creek (sites CCUS and CCDS), but below the trigger value at all receiving environment sites. There was no evidence of an impact from the mine on sediment quality and that differences between sites are due to natural spatial variation and the local geology.

Aquatic Plants

Aquatic plant communities of the area are generally sparse and species-poor, which is likely to be due to the naturally harsh environmental conditions of ephemeral waterways. In the State of the Rivers survey (Van Manen 2005), aquatic vegetation in the Isaac River subcatchment was rated as very poor for 83% of stream lengths and poor for 17% of stream lengths. The dominant growth form was submerged, followed by emergent (Van Manen 2005). Aquatic vegetation in the Isaac Northern and Central Floodplains subcatchment was rated as very poor for 100% of stream lengths, and the dominant growth form was emergent, followed by submerged. There was no floating aquatic vegetation at sites in either of the subcatchments.

Aquatic plants at sites in both the Isaac River subcatchment and the Isaac Northern and Central Floodplains subcatchment included:

- algae
- smartweeds
- rushes, and

- sedges.

The swamp lily (*Ottelia ovalifolia*) was also common in the Isaac River subcatchment (Van Manen 2005).

Submerged aquatic plants are not common in the region due to fluctuating water levels and high turbidity. Submerged aquatic plants cannot survive dry periods and high turbidity (high turbidity reduces light in the water column and inhibits photosynthesis); emergent forms are most tolerant to dry conditions.

Macroinvertebrates

Aquatic macroinvertebrate communities of the Fitzroy Basin were surveyed in the Isaac River at Yatton (EHP site 130401A) and in Nebo Creek at Nebo (EHP site 130407A). Taxonomic richness was:

- 30 taxa in bed habitat
- between 41 and 60 taxa in edge habitat, and
- 19 taxa in riffle habitat.

Aquatic macroinvertebrate communities were dominated by:

- non-biting midge larvae (sub-family Chironominae)
- mayfly larvae (family Baetidae)
- caddisfly larvae (family Leptoceridae), and
- freshwater shrimp (family Atyidae).

Macroinvertebrate taxonomic richness in the current surveys were less diverse than those surveyed by EHP, which was likely due to the low water levels and lack of habitat of the waterways in the Project study area.

Macroinvertebrates surveyed in the 2015 REMP were dominated by pollution tolerant taxa, such as:

- biting midges (family Ceratopogonidae)
- non-biting midge larvae (sub-families Tanypodinae and Chironominae), and
- mayflies (family Baetidae).

Taxonomic richness was typically lower than the biological WQO; however, the taxonomic richness of macroinvertebrates was similar between background and receiving environment sites. There was no evidence of an impact from the mine on macroinvertebrate communities and that differences between sites are due to natural spatial variation.

Fish

Fish communities in the South Walker Creek Mine receiving environment and surrounds vary spatially and temporally, but dominated by native species. Spangled perch (*Leiopotherapon unicolor*) were the most common fish, while common carp gudgeons (*Hypseleotris* spp.) were the most abundant.

No rare or threatened species of aquatic fauna have been recorded from the waterways of the receiving environment.

3.3 Environmental Values and Water Quality Objectives

Environmental Values

Environmental Values of waterways are protected under Queensland's *Environmental Protection (Water) Policy 2009* (EPP Water)[1]. The following Environmental Values may apply to waterways in Queensland, as outlined in the EPP Water (adapted from EPA 2005):

- ecosystem values – the intrinsic biological value of aquatic ecosystems that are:
  - unmodified or highly valued (high ecological value waters)
  - unmodified in terms of biological indicators, but slightly modified with respect to other indicators such as water quality (slightly disturbed waters)
  - adversely affected by human activity to a relatively small but measurable degree (moderately disturbed waters), or
  - measurably degraded and of lower ecological value (highly disturbed waters).
- primary industries – the suitability of water for:
  - irrigation of crops
  - stock water
  - farm water supply – uses other than drinking water
  - aquaculture
- human consumers – health of humans consuming wild or stocked fish or crustaceans from natural waterways
- recreation and aesthetic values – the suitability of the water for:
  - primary recreation – health of humans undertaking activities where there is a high probability of water being swallowed, e.g. swimming
  - secondary recreation – health of humans undertaking activities where there is a low probability of water being swallowed, e.g. boating, fishing
  - visual recreation – amenity of waterways for recreation that does not involve direct contact with the water, e.g. picnicking adjacent to the waterway
- drinking water – the suitability of the water for supply as drinking water

[1] Current and as in force on 28 November 2014. Reprint prepared by the Office of the Queensland Parliamentary Counsel.

- industrial uses – the suitability of the water for industrial use, and
- cultural and spiritual values – indigenous and non-indigenous cultural values.

South Walker Creek Mine is located in the Connors River Sub-basin of the Fitzroy Basin. The Environmental Values scheduled for the Central tributaries of the Connors River Sub-basin in the Isaac River Sub-basin Environmental Values and Water Quality Objectives Report (EHP 2013a) are:

- aquatic ecosystem values – slightly to moderately disturbed
- farm water
- irrigation of crops
- stock water (cattle)
- human consumers
- primary and secondary recreation
- visual amenity
- drinking water
- industrial use, and
- cultural and spiritual values.

The following Environmental Values were considered to be applicable to waterways within and in the vicinity of the South Walker Creek Mine, based on site conditions and existing adjacent and downstream land uses:

- aquatic ecosystem values – slightly to moderately disturbed
- farm water
- stock water (cattle)
- secondary recreation
- visual amenity, and
- cultural and spiritual values.

Water Quality Objectives

Water Quality Objectives (WQOs) are the specific values agreed between stakeholders, or set by local jurisdictions, that become indicators of management performance with respect to protection of an Environmental Value.

The published WQOs for water quality parameters applicable for the Environmental Values identified for the South Walker Creek Mine are presented in the Isaac River Sub-basin Environmental Values and Water Quality Objectives Report (Upper Isaac – central tributaries) (EHP 2013a) (Table 3.1), noting that in several cases this document refers to the Queensland Water Quality Guidelines (QWQG, EHP 2013c) and the Australian Water Quality Guidelines (ANZECC & ARMCANZ 2000a).

The most stringent value for a water quality parameter was selected as the WQO for that water quality parameter (Table 3.1). The rationale is that a WQO based on the most stringent value would ensure protection of all the identified Environmental Values.

There are no specific WQOs to protect cultural heritage, although the indigenous and non–indigenous cultural heritage values of waterways are likely to be protected where the WQOs for protection of aquatic ecosystems are achieved.

Similarly, there are no WQOs to protect visual amenity of watercourses. However, recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits, including:

- floating debris
- oil, scum and other matter
- substances producing objectionable colour, odour, taste or turbidity, and
- substances and conditions that produce undesirable aquatic life.

Table 3.1 Water Quality Objectives (WQOs) for the South Walker Creek Mine receiving environment, showing the recommended REMP water quality objectives and their source.

Parameter	Units	REMP WQO	Source (relevant environmental value)
Physical-Chemical			
Total Suspended Solids	mg/L	10	QWQG (aquatic ecosystem)
Total Dissolved Solids	mg/L	0–4000	EPP Water (stock watering)
Dissolved oxygen	% sat.	85-110	EPP Water (aquatic ecosystem)
pH	unit	6.5–8.5	EPP Water (aquatic ecosystem)
Turbidity	NTU	50	EPP Water (aquatic ecosystem)
Electrical Conductivity	µS/cm	<720 (base flow) <250 (high flow)	EPP Water (aquatic ecosystem)
Major Cations and Anions			
Sulphate	mg/L	25	EPP Water (aquatic ecosystem)
Fluoride	mg/L	2	EPP Water (stock watering)
Sodium	mg/L	30	EPP Water (irrigation)
Water Hardness	mg/L	not applicable	to support assessment of metals only
Total Petroleum Hydrocarbons			
TPH C6-C9 Fraction	mg/L	0.02	Model Water Conditions (not specified)
Sum of TPH (C10-C36) Fraction	mg/L	0.1	Model Water Conditions (not specified)
Nutrients			
Nitrate	mg/L	1.1	Model Water Conditions (aquatic ecosystem)
Nitrite	mg/L	0.06	QWQG (aquatic ecosystem)
Phosphorus	mg/L	0.05	EPP Water (aquatic ecosystem)
Filterable Reactive phosphorus	mg/L	0.02	EPP Water (aquatic ecosystem)
Nitrogen	mg/L	0.5	EPP Water (aquatic ecosystem)
Ammonia	mg/L	0.02	EPP Water (aquatic ecosystem)
Metals and Metalloids			
Aluminium	mg/L	0.055	Model Water Conditions (aquatic ecosystem)
Arsenic	mg/L	0.013	Model Water Conditions (aquatic ecosystem)

Parameter	Units	REMP WQO	Source (relevant environmental value)
Beryllium	mg/L	0.5	EPP Water (irrigation)
Boron	mg/L	0.37	Model Water Conditions (aquatic ecosystem)
Cadmium	mg/L	0.0002	Model Water Conditions (aquatic ecosystem)
Chromium	mg/L	0.001	Model Water Conditions (aquatic ecosystem)
Cobalt	mg/L	0.09	Model Water Conditions (aquatic ecosystem)
Copper	mg/L	0.002	Model Water Conditions (aquatic ecosystem)
Iron	mg/L	0.3	Model Water Conditions (aquatic ecosystem)
Lead	mg/L	0.004	Model Water Conditions (aquatic ecosystem)
Manganese	mg/L	1.9	Model Water Conditions (aquatic ecosystem)
Mercury	mg/L	0.0002	Model Water Conditions (aquatic ecosystem)
Molybdenum	mg/L	0.034	Model Water Conditions (aquatic ecosystem)
Nickel	mg/L	0.011	Model Water Conditions (aquatic ecosystem)
Selenium	mg/L	0.01	Model Water Conditions (aquatic ecosystem)
Silver	mg/L	0.001	Model Water Conditions (aquatic ecosystem)
Uranium	mg/L	0.001	Model Water Conditions (aquatic ecosystem)
Vanadium	mg/L	0.01	Model Water Conditions (aquatic ecosystem)
Zinc	mg/L	0.008	Model Water Conditions (aquatic ecosystem)

In-stream Sediments

For the purpose of the South Walker Creek Mine REMP, the default guidelines presented in the Revision of the ANZECC / ARMCANZ Sediment Quality Guidelines (Simpson et al. 2013) (Table 3.2), will be used as interim sediment quality guidelines to protect the EVs of the receiving environment. If the concentrations in the receiving environment are below this value, they can be considered to be low risk and no further action is required. If they are between the Trigger Value and 'SQG – High' values, or higher than the 'SQG- High' value, then further assessment of the results may be required (Simpson et al. 2013).

Table 3.2 Sediment Quality Guidelines for metals and metalloids (Simpson et al. 2013).

Parameter	Trigger Value (mg/kg)	SQG-High (mg/kg)
Arsenic	20	70
Bismuth	–	–
Boron	–	–
Cadmium	1.5	10
Chromium	80	370
Cobalt	–	–
Copper	65	270
Lead	50	220
Manganese	–	–
Mercury	0.15	1.0
Nickel	21	52
Selenium	–	–
Silver	1.0	4.0
Tin	–	–
Uranium	–	–
Zinc	200	410

– no trigger value available.

Biological Guidelines

There are prescribed biological WQOs for the Connors River catchment waters (moderately disturbed ecosystems) in the Isaac River Sub-basin (EHP 2013a) (Table 3.3). These guidelines are based on indices used to indicate current ecological health of a surveyed watercourse.

Table 3.3 Guidelines for biological indicators of water quality for the Upper Isaac River catchment waters (moderately disturbed) (EHP 2013a).

Indicator	Habitat	Biological WQOs
taxonomic richness	composite [a]	12–21
	edge	23–33
PET richness	composite [a]	2–5
	edge	2–5
SIGNAL 2 score	composite [a]	3.33–3.85
	edge	3.31–4.20

[a] Comprises all bed habitat within the site, including sandy pool, rocky pool, riffle, run and cascade

4 Environmental and Temporal Considerations for the REMP

Two environmental conditions are important for the South Walker Creek Mine REMP:

- periods of high rainfall where natural stream flow occurs (i.e. periods with adequate stream flow for authorised releases), and
- periods of rainfall where natural stream flow occurs but is not sufficient to enable releases (i.e. periods with inadequate stream flow for authorised releases).

The objectives and design of the monitoring program are the same for both of these conditions. Releases of mine-affected water will not occur when there is inadequate stream flow for authorised releases.

There are no temporal considerations for the REMP, such as seasonal considerations or planned changes to water release operations. Although rainfall in the region typically occurs during the wet season, there is no requirement for releases of mine-affected water or REMP sampling to be competed in this season. Releases and sampling may occur at any time of the year if there is sufficient rainfall.

5 Monitoring Program Design

5.1 Monitoring Program Components

The monitoring components of the South Walker Creek REMP are:

- hydrology
- water quality
- sediment quality
- aquatic habitat, and
- macroinvertebrates[2].

These monitoring components will be used to assess potential impacts to the EVs of the receiving environment through comparisons with specified guideline values (Table 3.1 and Table 3.2) and multivariate statistical analyses for macroinvertebrates (see Appendix B). Impacts to aquatic habitat will be assessed using on-site observations and comparisons of riverine bioassessment scores between receiving environment and background sites.

5.2 Monitoring Sites

Water quality, sediment quality, aquatic habitat and macroinvertebrates will be monitored at ten sites, to a distance of 15 km downstream of licensed discharge point RP4 (Table 5.1). Receiving environment monitoring sites will be used to determine the spatial extent of impacts from the discharge of mine-affected water, if required. Five background sites (i.e. sites upstream of the receiving environment that are not influenced by mining or other major urban or industrial activity) will be monitored.

The background sites serve as spatial controls in the sampling design. It is acknowledged that the background sites are not in pristine condition and are influenced by surrounding and upstream agricultural land uses (primarily dryland grazing). However, as explained in the QWQG, background sites that represent 'reference' condition are difficult to locate, and the least disturbed background sites can be used to provide best available reference

[2] Note that macroinvertebrates were selected as the indicator group to assess impacts to biological communities as they response rapidly to environmental change and can be sampled quantitatively in a short period of time to enable robust statistical analysis.

condition data. In this case, they enable the assessment of impacts from the mine in terms of departure from 'existing' condition. As mine discharges do not impact the background sites, they are considered appropriate for meeting the aims of the REMP.

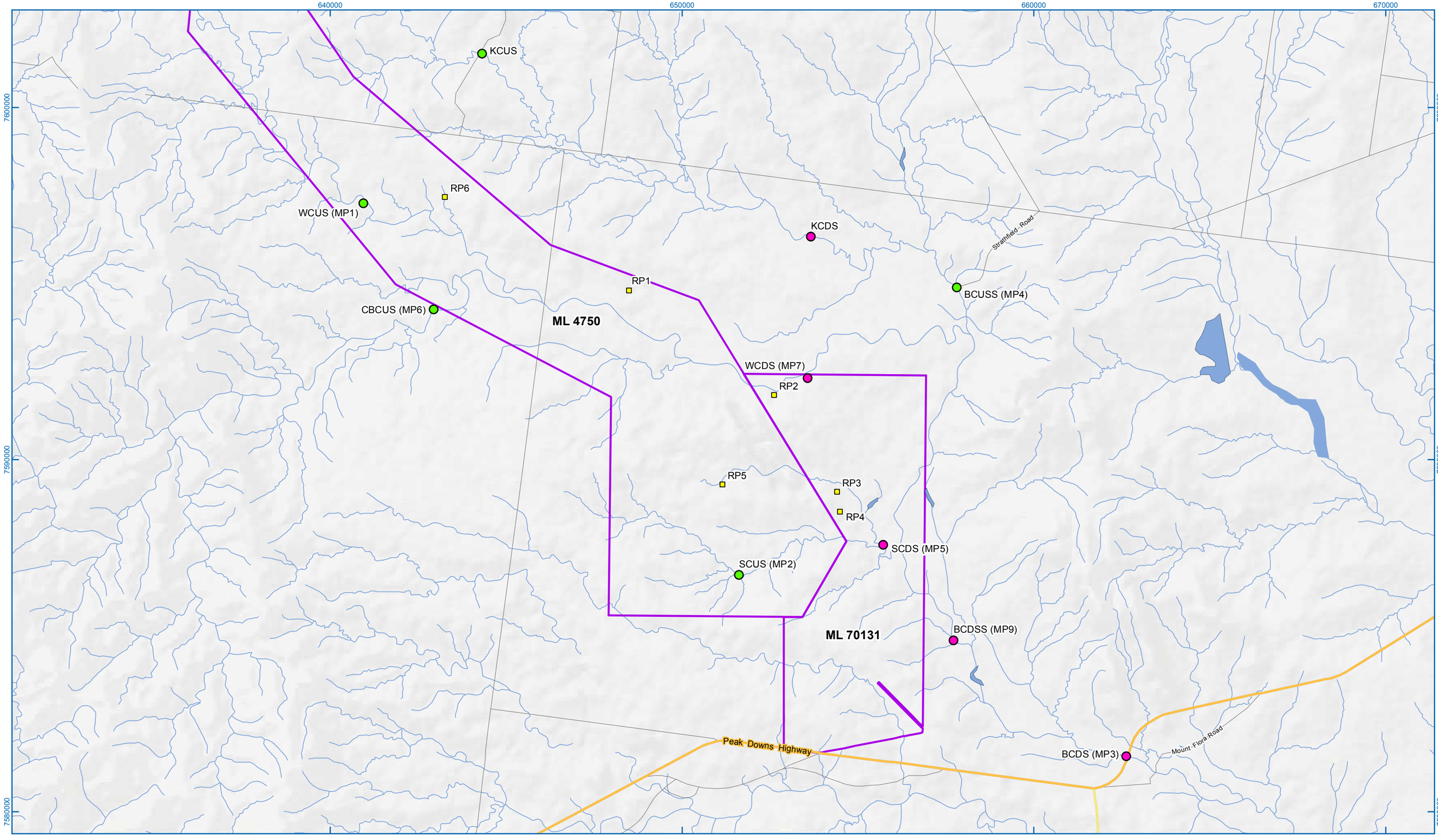
The site previously located on Bee Creek in Dipperu National Park has been removed from the REMP as there is restricted access and the aquatic habitat is considerably different to the aquatic habitat at other sites on Bee Creek (i.e. there are extensive areas of bedrock). The site located at the confluence of Walker Creek and Bee Creek has also been removed from the REMP as Walker Creek is frequently dry and the deposition of sand at the confluence prevents water from Bee Creek entering the confluence except in high flow conditions. The upstream site on Carborough Creek has been relocated to account for diversion works on Walker Creek.

Table 5.1 Location of monitoring sites for the South Walker Creek Mine REMP.

Site Code	Description	Easting [a]	Northing [a]
Upstream background sites			
SCUS (MP2) [b]	Sandy Creek upstream of South Walker Creek Mine activities	651 508	7 586 546
WCUS (MP1)	Walker Creek 4280 m upstream of confluence with Carborough Creek	640 840	7 597 098
CBCUS (MP6)	Carborough Creek upstream of South Walker Creek Mine activities	642 827	7 594 089
BCUSS (MP4)	Bee Creek 1500 m upstream of confluence with Walker Creek, at the Strathfield Road Crossing	657 697	7 594 712
KCUS	Kemmis Creek at St Albans	644 203	7 601 357
Receiving environment sites			
SCDS (MP5)	Sandy Creek downstream of release point and 1300 m upstream of the confluence with Bee Creek	655 609	7 587 404
WCDS (MP7)	Walker Creek downstream of release point, 130 m upstream from Hail Creek Mine railway spur	653 457	7 592 143
BCDSS (MP9)	Bee Creek immediately downstream of South Walker Creek Mine site	657 600	7 584 695
BCDS (MP3)	Bee Creek at Peak Downs Highway	662 516	7 581 402
KCDS	Kemmis Creek at Strathfield	653 549	7 596 153

[a] AGD84

[b] This site rarely contains water.



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South Walker Creek
Receiving Environment Monitoring Program Design

Map 1:
Monitoring sites

SOURCES

Document Path: Y:\Projects\2015\150404_BHP_SWC_REMP_Design\Mapping\Workspaces\150404_sitemap.mxd

LEGEND

Monitoring Site
- Upstream Background Site
- Receiving Environment Site
- Release Point
- South Walker Creek Mining Lease
- Watercourse
- Lake/Reservoir

Road Network
- Highway
- Main Road
- Local Road

N

SCALE

0 1 2 4
Kilometres

Scale: 1:100,032 @ A3

PROJECTION
Coordinate System: AGD 1984 AMG Zone 55
Projection: Transverse Mercator
Datum: Australian 1984

DATE
2016-09-12

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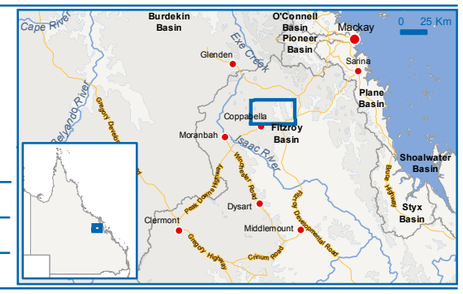

5.3 Sampling Methods

Hydrology

Rainfall data will be sourced from two monitoring stations at South Walker Creek Mine (one in the north and one in the south). Flow data will be sourced from monitoring stations at South Walker Creek Mine (Bee Creek upstream at Strathfield and Bee Creek downstream).

Flow velocity (measured as metres per second) will also be recorded at all sites using a portable flow meter during sampling for water and sediment quality, aquatic habitat and macroinvertebrates. The timed float method, described in the *Monitoring and Sampling Manual 2009 Version 2* (EHP 2013b), will be used where a flow meter is not available.

Water Quality

Water quality parameters will be monitored at each site once a year providing sufficient flow has occurred. Water quality will be measured in situ with a multi-parameter water quality probe for water temperature, pH, turbidity, dissolved oxygen and electrical conductivity.

Temperature, pH, turbidity, dissolved oxygen and electrical conductivity will be measured approximately 0.3 m below the surface of the water using a hand-held water quality meter that has been maintained and calibrated in accordance with the manufacturer's recommendations. Water samples for laboratory analysis will be collected as close to the mid-channel as possible (access dependent on safe conditions) at each site, 0.3 m below the water's surface, by hand or using a sampling pole.

Field sampling will be done by a suitably trained and competent person in accordance with Australian Standard (AS) AS5667 Water Quality Sampling, and the *Monitoring and Sampling Manual 2009 Version 2* (EHP 2013b). In summary:

- hand-held water quality meters will be calibrated before the commencement of sampling, checked on a daily basis (and recalibrated if necessary), and a calibration record kept
- hand-held water quality meters will be cleaned with tap water to remove mud etc. at the end of each field day
- powderless gloves will be used when collecting all water samples and care will be taken not to touch the inside of any sampling containers, or to place open bottles / jars or their lids onto the ground or other contaminated surfaces

- the container in which a sample is collected in (such as a bucket or bottle on a sampling pole) will be thoroughly rinsed three times with ambient site water to ensure it is not contaminated
- a field replicate and a field blank will be collected from one site during each sampling event, to assess sample handling procedures
- samples will be delivered to the laboratory within the appropriate holding times and holding conditions (as specified by the laboratory)
- a chain of custody form will be completed for all samples sent to the laboratory for analysis, and
- samples will be analysed by a NATA-accredited laboratory, and laboratory duplicates and blanks will be analysed in accordance with NATA-accredited protocols.

Additional water quality monitoring will be conducted in accordance with the EA using automatic logging stations (e.g. daily water quality monitoring of the release water during release and regular monitoring of storage ponds). The automatic logging stations will also measure H, electrical conductivity and turbidity hourly when the creeks are flowing.

Sediment Quality

Sediment quality will be assessed each site once a year by suitably qualified personnel. Where the water is shallow (< 0.8 m deep), a single sediment sample will be collected from the top 0.30 m of sediment using a stainless steel trowel, with the sediment transferred directly into the sampling jar provided by the analytical laboratory. Where the water is deep or the sediment is too soft to walk in, surface sediment (to 30 cm depth) will be collected using a stainless steel corer or Van Veen grab. The sample will be emptied into a bucket or other intermediate container, which has been thoroughly washed with ambient site water, and the sediment mixed and placed into the sample jar using a stainless steel trowel. Samples will be collected from an accreting bank, where possible.

Field sampling will be done by a suitably trained and competent person in accordance with *Australian Standard (AS) AS5667.1 Guidance on Sampling of Bottom Sediments*, and the *Handbook for Sediment Quality Assessment* (Simpson et al. 2005). In summary:

- powderless gloves will be used when collecting all sediment samples, and care taken not to touch the inside of any sampling containers, or to place open bottles / jars or their lids onto the ground or other contaminated surfaces

- sediment samples will be placed straight into the sample bottle wherever possible, and the bottles will not be rinsed prior to sample collection
- a field duplicate will be collected from one site during each sampling event, to assess within site variation
- samples will be delivered to the laboratory within the appropriate holding times and holding conditions (as specified by the laboratory)
- a chain of custody form will be completed for all samples sent to the laboratory for analysis, and
- samples will be analysed by a suitably qualified laboratory, and laboratory duplicates and blanks will be analysed in accordance with NATA-accredited protocols.

Aquatic Habitat

Aquatic habitat will be assessed once a year at each site by suitably qualified and trained aquatic ecologists.

Aquatic habitat characteristics will be described using AUSRIVAS protocols (DNRM 2001) and will include assessment of the following:

- substrate composition
- flow velocity, water depth and wetted width, noting if surface water is connected throughout the site or comprised of one or more disconnected pools in the channel
- channel morphology, including drainage pattern, bank height and slope
- physical habitat features, such as large woody debris, undercut banks, aquatic plants
- riparian vegetation condition and cover
- any notable disturbances at the site, including bank erosion, cattle access to waterway, barriers associated with nearby road crossings or dams, and
- other on-site observations, such as presence of filamentous or benthic algae, surface scums, unusual sediment deposits, or fish kills.

Each site will also be given a habitat assessment score using the River Bioassessment Program data sheet, which assesses nine habitat criteria:

- bottom substrate / available cover

- embeddedness (the amount of fine sediment surrounding larger substrate types)
- velocity / depth category
- channel alteration
- bottom scouring and deposition
- pool / riffle run / bend ratio
- bank stability
- bank vegetative stability, and
- streamside cover (DNRM 2001).

A photographic record of each site will be made.

Macroinvertebrates

Aquatic macroinvertebrates will be sampled by suitably qualified and trained aquatic ecologists at each site once a year.

At each site, three samples will be collected from the edge habitat following the standard Queensland AUSRIVAS methodology with respect to habitat selection and sampling technique (DNRM 2001, DERM 2009). As noted in the *Monitoring and Sampling Manual 2009 Version 2* (EHP 2013b), the sampling protocol used should be based on the objectives of the monitoring program, and may need to include replication in the sampling design. To reliably detect impacts associated with the release of mine-affected water, a sampling design that is statistically robust, and spatially and temporally replicated, is required. Replicated sampling enables a more rigorous analysis of the variability within and between sites than the standard AUSRIVAS method, which is essential to determine whether the mine discharge is impacting macroinvertebrate communities within the receiving environment.

Each sample will be collected by disturbing a 10 m length of substrate and edge habitat, and sweeping a standard triangular-framed dip net with 250 µm mesh through the disturbed area over a two-minute period. The samples will be preserved in the field in accordance with Queensland AUSRIVAS protocols or transferred to appropriate screw-cap jars, transported to a laboratory for sorting and identification.

Samples will be identified to the lowest practical taxonomic level (in most instances family) and counted, to comply with AUSRIVAS standards and those described in Chessman (2003).

Field sampling will be completed by aquatic ecologists that are experienced in sampling ephemeral waterways. Enumeration and identification of macroinvertebrate samples will be done by trained aquatic ecologists. Sorting, enumeration and data entry will be cross-checked by a second ecologist for 10% of the samples. An error rate of > 10% will be considered unacceptable (DERM 2009), and will result in a further 10% of samples being checked by a second ecologist, until no more errors occur.

5.4 Monitoring Schedule

The monitoring schedule for the South Walker Creek Mine REMP is presented in Table 5.2. The complete monitoring schedule applies when flow in Bee Creek is sufficient for an authorised release of mine-affected water, and a release occurs.

Where the release of mine-affected water does not occur (i.e. if there is insufficient rainfall or flow, or the mine elects not to release), there is no risk to the receiving environment from the release of mine-affected water. As such, in years where no mine-affected water is released, REMP sampling is not required.

The REMP includes a provision for a reduced sampling program to collect baseline data in years where there are no releases. This reduced baseline monitoring program is included in the REMP schedule, but will be completed at the discretion of BMC. If undertaken, the reduced background monitoring program will comprise sampling at two background sites (WCUS and BCUSS) and two receiving environment sites (BCDS and BCDSS). If any of these sites are dry at the time of the survey, an appropriate alternative site that contains water will be sampled, where possible. Alternatively, the REMP monitoring may be completed as scheduled and the data used to provide baseline information to the natural condition at all sites in the post-wet season. The collection of this baseline information will allow more robust statistical analyses to determine if there is an impact due to mine-affected water in years where releases do occur.

5.5 Quality Assurance and Quality Control

The REMP will be certified and undertaken by suitably qualified personnel. The monitoring, analysis and reporting will have regard to the procedures and quality assurance / quality control (QA/QC) requirements set out in this design document and in the following documents:

- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ 2000b);

- Monitoring and Sampling Manual 2009 Version 2, Environmental Protection (Water) Policy 2009 (EHP 2013b)
- AS 3778.3.1 Measurement of Flow in Open Channels
- Sustainable Rivers Audit physical habitat methodology (MDBC 2004)
- Australian / New Zealand Standard AS5667.1 Water Quality – Sampling
- AS/NZ5667.12 Guidance on Sampling of Bottom Sediments
- Handbook for Sediment Quality Assessment (Simpson et al. 2005), and
- Queensland Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual (DNRM 2001).

Review of the monitoring program methods and sampling and analysis will be carried out on an annual basis to ensure consistency of procedures and integrity of results and standardized interpretation of results.

Table 5.2 REMP Monitoring Schedule for South Walker Creek Mine.

Monitoring Components	Parameter	Monitoring Sites	Monitoring Frequency
Hydrological			
Stream flow	Depth	At sites that have automatic monitoring stations	Hourly during flow
	Flow velocity to support biological monitoring	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March)
Water Quality			
Physical parameters	pH, electrical conductivity, turbidity	At sites that have automatic monitoring stations	Hourly during flow (pH, electrical conductivity and turbidity only)
Physical parameters	Temperature, pH, electrical conductivity, turbidity, dissolved oxygen, total suspended solids	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March), and at other times in accordance with the EA
High risk parameters (excluding physical parameters)	sulfate, aluminum, iron	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March), and at other times in accordance with the EA

Monitoring Components	Parameter	Monitoring Sites	Monitoring Frequency
Moderate risk parameters (excluding physical parameters)	Nitraite, arsenic, chromium, copper, molybdenum, zinc, TPH (C6–C9)	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March), and at other times in accordance with the EA
Low risk parameters (excluding physical parameters)	Total suspended solids, total dissolved solids, sodium, fluoride, ammonia, nitrite, oxides of nitrogen, boron, cadmium, cobalt, lead, manganese, mercury, nickel, selenium, silver, uranium, vanadium, BTEX, cyanobacteria, TPH (C10–C14, C15–C28 and C29–C36)	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March), and at other times in accordance with the EA
Sediment Quality			
Metals and Metalloids	Ammonia, aluminium, copper, uranium, chromium, iron, lead, manganese, nickel, vanadium and zinc	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March)
Aquatic Habitat			
Aquatic habitat	On-site observations of habitat characteristics Riverine bioassessment score	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March)

Monitoring Components	Parameter	Monitoring Sites	Monitoring Frequency
Biological			
Macroinvertebrates	Aquatic macroinvertebrates identified to Family or the lowest practical taxonomic level	Background sites: WCUS, SCUS, CBCUS , and BCUSS Receiving environment sites: BCDS, SCDS, WCDS, MP8 and BCDSS	Once a year after substantial rainfall, notionally in the early post-wet season (February to March)

5.6 Assumptions and Qualifications

The proposed monitoring locations have been determined based on the location of existing monitoring sites to allow for comparisons with baseline / current condition.

It is likely that sites located at road crossings are impacted by the presence of the road, and this will be taken into account when analysing the data. However, sites located away from public roads or well-established tracks will not be accessible during wet conditions due to the risk of vehicles becoming bogged. Locating some sites at public road crossings is necessary to ensure that they are safely and easily accessible at almost all times of the year. Wherever possible, sites will be sampled upstream of road crossings.

Although REMP sampling is scheduled to occur after substantial rainfall, due to the ephemeral nature of waterways in the receiving environment and the unpredictability of rainfall in the region, the likelihood of sites being dry at the time of sampling is high.

Flooding waterways (e.g. when water overtops the upper bank of the channel) will not be sampled for safety reasons and due to the very high variability in water quality during these periods.

6 Data Analysis and Reporting

6.1 Data Entry and Preliminary Analysis

Water quality data will be entered into a database (e.g. Microsoft Excel or similar), and reviewed weekly by South Walker Creek Mine during release events, and by suitably qualified persons each year. This review will include comparisons of water quality at each site to the interim WQOs nominated in Section 3.3 (in accordance with the methods outlined in Section 5 of the QWQG), and initial comparisons between receiving environment sites and background sites. Where this review indicates that water quality in the receiving environment may have been impacted by a discharge event, the results will be investigated in more detail according to the methods in Section 6.2.

Sediment quality data will be entered into a database (e.g. Microsoft Excel or similar) and the results reviewed after each sampling event. This review will include comparisons of sediment quality at each site to the interim sediment quality guidelines nominated in Section 3.3, and initial comparisons between the receiving environment sites and the background sites. Where this review indicates that there may have been an impact to sediment quality in the receiving environment from a discharge event, results will be analysed in more detail according to the methods in Section 6.2.

Aquatic habitat information, including riverine bioassessment scores, will be entered into a database, and photographs will be electronically archived. Site photographs and habitat bioassessment scores will be compared with those from previous surveys and years at each site, and recorded habitat characteristics (e.g. presence of bed or bank erosion, algal blooms, unusual sediment deposits) will be used to qualitatively assess impacts relating to the release of mine-affected water. Any negative impact to aquatic habitat will trigger an investigation of release events, if any, to determine whether the releases could have affected downstream habitat. This may include additional sampling (e.g. samples of chlorophyll-a and blue-green algae if surface scums are noted) and more detailed analysis of results in accordance with the methodology outlined in Section 6.2.

Macroinvertebrate data will be entered into a database (e.g. Microsoft Excel or similar) at the completion of laboratory processing and indices will be calculated (taxonomic richness, PET richness and SIGNAL 2 scores; see Appendix B for a description of these indices). Indices will be compared to biological WQOs as well as between the receiving environment sites and the background sites. Where this review indicates macroinvertebrates in the receiving environment may have been impacted by a release of mine-affected water, the results will be investigated in more detail according to the methods in Section 6.2.

Fish kills that do not appear to be related to the natural drying of pools (i.e. in the order of 10 – 100 dead fish during flows or immediately after the cessation of flows) will be noted and reported to the Queensland Department of Environment and Heritage Protection. Investigation into possible causes of a fish kill will be commissioned and completed by a suitably-qualified aquatic ecologist. The investigation may include a review of water and sediment quality data collected prior to the incident and sampling of live fish for diagnostic laboratory examination (as fish that are found already dead are usually of little value for laboratory examinations), as outlined in the *Monitoring and Sampling Manual 2009* (EHP 2013b).

6.2 Detailed Statistical Analysis

Water and Sediment Quality

Where triggered by the preliminary analyses described above, further statistical analyses will be completed to determine if there has been a significant impact to water or sediment quality from any releases of mine-affected water.

Macroinvertebrates

Where triggered by the preliminary analyses as described above, further statistical analyses will be completed to determine whether there has been a significant impact to macroinvertebrate communities from any releases of mine-affected water. The analysis will include data from before each discharge event and data from background sites.

Multivariate data analyses can provide information on the similarities in the entire community structure between locations, and on temporal changes in assemblage. If required, analyses may be used to correlate macroinvertebrate data with sediment and water quality data, to determine if any water and sediment quality parameters are influencing macroinvertebrate community structure. This may indicate whether contaminants released with mine-affected water have impacted on macroinvertebrate communities in the receiving environment.

6.3 Spatial and Temporal Controls

The background sites in the REMP design are spatial controls; that is, data from these sites will enable ‘natural’ trends to be separated from those that may have been caused by the release of mine-affected water. Temporal controls in the REMP design include the

proposed frequency of sampling, which takes into account the expected temporal variation of the various indicators being monitored. Data collected in the absence of any releases of mine-affected water (i.e. at receiving environment sites) also provides a temporal control.

6.4 Reporting

An annual REMP report for South Walker Creek Mine will be prepared each year after completion of the survey. The report will:

- synthesise monitoring data for the reporting period, including:
  - water quality data collected during all release events over the previous 12 months
  - water quality data collected during the REMP sampling event
  - sediment quality data collected during the REMP sampling event
  - aquatic habitat characteristics and riverine bioassessment scores for the REMP sampling event, and
  - macroinvertebrate data collected during the two REMP sampling events
- provide an assessment of any impacts to the EVs of the receiving environment associated with the release of mine-affected water, which may include recommendations for further monitoring or assessment, and
- provide recommendations regarding changes to the monitoring design, and any changes that are required.

If any additional surveys are required due to non-compliance or unscheduled release of mine-affected water, then this data will also be included in the annual REMP report.

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Appendix A Overview of the Proposed Data Analyses

Macroinvertebrate Indices

A number of macroinvertebrate indices are effective indicators of ecosystem health (EHMP 2004). Use of multiple indices contributes to the robustness and reliability of any assessment. The following indices have all been found to be effective indicators of ecological health (EHMP 2004) and will be used as indicators in the REMP.

Taxonomic Richness

Taxonomic richness is the number of taxa (typically families) in a sample. Taxonomic richness is the most basic and unambiguous diversity measure, and is considered to be among the most effective diversity measures. It is however, affected by arbitrary choice of sample size. Where all samples are considered to be of equal size, taxonomic richness is considered to be a useful tool when used in conjunction with other indices. Richness does not take into account the relative abundance of each taxa, so rare taxa have as much 'weight' as common ones.

PET Richness

While some groups of macroinvertebrates are tolerant of pollution and environmental degradation, others are sensitive to these stressors (Chessman 2003). The Plecoptera (stoneflies), Ephemeroptera (mayflies), and Trichoptera (caddisflies) are referred to as PET taxa, and they are particularly sensitive to disturbance. There are typically more PET families in sites with good habitat and water quality than in degraded sites, and PET taxa are often the first to disappear when water quality or environmental degradation occurs (EHMP 2007). The lower the PET score, the greater the inferred degradation.

SIGNAL 2 Scores

SIGNAL (Stream Invertebrate Grade Number — Average Level) scores are also based on the sensitivity of each macroinvertebrate family to pollution or habitat degradation. The SIGNAL system has been under continual development for over 10 years, with the current version known as SIGNAL 2. Each macroinvertebrate family has been assigned a grade number between 1 and 10 based on their sensitivity to various pollutants. A low number means that the macroinvertebrate is tolerant of a range of environmental conditions,

including common forms of water pollution (e.g. suspended sediments and nutrient enrichment).

SIGNAL 2 scores are an index of macroinvertebrate communities that gives an indication of the types of pollutants and other physical and chemical factors affecting a site, that is also weighted for abundance, so that the relative abundance of tolerant or sensitive taxa can be taken into account (instead of only the presence / absence of these taxa). The overall SIGNAL 2 score for a site is based on the total of the SIGNAL grade (multiplied by the weight factor) for each taxa present at the site, divided by the total of the weight factors for each taxa at the site.

Low SIGNAL 2 scores indicate low abundance of moderately sensitive taxa and a high abundance of tolerant taxa, which in turn is indicative of poor habitat quality. In contrast, a high SIGNAL 2 score indicates moderate to high abundance of sensitive taxa, which is indicative of good habitat quality (Chessman 2003).

Multivariate Analyses

Multivariate statistical techniques are widely used in ecology to assess the similarities / relationships between communities. Whereas univariate analyses can only compare one variable at a time (e.g. an index of community structure such as a diversity index, or a single indicator species), multivariate analyses can compare samples based on the extent that communities share particular taxa and the relative abundances of each taxa (Clarke & Warwick 2001).

Ordinations are particularly useful tools for analysing, and visually presenting, differences among communities. Ordinations are maps of samples, in which the placement of samples on the map reflects the similarly of the community to the communities in other samples (Clarke & Warwick 2001). Distances between samples on an ordination attempt to match the similarities in community structure: nearby points represent communities with very few differences; points far apart have very few attributes in common (Clarke & Warwick 2001).

The first step of multivariate analysis usually involves the creation of a similarity or dissimilarity matrix, which incorporates the creation of a triangular matrix of similarity coefficients, computed between every pair of samples. The coefficient is usually a measure of how close the abundance levels are for each species (defined so that 100% = total similarity and 0% = complete dissimilarity). While there are a number of metrics used, the Bray-Curtis coefficient is commonly used to convert biological data (i.e. abundances of different taxonomic groups) into a similarity matrix (Clarke & Warwick 2001).

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